CEEW Crop Residue Management Survey - Punjab 2023

Survey Design and Data Quality Check

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Authors' contribution

Kurinji Selvaraj: Led the execution of the entire project, including survey and questionnaire design, enumerator training, data monitoring, cleaning, and analysis.
Ramandeep Singh: Led the enumerator training and contributed to the design, field-testing, and revision of the survey instrument, field supervision and data analysis.
Sneha Maria Ignatious: Contributed to field testing of the survey instrument, training of the enumerators, data monitoring, cleaning, and analysis.

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CEEW Crop Residue Management Survey - Punjab 2023

The Council on Energy, Environment and Water (CEEW) conducted an independent survey to assess the status of the adoption of zero-burn crop residue management (CRM) practices in Punjab. The survey covered 1478 farmers from 11 districts of Punjab between March and May 2023. We chose a sampling size to mirror Punjab's farmer population as per the latest agricultural census (2015)[1]. The selected districts – Amritsar, Bathinda, Fatehgarh Sahib, Fazilka, Firozpur, Gurdaspur, Jalandhar, Ludhiana, Patiala, Sangrur, and SBS Nagar – collectively accounted for about 58 per cent of the Kharif farm fires reported in Punjab in 2022. We hired a survey agency to administer the survey in Punjabi and Hindi.

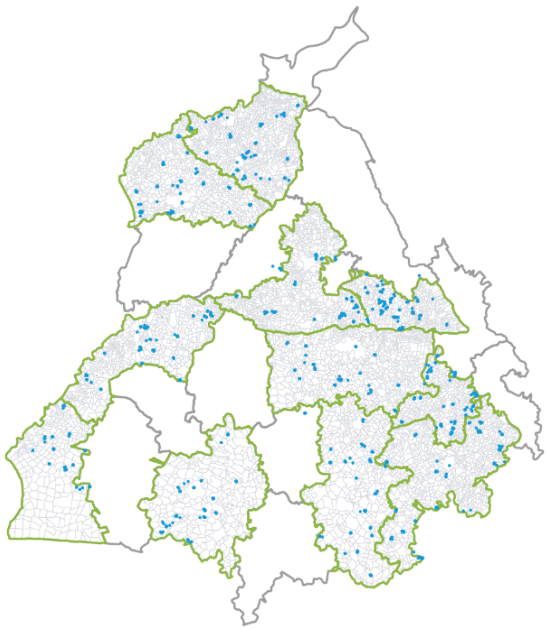
1.1 Multi-stage stratified sampling strategy

We used a random sampling approach with multiple levels of stratification (Figure T1). First, we categorised 22 districts of Punjab into 3 classes – high-burn, medium-burn, and low-burn districts. We chose the number of fire counts per unit area (1,000 acres) under non-basmati cultivation to categorise the districts (refer to Annexure). Districts with a fire count intensity in the first tertile (< 33.3 percentile value) were considered low-burn, districts in the middle tertile were considered medium-burn, and districts in the highest tertile (> 66.6 percentile) were considered high-burn. Given the logistical and resource constraints, we randomly sampled 3–4 districts in each category for a total of 11 districts across Punjab.

For the second level of stratification, using 2011 census data, we first categorised villages in each sampled district into two groups – small and large – based on their population size. From each village, we then sampled three small and marginal farmers, six semi-medium and medium farmers, and one large farmer to mirror Punjab's farmer population across different landholding categories. This formed our third level of stratification. Considering there is no comprehensive list at the farmer level, we adopted a convenience-based sampling approach to meet the target set on the number of farmers across different landholding categories in each village. Figure T2 describes the characteristics of the sample selected for this study.

[1] As per the standard rule, we considered the margin of error as 3 and the confidence interval as 95 per cent while deciding the sample size.

Figure T1 We employed a multi-stage stratified sampling approach, covering 1,478 farmers from 11 districts in Punjab



11 Districts
Stratified based on farm fire density

143 main villages
(5–10 backup villages in each district) *

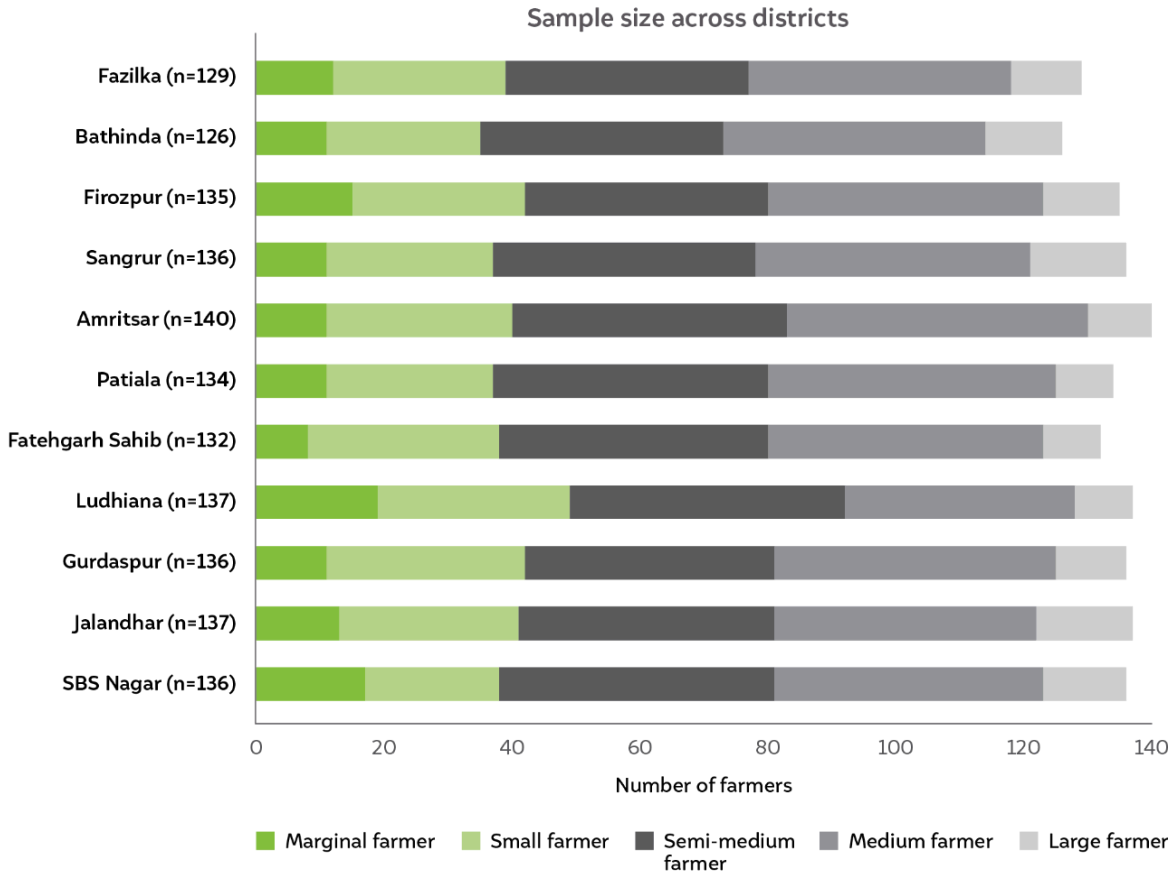
Probability proportional to size (PPS) sampling

1,478 farmers
(~10 farmers in each village)

Sampling through random walk

Three small and marginal farmers, six semi-medium and medium farmers, and one large farmer*

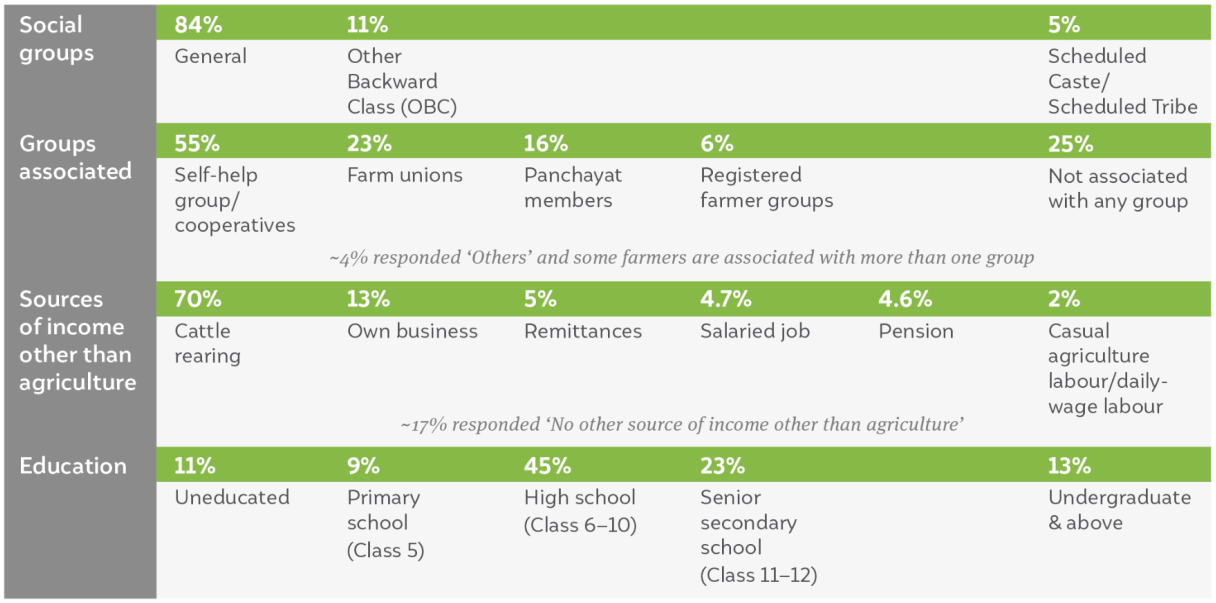
PPS sampling



Source: Authors' analysis

Note: We resorted to a list of backup villages in each district as the said number of farmers based on landholding categories, particularly in the case of large farmer groups, was difficult to meet in some villages. This is mainly because renting out land to other farmers (tenants) is common among farmers in the large landholding category in Punjab.

Figure T2 Sample characteristics



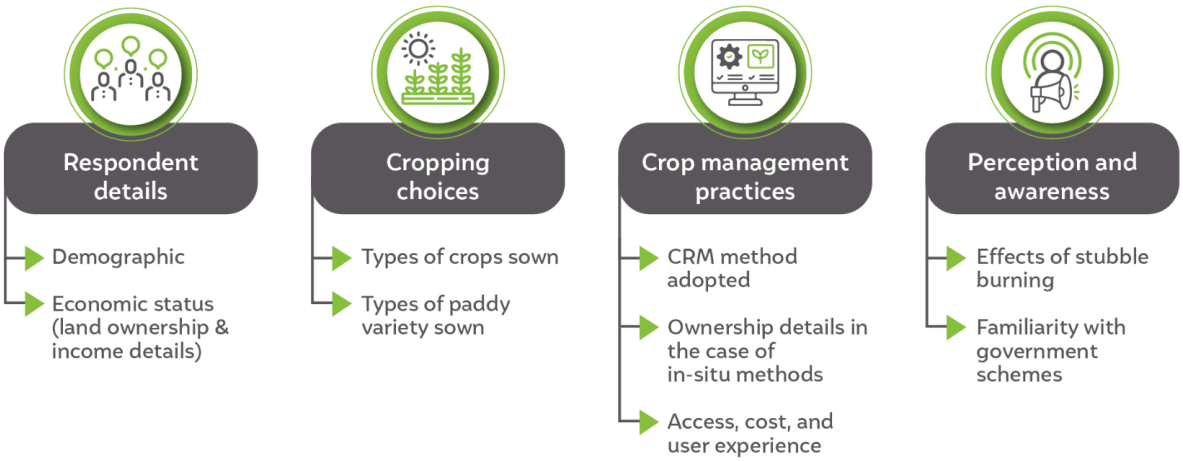
Source: Authors' analysis

1.2 Questionnaire design

We designed a structured questionnaire to capture farmers' behaviour on crop choices and CRM practices. The survey instrument included questions about farmers' preferences for different paddy seed varieties, the type of CRM method followed, experiences with the adoption of no-burn CRM methods, awareness of the effects of stubble burning and overall outlook, benefits, and challenges associated with the adoption of different CRM methods (Figure T3). The median time per interview was 20 minutes.

We developed the first draft of the questionnaire after reviewing the existing literature on crop residue burning and field interactions with farmers, Krishi Vigyan Kendras (KVKs), and agricultural officers. We revised the questionnaire after receiving inputs from experts within CEEW. Following that, we translated the questionnaire into Punjabi and piloted it in non-sampled villages in four districts–Ludhiana, Sangrur (Malerkotla), Patiala, and Rupnagar. The final questionnaire incorporated inputs from the pilot surveys.

Figure T3 Framework of the crop residue management survey questionnaire



Source: Authors' analysis

1.3 Qualitative interviews with farmers and agricultural officers

We conducted field visits in the Malwa region in October and November 2022, interviewing officials from agricultural departments and farmers to understand the current state of CRM practices. These interactions played a crucial role in shaping the design of our survey questionnaire. Following the completion of our primary survey, we interviewed KVK and agricultural department staff from three districts – Patiala, Fatehgarh Sahib, and Ludhiana – during the analysis phase in June 2023 to validate key findings of the survey.

1.4 Data quality and limitations

Survey responses are generally susceptible to numerous errors such as recall bias, enumerator bias, or measurement errors. To mitigate these issues and ensure data quality, we employed multiple strategies, such as building adequate checks, skips and value limits (upper and lower bounds) into the data collection software to reduce incorrect, missing, or invalid responses. The enumerators underwent thorough training to accurately code the diverse responses.

Throughout the data collection phase, we performed sanity checks on small data batches to identify gaps. We reported cases of incorrect responses to the survey agency for cross-verification or re-survey. Observations were dropped if the quality of the data was doubtful. We also visited multiple survey sites to observe the enumerators at work. This aided us in prescribing timely, corrective measures for the interview process and better understanding the context of the responses.

Despite these efforts, we cannot entirely overlook the possibility of errors in the survey data, such as the following:

- Questions on the expenditure incurred for buying or renting CRM machines are vulnerable to recall bias.
- The survey was administered in Punjabi. While we attempted to minimise translation and interpretation errors through pilot surveys, given the use of local terms and dialects for various farming processes, some questions may not have been administered adequately for a few farmers.
- In some cases, we observed that farmers were not honest about burning farm waste in the field. While we included adequate check questions to cross-verify the responses, there are possibilities for inaccurate responses in this variable. Therefore, we recommend prudence while using such data insights.

Annexure

Categorisation of Punjab's districts using farm fires

We categorised 22 districts of Punjab into three classes: high-burn, medium-burn, and low-burn districts, based on the number of fire counts per unit area (1,000 acres) under non-basmati cultivation. Districts with fire count intensity in the first tertile (< 33.3 percentile value) are considered low-burn, districts in the middle tertile are considered medium-burn, and districts in the highest tertile (> 66.6 percentile) are considered high-burn.

Table A1 Categorisation based on the number of open fires per 1,000 hectares under non-basmati cultivation

Categories	District	Area under non-basmati in 2020 ('000 hectare)	Fire counts during paddy residue burning in 2020	Fire counts per 1,000 hectares under non-basmati cultivation in 2020
Low-burn	Pathankot	28.6	24	0.839161
	SBS Nagar	60.9	199	3.267652
	Hoshiarpur	77.4	431	5.568475
	Rupnagar	37.3	251	6.729223
	SAS Nagar	26.7	201	7.52809
	Jalandhar	153.1	1,720	11.23449
	Gurdaspur	157.4	1,936	12.29987
Medium-burn	Kapurthala	109.7	1,507	13.73747
	Ludhiana	247.6	3,698	14.93538
	Fatehgarh Sahib	76.1	1,379	18.12089
	Patiala	213.3	4,722	22.13783
	Muktsar	180.4	4,762	26.3969
	Amritsar	87.7	2,389	27.24059
	Faridkot	108.2	3,299	30.48983
High-burn	Tarn Taran	130.7	4,026	30.80337
	Moga	177.9	5,599	31.47274
	Sangrur	244.8	8,805	35.96814

	Firozpur	167.3	6,110	36.52122
	Bathinda	167.2	6,954	41.59091
	Mansa	109.4	4,624	42.26691
	Fazilka	70.1	2,992	42.68188
	Barnala	99.3	4,274	43.04129

Source: CEEW compilation

Note: *33.3 percentile – 13.72; **66.6 percentile – 30.799. Darker shade indicates the randomly sampled survey districts.