



# Paddy Stubble Burning in Punjab: An Architect of Breathing Woes

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**Abstract:** Crop residue burning (CRB) is a persistent issue in north India, every year it engulfs the whole of North India in its fumes. CRB results in severe negative aftermaths on both human health and the environment especially now when the Covid-19 pandemic is so rampant to cause respiratory distress. The current study was being conducted to assess the state of crop residue burning in Punjab. The research was based on secondary data from the Punjab Remote Sensing Centre, which spans the years 2016 to 2020. During the *Kharif* season, the number of stubble-burning cases decreased from 81042 to 71081 (a decrease of about 13 percent) from 2016 to 2020. This dwindling trend in cases is a good sign for environmental conservation. There has been an increase of 25% in stubble burning during the Rabi season from 2016 to 2020, incidences of stubble burning have reached an all-time high in the last five years, even during the widespread Covid 19 outbreak and may be because of labour shortages during Covid-19. The farmers who had previously embraced good crop residue management methods may resort to burning fields in the coming rice harvesting season due to additional challenges which exacerbating the problem. The government should focus on subsidizing crop residue technologies and effective behavior change approaches to tackle the problem unanimously with the help of farmers themselves. The study recommends mandatory diversification of the cropping cycle on a minimum acreage basis, shift to early-maturing rice varieties as PAU suggested, and making paddy residue management technologies like happy seeder and super seeder widely available. Farmers should be incentivized accordingly for good agricultural practices rather than punished for burning.

**Keywords:** Covid-19, Crop residue burning, *Kharif* and *rabi* season

Historically Punjab is an agrarian state and largest contributor of food grains to the central pool. Out of total operational holding, a significant chunk of whopping, i.e., 28 lakh hectares under wheat and paddy cultivation in the state. Of which a total of 47.2 lakh t of straw is generated every year. This included 25 lakh t of wheat straw and 22 lakh tones of paddy straw. Out of this 95 per cent of paddy straw and 25 per cent of wheat straw is burnt each year. The mechanized harvesting of these crops further adds to the quantity of residue. At the time of manual harvesting, the straw is chopped into small pieces and ploughed back into the soil to improve its content. Though a ban was imposed on stubble burning by the state government way back in 2005, the practice is still going on due non-implementation of the ban. The problem has been highlighted by the United States National Aeronautics and Space Administration (NASA), and the Supreme Court of India has also taken a serious note of it, but for two major reasons. Firstly, stubble burning is only responsible for a fraction of the overall pollution, and it occurs for less than a month. Secondly, it is less a matter of environmentally unfriendly farmers and more government inaction. This utterly predictable annual phenomenon is not manageable at the farmer level as the infrastructure to care for paddy residue is not commonly and economically available. On a positive note, this does seem to be changing. Farmers in Punjab (and, to a lesser extent

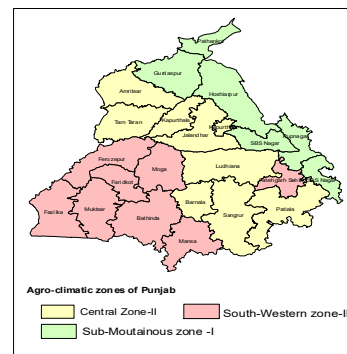
Haryana) grow a significant share of India's cereals. There are many policy reasons for this, including the electricity pricing policy and the government's minimum support price scheme that favors cereals. This means that rice paddy farmers dominate Punjab's agriculture and they also grow wheat in the winter months. The time window between harvesting the paddy crop and planting the wheat crop is just 10 to 20 days in late October–November. Delay in sowing would risk compromising on the yield of the wheat crop, while planting the paddy crop earlier would entail suboptimal utilization of monsoon rains and consequently greater reliance on scarce groundwater. Therefore, the farmer cannot lengthen this time window and has to speedily dispose of the leftover residue by the combined harvesters before sowing the wheat crop. Burning has been the traditional go-to option for farmers in North India (especially in Punjab); it is easy and costless, unlike alternative means of disposal. While the agricultural residue could serve as an excellent fuel source for biomass power plants, these power plants are costly to set up and are few and small in capacities; they are currently capable of utilizing less than 5 per cent of the 20 million t of paddy residue generated annually (Gupta 2019). Baling is also not a farmer-friendly practice, but the transportation costs are high, and the open market price of bails of paddy residue is too low to be economically feasible.

Fortunately, there are solutions, and among them, a viable, affordable and scalable technological solution has become particularly attractive in the past several years. An innovative machine called the Happy Seeder cuts and lifts the rice straw and then leaves it as mulch over the field even as it plants the wheat seeds. Generally, it increases yields (Sidhu et al 2015), and profitability is higher than other disposal alternatives. These alternatives include other machines and the traditional practice of residue burning (Shyamsundar et al 2019). It is estimated that 35,000 Happy Seeders would be enough to cover the entire crop area responsible (Gupta 2019). Despite these advantages, the uptake has been somewhat limited. Barriers to the adoption of Happy Seeders include high upfront cost of purchase, high and variable cost of rental and lack of farmer awareness. The number of Happy Seeders manufactured was also unable to keep pace with increasing sales. These problems are finally being addressed: a substantial government subsidy is available for purchase, the state government is actively promoting Happy Seeders, and manufacturing facilities are being expanded. Thousands of Happy Seeders are now expected to join the agricultural workforce each year. Even biomass power plants may receive game-changing fresh investments to produce thousands of megawatts of electricity (IANS 2019). Farmer support for them had already been picking up, with some farmers even paying for the baling process and transportation, thus adding to the double whammy of cost and convenience (Krur 2018). Not all farmers could be expected to bear residue disposal costs altruistically. Many also mistakenly believe that burnt residue contains soil nutrients. Given that the cost of moving to alternatives is non-zero and that traditional practices are entrenched, the threat of legal enforcement may be needed as a motivating factor. Yet, it is insensitive to do that at present, when farmers realistically have no immediate alternative. This is justifiably making them angry (Khanna 2019). The Supreme Court's directive of providing farmers Rs. 100 (\$1.5) per quintal of residue is insufficient for proper disposal. Nevertheless, it does seem that a combination of Happy Seeders and biomass power plants would solve the stubble burning problem in the next several years, at least in Punjab. The lessons learnt need to be implemented actively in India because many kinds of stubble are regularly burnt across the agricultural landscape. Agricultural waste burning is not benign, not in India and not elsewhere. Brazil, for example, suffers from the health consequences of post-harvest sugarcane fields set on fire (Rangel and Vogl 2016). Still, its contribution must be understood in context; a study found that burning all the agricultural wastes of the San Francisco Bay Area for one year would still emit less pollution than one day of traffic in the

same area (Darley et al 2012). The Bay Area has far lesser vehicles than the National Capital Region of India. So, while residue burning could account for a significant portion of Delhi's pollution on certain days (Gandhiok 2018), the primary problems lie elsewhere. Instead of Delhi's reactive strategy of undertaking short-term emergency measures on pollution only after it crosses unbearable thresholds, there is a need for a predictive strategy as followed successfully in Beijing. However, the changing pattern of agriculture and usage of machines at the time of harvesting as less numbers of labourers, and many more reasons are associated with the problem of crop residue burning. Amid, Covid-19 pandemic raging around the world which is known to affect the lungs and cause respiratory distress, cases of wheat crop residue burning are not quashed in Punjab. Crop residue burning (CRB) is a solemn problem in north India, especially when the burning of stubble affects environmental pollution. The present scenario could be detrimental for Covid-19 patients with breathing problems. So, bearing in mind the seriousness of this problem, the present study was undertaken to check the status of crop residue burning in Punjab. Consequently, there is a need to study the current status of crop residue burning in the study area and scrutinize why farmers of this region burn crop residue.

## MATERIALS AND METHODS

The study is based on secondary data collected from the authentic online portal of Punjab Remote Sensing Centre (PRSC) for collecting the data related to stubble burning case in Punjab state from the period 2016 to 2020. For concise study, the Punjab state is divided into agro-climatic zone to have the depth picture of burning cases in the state. The division of state shown in Punjab map made by using ArcGIS software and for analysis of data descriptive tools are used to achieve the objective.

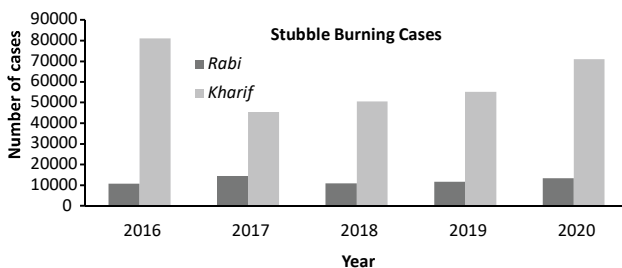


Agroclimatic zone of Punjab state

## RESULTS AND DISCUSSION

**Stubble burning:** There is large variability in the production of straw production, and their use which solely depend upon

the crop grown, cropping intensity and productivity in a different region of India (Singh and Sidhu 2014). Cereal crops (rice, wheat, maize, millets) contribute 70 per cent of the total crop residue (352 Mt), comprising 34 per cent of rice and 22 per cent of wheat crops. The rice-wheat system accounts for nearly one-fourth of the total residue produced in India. The amount of straw is calculated by the difference of total residue and the amount used for various purposes. Traditionally the surplus amount of crop residue is burnt on farm by the farmers instead of using it for some other purpose. In India, it is estimated that nearly 84 to 141Mt per annum of surplus stubble left in which cereal crops contribute more than 50 per cent and also observed 82 Mt of surplus crop residue, nearly 70 Mts (44.5 Mt rice straws and 24.5 Mt wheat straws) are burnt annually. But in the case of Punjab, 28 lakh hectares under wheat and paddy cultivation in the state, 47.2 lakh t of straw are generated every year. This included 25 lakh t of wheat straw and 22 lakh t of paddy straw. Out of this, 95 per cent of paddy straw and 25 per cent of wheat straw is burnt each year. The mechanized harvesting of these crops has further added to the quantity of residue (Kaur 2017). The current study recorded that the number of stubble burning cases has declined from 81042 to 55210, i.e., nearly 32 per cent, during the years 2016 to 2019 in Kharif season. This declining trend of crop residue burning cases is a favorable indicator in order to protect the environment of state. It is also considered as the reward for untiring initiatives taken by the government and agricultural university of the state. At the same, the results of instability have been shown an increase of CRB cases during the study period in Rabi season. It is almost maximum as compared to the last five years in Punjab state and that too in the times of widespread Covid 19 pandemic. At present, burning wheat straw means creating an excess of particulate matter in the air, which is harmful to people with respiratory illness (especially with Covid 19). The study elucidates that the residue left after the harvesting the wheat crop is far less in quantity as compared to paddy, still the farmers are burning it.



Source: Punjab Remote Sensing Centre, Ludhiana, (GOP 2020)

Fig. 1. Number of stubble burning cases in Punjab during Rabi and Kharif season

This trend can intensify in the coming paddy harvest season when farmers have to arrange for the sowing of the next crop in a rush amid a labour shortage in the current scenario of reverse labour migration.

In Punjab, stubble burning from the yearly rice-paddy harvest is a timeworn practice that the farmers have been doing for many decades. It emits particulate matter (PM10 and PM2.5), which are the leading causes of smog, affecting visibility and the most significant contributor to global warming after CO<sub>2</sub>, which aggravates the poor air quality in Punjab. Moreover, it also emits carbon monoxide (CO), volatile organic compounds (VOCs), ammonia (NH<sub>3</sub>) which are precursors to ground-level ozone layers and health problems for human beings. Many policies and research project has been framed to overcome this problem for past few years. Although, alternative technologies, practices have been launched time to time, yet farmers are reluctant to adopt that measure and still the rule of burning is persist (Gupta 2019). As per estimates, Punjab produces approximately 19-20 Mt of paddy straw and about 20 Mt of wheat straw in a year, in which about 85-90 per cent of this paddy straw is burnt in the field, and wheat straw is also being burnt during the harvesting of Rabi season (Singh et al 2019)

Due to the above-listed reasons, stubble burning becomes the most significant problem during *Kharif* season in the Punjab state. The number of cases of stubble burning has been declining during the *Kharif* season. Still, the highest declining rate is be associated with Zone I (-32.01%), followed by Zone II (-14.02%) and Zone III (-8.30%). In the case of Zone I, the number of burning cases are recorded more in the case of SBS Nagar (82.73%), followed by Rupnagar (63.18%) and Pathankot, which is 60.71 per cent. The sub mountainous zone of Punjab (Gurdaspur, Hoshiarpur, SAS Nagar, SBS Nagar, Pathankot and Rupnagar) is dominated by wheat-maize rotation. Due to this reason, the zone comprises less sown area under paddy, which further leads to fewer problems of residue burning. In the case of Zone II of Punjab, which is dominated by wheat-paddy cropping pattern and relatively more responsible for residue burning as compared to another two zones but now the number of cases of stubble burning is decreased from 38279 in the year 2016 to 32913 in the year 2020 due to various initiative provided by the government and concerned authorities. In case of Central zone or Zone II, the number of cases declined from year 2016 to 2020 is Jalandhar (52.43%), Ludhiana (47.89%) and Kapurthala (31.79%), while increasing trends were found in case of Amritsar (34.28%), and Tarn Taran, i.e. 23.87%. In Zone, i.e. South Western Zone of Punjab, the number of stubble burning cases declined but least compared to other Zones.

Fatehgarh sahib, Fazilika, Moga and Mukstar were the district that showed a declining trend in burning cases as compared to other districts in this Zone.

The wheat is the only crop that leads the farmers towards stubble burning during Rabi season, but wheat residue is not a big concern compared to paddy residue because it is used as dry fodder has good economic value. Farmers also earn money by selling it. That is why most of the wheat residue is used to make wheat straw in Punjab. Secondly, it does not take as much effort to clear the field as paddy field requires after making wheat straw. Even if this leftover residue is burned, it does not create as much pollution as paddy residue burning due to less quantity of residue and dry weather during harvesting. But still, stubble burning is a solemn problem in north India, especially when the burning of stubble

affects environmental pollution. The number of stubble burning cases was increased in all the three zones i.e., Zone-I (10.98), Zone II (12.26%) and Zone III (47.10 %), which still needs more attention of concerned agencies (Table 3). In Zone I, only Rupnagar district showed a slightly lower case of burning compared to other districts. While in the case of Zone II i.e. central Zone of Punjab, Patiala and Tarn Taran districts had shown a decline in burning trend. In the case of Zone III, Fatehgarh Sahib had shown a 36.07% decline trend in stubble burning cases. So to avoid the problem of crop residue or stubble burning cases during Rabi season, different steps should be taken to utilize the residue such as it can be used as fodder purpose, organic manure, power generation, mushroom cultivation, cattle shed construction, packaging, mat making and strawboard etc. Moreover, the

**Table 1.** Number of stubble burning cases in Punjab during *Kharif* season, 2016-2020

District	2016	2017	2018	2019	2020	% change from 2016 to 2020
Zone I						
Gurdaspur	1768	1185	1036	1497	1925	8.88
Hoshiarpur	709	378	175	316	399	-43.72
SAS Nagar	240	168	144	201	262	9.17
SBS Nagar	1100	547	256	279	190	-82.73
Pathankot	28	13	9	4	11	-60.71
Rupnagar	554	244	82	131	204	-63.18
Total	4399	2535	1702	2428	2991	-32.01
Zone II						
Amritsar	1788	999	1151	1510	2401	34.28
Jalandhar	3679	1543	1198	1627	1750	-52.43
Kapurthala	2369	1155	684	1422	1616	-31.79
Ludhiana	7697	3239	2481	2532	4011	-47.89
Patiala	4986	3829	3784	4212	5161	3.51
Sangrur	9556	6968	6862	7021	9357	-2.08
Tarn Taran	3619	2085	2420	3373	4483	23.87
Barnala	4585	2481	2735	3257	4134	-9.84
Total	38279	22299	21315	24954	32913	-14.02
Zone III						
Bathinda	7047	3693	5402	6036	6977	-0.99
Faridkot	3550	2277	2570	2545	3573	0.65
Fatehgarh Sahib	1862	1229	828	896	1338	-28.14
Fazilika	3063	1359	2181	1886	2080	-32.09
Firozpur	6036	3496	4924	5313	6616	9.61
Mansa	4405	3293	3596	3924	4564	3.61
Moga	7150	2200	3280	3267	5463	-23.59
Muktsar	5250	3003	4792	3961	4566	-13.03
Total	38363	20550	27573	27828	35177	-8.30

**Source:** Punjab Remote Sensing Centre, Ludhiana (GOP 2020)

Power and paper industries are now approaching to farmers for crop residue. Further, the stubble can also improve crop yield by 4–9% (Sood 2016) and is employed in biofuel generation (Singh et al 2016).

**Reasons for crop residue burning (CRB):** In Punjab, the major crop of them are paddy, wheat, cotton, maize, sugarcane, but the paddy is the dominant crop that leads to the problem of stubble burning. It might be due to straw left after the harvesting of wheat crop i.e. bhus a has an alternative use such as animal feeding and is also traded across districts. Moreover, the burning of wheat residue is unnecessary for the farmers because of the availability of technology and other alternative usage such as higher economic value as dry fodder. However, the residue left from rice cultivation is not used as fodder as it was non-palatable

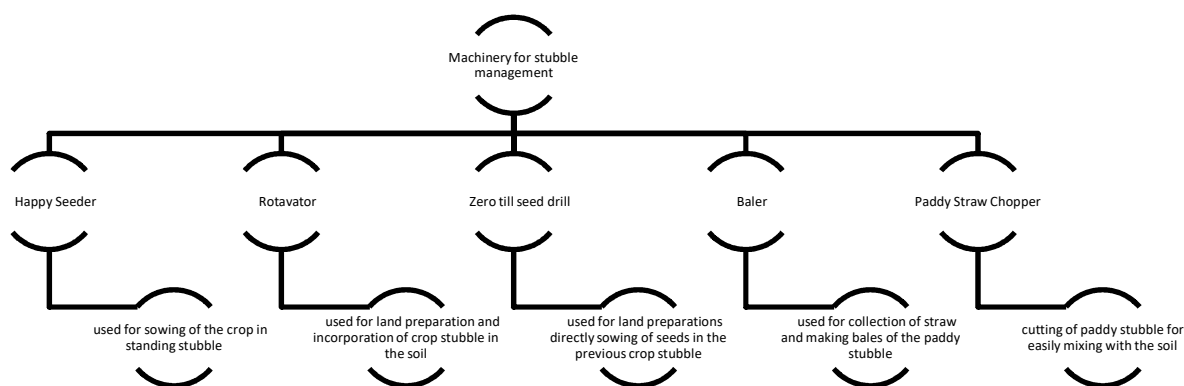
to animals due to its high silica content. Due to less economic value as animal feed and other general uses, farmers are forced to burn it on the field instead of incurring a high cost on collecting it. The further study also examined the various determinants that force farmers to burn paddy residue, i.e., use of a combine harvester, unavailability of paddy stubble machinery at a concessional rate in cooperative societies, and farmers producer organization. In addition to it, labour shortage at the time of harvesting and the costly process of cleaning the field after harvesting paddy crop are other vital determinants leading to crop residue burning cases in the study area. Another reason for CRB is the shortage of time (2-3 weeks) between harvesting paddy and sowing of wheat, which does not allow the farmers to perform the time-consuming operation of clearing the paddy straw from the

**Table 2.** Number of stubble burning cases in Punjab during *Rabi* season, 2016-2020

District	2016	2017	2018	2019	2020	% change from 2016 to 2020
Zone I						
Gurdaspur	896	1184	741	673	963	7.48
Hoshiarpur	364	541	340	263	434	19.23
SAS Nagar	29	92	28	93	36	24.14
SBS Nagar	160	274	150	172	193	20.63
Pathankot	132	217	121	111	138	4.55
Rupnagar	68	120	71	89	66	-2.94
Total	1649	2428	1451	1401	1830	10.98
Zone II						
Amritsar	949	1542	1027	1022	1147	20.86
Jalandhar	620	500	426	571	728	17.42
Kapurthala	469	495	442	441	536	14.29
Ludhiana	918	875	730	1035	1019	11.00
Patiala	412	456	530	518	407	-1.21
Sangrur	587	722	948	877	607	3.41
Tarn Taran	864	1753	770	875	851	-1.50
Barnala	261	434	417	479	408	56.32
Total	5080	6777	5290	5818	5703	12.26
Zone III						
Bathinda	577	831	772	797	1065	84.58
Faridkot	365	358	410	373	508	39.18
Fatehgarh Sahib	219	209	120	216	140	-36.07
Fazilika	401	405	322	532	560	39.65
Firozpur	856	1328	806	794	1059	23.71
Mansa	231	40	387	360	341	47.62
Moga	771	1151	760	724	1192	54.60
Muktsar	582	549	589	686	1022	75.60
Total	4002	4871	4166	4482	5887	47.10

**Source:** Punjab Remote Sensing Centre, Ludhiana (GOP 2020)

Reason	Reference
Shortage of labour and short window of time between paddy harvesting and paddy growing	Singh et al (2019)
High cost of paddy stubble management technology, non-availability of stubble management technology with co-operatives	Sandhu et al (2019)
Late-maturing basmati rice varieties	Iqbal et al (2002)
Lack of buyers, shortage of time for next crop, lack of assistance by the state government and labour shortage	Kaur (2017)
Discontinuing of its traditional uses (animal feed, fodder, fuel, roof thatching, packaging and composting)	Yadav et al (2017)



field. Moreover, the higher price of diesel, costly farm equipment, and machinery used in removing the field add an extra burden to the farmers. Whereas the wheat straw and fodder crops mostly meet the requirement of dry fodder for livestock. Further sowing of wheat by ploughing paddy stubble in the soil also leads to various problems. A high silicon dioxide content (SiO<sub>2</sub>) in paddy straw resists its decomposition when retained in the soil for the next crop. While observing the present situation of Punjab, shortage of labour (especially during Covid-19 times) could be another added big cause. Labour shortages due to the reverse migration of labour amid the present pandemic will further inflate the process of ploughing crop residue in the field. There will be a dearth for available labour in this situation, and wages will rise from Rs 600-700 from Rs 400-500 presently.

**Solutions to the burning problem:** In 2014, the central government released the National Policy for Management of Crop residue. Since then, crop residue management has helped make the soil more fertile, resulting in savings of Rs 2,000/hectare from the farmer's manure cost. Farmers can also manage crop residues effectively by employing agricultural machines like:

The various government initiatives that have been taken by both state and center government are as follows:

- To overcome the problem of stubble burning, the government established custom hiring centers and undertook Information Education and Communication (IEC) activities. At the same time, the state government had released funds of Rs 269.38 crores in 2018-19 and

Rs 273.80 crore in 2019-20 for the distribution of in-situ crop residue management machinery to the farmer's subsidy (Anonymous (2018)).

- The burning of crop residue was considered a legal offence under the Air Act of 1981, the Code of Criminal Procedure, 1973 and various appropriate Acts.
- National Green Tribunal (NGT) funds had released funds within the sanctioned budget for Sub Mission on Agricultural mechanization (SMAM).
- In order to create awareness about its effects on the environment and human health, the government of Punjab has launched three mobile apps developed by Punjab Remote Sensing Centre (PRSC). These are i-Khet Machine for facilitating farmers access to the agriculture machinery, e-PEHaL for monitoring tree plantation and e-Prevent to have prompt and accurate information about incidents of crop residue burning (Anonymous 2020).

Crop residue is a scorching topic at present and also the situation of covid-19 pandemic adds oil to the fire, especially during paddy harvesting. There is no doubt that smoke from CRB affects people's health, road safety and the environment. This study concluded that the number of stubble burning cases had declined year to year in Punjab. But still, it is a matter of consideration that in light of current labour scarcities during covid-19 the farmers who had earlier adopted good management practices of crop residue could also go for burning of crops in the coming season of paddy harvesting due to added problems to their plate which will intensify the problem of

CRB plus add to the throbbing pain of Covid19patients.Labour shortages due to reverse migration of labour amid the present pandemic will further make ploughing crop residue in the field costly. There will be a shortage for available labour in this situation and wages are bound to rise to Rs 600-700 from Rs 400-500 presently. Therefore, there is a need for higher authorities to take early precautionary steps to control their menace in the coming season plus nudge the awareness among farmers to take anticipatory measures to monitor the burning of crop residue in coming 2020-21 season.

### CONCLUSIONS

The study regarding the comparison between the years 2016 and 2020 reveals that there is a decrease in the burn area for all zones of Punjab state, respectively. These results are promising and show that remote sensing data may be used to estimate and detect stubble burning. Although stubble burning has decreased, the percentage decrease is significantly less. Hence it needs more policies and innovations to find a feasible solution. Make paddy residue management technologies widely available. A careful assessment of farm-level constraints, trade-offs, and viable business models is needed to widen the use of alternative machines. Shift to early-maturing rice varieties (such as those being developed by the Punjab Agricultural University) allow farmers more time to clear and prepare fields for sowing wheat. Raise farmer awareness through awareness campaigns to demonstrate better residue management practices, and rid farmers of misconceptions around practices and costs of alternative technologies. Punjab should break the wheat-rice rotation and diversify the cropping cycle in the medium and long term.

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