

Report | October 2026

Mitigating Stubble Burning in Haryana

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Survey Insights from 1500 Farmers





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Suggested citation:	Jain, Srishti, Kurinji Kemanth, Ayushman Saboo and Navjot Singh Sarao 2026. <i>Mitigating Stubble Burning in Haryana: Survey Insights from 1500 Farmers</i> . New Delhi: Council on Energy, Environment and Water.
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Cover images:	Ayushman Saboo/CEEW.
Peer reviewers:	Kofi Boateng, Senior Program Officer, Global Methane Hub; P. P. Krishnapriya, Affiliate, Duke University; Dr. Mohanasundari Thangavel, Associate Professor, Indian Institute of Technology, Indore; Rashi Singh, Bhamini Jain, and Ruchira Goyal, Programme Leads, CEEW.
Publication team:	Rhea Khanna (CEEW); Archana Chandrashekar (CEEW); Alina Sen (CEEW); Shreyas Sharma; Enseur, and FRIENDS Digital Colour Solutions.
Acknowledgments:	We express our sincere gratitude to Coefficient Giving for supporting this study. We thank all the stakeholders: officials from the Department of Agriculture and Farmers Welfare (Do-AFW), Haryana Renewable Energy Development Agency (HAREDA), and Chaudhary Charan Singh Haryana Agricultural University for their valuable inputs to the study. We acknowledge the NYAS Research team for executing the primary survey seamlessly and thank all farmers who participated in the study.
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Paddy residue being transported for use as animal fodder near Kaithal, Haryana.

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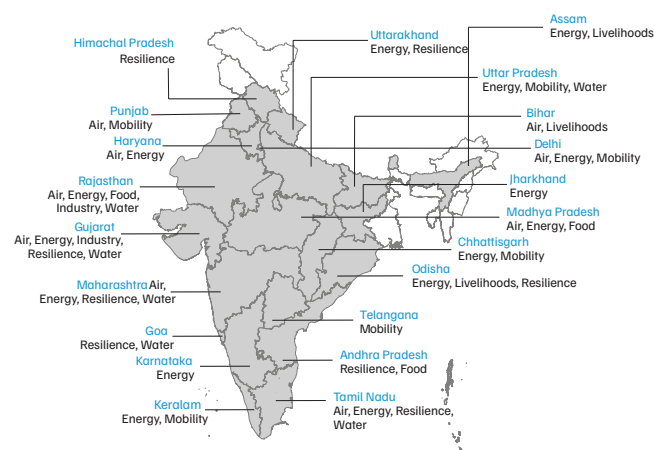
NATIONAL/INTERNATIONAL

2011 | National Water Resources Framework
2014 | 175 GW renewables target
2015 | International Solar Alliance
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2019 | India Cooling Action Plan
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2022 | Mission LiFE
2022 | National Bioenergy Programme
2022 | E-waste (Management) Rules
2023 | G20 Green Development Pact
2023 | National Green Hydrogen Mission
2024 | Green Steel Taxonomy
2024 | PM Surya Ghar Yojana
2025 | National Critical Mineral Mission
2025 | Rajya Sabha Guidelines on Crop Residue Burning
2025 | India's Carbon Credit Trading Scheme (CCTS)
2025 | IFSCA's Framework for Transition Bonds
2026 | Disaster Risk Index for 16th Finance Commission
2026 | India's NDC 3.0
2026 | India's Scenarios towards Viksit Bharat and Net Zero

STATE

2022 | Rajasthan Organic Farming Mission
2022 | Jharkhand State Solar Policy
2022 | Uttar Pradesh Vidyut Sakhi programme
2023 | Rajasthan Renewable Energy Policy and Green Hydrogen Policy, 2023
2023 | Uttarakhand Solar Policy
2025 | Green Odisha Initiative
2025 | Maharashtra Climate Action Plan 2.0
2025 | Delhi Clean Air Action Plan
2026 | Delhi EV Policy 2.0
2026 | Bihar Promotion of New and Renewable Energy Sources
2026 | Gujarat Integrated Renewable Energy Policy and Green Hydrogen Policy
2026 | Uttarakhand Mukhyamantri Saur Swarojgar Yojana
2024-26 | Directives of Commission on Air Quality Management
Net Zero Roadmaps (BH, GJ, TN, UK)
Agroforestry Roadmaps (AS, MH, OD)
140+ Heat Action Plans (GJ, MH, OD, TN)
Treated Used Water Reuse Plans (MH, UP)
Flood Risk Mitigation Plans (GJ, MH)

21 STATES SUPPORTED





Despite the availability of in-situ and ex-situ management methods, farmers continue to practice stubble burning

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Executive summary

Agricultural residue burning has evolved from a regional issue into a pan-India crisis amid rising cultivation costs, declining land productivity, and climate-induced stress. While historical hotspots like Punjab and Haryana remain central to the discourse, states including Madhya Pradesh, Uttar Pradesh, Telangana, and Rajasthan experienced a surge in farm fires during 2025 and 2026. Nationally, agricultural residue burning is responsible for an estimated 13 per cent of India's PM2.5 emissions (TERI 2021).

Recognising this, the Centre and several state governments launched circularity initiatives such as the *Crop Residue Management (CRM) Scheme*, the *GOBARDhan* scheme, 5–7 per cent mandated biomass pellet co-firing in thermal power plants, 20–50 per cent

mandated biomass co-firing in brick kilns, and others. The CRM scheme released INR 4,266.47 crore between 2018 and 2025 to key states, establishing over 43,500 Custom Hiring Centres (CHCs) and supplying more than 3.54 lakh CRM machines (PIB 2026a). Concurrently, state-led initiatives like Haryana's *Parali Protsahan Yojana* (PPY) offer direct cash incentives to farmers practising no-burn methods (DoAFW Haryana n.d.). While Haryana reported an ~90 per cent reduction in farm fires over the last five years, emerging evidence suggests a temporal shift in farmers' burning behaviour to late afternoon (~17:00 IST), to evade detection by polar-orbiting satellites (Singh et al. 2025, CAQM 2026a). This infers that the dip in fire numbers might be comparatively less drastic than reported.



CEEW researchers interviewing farmers on their crop residue management practices in Haryana (January, 2026).

To decode Haryana's CRM model and evaluate the on-ground efficacy of policy interventions, we conducted a state-level representative survey between January and March 2026. We employed stratified random sampling to sample 1,588¹ farmers across 12 districts—Ambala, Fatehabad, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, Panchkula, Rohtak, Sirsa, and Yamuna Nagar, which accounted for ~92 per cent of the total kharif fires between 2018 and 2024. **Readers should note that our analysis provides for weighted percentages, while the corresponding totals (in brackets) remain unweighted unless stated otherwise.**

Through this study, we seek to understand how CRM has evolved over the eight years of the scheme's existence, current trends, farmers' perspectives, and the state's future outlook, going beyond kharif to also include the growing concern over rabi residue management—of paddy and wheat residue, respectively.

Key findings

A) How do crop choices dictate farmers' residue management methods?

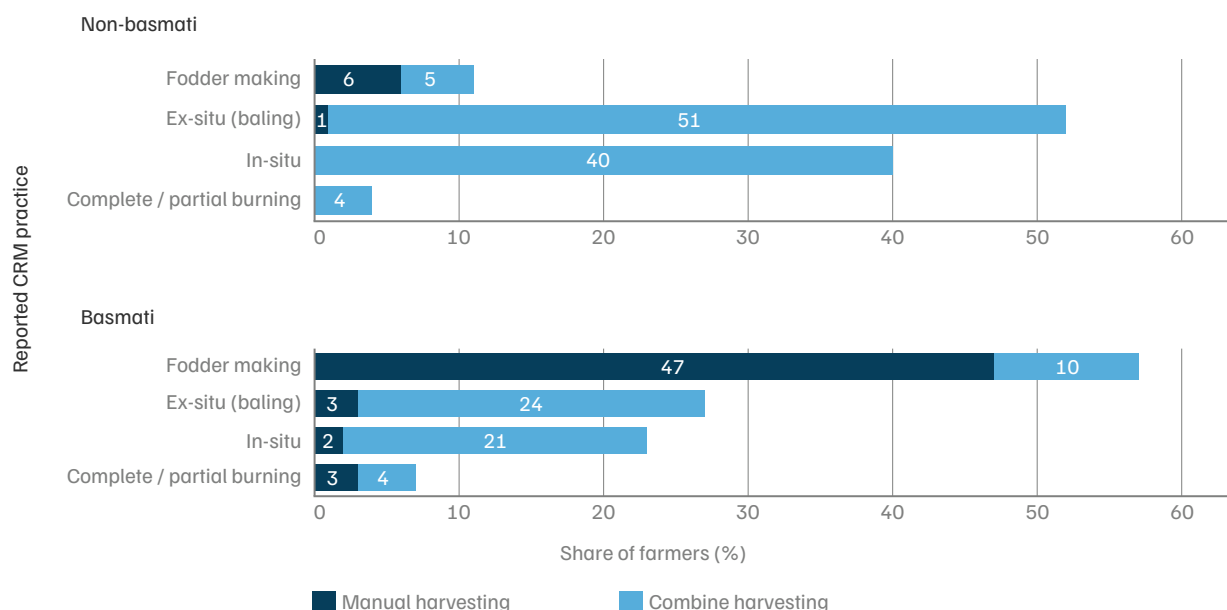
- **Comparable adoption across the three common CRM pathways in Haryana, with farmers often practising more than one.** 32 per cent of surveyed farmers use in-situ CRM machinery such as super seeders; 38 per cent opt for ex-situ management (baling); and 39 per cent use residue as fodder (n = 1,588). As farmers report more than one harvesting or management practice, shares do not sum up to 100 per cent. About 6 per cent also acknowledged complete or partial burning, though this figure is likely underestimated, as fear of penalties and social stigma introduces a degree of social-desirability bias into self-reported burning. A larger share—26 per cent of all farmers—reported burning incidents in their village, with ~77 per cent of them citing that burning is prevalent between 4 pm and 10 pm, corroborating the recently observed temporal shift in fire incidents (Singh et al. 2025, CAQM 2026a).

- **Non-basmati residue is baled or managed in-situ, while basmati residue serves as fodder.** Haryana's paddy landscape is split between basmati and non-basmati. According to our survey, 50 per cent of farmers grew basmati, 40 per cent grew non-basmati paddy, and 10 per cent grew both. While the decision to grow basmati is driven by soil and water suitability, along with its potential for export revenue, non-basmati paddy is chosen for its perceived price security through the minimum support price.
- **While non-basmati growers use combine harvesters, basmati farmers continue with manual harvesting for better grain recovery.** The majority of non-basmati farmers (93 per cent) use combine harvesters, while the straw is managed via baling (52 per cent) and in-situ management (41 per cent) (n = 972). On the other hand, more than half of basmati growers (57 per cent) follow manual harvesting, with the basmati straw used as cattle fodder (57 per cent) due to its lower silica content (n = 755), and for baling activities (27 per cent). Manual harvesting is common among basmati growers for its efficient straw collection and suitability for chaff cutters common in households, while combine harvesters consume less time and help avert labour shortages and high manpower costs.

We interviewed 1,588 farmers across 12 districts in Haryana to study their paddy and wheat CRM practices.

¹ Minimum sample size at a 3 per cent margin of error and 98 per cent confidence level is 1,502 farmers, for a population of 16,28,015 farmers in Haryana. Our final sample of 1,588 exceeds this by 5.7 per cent, to cover at least half of Haryana's districts, and to account for anticipated non-responses.

Figure ES1. Non-basmati residue is mostly baled or managed in-situ, while basmati residue primarily serves as fodder



Source: Authors' analysis

Note: Non-basmati (n = 972) & basmati farmers (n = 755). Farmers may report more than one CRM practice, so shares do not sum to 100%.

B) What are the emerging trends and cost drivers in in-situ CRM machine usage?

- **Super seeders have evolved from niche CRM machinery to the default wheat sowing machine.** 82 per cent of all in-situ CRM farmers (n = 587) rely on super seeders for residue management and wheat sowing. Interestingly, ~75 per cent of ex-situ farmers (n = 1,103) who removed residue through baling or for fodder use also used super seeders for wheat sowing, with seed drills relatively less common. Therefore, any disruption to super seeder availability through supply bottlenecks, price spikes, or breakdowns during peak rabi sowing season would affect the CRM practices of both in-situ and ex-situ farmers.
- **Cultural preference for visually 'clean' and smooth fields is changing the machinery use patterns.** 71 per cent of super seeder users (n = 475) and 62 per cent of Rotavator users (n = 77) run the machinery two or more times, with irrigation in between, for optimal residue decomposition and wheat germination, which ends up doubling the operational costs to INR 4,000-4,500 per acre. The ideal way is to operate combine harvesters fitted with Super Straw Management Systems, followed by a single pass of super seeders.

- **CRM rental behaviour is dominant among farmers.** 82 per cent of in-situ farmers rent machines, with 99 per cent of these rentals occurring through individual farmer networks rather than government-backed CHCs. This is because the state's priority has shifted to individual farmers in recent years, with no new CHCs set up since 2021–22. Given the Commission for Air Quality Management's (CAQM) Direction No. 90, which mandates CHCs to provide free machines to small and marginal farmers, incentivising the ecosystem is crucial to develop the service delivery mechanism and to improve affordable access to machines for farmers.

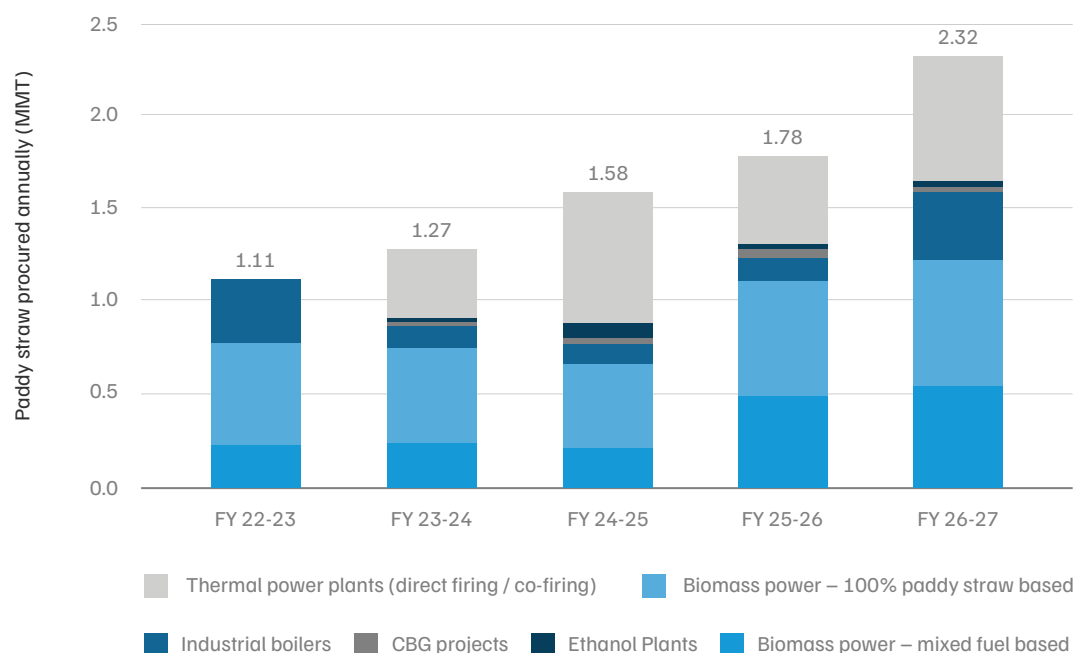
C) How is Haryana faring against its ex-situ CRM targets?

- **Haryana has doubled its ex-situ CRM capacity targets from 1.1 to 2.3 million metric tonnes (MMT), but supply chain bottlenecks persist.** Meeting this target hinges on improving processing technology, preserving the feedstock during storage, and meeting feedstock quality standards. The CAQM recently ordered three power plants (in Panipat, Yamuna Nagar, and Hisar) to pay INR 21.22 crore in environmental compensation for missing the 5 per cent biomass co-firing mandate. Infrastructure rollout also lags, with only three out of seven proposed agri-residue-based CBG plants currently operational.

- **Ex-situ payment ecosystem is nascent and fragmented.** While biomass aggregators handled 87 per cent of baled residue (n = 583), only 7 per cent of farmers received payments; 62 per cent of farmers gave this straw away for free, and 31 per cent actually paid out-of-pocket (~INR 1,000 per

acre) to have their fields cleared. In contrast, 67 per cent of farmers selling their residue as fodder were paid, though they also incurred higher manual harvesting costs (mainly basmati growers).

Figure ES2. Ex-situ industries' paddy straw utilisation potential has almost doubled in the last 5 years



Source: Authors' compilation based on data procured from HAREDA 2025–26

- **In the fodder market, basmati residue commands a premium of INR 3,000 per tonne,** reflecting its preference as animal feed, against INR 2,250 per tonne for non-basmati residue. In the biomass-aggregator channel, non-basmati farmers receive INR 1,200 per tonne (~INR 3,000 per acre).²
- **Despite the varying remunerative benefits, ex-situ CRM farmers reported satisfaction.** 80 per cent of ex-situ CRM farmers (baling and fodder,

n = 1,109) reported that they would continue with the same method in 2026 with shares fairly similar across pathways as it ensures timely field clearance, provides fodder for livestock consumption or sale, and is perceived to be cheaper than bearing the operational expenses of running in-situ machines. However, of the dissatisfied lot, collection delays and absence of monetary compensation were the most common complaints we observed.

² Assuming 2.5 tonnes per acre.



Image: Srishti Jain / CEEW

CEEW's Navjot Singh discussing the pricing structure in the ex-situ supply chain with a biomass aggregator in Jind, Haryana (October, 2025).

D) What drives Haryana's wheat stubble fires?

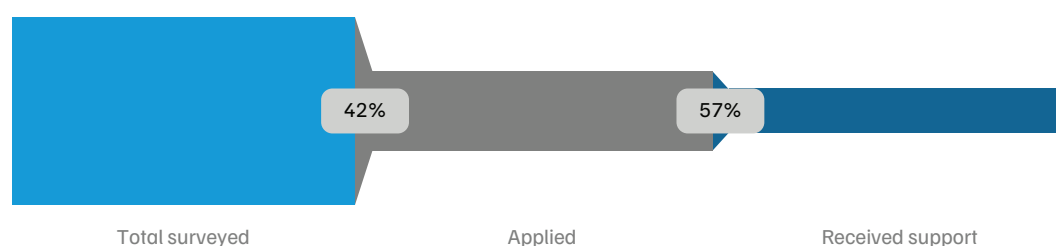
- **Wheat stubble fires are rising with dwindling market demand for wheat residue.** Almost all surveyed farmers (~98 per cent) reported using wheat residue as fodder due to its low silica content, with ~94 per cent using it for self-consumption and 22 per cent giving it away. Asked about the status of wheat fodder prices five years back, surveyed farmers in nine out of twelve districts reported a decline in the median fodder prices (from INR 500 to INR 350 per quintal, $n = 1,091$). Price volatility and falling wheat fodder demand, with livestock reduction in the state, drive wheat stubble burning.

E) How are farmers responding to government zero-burn incentives?

- **The Parali Protsahan Yojana, Haryana's special initiative that provides INR 1,200 per acre for zero-burn CRM, is popular.** Awareness about

the scheme is high, at ~80 per cent. With regard to the completed PPY cycle for the FY 24–25 burning season, nearly 42 per cent applied for the benefit, with more than half of them (57 per cent) receiving benefits. The remaining share either received compensation from residue buyers, withdrew the application midway, or were disqualified for non-compliance. The CRM subsidy scheme also achieved significant outreach, with ~70 per cent of respondents aware of it.

- **The risk of behavioural regression toward burning is reportedly low if PPY were to be phased out.** When asked if farmers would switch to burning if the incentives are discontinued, nearly two-thirds of farmers who received PPY benefits ($n = 415$) indicated that they would not burn despite the withdrawal, although this share was lower for medium and large farmers compared to small and marginal farmers. This is likely driven by larger residue volumes and greater bargaining power relative to peers.

Figure ES3. *Parali Protsahan Yojana* has been instrumental in driving no-burn CRM practices in Haryana

Source: Authors' analysis

Note: Total farmers (n = 1,588). Percentages inside each band are stage-to-stage conversion; header shares are of the group total.

- **Despite high adoption rates of no-burn CRM, there is no clear consensus among farmers on the long-term benefits of no-burn agriculture.** While 48 per cent of in-situ farmers reported an increase in wheat yields (n = 571), 52 per cent reported no impact on wheat productivity post the

in-situ intervention. In fact, 94 per cent of farmers who transitioned away from burning towards in-situ and ex-situ CRM practices (n = 1,579) reported no reduction in chemical fertiliser use, including urea and diammonium phosphate (DAP) requirements.

7 ways Haryana's institutional and incentive structure is outperforming other states for crop stubble management

	Parali Protsahan Yojana	Provision of INR 1,200 per acre to non-burners
	Paddy varietal diversification landscape	Near-equal basmati and non-basmati acreage enables CRM pathways across fodder, baling and in-situ CRM
	Haryana Clean Air Project	An INR 3,646 crore (USD 300 million) World Bank-supported initiative targeting emissions from transport, industry, and agriculture by 2030
	Accelerated push on ex-situ supply chain and end-use infrastructure	Deliberate push to grow industrial off-take for straw, turning residue into an input rather than waste to burn
	Common determined price for paddy straw	Declaration of a common determined rate for procurement of paddy crop residue at INR 2,500 per tonne
	Dedicated CRM dashboard for progress tracking	A public dashboard tracking CRM progress, including machines disbursed, biomass industries registered, farmers enrolled under PPY, etc
	Enforcement with teeth	Burners face FIRs and red entries on the Meri Fasal, Mera Byora (MFMB) portal, blocking e-kharid crop sales for two seasons — an effective but financially punitive deterrent for small-scale farmers

Source: Authors' compilation

Policy recommendations

- The Haryana Agriculture Department should rationalise the allocation of CRM equipment in line with basmati and non-basmati area needs.**
 Haryana's state action plan estimates a requirement of an additional 13,633 and 1,297 machines for paddy and wheat residue management, respectively (CAQM 2026b). To ensure optimal use, the state should focus on targeted, cluster-specific machinery deployment in line with the district's needs, deployed through the setting up of CHCs and promotion of village-level entrepreneurs (VLEs). Non-basmati clusters should scale ex-situ management by deploying balers and boost industrial-scale biomass aggregation, supplemented by in-situ machinery where end-use demand is low. In contrast, basmati clusters should prioritise formalising unorganised fodder markets, and establishing fodder banks and supply chains for fodder logistics.
- State departments should allocate biomass storage capacity to match the state's ex-situ targets and ensure a smooth supply chain.** In line with CAQM's Direction No. 99, which calls for planning adequate storage facilities for bales to safeguard from moisture, decomposition, and fires, Haryana should scale up its storage infrastructure to match its growing ex-situ ambitions (2.3 MMT target capacity)(CAQM 2026c). This requires identifying and earmarking 1,610–2,300 acres of land, with a projected storage infrastructure investment of INR 58–92 crore in accordance with the bale size. The state should prioritise government/panchayat land close to aggregation points and incorporate moisture control and fire-safety measures into storage design to pre-emptively reduce feedstock losses and preserve bale quality.
- Fast-track the commissioning of proposed ex-situ biomass projects while strategically siting the new plants.** To meet Haryana's ex-situ CRM target, the state should enforce strict commissioning timelines for approved biomass projects, while maximising the capacity of existing facilities. Currently, with only three out of seven commissioned compressed

biogas (CBG) plants operational, expediting pending projects is critical to generate feedstock demand. Additionally, with biomass power dominating current utilisation (52 per cent), Haryana should actively diversify its end-use ecosystem by promoting industrial boilers, pellets/briquettes, and brick kilns. To ensure accountability, the State Action Plan must transparently track and document how residue is being distributed and managed across these varied industries.

Additionally, states should use satellite imagery, groundwater data, supply chain logistics, and end-user availability to algorithmically cluster agricultural blocks and identify where ex-situ projects are viable. Public capital support for balers, storage, and transport should be concentrated in areas where industrial demand exists. High stubble areas without nearby buyers should instead prioritise in-situ management, while water-stressed regions should pursue crop diversification. Such precise allocation will ensure new biomass projects are commissioned only where feedstock supply is inherently viable, preventing stranded assets.

- Phase out incentives under *Parali Protsahan Yojana* as ex-situ market matures.** To make zero-burn agriculture financially self-sustaining, Haryana should gradually shift the cost burden from the state to industrial stakeholders. The state should phase out PPY incentives for ex-situ practices as the biomass market matures in the coming years, to directly compensate farmers and transform residue into a commodity. However, the state should continue supporting in-situ CRM with incentives compensating for its high operational costs due to its proven soil moisture and health benefits (Keil et al. 2021). By strategically restricting these payments to in-situ CRM practising farmers in the long run, Haryana can slash its total estimated PPY budget of INR 495 crore per annum by half (assuming the current PPY incentive of INR 1,200 per acre). Limiting this support to small and marginal farmers would further improve savings — a crucial requirement for the state's long-term fiscal prudence (Annexure A5).

States need to align satellite imagery, groundwater data, supply chain logistics, and end-user availability to identify viable ex-situ project locations.

- **Expand the scope of CRM initiatives and state action plans for stubble management operational year-round.** With rising rabi fires, the Union government should expand the scope of CRM initiatives to include both kharif and rabi crops, in line with CAQM Direction No. 96. Implementing this year-round mandate requires (including wheat straw) specific machinery like straw reapers in the subsidised equipment list for CHCs and individual farmers, launching dedicated IEC and behaviour change communication campaigns for rabi residue management, and establishing robust supply chains to transport surplus wheat fodder to deficit regions.
- **Develop a dedicated compliance monitoring and progress tracking portal for CAQM directions on stubble management.** The Haryana CRM Dashboard—a tracking architecture providing data on machines disbursed and crop biomass-using industries—should be upgraded for better usability. Additionally, having such a standardised platform should be mandated across other states to ensure uniform reporting standards.
- **To effectively enforce its statutory directives, the CAQM itself should also develop a portal for tracking the compliance status of its directions, such as No. 99 and No. 96, calling for the complete elimination of crop residue fires for both kharif and rabi, respectively. At a minimum, the portal should include:**
 - A central, dated record of every CAQM directions issued, with its specific compliance deadline.
 - Automated consistency checks on submitted data for instance, flagging any pathway-level target to prevent errors and imprecise reporting.
 - Integration of satellite fire-count data/burnt area with ground-level administrative actions.
 - A public-facing view of which states and which directions are compliant, pending, or overdue.



A wall painting describing the benefits of residue incorporation to soil health, located in Kurukshetra, Haryana.

1. Why is addressing stubble burning critical for Haryana



Image: Srishti Jain / CEEW

CEEW team examining partial burning patterns in Haryana.

India has become the world's largest rice producer, surpassing China (PIB 2026b). While agriculture plays a significant role in India's food and nutritional security, it also generates valuable waste during harvesting and processing. India's Ministry of New and Renewable Energy (MNRE) estimates that agriculture generates over 228 million tonnes of surplus crop residue annually, and farmers burn a majority of it (National Institute of Bio Energy n.d.). Crop residue burning (CRB) accounts for nearly 13 per cent of India's total PM_{2.5} emissions (TERI 2021). In fact, biomass burning alone, including CRB, contributes 20 per cent to Delhi's PM_{2.5} concentrations during winter and 12 per cent during the summer months (PIB 2026c).

Recognising the gravity of this crisis, the Union government, under the *Crop Residue Management (CRM)* scheme, has released INR 4,266.47 crore (2018–25) to the states of Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, and NCT of Delhi, focusing on both in-situ (residue incorporation into the soil) and ex-situ (residue removal for fuel or energy use) management. Between 2018–19 and 2025–26, these states have established more than 43,500 Custom Hiring Centres (CHCs), and over 3.54 lakh CRM machines have been supplied to CHCs and individual farmers (PIB 2026a). For 2026–27, the central government has earmarked INR 544.15 crore under the CRM scheme (with the first instalment of INR 272.07 crore already released to states) to manage an estimated 27.62 million tonnes of crop stubble (PIB 2026a).

Analysing the states' residue management status, Haryana reported a significant reduction in farm fires in kharif 2025 compared to 2021 (PIB 2025). However, evidence attributes this to a shift in timing in farmers' burning behaviour in the states of Punjab and Haryana from ~13:30 IST to late afternoon hours (~17:00 IST) to avoid detection by polar-orbiting satellites (Singh et al. 2025, CAQM 2026). While several sources state that the fire numbers have reduced, the dip might be comparatively less drastic than reported.

Notwithstanding these claims, Haryana has indeed emerged as a success story by charting a positive trajectory in fire reduction through the deployment of funds, empowering farmers to act as local CRM access points, and providing ex-situ management pathway opportunities to farmers. The state has been able to achieve this feat while navigating through its unique operational landscape as compared to its neighbours.

- A significantly larger share of small and marginal farmers at 69 per cent (~33 per cent in Punjab; the national average is still higher at ~86 per cent)(MoAFW 2019), limiting access to CRM resources.
- A massive share of basmati in the total paddy sown area at 52 per cent (MoEFCC 2025), with its residue largely absorbed by fodder markets.
- A significant machinery-renting farmers' pool in a non-existent CHC network.
- A first-of-its-kind provision of state financial incentive for non-burners, raising the opportunity cost of burning.

The state has rolled out schemes such as the *Parali Protsahan Yojana* (PPY) in 2022, offering cash incentives of INR 1,000 per acre, which was increased to INR 1,200 per acre in 2025, for farmers practising no-burn CRM methods (DoAFW Haryana n.d.). Under this scheme, Haryana has released INR 461.75 crore to ~5.5 lakh farmers who did not burn paddy residue in FY 25–26 (The Statesman 2026).

While the efforts are commendable, certain gaps persist in solution delivery, awareness generation, and market development of residue and its by-products. By conducting a ground-level assessment of the state's CRM adoption patterns and the efficacy of incentive structures among 1,588 farmers across 12 districts, we aim to decode Haryana's model to solve for the gaps and provide a scalable and replicable blueprint for other states. Through this study, we seek to understand how CRM has evolved over the eight years of the scheme's existence, current trends, farmers' perspectives, and the state's future outlook, going beyond kharif to also include the growing concern over rabi residue management, especially wheat residue.

The ground-level insights and recommendations in the report to address CRB as a year-round problem can help the Commission for Air Quality Management (CAQM), Ministry of Agriculture and Farmers Welfare (MoAFW), and state agricultural and energy departments in Haryana and beyond to optimise resource allocation, refine incentive structures, and establish crop biomass-based projects for industrial demand.

2. Methodology



Image: Srishti Jain / CEEW

CEEW researchers training enumerators on dominant cropping patterns and biomass residue management practices (January, 2026).

To study the adoption status of CRM methods in Haryana, we conducted an independent survey of 1,588 farmers³ across 12 districts between January and March 2026, representing Haryana's farmer population as per the latest agricultural census (2015–16). The 12 districts—Ambala, Fatehabad, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, Panchkula, Rohtak, Sirsa, and Yamuna Nagar—accounted for ~92 per cent of the average kharif fires and about ~81 per cent of the state's average paddy sown area between 2018 and 2024.⁴ The survey was administered to farmers in Punjabi and/or Hindi by a survey agency.

2.1 Sampling framework

As part of the research design, we used a stratified random sampling approach at three levels. The first level of stratification is at the district level. Since the primary objective of the study is to focus on paddy residue, as it is the major crop burnt in the Indo-Gangetic plains, we excluded districts with less than ~10 per cent of their net sown area under paddy, namely Gurugram, Charkhi Dadri, Bhiwani, Nuh, Rewari, and Mahendragarh. We then categorised the remaining 16 districts as high-, medium-, and low-burn, based on the number of kharif farm fires per unit of paddy sown area in acres (also called fire count intensity) from 2018 to 2024 (Annexure A1). Districts with a fire count intensity in the first tertile

³ We chose a margin of error of 3 per cent, and confidence level of 98 per cent for sample selection.

⁴ Sourced from open fires detected by Suomi NPP-VIIRS satellite; it captures all thermal anomalies, so we used the National Remote Sensing Centre's Land Use Land Cover (250k) to clip the open fires those reported on crop land.

(< 33.3 percentile value) were considered low-burn, those in the middle tertile (> 33.3 but < 66.6 percentile value) were considered medium-burn, and those in the top tertile (> 66.6 percentile value) were considered high-burn. We then randomly sampled four districts from each tertile to understand the CRM practices adopted by farmers. However, due to field-level challenges such as the unavailability of paddy-growing farmers in the selected districts, the sample had to be altered to replace Faridabad (low-burn) with Sirsa, a high-burn district. Thus, the final sample contained five districts from the high-burn category, four from medium-burn, and three from low-burn.

After this, we randomly selected 12 villages from each district, totalling 144 villages. For this, we eliminated villages with fewer than 10 per cent of a district's total farmer population to ensure adequate sample density and reduce field-level constraints prior to selection. We then classified the remaining villages into two sub-strata—small and large—based on the district's farmer population distribution, and randomly sampled

six villages from each sub-stratum. To ensure that the data are representative at the state level, we selected 11 farmers from each village (five marginal, two small, two semi-medium, one medium, and one large), mirroring the share of cultivators across different landholdings. While small and marginal farmers made up 63.85 per cent⁵, semi-medium, medium, and large farmers together made up 36.15 per cent of the final sample. All respondents were landowners. While 62 per cent of farmers cultivated exclusively on owned land, 38 per cent cultivated on both owned and leased plots.

At the village level, farmers were interviewed by randomly walking to select the respondents through a quota-based sampling method. We also maintained eight backup villages in each district, four from each of the small and large categories, resulting in a total of around 96 backup villages. This was maintained to ensure that quotas across landholdings were met, since in some villages, farmers were concentrated in the extreme landholding categories.

Figure 1. We employed a multi-stage random sampling technique to understand Haryana's CRM practices

District-level map with surveyed villages ⁶	Sample details
	12 districts Stratified random sampling based on fire density 144 villages (12 main and 8 backup villages in each district) Fixed villages in each district; district-wise sampling weights used for analysis 1,588 farmers (11 farmers in every village) 7 small and marginal; 4 semi-medium, medium, and large covered using quota-based snowball sampling

Source: Authors' analysis

⁵ The actual share of the two categories i.e. small & marginal as the first and semi-medium, medium, & large farmers as the second is 68.57 and 31.43 per cent in Haryana's total landowning population Agricultural Census, 2015-16 (DESA, Haryana).

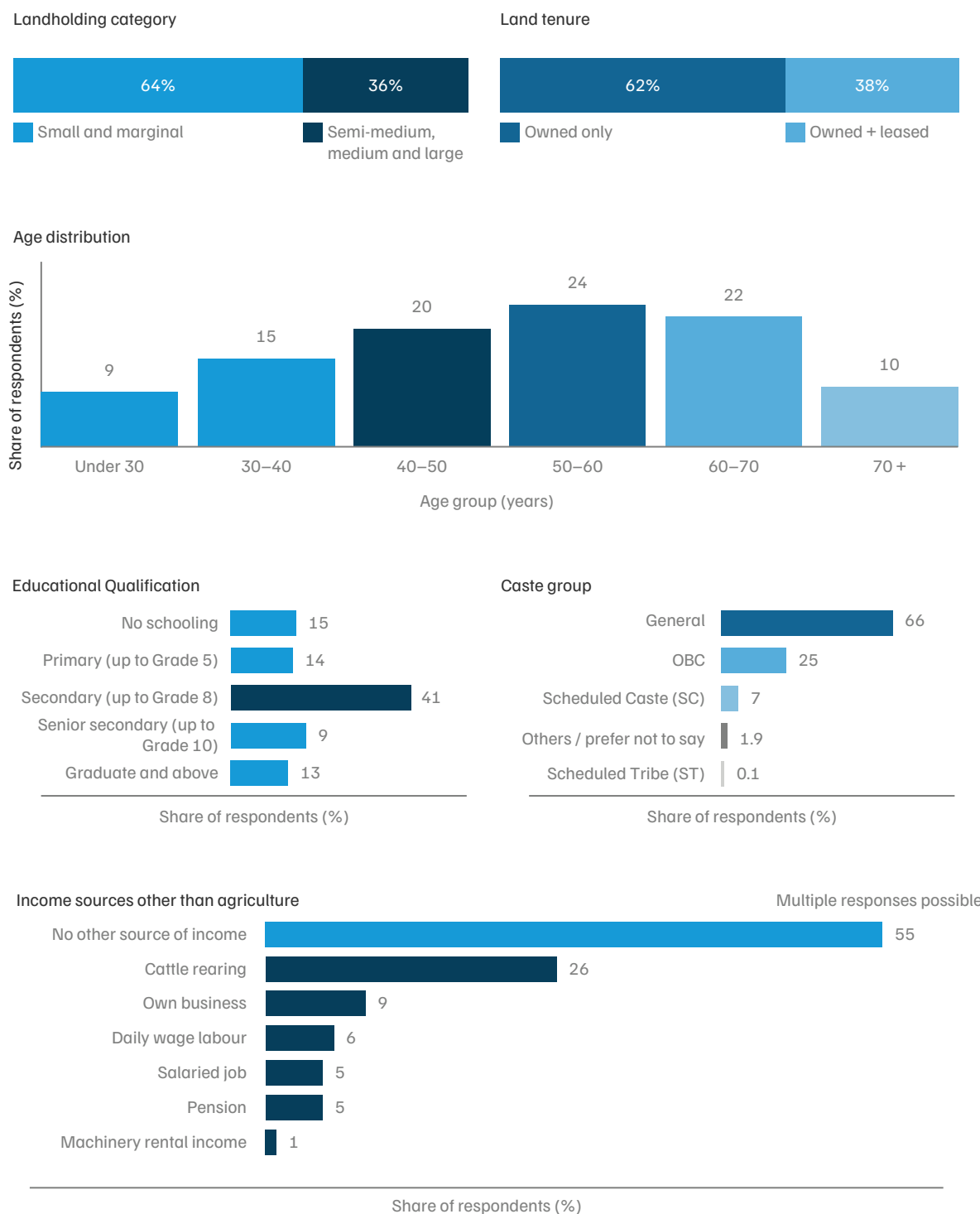
⁶ The blue dots represent the sampled villages in the study.

2.2 Questionnaire design

As part of the survey, we focused on interviewing paddy-growing farmers on their crop varieties, CRM practices followed, payment ecosystem, awareness of government schemes, and future outlook. Despite not being statistically representative of wheat growers, we also

included them in the study to understand wheat residue management and payment pathways. Surveying farmers on both crops helped provide a holistic understanding of the residue management ecosystem in a paddy-wheat-paddy cycle in the state.

Figure 2. Who were the farmers: Study sample demographics



Source: Authors' analysis

Note: All values are expressed as actual shares (non-weighted). Income-source shares sum to more than 100% as respondents could report multiple sources.

2.3 Qualitative interviews

To understand the current state of CRM practices in Haryana, we undertook field visits from October to December 2025. During these visits, we interviewed officials from the Department of Agriculture and Farmers Welfare (DoAFW), Chaudhary Charan Singh Hisar Agricultural University (CCSHAU), Haryana Renewable Energy Development Agency (HAREDA), APMC officials, and farmers. These initial interactions were important in designing our primary survey questionnaire. After concluding the primary survey, we also conducted focus group discussions (FGDs) in April 2026 in two districts, Hisar and Fatehabad, to validate the key findings derived from the survey analysis.

2.4 Data quality and study limitations

To test the questionnaire and the data collection tool, we conducted pilot surveys in non-sampled villages of Ambala, Fatehabad, Hisar, Jind, Kurukshetra, Kaithal, Panipat, and Sirsa. To accurately code the diverse responses, the enumerators underwent thorough classroom training and mock survey sessions. Data quality protocols included setting lower and upper bounds for numerical inputs, incorporating cross-

verification questions to assess consistency, and randomising the order of response options to mitigate positional bias. However, despite these efforts, we recognise that the dataset remains subject to potential limitations—specifically recall, enumerator, and social desirability biases⁷ driving people to respond in a certain manner divorced from actual practices, impacting the validity of responses.

As part of the analysis, we attribute district-wise weights to each surveyed entity, in line with its district farmer population. Such a method helps ensure that we do not oversample or undersample any district, and our values are representative at the state level. Throughout this report, we use weighted percentages while the pertaining totals (in brackets) remain unweighted unless stated otherwise.

We also acknowledge that despite our survey analysing both kharif and rabi residue management practices, our sampling method only considers kharif fires, as it remained the major study focus. However, in the absence of a large-scale survey on wheat residue management practices, this work can act as a critical baseline, laying the groundwork for future, statistically representative rabi studies.

Additionally, we acknowledge that our sample inherently represents landowning cultivators, not the rural population affected by crop residue burning.



CEEW researchers conducting a focus group discussion in Hisar, Haryana to deep dive into farmers' outlook towards crop residue management (April, 2026).

⁷ Driving individuals to give responses that look good rather than reflecting their true thoughts.

3. Crop choices shape farmers' CRM practices

Crop residue management does not follow a one-size-fits-all approach. The choice of variety itself shapes residue volume, harvesting techniques, and downstream management requirements. With Haryana having an almost equal share of area under basmati and non-basmati paddy (MoEFCC 2025), this section examines how CRM differs across the two varieties. This will help contextualise Haryana's CRM profile and enable a more targeted, needs-based strategy for CRM support services for farmers.

3.1 CRM methods diverge between basmati and non-basmati growers

In kharif 2025, Haryana sowed paddy in over 41.26 lakh acres, generating nearly 8.55 million metric tonnes (MMT) of crop residue. Of the total paddy cultivated area, basmati paddy covered 22.64 lakh acres, making up 52 per cent of the sown area, while non-basmati paddy accounted for 20.81 lakh acres, making up the remaining 48 per cent (MoEFCC 2025; DoAFW Haryana n.d.). Haryana generates about 4.67 MMT of basmati and 3.88 MMT of non-basmati residue, respectively. According to the state government, as of 2025, the residue is being

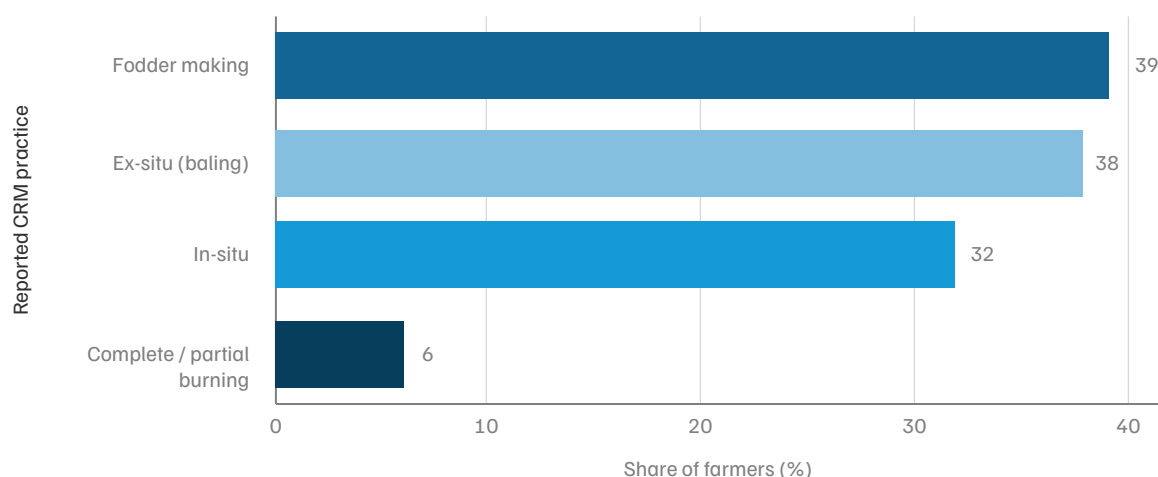
managed majorly through in-situ (4.44 MMT), ex-situ (1.91 MMT), and fodder (2.2 MMT) methods, making up 52, 22, and 26 per cent of the share, respectively (DIPRL Haryana 2025).

Our survey finds broadly comparable adoption across the three CRM pathways, with farmers often practising more than one: 32 per cent incorporate the residue into the soil using machines such as super seeders; 38 per cent opt for ex-situ management (baling), and 39 per cent make fodder (26 per cent kept it for their own cattle while 22 per cent gave it away) (n = 1,588). About 6 per cent also acknowledged complete or partial burning, though this figure is likely underestimated, as fear of penalties and social stigma introduces a degree of social desirability bias into self-reported burning.

Interestingly, 26 per cent of all farmers reported burning incidents in their village, with ~77 per cent of these citing that burning is prevalent between 4 pm and 10 pm, corroborating the recently observed temporal shift in fire incidents (Singh et al. 2025, CAQM 2026a).

On analysing the district-wise residue management methods, we observe that off-farm residue management is the dominant practice across most surveyed districts in north Haryana, with baling prevalent in high-burn areas such as Sirsa and Fatehabad, which neighbour Punjab.

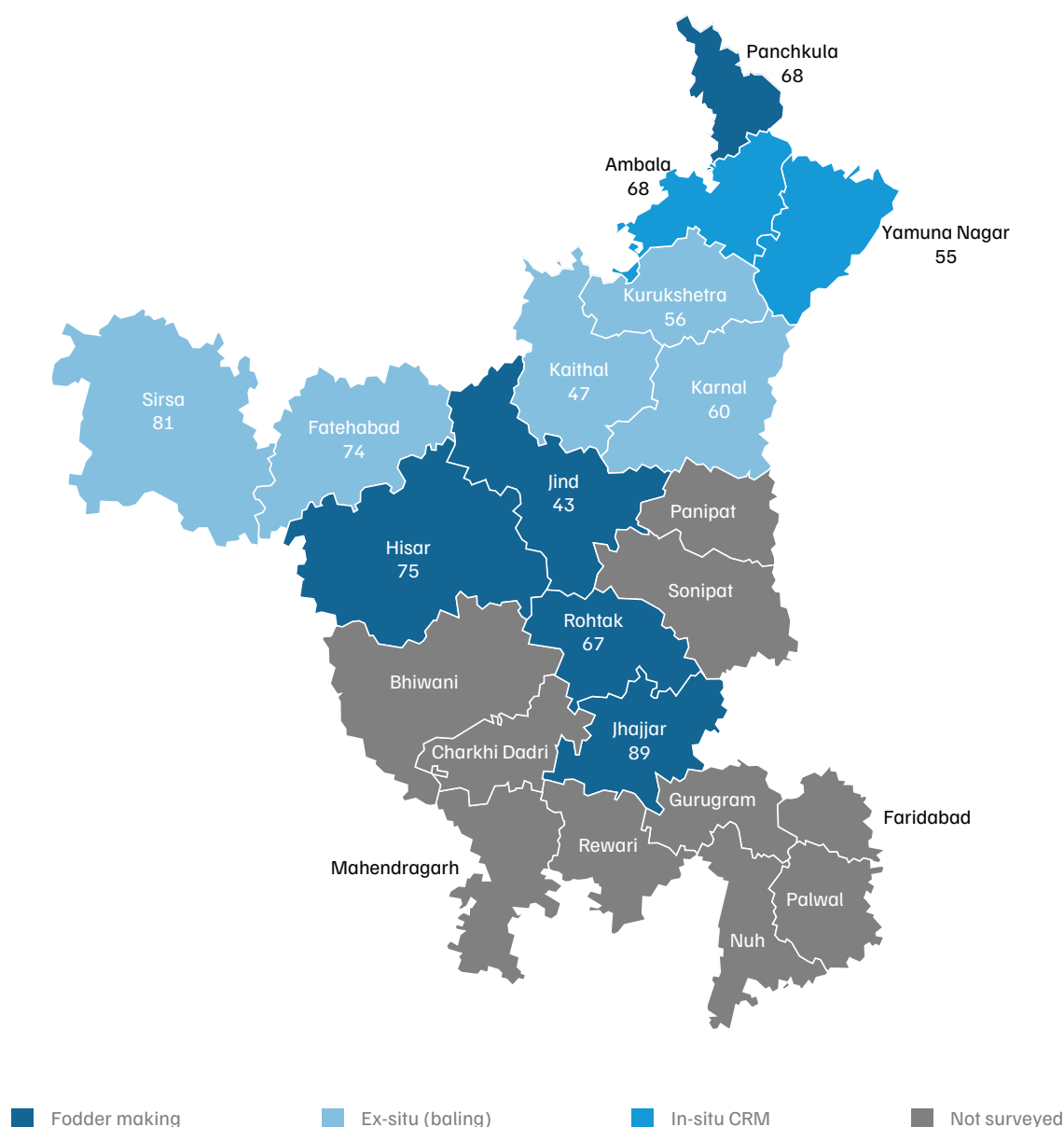
Figure 3a. Off-farm residue management practices are more dominant in Haryana



Source: Authors' analysis. Figures represent weighted percentages using district-level survey weights

Note: Farmers may report more than one harvesting or management practice, so shares do not sum to 100%; n = 1,588 farmers.

Figure 3b. 10 out of 12 surveyed districts had off-farm residue management as the dominant CRM method



According to our analysis, crop type and harvesting methods also have a subsequent effect on how the residue is eventually managed.

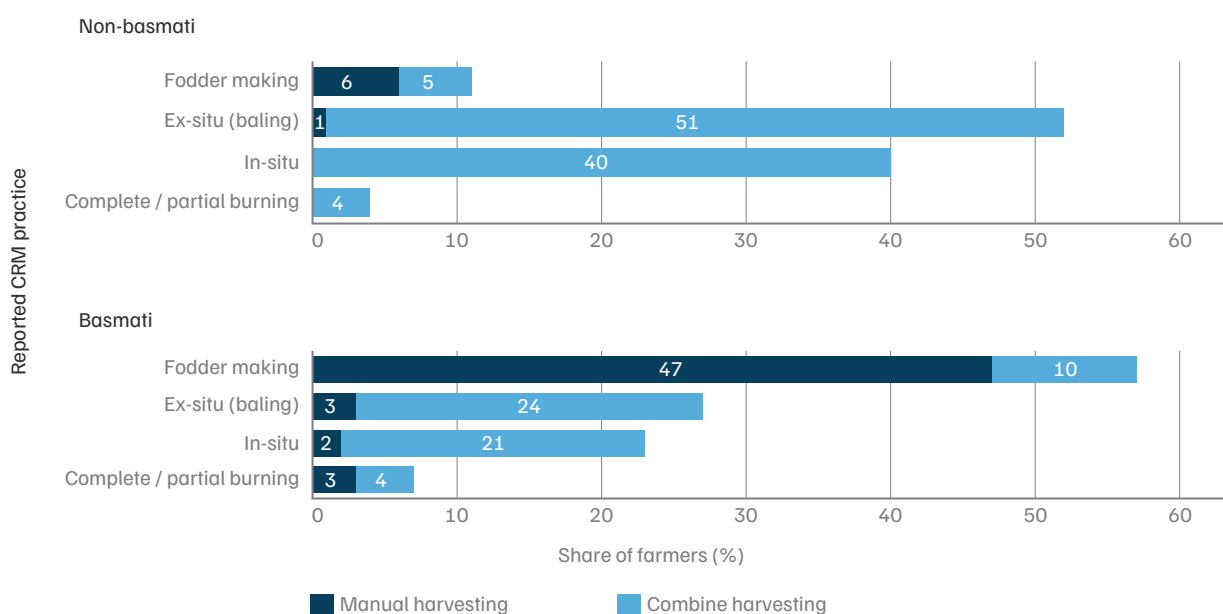
- Of the total sample, 50 per cent of farmers grew basmati, 40 per cent grew non-basmati paddy, and 10 per cent grew both (Annexure A2). The share of farmers growing both was higher among the medium and large farmers' group, which could probably be due to their larger holdings and greater risk-taking capacity. As per our analysis, farmers' decision to grow basmati is driven largely by soil and water suitability, access to export premiums, ease of sale, and the option to use or sell residue as fodder. Non-basmati paddy, by contrast, offers higher yield, a shorter crop duration, and price security through minimum support price, insulating farmers from price shocks and market volatility (Jha 2008; Sekhar and Bhatt 2017; Tuteja 2015).
- Basmati growers predominantly use manual harvesting with sickles (57 per cent) to maximise grain recovery and straw collection, leaving

little standing stubble behind (Bhardwaj et al. 2021). However, a sizeable share (50 per cent) also use combine harvesters due to labour shortages and rising manpower costs (n = 755). Overall, a majority of basmati residue (57 per cent) is managed as fodder, given its lower silica content and suitability as cattle feed (Downing et al. 2022), with baling and in-situ practices considerably less common at 27 and 23 per cent, respectively (Bhardwaj et al. 2021; Bhushan 2020; Sarnklong et al. 2010) (Figure 4). Across all paddy producers, we also observed that combine harvester-using farmers lean towards in-situ and baling methods, while fodder-making is more common among manual harvesters due to more

efficient straw collection and its suitability for chaff cutters commonly used in households.

- Driven by short cropping windows, almost all non-basmati growers (93 per cent) rely on combine harvesters to cut cultivation and labour costs, leaving large amounts of loose and standing stubble behind (n = 972) (Bhardwaj et al. 2021; Mishra et al. 2024). As per our analysis, non-basmati residue is managed mainly through baling or in-situ CRM, each accounting for 52 and 41 per cent of cases; with fodder-making relatively less common due to the residue's high silica content and low bovine digestibility (Malik et al. 2015)(Figure 4).

Figure 4. Non-basmati residue is mostly baled or managed in-situ, while basmati residue primarily serves as fodder



Source: Authors' analysis

Note: Non-basmati (n = 972) & Basmati farmers (n = 755). Farmers may report more than one harvesting or management practice, so shares do not sum to 100%.

4. Emerging trends in in-situ CRM use



Image: Srishti Jain / CEEW

A freshly harvested paddy field in Kurukshetra, with the residue ready to be incorporated back into the soil (November, 2025).

Despite the rising popularity of ex-situ CRM techniques, states remain committed to managing a section of residue through in-situ CRM pathways, as on-field CRM is beneficial for improving soil organic carbon and soil health (Gupta et al. 2024). For 2025–26, Haryana has set a target to manage nearly half of its basmati and non-basmati residue through in-situ methods (DIPRL Haryana 2025). Our analysis shows that in-situ CRM techniques have evolved significantly over the years, driven by technical innovations, changing farmer perspectives, and the need to adapt to farm-based challenges such as pest attacks. This section analyses the latest in-situ techniques used by farmers in Haryana, alongside changing CRM patterns, emerging field-level challenges, and evolving farmer behaviours.

4.1 Super seeders popular as a wheat sowing machine

Our state-level survey highlights a behavioural shift. The super seeder, once seen as a CRM machine for in-situ management, has emerged as a wheat-sowing machine in recent years. With more than half of the 41,195 applications for CRM machines in 2025 in Haryana, super seeders have become quite popular and are being

used irrespective of the CRM practiced (DoAFW Haryana n.d.).

Our survey finds that 82 per cent of all in-situ machinery users ($n = 587$) rely on super seeders, whose multi-functional design cuts straw, prepares seedbeds, and sows wheat in a single operation (Buttar et al. 2023). Interestingly, ~75 per cent of ex-situ farmers ($n = 1,103$)—those who removed residue through baling or fodder use—also used a super seeder for subsequent wheat sowing, with seed drills becoming relatively less common. Traditionally, farmers had to perform multiple operations before sowing wheat, such as harrowing and planking (Keil et al. 2021). However, with the super seeder, these operations, along with seeding, can be completed in a single pass, making it a less fuel- and labour-intensive practice (Latif et al. 2024).

This is significant for two reasons. First, it means the super seeder has become the default wheat-sowing machinery for most paddy farmers, regardless of their choice of residue management. Second, and consequently, any disruption to super seeder availability through supply bottlenecks, price spikes, or breakdowns during peak season would affect both in-situ CRM practitioners and the much larger pool of ex-situ farmers who depend on it for subsequent sowing operations.

4.2 Farmers prefer multiple machine runs for clean fields

The cultural preference for visually ‘clean’ and smooth fields remains a dominant driver in agricultural machinery adoption and usage patterns across states (Loch et al. 2018). Our survey data shows that this same motivation is now causing an increase in the operational frequency of machines, with farmers routinely running CRM machines over multiple passes. Results show that 71 and 62 per cent of super seeder (n = 475) and rotavator (n = 77) users ran the machines two or more times on their farms, respectively. To ensure proper decomposition of residue, field preparation and optimal wheat germination, most farmers reported using the machines twice, with irrigation in between. Insights from focus group discussions confirm that despite repeat machine runs, which increase the machine rental costs, the action is largely driven by a desire for field smoothness, the psychological reassurance of a visually clean seedbed, and strong farm-fire monitoring standards.

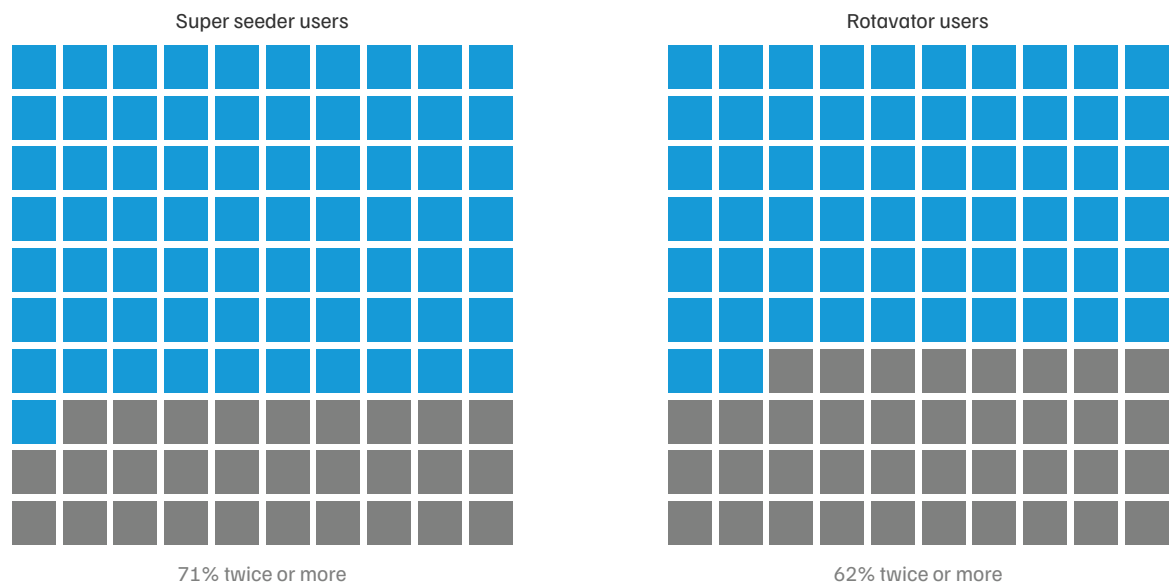
For machines such as super seeders, the machine is first run across the fields, followed by irrigation, and then run a second time for wheat sowing, typically a week later, once soil moisture reaches an optimal level. This multi-stage approach results in superior germination and minimises the risk of pest infestations. While renting the CRM machine such as a super seeder costs about INR 2,000–2,500 per acre, field insights show that despite some discounts for multiple machinery use, running it twice almost doubles the cost to about INR 4,000–4,500 per acre as the farmer typically has to rent and run the machine again (Annexure A3).

4.3 Renting preferred for accessing machines

Haryana has set up 6,775 CHCs since 2018; however, the state’s priority has completely shifted towards individual farmers in recent years, with no new CHCs set up since 2021–22 (MoEFCC 2025). However, rental behaviour remains strong among farmers in Haryana. Our survey reveals that ~82 per cent of all farmers rely on machine rentals either for in-situ management or wheat-sowing machines, with 99 per cent of them tapping into individual farmer networks, while utilisation of CHCs remains grossly limited. Rental adoption was higher among small and marginal farmers at 91 per cent, while 68 per cent of medium and large farmers rent, as they usually tend to own individual machines.

However, in order to phase out the financial benefits for practising no-burn methods currently provided for all farmers, the state needs to revitalise the CHC network. Under CAQM’s Direction No. 90, CHCs have a mandate to provide CRM machines rent-free for small and marginal farmers (CAQM 2025). By developing a robust CHC infrastructure, the state can ensure fiscal prudence in its budgetary expenses by limiting machinery use subsidies for the smaller farmers, lowering capital costs for machine access, making CRM more affordable, and fostering rural entrepreneurial opportunities for CHC operators (Jain et al. 2025).

Figure 5. A majority of CRM machinery users run the machines multiple times in their fields



Source: Authors’ analysis

Note: This analysis covers super seeder (n = 475) and Rotavator users (n = 77).

5. The ex-situ CRM ecosystem is evolving



Image: Srishti Jain / CEEW

Bale production in action. Biomass aggregators dominate the baling ecosystem in the state.

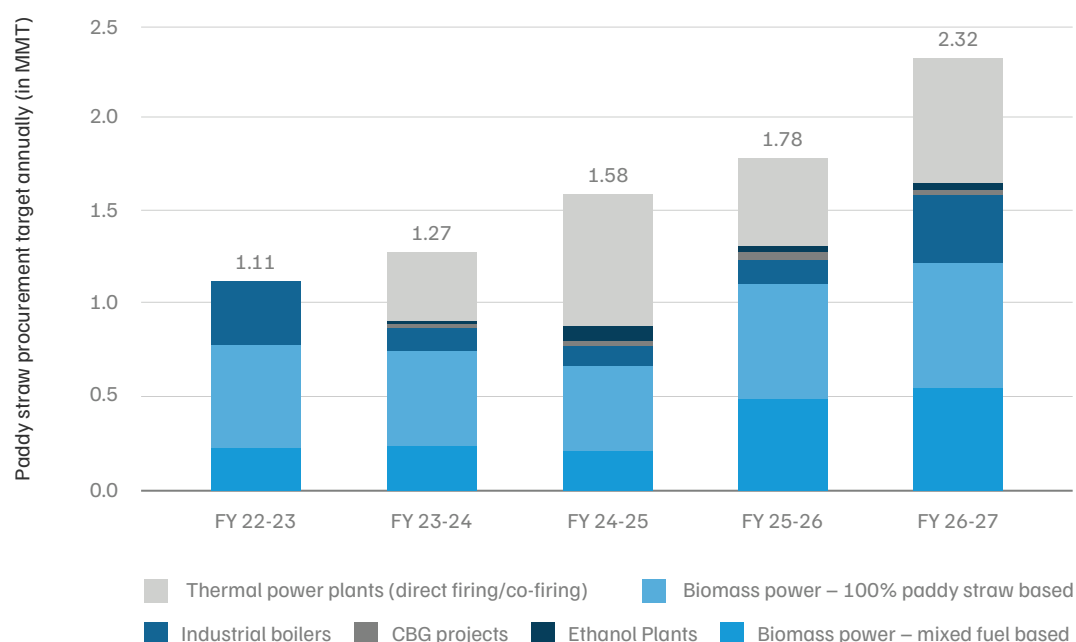
Haryana's biomass utilisation capacity has been expanding, with the state doubling its biomass target capacity for ex-situ CRM from 1.1 to 2.3 million tonnes between FY 2022–23 and FY 2026–27 (HAREDA). This rise has been driven by centrally sponsored schemes such as the *National Bioenergy Programme* and the *Sustainable Alternative Towards Affordable Transportation* (SATAT) scheme (IOCL 2026; MNRE 2024). In August 2026, the Government of India augmented the *GOBARdhan* scheme with an outlay of INR 23,731 crore

through FY 2026–36 to promote the offtake of surplus residue among other organic wastes (PIB 2026d). Haryana has also been a leading state in introducing a dedicated bioenergy policy, which it did in 2018 with amendments in 2023 (DNRE 2018). On the ground, farmers prefer off-farm treatment of residue as it has lower perceived CRM-related costs, leaves a clean field, and also provides an opportunity to earn additional income (Kemanth et al. 2024; Jack et al. 2025).

According to the state government, Haryana managed 48 per cent of the paddy residue either through ex-situ (baling) or fodder-making pathways in 2025–26 (DIPRL Haryana 2025). Combined, these two management pathways account for 73 per cent of paddy growers in the survey, with 39 per cent either using or selling the residue as fodder, and 38 per cent practising baling methods with

certain farmers practising more than one method. As agricultural residue grows into a marketable commodity for biofuel production, energy generation, and fodder use, a biomass-based economy has started to develop. This section treats the two separately, as the pathways are dependent on the paddy variety, and have different end-users and remuneration benefits.

Figure 6. Industrial paddy straw utilisation potential has almost doubled in the last 5 years



Source: Authors' compilation based on data procured from HAREDA 2025–26

5.1 Biomass aggregators dominate the baling ecosystem

Bale collection in Haryana is led by biomass aggregators (chosen by 87 per cent of ex-situ, i.e., baling farmers) serving as a link between industry and farmers, collecting residue from the ground, and supplying it to the intended industry users (n = 583). Involving biomass aggregators is popular among farmers largely for its convenience, as the process is managed entirely by the aggregator with

minimal farmer involvement, ensures industry offtake, and is perceived to be cheaper than the operational expenses of using in-situ machines. Bale production typically follows combine harvesting, used by 95 per cent of ex-situ farmers (n = 583), cutting the paddy stalk and leaving loose straw behind, which is then cut and gathered for bale production. As per our survey, 88 per cent of baling farmers rented the cutter, with a majority of them renting it from the aggregator itself as a bundling arrangement.

Box 1. Farmers practise no-burn methods, but how do they receive the no-burn subsidy? Decoding the verification system for incentive delivery

Aggregators use a receipt book to provide certification of adopted ex-situ management pathway to farmers in Haryana.

'I take INR 1,000 from farmers and provide them with baling services from biomass collection to residue transport. Due to the high cost of residue aggregation, generating profits solely through biomass is nearly impossible; thus, collecting fees becomes crucial. Upon payment, I issue a receipt to the farmers that they can submit for claim verification' - Kultar Singh (name changed), a biomass aggregator in Kurukshetra.

The aggregators provide a receipt to farmers post biomass collection on the farms, which serves as critical evidence of practicing no-burn methods, enabling farmers to apply for the financial incentive of INR 1,200 per acre under the *Parali Protsahan Yojana*, which is later verified by DoAFW for claim disbursement.

5.2 Ex-situ CRM finds favour regardless of remuneration benefits

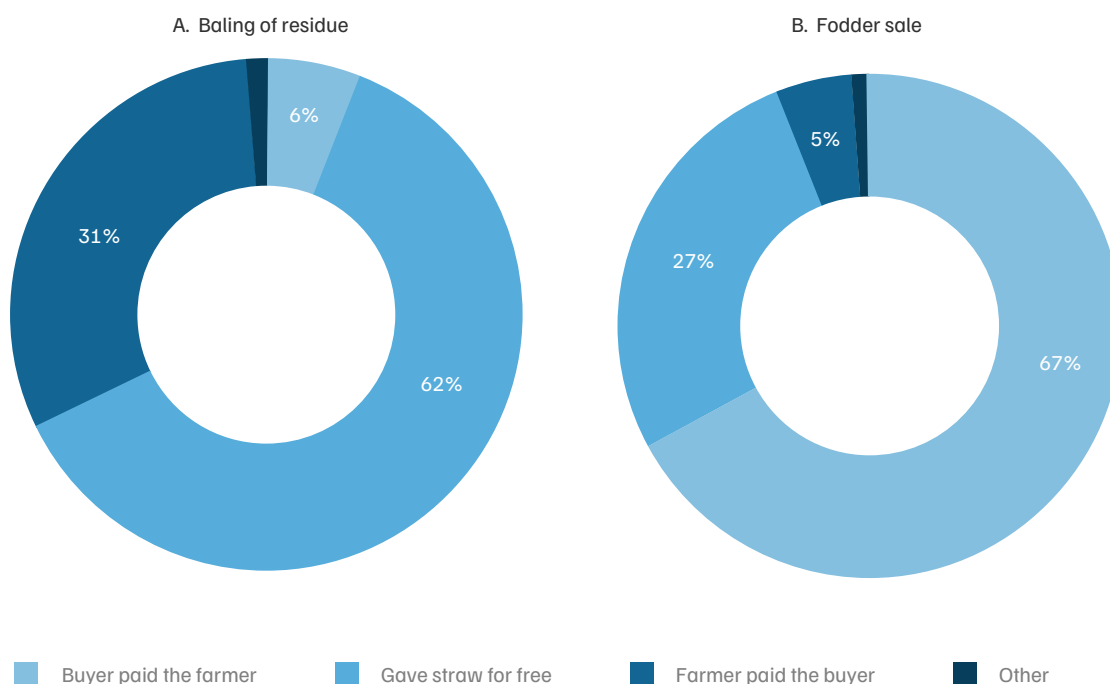
Haryana is one of the pioneers in setting a common determined rate for paddy straw residue of INR 2,500 per tonne to incentivise farmers with an additional INR 500 per tonne for moisture levels below 20 per cent back in 2023 (PIB 2024). Besides this, the state has provided a top-up of INR 500 per tonne to clusters identified by the Indian Oil Corporation Limited for their 2G Ethanol plant at Panipat, and a transport subsidy of INR 500 per acre (capped at INR 15,000) for bales delivered to gaushalas (PIB 2024). However, with the payment ecosystem still in its nascent stage and limited to certain geographies and industry offtakers, a majority of farmers continue to provide their residue for free. Only 6 per cent of farmers involved in baling receive payments for their residue, while 62 per cent gave away their residue free of cost,

and 31 per cent of them also paid ~INR 1,000 per acre to get their fields cleared (n = 566).

In contrast, 67 per cent of farmers selling their residue as fodder were paid for their residue; however, they also spent more on manual harvesting methods (mainly basmati growers). Our field insights also show that, due to the preferred use of basmati residue as fodder because of its low silica content and high bovine digestibility, a higher share of basmati farmers were paid for their residue than non-basmati farmers.

Despite the varying remunerative benefits across the ex-situ CRM pathways (baling and fodder), 80 per cent of them are expected to continue with the same method in 2026, with shares fairly similar across pathways as it ensures timely field clearance, provides fodder for livestock consumption or sale, and tends to be cheaper than bearing the operational expenses of running in-situ machines (n = 1,109). However, among the dissatisfied lot, collection delays and absence of monetary compensation were the most common complaints observed.

Figure 7. Baled residue is mostly given away for free, while residue used as fodder is paid for



Source: Authors' analysis

Box 2. Haryana's bioenergy ecosystem needs to be strengthened with rising demand

Haryana reached an ex-situ capacity utilisation of 1.9 million tonnes in 2025. With its bioenergy capacity almost doubled in the past five years, the state has the potential to increase this target (DIPRL Haryana 2025). However, data on actual plant utilisation is currently missing. In fact, the bioenergy sector continues to face challenges at ground-level in technology processing, timely aggregation, and meeting feedstock quality standards.

The CAQM also recently imposed environmental compensation (EC) of INR 21.22 crore on three of Haryana's power plants in the NCR for being non-compliant of the 5 per cent biomass pellets/briquettes co-firing mandate in coal thermal power stations (TPPs) (PIB 2026e). These are:

- Panipat Thermal Power Station – proposed EC of INR 8.98 crore;
- Deenbandhu Chhotu Ram Thermal Power Station, Yamuna Nagar – proposed EC of INR 6.69 crore;
- Rajiv Gandhi Thermal Power Plant, Hisar – proposed EC of INR 5.55 crore.

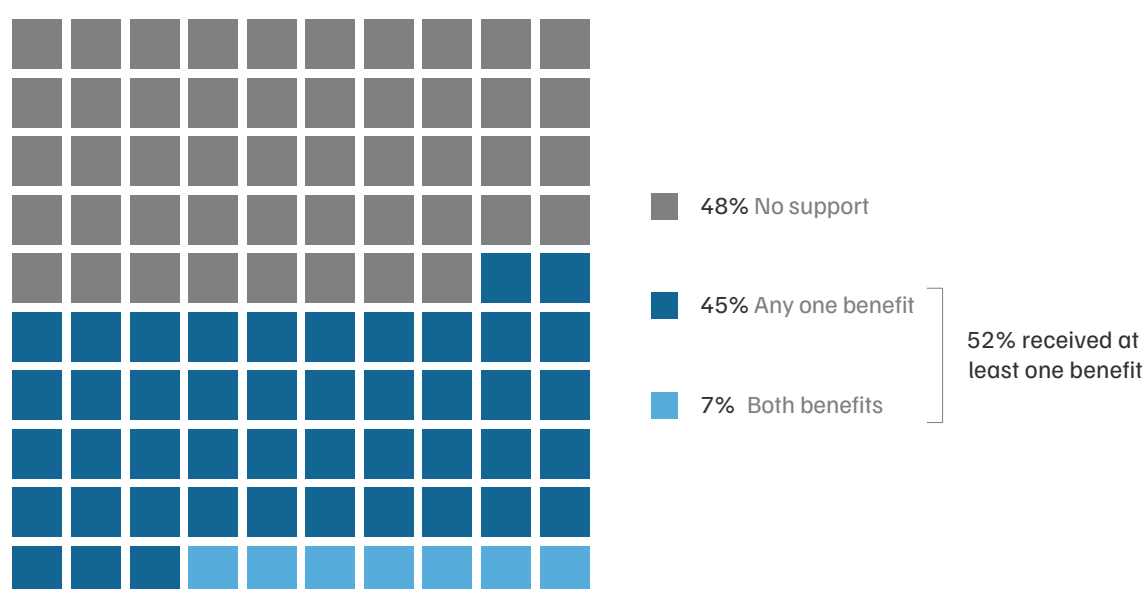
Further, the 100 KLD 2G Ethanol Indian Oil Corporation Limited (IOCL) plant in Panipat, with an investment of INR 1,000 crore faces technical and supply chain issues with older stock of biomass bales left unused (ChiniMandi 2026).

Similarly, only three of the proposed seven agri-residue-based CBG plants are functional in the state, with the CBG shortfall part of a much larger pattern visible across the country. Against the SATAT scheme, which provides support in offtake pricing from oil marketing companies (OMCs), capital subsidies, and blending obligations, the CBG targets fall short. Of the original aim of establishing 5,000 CBG plants nationwide by 2024–25, only 100–120 plants have actually been commissioned as of mid-2025, a fraction of the intended scale (MoPNG 2025). These plants also face operational challenges in securing feedstock, meeting fuel quality standards and the sale of CBG by-products such as fermented organic manure (FOM).

Box 3. FOM sale: A crucial missing link in the biomass supply chain

In addition to the CBG offtake, FOM sale is central to making the CBG plants financially viable. The recently launched Gobardhan scheme provides an incentive component for FOM sale in its administered CBG price of INR 2,110 per MMBTU itself, replacing the previously provided Market Development Assistance (MDA) of INR 1,500 per tonne for FOM (MoPNG 2026; PIB 2026f). With the responsibility for the sale of CBG by-products and ensuring their appropriate and beneficial utilisation with the CBG producer, there is a need for the retail sale of FOM. This requires awareness generation among farmers, which currently remains limited. In Haryana, only 21 per cent of farmers had heard of FOM ($n = 1,588$), and only 4 per cent of them had ever used it. Encouragingly, four out of every five farmers ($n = 1,588$) showed interest in a straw-for-FOM barter, handing over straw for free in exchange for free FOM, with a small share of farmers open to it if transport costs were kept low. This suggests that the barrier to FOM adoption is not just the farmers' resistance to trying new methods, but unproven and unobserved benefits. Closing that gap will likely require on-the-ground demonstrations, and free trial applications increase farmer trust.

Figure 8. Only 7 out of 100 farmers get both benefits—PPY and payments from biomass buyers



Source: Authors' analysis

Note: $n = 822$

In addition to the payments by end-users across biomass aggregators and fodder buyers, Haryana provides a unique opportunity, with the state disbursing an INR 1,200 benefit per acre under the *Parali Protsahan Yojana* for practising no-burn CRM activities. However, our analysis shows that there is very little overlap between farmers receiving residue-based payments

and government-based incentives, with only 7 per cent of farmers receiving both. While about 52 per cent of all ex-situ farmers received at least one benefit, 48 per cent received none, either because they were unaware/did not apply under PPY or because aggregators did not pay them for their residue ($n = 822$).

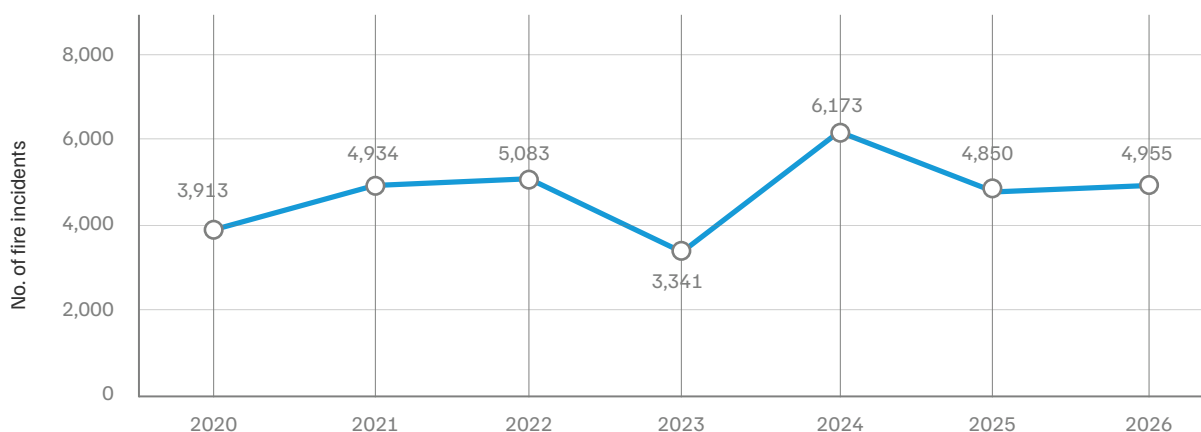
6. What drives Haryana's wheat stubble fires

Historically, paddy straw has been the major focus area for crop residue burning in the Indo-Gangetic Plains (IGP) region. But with the rising challenges in wheat residue management, wheat fires are also rising. Haryana has ~67 per cent of its agricultural sown area under wheat at 59 lakh acres (MoAFW 2025). With a dwindling demand for wheat residue, its management is becoming a growing concern.

According to our survey, due to wheat residue's low silica content, almost all farmers (98 per cent) reported utilising

it as fodder, with 94 per cent of them using it for their own animals' consumption and 22 per cent giving it away (n = 1,580). However, these figures are likely subject to social desirability bias in farmers' self-reporting. Wheat residue management is largely dependent on fodder demand (Lopes et al. 2023). Thus, livestock reduction and unorganised market trends are eroding its value, acting as a major driver for wheat residue burning (Kemanth et al. 2026). This section analyses wheat residue management patterns and fodder supply chains across districts for alternative residue management.

Figure 9. Wheat residue burning has been a continuous trend in the past few years



Source: Authors' compilation. Open fires detected by Suomi NPP-VIIRS satellite; it captures all thermal anomalies, so we used the National Remote Sensing Centre's Land Use Land Cover (250k) to clip the open fires reported on cropland

Note: Fire incidents recorded between April 1 and May 31 each year in Haryana.

6.1 Wheat farmers prefer straw reapers for CRM

Of all farmers making fodder (n = 1,553), 91 per cent used a straw reaper to manage wheat residue. A straw reaper is a tractor-drawn machine that collects, cuts, threshes, and cleans leftover stalks and stubble after combine harvesting, converting residue into fine animal fodder (bhusa) in a single operation. As per our analysis, renting is the dominant mode of machinery access, with

93 per cent of straw reaper users renting the machines (n = 1,334). Almost all machines were sourced from fellow farmers, making straw reapers one of the most highly rented machines in the CRM ecosystem. This holds across farm sizes: 97 per cent of small and marginal farmers and 86 per cent of semi-medium, medium and large farmers accessed the machine on rent. Notably, the straw reaper is typically rented as a bundled service along with a tractor and operator, rather than as a standalone machine, across all farm-size groups.

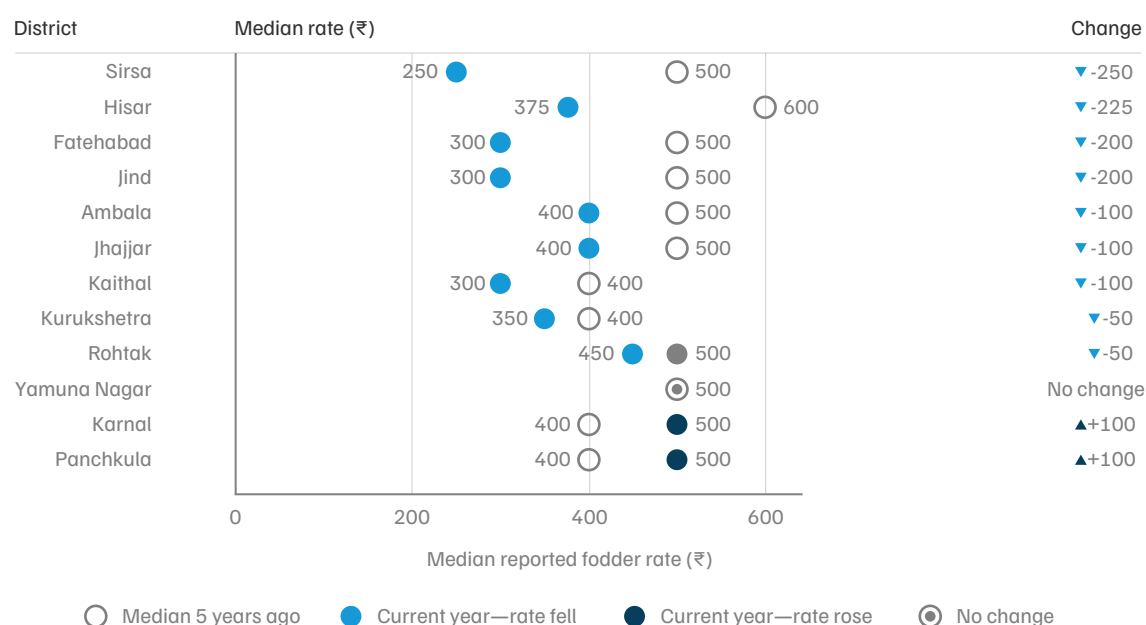
6.2 Fodder market dynamics are shaping wheat CRM decisions

One of the major reasons cited for the rising farm fires in the rabi season is the non-remunerative price for fodder in recent years (Kemanth et al. 2026). Typically, straw reapers are rented for making fodder at INR 1,800 per trolley, or the same amount is paid on a per-acre basis, with the former method more common. Of all farmers who gave away their wheat residue as fodder in the rabi harvest season in 2025, 63 per cent received payments (n = 363), with median earnings of about INR 2,500 per trolley (or INR 2,000 per acre or INR 400 per quintal). However, once the rental cost of the reaper is factored in, farmers' profits from fodder sale drop drastically, leaving them with merely 10 to 30 per cent of their initial INR

2,500 revenue. In fact, this amount too is only enjoyed by farmers who received payments, while the remaining farmers give away the residue free of cost or pay to get it cleared.

This financial strain is compounded by market volatility. The fodder market appears divided, with surveyed farmers split almost evenly between those reporting that prices had fallen or held steady and those reporting increases, with significant variation across districts. While we acknowledge the recall bias, farmers reported that the median value of fodder has reduced by 30 per cent from INR 500 to INR 350 per quintal in the last five years (n = 1,091). On further analysis, price reductions were observed across nine of the 12 sampled districts, exposing the issue of dwindling fodder demand in recent years.

Figure 10. Nine out of twelve surveyed districts saw a decline in median fodder prices in the last five years



Source: Authors' analysis

Note: Points show the median reported fodder rate in each district; districts are ordered by the size of the fall.

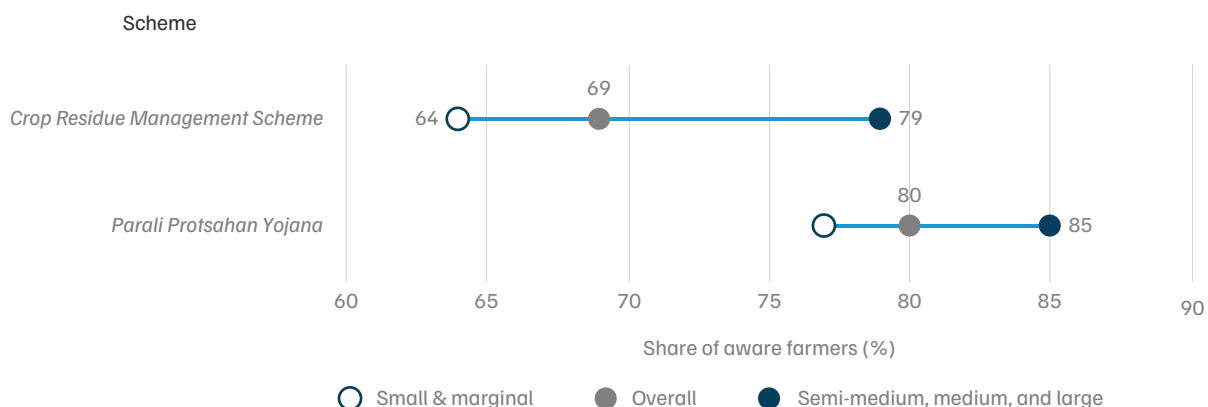
7. Haryana's zero-burn adoption efforts

The government of Haryana has made significant efforts to mitigate the stubble burning crisis. Beyond the *Crop Residue Management scheme*, the state has also introduced schemes such as the PPY, providing INR 1,200 per acre⁸ to all farmers practising no-burn agriculture methods. Additionally, the state has launched schemes to promote crop diversification such as the *Mera Pani, Meri Virasat* (MPMV) where farmers receive INR 8,000 per acre⁹ for growing less water-intensive crops such as maize, cotton, moong, and other kharif oilseeds, as an incentive to shift away from paddy in select districts.¹⁰ The state also offers INR 4,500 per acre for adopting direct seeding of rice (DSR) techniques (DIPRL Haryana 2025). For 2025–26, the state allocated INR 471 crore for these initiatives (DIPRL Haryana 2025). This section dives deep into the status and performance of some of these schemes in solving the stubble burning crisis.

7.1 The *Parali Protsahan Yojana* draws large farmer participation

On analysing the awareness levels of farmers regarding government-launched schemes for CRM, our survey found that 80 and 69 per cent of farmers were familiar with the PPY and CRM schemes, respectively (n = 1,588). Large farmers show maximum awareness of both schemes, mainly because they are better positioned to leverage the subsidies offered by these programmes, especially when buying machines.

Figure 11: ~80 per cent of farmers surveyed are aware of the *Parali Protsahan Yojana*



Source: Authors' analysis

Note: Total farmers (n = 1,588), small & marginal farmers (n = 1,014); semi-medium, medium & large farmers (n = 574).

⁸ The PPY, when first introduced in 2022, provided INR 1,000 per acre, which was hiked to INR 1,200 per acre in 2025.

⁹ The financial incentive has been increased from INR 7,000 to INR 8,000 per acre since 2026.

¹⁰ 10 districts of Haryana namely Ambala, Yamunanagar, Kurukshetra, Karnal, Panipat, Sonapat, Jind, Kaithal, Fatehabad and Sirsa are included in the scheme.

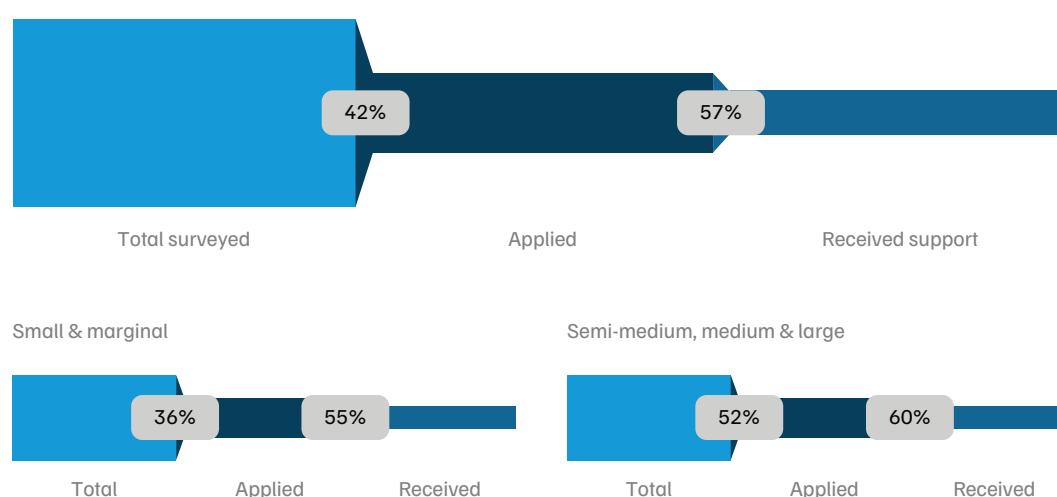
The PPY is broadly recognised owing to its incentive-based model, under which farmers can apply to the scheme while completing their crop registration (i.e., *Panjikaran*) through the *Meri Fasal Mera Byora* portal. During the application window, typically open from June to August, farmers input details on their sown paddy variety, sowing method, and the CRM technique to be followed (DoAFW Haryana n.d.). According to our survey, there was a 13 per cent increase in applications—from 52 to 65 per cent—from 2025 to 2026.

Of all the farmers surveyed, 24 per cent received benefits under the PPY scheme. Our analysis shows that 42 per cent of farmers applied for the scheme with more than half of them (57 per cent) receiving the promised incentives for the 2025 stubble burning season ($n =$

1,588). During our field interactions, we noted that the timely disbursal of benefits under the scheme has built trust and credibility among farmers, promoting no-burn agriculture methods. However, eventually, many small and marginal farmers opt out of the application process, citing insufficient financial incentives for their land size, uncertainty in payments, or limited awareness of the application procedure.

While a greater share of medium and large farmers apply for the PPY benefit than small and marginal farmers (52 versus 36 per cent), benefit disbursement remained equitable across both landholding categories and CRM type (60 versus 55 per cent), indicating that state support is reaching farmers regardless of farm size and residue management methods.

Figure 12. About half of all farmers who applied for the *Parali Protsahan Yojana* received benefits for 2025 across landholding categories



Source: Authors' analysis

Note: Total farmers ($n = 1,588$), small & marginal farmers ($n = 1,014$); semi-medium, medium & large farmers ($n = 574$). Percentages inside each band are stage-to-stage.

Additionally, we also assessed the potential ramifications of discontinuing the financial incentive under PPY to understand the chance of a behavioural regression to burning. Surprisingly, among the cohort of farmers who received benefits for the scheme before 2025 ($n = 415$), nearly two-thirds (~65 per cent) indicated that they would not burn residue despite the withdrawal of incentives. However, while about 67 per cent of small and marginal

farmers mentioned that they would not burn residue ($n = 213$), this share was smaller at 61 per cent for medium and large farmers ($n = 202$), likely driven by larger residue volumes and greater bargaining power relative to smaller peers. While the current allocation is able to offset a portion of the immediate residue management costs, permanent reliance on such fiscal mechanisms poses long-term risks. By observing that more than half of the

beneficiary farmers would not burn residue despite the discontinuation of incentives, there is scope for altering the scheme benefits in the long run. With the growing interest in the bioenergy space and market development initiatives under the Sampoorna GOBARdhan scheme launched in 2026, the state should shift away from providing farmers transient cash transfers to accessible and affordable CRM services through CHCs and VLEs. Additionally, the state needs to promote the bioenergy ecosystem so that those industries can become profitable, paying farmers for the feedstock in the long run.

7.2 Farmers continue with no-burn practices, despite unobserved long-term benefits

Our analysis shows that farmers have largely settled into their chosen CRM method and intend to continue with their respective practices. On asking if they would practise the same CRM method in the coming year, 87 per cent of in-situ (n = 571) and 80 per cent of ex-situ farmers (n = 1,109) wished to continue with their ongoing practice. However, high retention has not translated into proven agronomic returns; farmers remain divided on CRM's benefits for yield and soil health—48 per cent of in-situ farmers reported higher wheat yields (n = 571), while 52 per cent reported no discernible impact on productivity post-intervention.

In fact, 94 per cent of farmers who transitioned away from burning towards in-situ and ex-situ CRM practices (n = 1,579) reported no reduction in chemical fertiliser use, including urea and DAP requirements. Median urea application remained flat at three bags per acre across farm sizes, with no difference between in-situ and ex-situ practitioners. While long-term residue incorporation leads to soil health benefits, such as fertiliser and cost savings, there is a probability that the surveyed farmers did not observe them as they had newly shifted to these no-burn practices.

The survey findings also raise a longer-term concern about the state's growing emphasis on ex-situ pathways. While ex-situ methods are effective from an air quality standpoint, continuous and prolonged removal of crop

residue from fields has a risk associated with depleting soil organic carbon and nutrient retention over time (Gupta et al. 2024). The state's ex-situ push should therefore be accompanied by parallel investment in soil health monitoring and organic matter replenishment, to avoid trading one environmental problem for another.

Over 80% of in-situ and ex-situ farmers intend to continue with their ongoing CRM methods in coming years.

7.3 Farmer interest in CRM machinery training outpaces current coverage

Crop residue management guidelines direct states to conduct information, education, and communication (IEC) activities including training and demonstrations, while the state action plans set annual targets for these activities accordingly. Yet only 8 per cent of farmers practising in-situ management received training on machine use (n = 571). Of these, almost half (47 per cent) were trained by fellow farmers, while agricultural extension workers accounting for another 16 per cent (n = 39).

Despite strong farmer interest in training (54 per cent extremely willing and 29 per cent somewhat willing to attend), uptake remains low (n = 1,588). With farmers placing the most trust in government officials, information, education and communication (IEC) activities and their content require to be modified, tailoring them to the local context, and allocating budgets to preferred channels (such as training and scaling up on-ground demonstrations), to be delivered through agricultural extension workers for improving awareness and CRM technique adoption (Kumar et al. 2026, Krishnapriya et al. 2024).

8. Policy recommendations

While Haryana has made significant efforts to solve the stubble burning crisis, declining residue demand for fodder and limited ex-situ industries—as compared to the scale of biomass produced—have led to the persistent issue of stubble burning year on year. Wheat burning, in fact, has risen in the past few years. As part of this section, we aim to provide recommendations to the state, including modifications to the Haryana state action plan to solve stubble burning as a year-round problem.

8.1 Align CRM equipment allocation with basmati and non-basmati needs

According to the state action plan, Haryana needs an additional 13,633 machines for paddy and 1,297 machines for wheat residue management for the 2026 stubble burning season (CAQM 2026b). To ensure their optimal use, these machines need to be deployed considering the district realities.

For instance, while basmati growers mainly deploy the residue for fodder, non-basmati growers are usually involved either in residue incorporation or baling. Since Haryana cultivates almost an equal share of basmati and non-basmati, policymakers should go beyond macro-level machinery distribution to targeted cluster-level action.

We also recommend the machines be deployed well in advance of the stubble-burning months, as any possible procurement or deployment spillage could risk pushing the equipment past the season they are meant to serve. Haryana’s 2026 action plan keeps the machinery capacity constant till August, and adds all machines between August and November (CAQM 2026a). Front-loading the machinery deployment in advance of the stubble burning months can better support machinery deployment and availability during the stubble burning season between September and November.

Table 1. Haryana needs to determine CRM-related interventions based on crop type

Cluster	Non-basmati	Basmati	Wheat
Priority	Focus primarily on scaling ex-situ management by deploying balers and encouraging industrial-scale biomass aggregation by revitalising Custom Hiring Centres (CHCs) and promoting village-level entrepreneurs (VLEs). Subsidise in-situ CRM machinery in areas with limited biomass end-use demand.	Formalise currently unorganised fodder markets, establish fodder banks, and build supply chains connecting basmati straw-surplus areas with fodder-deficit districts.	Deploy an adequate number of straw-reapers and develop viable supply chains to transport residue to fodder-deficient regions, reducing the risk of residue-burning driven by localised demand shocks.

Source: Authors’ analysis



Image: Khushi Sharma / CEEW

A well equipped bale storage facility at an industrial site in Ludhiana, Punjab (October, 2024).

8.2 Invest in feedstock storage to reduce losses and maintain bale quality

In line with CAQM's Direction No. 99, which calls for planning adequate storage facilities / yards for paddy straw bales to minimise fire-related losses, Haryana needs to scale up its storage infrastructure to match its ex-situ ambitions (CAQM 2026b). In its state action plan submitted to the CAQM, Haryana has taken a positive step in this direction by calculating the optimum storage capacity requirements as per its current needs, and stating the objective of closing the remaining gap by the end of 2026.

While allocating land is the first step, industry bodies need to set up adequate storage infrastructure, including moisture-control and fire-safety measures, in storage design to actively reduce feedstock losses and preserve the quality of bales. Since 15–25 per cent of stored feedstock is typically lost to microbial decomposition and fire from high moisture content (Saboo et al. 2025), adequate biomass storage becomes critical. Our analysis shows that the state needs about 1,610 to 2,300 acres of land and a projected infrastructure investment of INR 58–92 crore for rectangular and round bales, respectively, to meet the projected 2.3 MMT paddy straw utilisation target (Annexure A4).

Table 2. Haryana needs to invest at least INR 58 crore in building storage infrastructure capabilities

Bale shape (size)	Land Requirement (acres)	Minimum financial investment (INR crore)
Rectangular (15-25 kg)	1610	58
Round (250-300 kg)	2300	92

Source: Authors' analysis

Note: The analysis assumes that 100 per cent of the feedstock is either stored as rectangular or round bales. Storing 10,000 tonnes of feedstock requires 7 acres (for rectangular bales) and 9.3 acres (for round bales) of land, with infrastructure investment requirements of INR 250 per tonne (rectangular bales) to INR 400 per tonne (round bales) (Saboo et al. 2025).

8.3 Fast-track commissioning of proposed plants with location-sensitive planning

Haryana has set a target of utilising 2.3 million tonnes of paddy straw through ex-situ pathways. However, existing operational facilities do not always run at maximum capacity due to technical challenges and absence of quality feedstock. Additionally, to absorb the residue in line with targets, the state must mandate and enforce strict commissioning timelines for all approved biomass projects. The push for CBG through the newly launched *GOBARdhan* scheme can play an imperative role in utilising surplus biomass and strengthening energy security by reducing oil imports (PIB 2026d).

Given that the largest ex-situ pathway is concentrated in biomass power in the state (52 per cent of current ex-situ utilisation), the MNRE needs to also promote pathways such as industrial boilers, pellets/briquettes, and 2G ethanol plants. Additionally, the state action plan should include provisions on tracking the managed residue beyond reporting plant capacity targets.

States need to use satellite imagery, groundwater data, supply chain logistics, and end-user availability to algorithmically cluster agricultural blocks and identify where ex-situ projects are viable. Public capital support for balers, storage, and transport should be concentrated in areas where industrial demand exists. High stubble areas without nearby buyers should instead prioritise in-situ management, while water-stressed regions should pursue crop diversification. Such precise allocation will ensure new biomass projects are commissioned only where feedstock supply is inherently viable, preventing stranded assets.

8.4 Extend CRM initiatives beyond paddy to include wheat for year-round CRM

With rising instances of wheat residue fires, stubble burning has become an annual concern impacting air quality all year round. Recognising this, the CAQM's Direction No. 96 instructs states to develop and implement rabi stubble management plans, covering machinery deployment and utilisation, monitoring, and IEC programmes for wheat CRM. For this, states need to establish a credible baseline on the amount of wheat residue generated and managed each year, as part of the state action plan across CRM pathways such as fodder, bioenergy production, and use in value-added products.

Additionally, the Union government should expand the scope of the CRM scheme beyond paddy to include wheat as well. This would entail:

- Expanding access to no-burn methods by including wheat CRM machinery, such as straw reapers, in the subsidised machinery list under the CRM scheme;
- Awareness generation through dedicated IEC plans for wheat stubble management;
- Developing agricultural residue markets by building robust supply chains to move fodder from surplus to deficient regions.

8.5 Scale up demonstrations to generate evidence and awareness on no-burn benefits

Our survey finds a split among farmers in terms of the observed soil health benefits, cost savings, and yield improvements on practising no-burn solutions. Without observable returns, retention beyond the subsidy window remains fragile. Thus, state agricultural universities, in coordination with the Indian Council of Agricultural Research (ICAR), should establish multi-year soil health and yield monitoring evidence across representative in-situ and ex-situ plots. This evidence base is essential for sustaining farmer adoption post-PPY, and for calibrating how far ex-situ can scale-up before soil carbon depletion and soil health become a concern. Generating this evidence, however, will only shift behaviour if it reaches farmers through trustworthy channels, such as government officials. The state needs to thus modify the IEC activities' content, tailoring them to the local context, allocating budgets to preferred channels such as training and scaling up on-ground demonstrations through agricultural extension workers, and timing these content delivery strategies immediately before paddy harvest and wheat sowing, when machinery decisions are actually made (Kumar et al. 2026, Krishnapriya et al. 2024).

The same pattern holds for FOM. While only 21 per cent of farmers were aware of FOM, four out of every five farmers expressed interest in a straw-for-FOM barter. With the launch of the *GOBARdhan* scheme and CBG plants bound to increase, HAREDA should work with CBG plant operators and KVKs to launch village-level FOM demonstrations and free-trial applications in high-CBG-capacity districts. Piloting this with a barter model would increase farmer trust and can help close the FOM offtake gap.

8.6 Phase out *Parali Protsahan Yojana* as ex-situ ecosystem matures gradually

To make no-burn agriculture financially self-sustaining in the long term, the onus of financing CRM adoption should shift from the state to biomass buyers and industry stakeholders, through a phased process in the coming years. For this, firstly, Haryana should narrow its no-burn payments to cover only in-situ CRM, withdrawing support for ex-situ practices. With the maturing of the ex-situ ecosystem, biomass buyers and industry players should take over compensating farmers directly for their residue—turning it into a marketable commodity rather than a subsidy-dependent activity. In-situ CRM, however, can remain state-supported, given its high operational costs and benefits for soil health. This strategy would help make crop residue marketable, preserve soil quality, and ensure prudence in state finances (Table 3, Annexure A5).

8.7 Develop a dedicated portal for CAQM compliance monitoring and tracking

The Haryana CRM Dashboard has been a step forward in transparent governance, offering detailed data on machines disbursed, their verification status, and industries' crop biomass utilisation. To maximise its

impact, the platform needs user interface (UI) upgrades that improve data accessibility and readability for administrators, farmers, and the general public. Such a dashboard needs to also be developed for other states such as Punjab and Madhya Pradesh under the CRM scheme.

To enforce CAQM's statutory directions such as No. 96 and 99, mandating complete elimination of crop residue fires in kharif and rabi respectively, **the CAQM should develop a unified monitoring portal** integrating satellite fire-count and burnt-area data for ground-level administrative actions. Additionally, to ensure data credibility and reduce inconsistencies in the state action plans, as observed in Haryana's ex-situ target of 9 million tonnes (CAQM 2026a) and the state's 2025 document citing 1.9 million tonnes (DIPRL Haryana 2025), the CAQM should verify the plans on time. For this, the monitoring portal should include:

- A central, dated record of every CAQM direction and its specific compliance deadline.
- Automated consistency checks that flag implausible pathway-level targets.
- A public view of which states and directions are compliant, pending, or overdue.

Table 3. Haryana can cut its PPY budget by ~64 per cent by focusing on in-situ management for the most vulnerable farmers

Nature of deployment	Payments for all no-burn practices for all farmers	Payment for in-situ activities for all farmers	Payments for in-situ activities for small & marginal farmers
Total estimated budget (INR crore)	495.12	257.46	177.6

Source: Authors' analysis

Note: Assuming a financial benefit of INR 1200 per acre, Haryana needs ~INR 495 crore annually for 41.26 lakh acres of paddy sown area. For more information, check Annexure A5.

Acronyms

APMC	Agricultural Produce Market Committee	KLD	kilolitres per day
CAQM	Commission for Air Quality Management	MDA	Market Development Assistance
CBG	compressed biogas	MFMB	<i>Meri Fasal Mera Byora</i>
CCSHAU	Chaudhary Charan Singh Hisar Agricultural University	MMT	million metric tonnes
CEEW	Council on Energy, Environment and Water	MNRE	Ministry of New and Renewable Energy
CHC	custom Hiring Centre(s)	MoAFW	Ministry of Agriculture and Farmers Welfare
CRB	crop residue burning	MoEFCC	Ministry of Environment, Forest and Climate Change
CRM	crop residue management	MoPNG	Ministry of Petroleum and Natural Gas
DAP	diammonium phosphate	MPMV	Mera Pani, Meri Virasat
DIPRL	Directorate of Information, Public Relations & Languages	MSP	minimum support price
DNRE	Department of New and Renewable Energy	NCR	National Capital Region
DoAFW	Department of Agriculture and Farmers Welfare	NCT	National Capital Territory
DSR	direct-seeded rice	NPP	National Polar-orbiting Partnership (Suomi NPP)
EC	environmental compensation	OMC	oil marketing company
FGD	focus group discussion	PIB	Press Information Bureau
FIR	first information report	PM2.5	particulate matter 2.5
FOM	fermented organic manure	PPY	<i>Parali Protsahan Yojana</i>
HAREDA	Haryana Renewable Energy Development Agency	SATAT	Sustainable Alternative Towards Affordable Transportation
ICAR	Indian Council of Agricultural Research	TERI	The Energy and Resources Institute
IEC	information, education and communication	TPP	thermal power plant
IGP	Indo-Gangetic Plain	UI	User Interface
INR	Indian rupee	VIIRS	Visible Infrared Imaging Radiometer Suite
IOCL	Indian Oil Corporation Limited	VLE	village -level entrepreneur

References

- Bhardwaj, Manvendra, Ritu Dogra, Mohammed Javed, Manjeet Singh, and Baldev Dogra. 2021. 'Optimization of Conventional Combine Harvester to Reduce Combine Losses for Basmati Rice (*Oryza sativa*)'. *Agricultural Sciences* 12 (3): 253–67. <https://doi.org/10.4236/as.2021.123017>.
- Bhushan, Chandra. 2020. 'How to Control Air Pollution from Stubble Burning – iFOREST'. iFOREST. <https://iforest.global/how-to-control-air-pollution-from-stubble-burning/>.
- Buttar, G. S., G. P. S. Sodhi, G. S. Manes, K. Sunidhi, Taranreet Kaur, Navjot Singh Brar, Arvind Kumar, Rajbir Singh, and Simerjeet Kaur. 2023. 'Adoption Pattern of Farm-Machinery Based Solutions for In-Situ Paddy Straw Management in Punjab'. *Indian Journal of Extension Education* 59 (4): 103–8. <https://doi.org/10.48165/IJEE.2023.59421>.
- CAQM. 2025. "Direction No. 90: Implementation of the Action Plan for Prevention and Control of Paddy Stubble Burning in 2025, Targeting Complete Elimination – reg." May 09, 2025. <https://caqm-prod.amnec.co.in/FileUploadDomain/WebsiteDocument/Home/News/Direction%20No-904d88bdb5-5814-4f30-b05d-49917ac33c03.pdf>
- CAQM. 2026a. "Use of Drones for Monitoring Stubble Burning Incidents – reg." Letter to Chief Secretaries of Punjab, Haryana, Uttar Pradesh, and Rajasthan, July 28, 2026. <https://caqm.nic.in/FileUploadDomain/WebsiteDocument/Login/WhatsNew/8f0a067c-d0d3-4d4e-aff3-5b331e5d8ca0.pdf>.
- CAQM. 2026b. "Annual Action Plan 2026 for State of Haryana." Annexure-I, Commission for Air Quality Management in NCR and Adjoining Areas. <https://caqm.nic.in/FileUploadDomain/WebsiteDocument/Documents/State%20Action%20Plans/Haryana%20State%20action%20plan687d7773-f4e4-46d2-874f-520d02e7f87f.pdf>.
- CAQM. 2026c. "Direction No. 99: Implementation of the Action Plan for Prevention and Control of Paddy Stubble Burning in 2026, Targeting Complete Elimination – reg." May 15, 2026. <https://caqm.nic.in/FileUploadDomain/WebsiteDocument/Advisories%20and%20Direction/Directions/Direction%20No%2099af27a9c8-5c70-4df4-8bfc-432cd1a08775.pdf>.
- ChiniMandi. 2026. "India's First 2G Ethanol Plant at Panipat Costs ₹984 Crore, Government Tells Lok Sabha." April 4. <https://www.chinimandi.com/indias-first-2g-ethanol-plant-at-panipat-costs-%E2%82%B9984-crore-government-tells-lok-sabha/>.
- Directorate of Information, Public Relations & Languages, Government of Haryana (DIPRL). 2025. 'Press Note | Directorate of Information, Public Relations & Languages, Government of Haryana'. <https://www.prharyana.gov.in/en/press-note-235>.
- Department of Agriculture and Farmers Welfare, Haryana. n.d. "Mechanization – Crop Residue Management Scheme." Accessed June 15, 2026. <https://agriharyana.gov.in/MechCRMScheme>.
- Department of Agriculture and Farmers Welfare, Haryana. n.d. "Meri Fasal Mera Byora." Accessed September 15, 2026. <https://fasal.haryana.gov.in/>.
- Downing, Andrea S., Manish Kumar, August Andersson, Amar Causevic, Örfan Gustafsson, Niraj U. Joshi, Chandra Kiran B. Krishnamurthy, Bert Scholtens, and Beatrice Crona. 2022. 'Unlocking the Unsustainable Rice-Wheat System of Indian Punjab: Assessing Alternatives to Crop-Residue Burning from a Systems Perspective'. *Ecological Economics* 195 (May): 107364. <https://doi.org/10.1016/j.ecolecon.2022.107364>.
- Government of Haryana, Department of Agriculture and Farmers Welfare (DoAFW Haryana). 2026. 'Dashboard: Crop Residue Management'. Agriharyana.gov.in. <https://agriharyana.gov.in/dashboardcrm>.
- Government of Haryana, Department of Agriculture and Farmers Welfare (DoAFW Haryana). 2026. 'Mechanisation Scheme for Crop Residue Management'. Agriharyana.gov.in. <https://agriharyana.gov.in/MechCRMScheme>.
- Government of Haryana. 2026c. 'Meri Fasal, Mera Byora Scheme'. Fasal.haryana.gov.in. <https://fasal.haryana.gov.in/>.
- Department of New and Renewable Energy (DNRE). 2018. Haryana Bio-Energy Policy 2018. Panchkula: Government of Haryana. <https://cdnbbsr.s3waas.gov.in/s3f80ff32e08a25270b5f252ce39522f72/uploads/2020/12/20201209100.pdf>.
- Gupta, Rajeev Kumar, Paramjit Kaur Sraw, Jasjit Singh Kang, Jagroop Kaur, Vivek Sharma, Neemisha Pathania, Anu Kalia, Nadhir Al-Ansari, Abed Alataway, Ahmed Z. Dewidar, and Mohamed A. Mattar. 2024. "Interactive Effects of Long-Term Management of Crop Residue and Phosphorus Fertilization on Wheat Productivity and Soil Health in the Rice–Wheat [System]." *Scientific Reports* 14: 1399. <https://doi.org/10.1038/s41598-024-51399-8>.
- Indian Oil Corporation Ltd. 2026. "SATAT (Sustainable Alternative Towards Affordable Transportation) – Overview." Last modified September 14, 2026. <https://iocl.com/pages/satat-overview>.
- Jack, B. Kelsey, Seema Jayachandran, Namrata Kala, and Rohini Pande. 2025. 'Money (Not) to Burn: Payments for Ecosystem Services to Reduce Crop Residue Burning'. *American Economic Review: Insights* 7 (1): 39–55. <https://doi.org/10.1257/aeri.20230431>.
- Jain, Srishti, Kurinji Kemanth, and Navjot Singh Sarao. 2025. Custom Hiring Centres for Better Crop Residue Management: Insights from Punjab. Council on Energy, Environment and Water. <https://www.ceew.in/publications/improving-access-to-crop-residuemanagement-solutions-with-custom-hiring-centres-in-agriculture>.
- Jha, Brajesh. 2008. 'Agricultural Diversification in India with Special Reference to Haryana'. *Agricultural Economics Research Centre Report Series*. New Delhi: Institute of Economic Growth. <https://iegindia.org/ardl/2008-bj.pdf>.

- Keil, Alwin, P. P. Krishnapriya, Archisman Mitra, Mangi L. Jat, Harminder S. Sidhu, Vijesh V. Krishna, and Priya Shyamsundar. "Changing Agricultural Stubble Burning Practices in the Indo-Gangetic Plains: Is the Happy Seeder a Profitable Alternative?" *International Journal of Agricultural Sustainability* 19, no. 2 (2021): 128–151. <https://doi.org/10.1080/14735903.2020.1834277>.
- Kemanth, Kurinji, Ayushman Saboo, and Srishti Jain. 2026. 'Why Wheat Stubble Burning Is Rising in India'. Council on Energy, Environment and Water (CEEW). <https://www.ceew.in/blogs/why-wheat-stubble-burning-rising-india>.
- Kemanth, Kurinji, Ramandeep Singh, and Sneha Ignatious. 2024. 'How Can Punjab Increase the Adoption of Crop Residue Management Methods?'. Council on Energy, Environment and Water (CEEW). <https://www.ceew.in/publications/how-can-punjab-adopt-crop-residue-management-methods-and-tackle-paddy-stubble-burning>.
- Krishnapriya, P. P., Subhrendu K. Pattanayak, E. Somanathan, Alwin Keil, M. L. Jat, H. S. Sidhu, and Priya Shyamsundar. 2024. "Mitigating Agricultural Residue Burning: Challenges and Solutions across Land Classes in Punjab, India." *Environmental Research: Food Systems* 1: 015001. <https://doi.org/10.1088/2976-601X/ad2689>.
- Kumar, Arvind, Ayushman Saboo, Navjot Sarao Singh, and Kurinji Kemanth. 2026. 'Behaviour Change Approaches to Tackle Stubble Burning at Scale'. Council on Energy, Environment and Water (CEEW). <https://www.ceew.in/publications/how-can-crop-residue-management-communication-drive-behaviour-change>.
- Latif, Muhammad Tahir, Muzzammil Hussain, Ali Zohaib, and Ishtiaq Hassan. 2024. 'Performance Evaluation of Super Seeder for Wheat Sowing in Rice-Wheat Cropping System of Pakistan'. *Sarhad Journal of Agriculture* 40 (1): 109–18. <https://doi.org/10.17582/journal.sja/2024/40.1.109.118>.
- Loch, Adam, Jay Cummins, Alec Zuo, Rohan Mr, and Eric Huttner. 2018. Final Report Small Research and Development Activity Project: Value Chain and Policy Interventions to Accelerate Adoption of Zero Tillage in Rice-Wheat Farming Systems across the Indo-Gangetic Plains. Project Number AGB/2017/027. Canberra: Australian Centre for International Agricultural Research (ACIAR).
- Lopes, Adrian A., Dina Tasneem, and Ajalavat Viriyavipart. 2023. 'Determinants of Wheat Residue Burning: Evidence from India'. *PLOS ONE* 18 (12): e0296059. <https://doi.org/10.1371/journal.pone.0296059>.
- Malik, Kamla, Jayanti Tokkas, Ramesh Chander Anand, and Nisha Kumari. 2015. "Pretreated Rice Straw as an Improved Fodder for Ruminants—An Overview." *Journal of Applied and Natural Science* 7 (1): 514–20. <https://doi.org/10.31018/jans.v7i1.640>
- Ministry of Agriculture & Farmers Welfare. 2019. Agriculture Census 2015-16 (Phase-I): All India Report on Number and Area of Operational Holdings. Prepared by the Agriculture Census Division, Department of Agriculture, Co-operation & Farmers Welfare. Government of India. https://www.fao.org/fileadmin/templates/ess/ess_test_folder/World_Census_Agriculture/WCA_2020/WCA_2020_new_doc/IND_REP_ENG_2015_2016.pdf.
- Ministry of Petroleum and Natural Gas. 2026. "Component-wise Operational Guidelines under the GOBARdhan Scheme for Development of the Compressed Biogas (CBG) Sector – reg." Office Memorandum F. No. L-16022/9/2025-GP-I-Part(1) (E:57024), September 15, 2026. https://mopng.gov.in/files/Whatsnew/GOBARdhan-Scheme_Component-wise-Guidelines.pdf
- Mishra, Ajay Kumar, Hitoshi Shinjo, Hanuman Sahay Jat, Mangi Lal Jat, Raj Kumar Jat, and Shinya Funakawa. 2024. 'Assessing the Impact of Rice-Wheat-Maize Residue Decomposition Rate and Nutrient Dynamics of Residue and Soil Using Different Placement Methods in the IGP of India'. *Frontiers in Sustainable Food Systems* 8 (November): 1409370. <https://doi.org/10.3389/fsufs.2024.1409370>.
- Ministry of Environment, Forest and Climate Change. 2025. "Air Pollution in NCR." Rajya Sabha Unstarred Question No. 1328, answered by Kirti Vardhan Singh, December 11, 2025. https://sansad.in/getFile/annex/269/AU1328_9zdCJP.pdf?source=pqars.
- Ministry of New and Renewable Energy. 2024. "Bio Energy Overview." Last modified May 21, 2024. <https://mnre.gov.in/en/bio-energy-overview/>.
- National Institute of Bio Energy. n.d. "Biomass Atlas." National Institute of Bio Energy. <https://nibe.res.in/english/biomass-atlas.php>.
- PIB (Press Information Bureau). 2023. 'Haryana to Bring down Fire Counts Substantially and Will Attempt near Elimination This Year, as per the Haryana State Action Plan for Management of Paddy Stubble Burning Submitted to CAQM'. New Delhi: Ministry of Environment, Forest and Climate Change, Government of India. 22 September 2023. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=1959679>.
- PIB (Press Information Bureau). 2024. "Minister Level Inter-Ministerial Meeting on the Issues of Management of Crop Residue Burning Held on Today." Ministry of Agriculture & Farmers Welfare, Government of India. October 26. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2068477®=48&lang=2>.
- PIB (Press Information Bureau). 2025. 'Paddy Harvesting Season 2025 Concludes with Significant Reduction in Farm Fire Incidents across Punjab and Haryana'. New Delhi: Ministry of Environment, Forest and Climate Change, Government of India. 5 December 2025. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2197201>.
- PIB (Press Information Bureau). 2026a. 'Union Agriculture Minister Shri Shivraj Singh Chouhan and Union Environment, Forest and Climate Change Minister Shri Bhupender Yadav Chair High-Level Meeting on Permanent Solution for Stubble Management'. New Delhi: Ministry of Agriculture & Farmers Welfare, Government of India. 17 April 2026. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2273815>.
- PIB (Press Information Bureau). 2026b. "Centre Accelerates Kharif Preparedness; Union Agriculture Minister Shri Shivraj Singh Chouhan Addresses Press Conference." Ministry of Agriculture & Farmers Welfare, Government of India. May 28 2026. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2266270®=48&lang=2>.

- PIB (Press Information Bureau). 2026c. "CAQM Reviews Supreme Court-Mandated Expert Report at 27th Meeting; PM2.5 Identified as Key Pollutant in Delhi." Ministry of Environment, Forest and Climate Change, Government of India, February 20 2026. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2230850®=3&lang=1>.
- PIB (Press Information Bureau). 2026d. "Cabinet Approves GOBARDhan, India's National Unified Scheme for Compressed Biogas, with an Outlay of Rs.23,731 Crore." Government of India. August 6, 2026. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2295480®=48&lang=1>.
- PIB (Press Information Bureau). 2026e. 'CAQM Issues Show Cause Notices to Six Thermal Power Plants within 300 Km of Delhi, for Non-Compliance of Biomass Co-Firing Norms'. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2207853>.
- PIB (Press Information Bureau). 2026f. 'Shri Jagat Prakash Nadda Highlights Implementation of MDA Scheme to Promote Organic Fertilizers from GOBARDhan and CBG Plants'. New Delhi: Ministry of Chemicals and Fertilizers, Government of India. 10 March 2026. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2237444>.
- Saboo, Ayushman, Kurinji Kemanth, and Harsha Arya. 2025. 'How Can Paddy Straw Storage Solutions Boost Biomass Supply Chain?'. Council on Energy, Environment and Water (CEEW). <https://www.ceew.in/publications/how-can-india-make-biomass-collection-storage-and-supply-chain-effective-with-paddy-straw-storage-solutions>.
- Sarnklong, C., J. W. Cone, W. F. Pellikaan, and W. H. Hendriks. 2010. 'Utilization of Rice Straw and Different Treatments to Improve Its Feed Value for Ruminants: A Review'. *Asian-Australasian Journal of Animal Sciences* 23 (5): 680–92. <https://doi.org/10.5713/ajas.2010.80619>.
- Sekhar, C. S. C., and Yogesh Bhatt. 2017. 'Relationship Between Wholesale Prices, Retail Prices, Export Prices (FOB) and Prices Realized by Farmers'. Agricultural Economics Research Centre (AERC) Research Report Series. Delhi: University of Delhi. <https://www.cabidigitallibrary.org/doi/full/10.5555/20183047904>.
- Singh, Nimisha, Rohit Pradhan, Bipasha Paul Shukla, and Mehul R. Pandya. 2025. "Evidence of Shift in Stubble Burning Timing over Northwest India from Geostationary Satellite Observations." *Current Science* 129 (10): 921–23. <https://doi.org/10.18520/cs/v129/i10/921-923>.
- TERI (The Energy and Resources Institute). 2021. Development of Spatially Resolved Air Pollution Emission Inventory of India. New Delhi: The Energy and Resources Institute. <https://www.teriin.org/sites/default/files/2021-05/Exxon-Report.pdf>.
- The Statesman. 2026. 'Haryana CM Digitally Releases over Rs 858 Crore under Key Welfare Schemes'. <https://www.thestatesman.com/india/haryana-cm-digitally-releases-over-rs-858-crore-under-key-welfare-schemes-1503542358.html>.
- Tuteja, Usha. 2015. Possibilities and Constraints in Adoption of Alternative Crops to Paddy in Green Revolution Belt of North India: Haryana. Research Study No. 2015/01. Delhi: Agricultural Economics Research Centre, University of Delhi. <https://aerc.du.ac.in/uploads/Possibilities%20and%20Constraints-Paddy%20Haryana-%20Usha%2020.pdf>





A well harvested paddy residue field using non burn residue management practice in Kurukshetra, Haryana

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