

Cash or Lottery? Experimental Evidence on Incentive Design and Crop Residue Burning in Thailand

**Witsanu
Attavanich**

witsanu.a@ku.ac.th
+66 2 561 3474

Department of
Economics
Faculty of Economics
Kasetsart University
Thailand

**Adrian A.
Lopes**

alopes@aus.edu
+971 6 515 4691

Department of
Economics
American
University of
Sharjah, UAE

Sailesh Tiwari

stiwari@worldbank.org
+1 401 3385813

World Bank
Thailand

**Ajalavat
Viriyavipart^{*,1}**

Ajalavat.V@Chula.ac.th
+66 2 218 6275

Faculty of Economics
Chulalongkorn University
Thailand
* Corresponding author

¹ AV and AL acknowledge the receipt of a Faculty Research Grant (#FRG22-C-B48) from the American University of Sharjah, which enabled primary data collection in Thailand. ST acknowledges financial support from the Climate Support Facility (CSF) Whole of Economy Program administered by the World Bank. WA gratefully acknowledges financial support from the SVITA Foundation (Maevadi Karnchanachari Navapan and Karnitha Karnchanachari) and the Senior Research Scholar Grant from the National Research Council of Thailand (NRCT). The authors extend their sincere thanks to Siwabhorn Pipitpukdee and Juthamas Prerattanasup for their invaluable assistance in coordinating the data collection. They gratefully acknowledge the Department of Agricultural Extension for coordinating with local officers and facilitating field data collection from farmers, and the Geo-Informatics and Space Technology Development Agency (Public Organization) (GISTDA) for its technical assistance in GIS and guidance on satellite-based burned-area verification. The authors also thank the students and staff of Kasetsart University for their significant contributions to the data collection process.

Abstract

Postharvest crop residue burning (CRB) contributes substantially to air pollution, greenhouse gas emissions, and public health damages across many parts of Asia. This paper examines how alternative incentive designs affect farmers' burning behavior, with a particular focus on whether incentives with identical expected monetary values generate different behavioral responses. We report results from a randomized field experiment involving 299 rice farmers in three provinces of Thailand. Farmers were assigned to one of three incentive schemes conditional on verified non-burning: a guaranteed individual payment, a lottery-based payment with an equivalent expected value, or an anonymous group-based incentive, alongside a control group. Compliance was measured using satellite imagery and field verification. Individually targeted incentives significantly reduced CRB, but their effectiveness varied across designs. Guaranteed payments reduced burning by approximately 9 percentage points, while lottery-based incentives reduced burning by approximately 14 percentage points despite having the same expected payout. Regression estimates controlling for observable characteristics and subdistrict fixed effects confirm the robustness of these findings. In contrast, anonymous group-based incentives had no detectable effect on burning behavior. The results suggest that incentive design can substantially influence environmental compliance even when expected payments are held constant. An illustrative cost-benefit analysis suggests that scaling the lottery-based intervention could generate approximately US\$220 million in avoided air-pollution damages at an estimated cost of US\$46 million. The findings provide evidence on the design of cost-effective and scalable policies for reducing agricultural burning and improving environmental outcomes.

Keywords: Crop residue burning; Payment for ecosystem services; Field experiment; Behavioral incentives; Lottery-based payments.

JEL codes: C93, D91, O13, Q52, Q56

1. Introduction

Postharvest crop residue burning (CRB) is a persistent agricultural practice across much of Asia, contributing substantially to regional air pollution, greenhouse gas emissions, and public health crises. The persistence of CRB characterizes a public good problem. Farmers may recognize that burning contributes to haze and environmental degradation, but individual restraint is seen as futile if neighboring farmers continue to burn. Individual incentives to burn dominate even though collective welfare would improve if all refrained. The policy challenge lies not only in addressing economic constraints but also in designing institutional and incentive structures that encourage shifting toward coordinated non-burning. Although many countries formally prohibit open burning, monitoring and enforcement are especially difficult and costly in rural areas where regulatory capacity is limited. Consequently, the widespread prevalence of CRB reflects not a lack of regulation, but weak enforcement of existing policies at the local level (Yu et al., 2025). Economic instruments—such as subsidies or payments for environmental services—are increasingly used to influence environmentally harmful practices (Börner et al., 2017; Jack et al., 2025). Yet the design and targeting of such instruments remain an open empirical question since the outcomes of payments for environmental service schemes can vary by known program design and local contexts (Börner et al., 2017).

This paper presents a field experiment conducted in Thailand to empirically evaluate the effectiveness of individually-targeted and group-based financial incentives in reducing CRB. The experimental design introduces various conditional cash payment schemes tied to verifiable non-burning behavior. We compare a fixed cash payment with a probabilistic (lottery-based) payment, where expected earnings are equivalent across treatments but the incentive structure differs in its behavioral framing. In addition, farmers are randomly and anonymously assigned to small groups to allow us to test whether collective rewards can offset

incentives to free-ride. This design enables us to examine whether social structures and group accountability affect compliance with environmental regulations if financial incentives were to be contingent on group-level performance.

Despite growing awareness of the environmental, health, and economic costs of CRB, the adoption of sustainable residue management practices remains limited across much of the Global South. Studies have employed a range of empirical approaches—including household surveys, quasi-experimental analyses, and field experiments—to investigate the persistence of burning behavior. Studies examining farmer choices and policy reviews often indicate that alternatives to burning are perceived as both financially constraining and/or logistically impractical. Key barriers include limited access to machinery, high labor and time requirements, difficulties with farmland plowing, and underdeveloped markets for crop residue reuse (Attavanich et al., 2026; Bhuvaneshwari et al., 2019; Erbaugh et al., 2024; Garg et al., 2024; Lopes et al., 2020; Parihar et al., 2023).

These structural constraints often interact with behavioral factors—such as adherence to social norms, collective action failures, and risk perceptions—further reinforcing reliance on burning as the default management strategy. Related research has explored how financial incentives and informational interventions shape farmer decision-making. Field experiment, quasi-experiment, and natural experiment studies have examined several pathways to reduce CRB, such as: addressing liquidity constraints through partial up-front payments to farmers (Jack et al., 2025), deploying conditional financial incentives along with informational nudges (Lopes et al., 2023), institutional support mechanisms such as having access to biomass power plants that purchase crop residue from nearby farmers (Nian, 2023), incentives for bureaucrats tasked with controlling burning (Dipoppa & Gulzar, 2024), and the role of women leaders as pathways

for change (Jagnani & Mahadevan, 2025). These approaches collectively demonstrate substantial potential to reduce burning.

While incentives and behavioral nudges can influence individual decision-making, the scalability and generalizability of approaches across different contexts remain active areas of research. To meaningfully inform policy, studies highlight the importance of proper experimental design and implementation, and increasing the generalizability of findings and their long-term impacts (Al-Ubaydli et al., 2017; Czibor et al., 2019). Economic instruments that succeed in one agro-ecological or cultural setting may fail in another if they do not align with the local norms of cooperation, prevailing social structures, and other motivating factors. Such heterogeneity warrants further empirical research in diverse institutional and cultural contexts—particularly those where collective resource management and social interdependence could play important roles—to identify mechanisms that facilitate more systemic changes in pro-environmental behavior.

The academic literature has increasingly examined probabilistic incentives as a mechanism for promoting socially desirable behaviors. Compared with guaranteed payments, probabilistic rewards can increase the salience and attractiveness of incentives while maintaining similar expected costs. Empirical evidence suggests that such incentives can influence a wide range of behaviors, including healthy eating, weight management, physical activity (Boonmanunt et al., 2023), compliance with public transportation ticket purchases (Fabbri et al., 2019), and bicycling (Ciccone et al., 2021). Proposed explanations include heightened attention to potential rewards, greater engagement with the incentive scheme, and the tendency of individuals to respond differently to uncertain rewards than to equivalent guaranteed payments. These features make probabilistic incentives a potentially cost-effective policy tool for encouraging behavioral change.

The effectiveness of probabilistic incentives is likely to depend on context. Prior research suggests that responses to lottery-based rewards can vary across settings and populations, and that attitudes toward risk and uncertainty do not always translate consistently into real-world behavior (Rommel et al., 2019). Moreover, probabilistic incentives may not uniformly outperform deterministic incentives in all environments (Meiselman et al., 2022). These findings highlight the importance of examining such mechanisms in specific institutional and cultural contexts.

Thailand provides a particularly relevant setting for this inquiry. State lotteries are deeply embedded in Thai society and attract widespread participation across socioeconomic groups (Matters, 2025; Momkaew, 2023; Pusaksrikit et al., 2018). Because lottery participation is both familiar and socially accepted, lottery-based incentives may be especially salient and credible to farmers. This raises the possibility that probabilistic rewards could represent a cost-effective mechanism for encouraging environmentally beneficial behavior, such as reducing crop residue burning.

While previous research has examined the effectiveness of monetary incentives in promoting environmentally beneficial behavior, relatively little is known about how different incentive structures influence farmers' decisions regarding crop residue burning. This study contributes to the literature by comparing three distinct incentive mechanisms—a fixed payment, a probabilistic lottery payment, and a group-based payment scheme—within a framed field experiment. By holding expected payments constant across the fixed-payment and lottery treatments, we isolate the role of incentive structure in shaping behavior. The group-payment treatment further allows us to examine whether incentives tied to collective outcomes can overcome or exacerbate free-rider problems inherent in environmental externalities. Together,

these treatments provide new evidence on how alternative policy designs affect farmers' adoption of non-burning practices.

Methodologically, the study combines behavioral experimental data, socioeconomic survey responses, and satellite-based remote sensing with ground-truth verification to provide a robust measure of compliance—offering an integrated approach to evaluating environmental policy outcomes. By addressing both the economic and social-behavioral dimensions of CRB, this paper will examine how culturally-relevant behavioral mechanisms could complement policy interventions in promoting sustainable agriculture. The following section outlines the experimental design and conceptual foundation used to test individual and group-based incentive treatments in rural Thailand. We describe the structure of the field experiment, the random assignment of treatments, and the procedures for data collection and verification.

2. Methodology

This study evaluates whether targeted individual incentives or group-based incentives are more effective in encouraging farmers to adopt non-burning practices. To do so, we implement a framed field experiment comprising a control group and three treatment arms: Fixed Payment (FP), Lottery Payment (LP), and Group Payment (GP). Incentive levels are calibrated using original survey data collected in April–May 2024 (Attavanich et al., 2026). Farmers' revenues from rice and straw, combined with production and residue-management costs—including plowing, baling, fuel, herbicides, microbial decomposers, and labor—indicate that burning produced a net financial advantage of approximately 150 THB per rai.² To offset this

² US\$ 1 was approximately 34 THB during the study period; 1 rai = 0.395 acres; 150 THB/rai translates to approximately US\$11.17/acre.

opportunity cost and ensure that incentives are economically meaningful, we set compensation for verified non-burning at 200 THB per rai, capped at 10 rai.

2.1 Treatment Design

Farmers were randomly assigned to one of four experimental arms described above. Regardless of treatment assignment, all participants received a participation payment of 150 THB per visit, for a total of 300 THB across the two field visits. The payment structures and incentive rules associated with each experimental arm are summarized in Table 1.

Table 1. Experimental Treatments and Payment Structures

Group	Payment Rule
Control (C)	No treatment incentive (participation payment only)
Fixed Payment (FP)	200 THB/rai for verified non-burning (cap: 10 rai)
Lottery Payment (LP)	300 THB/rai or 100 THB/rai with equal probability for verified non-burning (cap: 10 rai)
Group Payment (GP)	Group-based payment depending on the number of verified non-burners in the group (cap: 10 rai)

Note: All participants received a participation payment of 150 THB per visit (300 THB in total across two field visits), regardless of treatment assignment.

Control Group (C): Farmers in the control group received only the participation payment, which compensated them for time spent during each field visit (150 THB per visit, or 300 THB in total across the two visits).

Fixed Payment (FP): In this treatment farmers received a guaranteed cash payment of 200 THB per rai, capped at 10 rai, conditional on verified non-burning of rice straw. Payments were calibrated to reflect the estimated cost of adopting non-burning alternatives, based on data collected in the baseline survey (Attavanich et al., 2026). This treatment reflects a feasible policy shift: whereas Thailand currently provides agricultural subsidies largely independent of residue-management practices, redirecting subsidies toward verified non-burning behavior could reduce environmental and public health damages at a similar fiscal cost.

Lottery Payment (LP): This treatment is based on Thai farmers' widespread participation in state lotteries (Matters, 2025; Momkaew, 2023; Pusaksrikit et al., 2018). Farmers who refrained from burning received either 300 THB per rai or 100 THB per rai with equal probability, with payments capped at 10 rai. The expected payment is therefore identical to that under the FP treatment. The outcome was determined using the last two digits of the official government lottery number. Prior to the draw, farmers selected one of two number ranges (00–49 or 50–99). If the winning number fell within the farmer's chosen range, the farmer received 300 THB per rai; otherwise, the farmer received 100 THB per rai.

While guaranteed compensation may be insufficiently attractive due to relatively small cash amounts, a lottery-based incentive allows policymakers to offer a larger potential reward without increasing expected fiscal expenditure. Because the expected payment is identical to that under the FP treatment, this design allows us to isolate the effect of incentive structure from incentive magnitude and test whether a probabilistic reward can generate stronger behavioral responses than a guaranteed payment of equal expected value.

Group Payment (GP): This treatment reflects the limited feasibility of monitoring burning at the individual level. In many settings, satellite-based fire detection occurs at the community scale, making it difficult to tie incentives to individual behavior. To mimic such policies, farmers were randomly assigned to anonymous groups of four, with members unaware of one another's identities or actions. Compensation depended on group performance rather than individual behavior and was proportional to cultivated area, capped at 10 rai. If at least two group members were verified non-burners, all four received compensation regardless of their own burning decision: 200 THB per rai if all four were non-burners, 150 THB if three were non-burners, and 100 THB if two were non-burners. No compensation was provided if only one or none were verified non-burners. This treatment allows us to assess whether collective

incentives can encourage non-burning when rewards depend on group outcomes. Because group membership was anonymous, farmers could neither monitor nor coordinate with others, limiting direct social pressure or accountability.

2.2 Study Sites and Sampling

The study was conducted in seven subdistricts across three provinces—Nakhon Nayok, Ayutthaya, and Chachoengsao—selected for their proximity to Bangkok and their high incidence of crop residue burning (CRB). Satellite data from GISTDA (2024) recorded 345, 114, and 89 fire hotspots, respectively, between January 1 and March 11, 2024, making these provinces the highest-burning rice-producing areas near the Bangkok metropolitan region. Figure 1 shows the locations of the study sites.

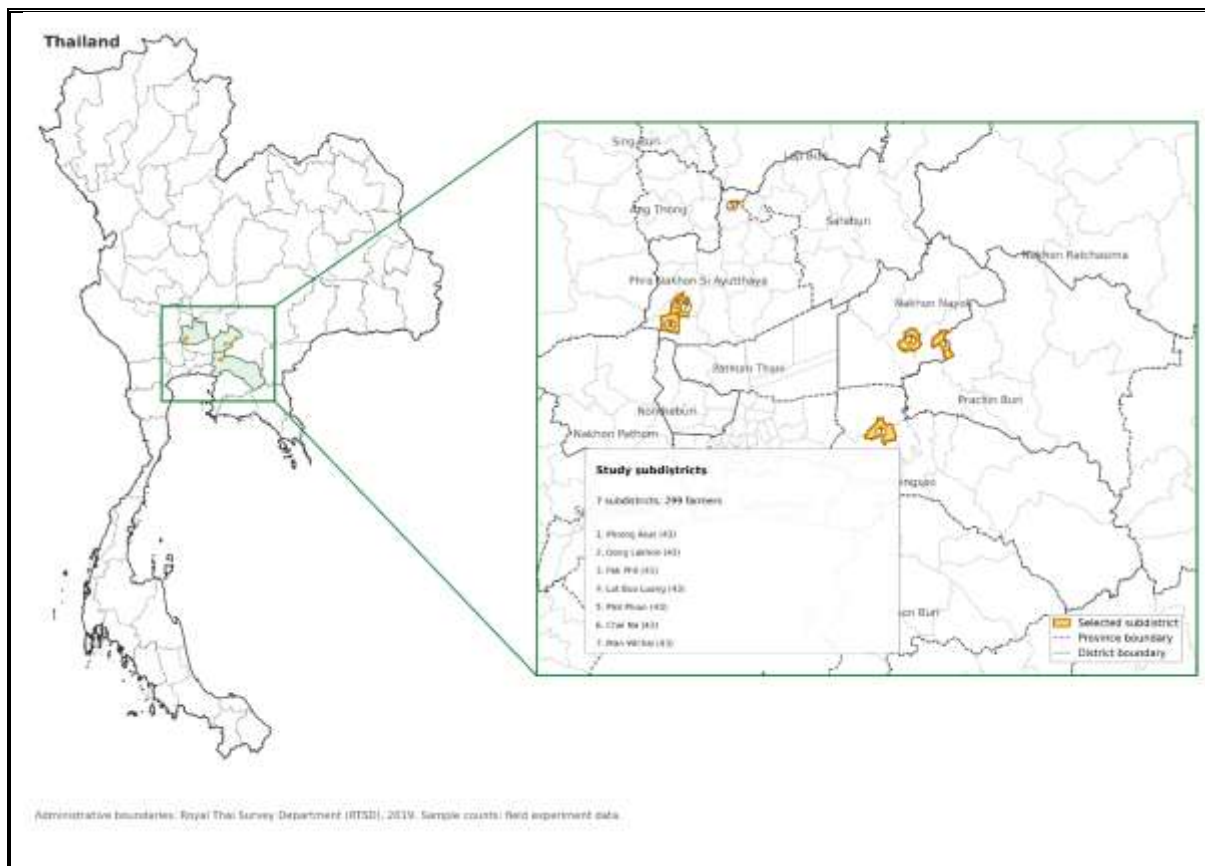


Figure 1: Selected sites and distribution of sampled rice-farming households.

Source: (Attavanich et al., 2026)

Site selection was motivated by both environmental urgency and the potential for substantial economic and public health consequences of CRB. Figure 2 presents the distribution of agricultural fire hotspots by crop type during 2020–2025. Rice accounts for the majority of recorded hotspots, underscoring the importance of focusing on rice residue burning in this study. Bangkok and its surrounding provinces are among Thailand’s most densely populated and economically important regions. In 2024, the Bangkok Metropolitan Region had a population of approximately 16.44 million, including an estimated 5.61 million unregistered migrant workers—roughly one-quarter of Thailand’s total population of 65.95 million (DPA, 2024; NSO, 2024). As a result, crop residue burning in nearby agricultural areas has the potential to generate substantial environmental, health, and economic costs.

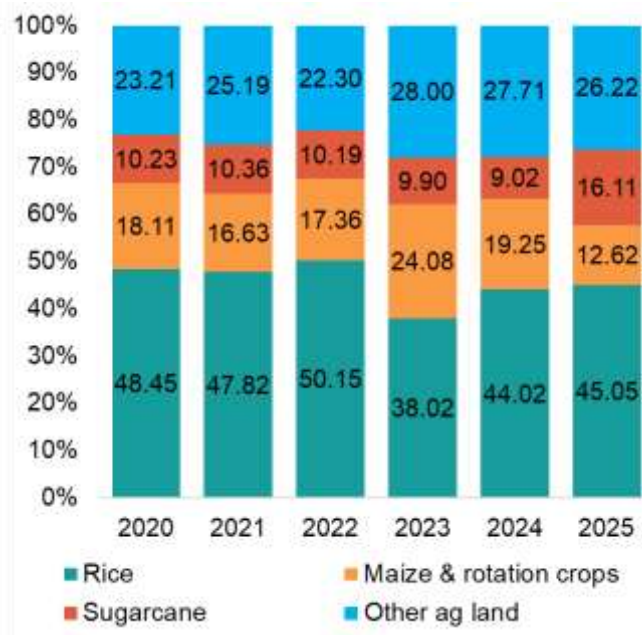


Figure 2. Proportion of hotspots by crop variety. Source: GISTDA (2025).

A total of 299 rice farmers were recruited from the seven study subdistricts and randomly assigned to one of four experimental arms. Randomization was stratified at the subdistrict level to ensure a balanced distribution of participants across treatments within each study area.

To assess statistical power, we conducted calculations using baseline burning rates from (Attavanich et al., 2026), in which approximately 64 percent of farmers reported crop residue burning. Assuming a two-sided test with a 5 percent significance level and 80 percent power, detecting treatment effects of slightly above 20 percentage points—equivalent to roughly a one-third reduction relative to baseline burning rates—required approximately 75 farmers per experimental arm. To provide an additional margin of safety against attrition and implementation constraints, we initially targeted approximately 100 farmers per experimental arm, consistent with the pre-analysis plan registered in the AEA RCT Registry (Attavanich et al., 2024). However, due to field logistics and budget constraints, the final analytical sample consists of 299 farmers across the four experimental groups.

2.3 Survey Implementation and Verification

Round 1: Initial Visit and Contract Assignment

Initial visits were conducted from December 2024 to January 2025. Enumerators visited farmers at their fields, administered a structured questionnaire, and explained assigned contracts according to experimental terms. Randomization occurred at the individual farmer level within each study subdistrict. Enumerators photographed plots, recorded GPS coordinates, and documented reported plot size and pre-burning conditions to enable later compliance verification. In February 2025, farmers received phone reminders of contract terms and associated incentives.

Round 2: Burning Verification

Follow-up visits took place during April–May 2025, after rice harvest and before preparation for the subsequent crop, ensuring that any burning activity had already occurred. Prior to field visits, satellite imagery was reviewed to identify burn scars at the plot level. Enumerators

revisited study plots to verify burning through visual inspection, photographs, and georeferenced records. Combining remote sensing with ground-truth verification enabled accurate classification of residue burning. Treatment plots were digitized as GIS polygons using the *Cropsdrought* application developed by the Geo-Informatics and Space Technology Development Agency (GISTDA) and served as the spatial unit of analysis (Figures 3–4).

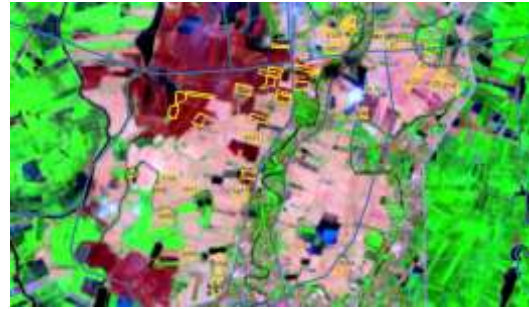
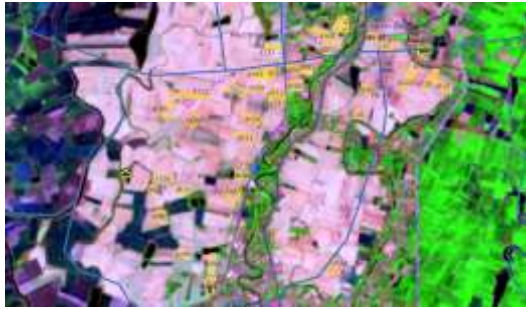
For each study area, paired pre- and post-harvest satellite images were compiled to define a burning window and support change-based interpretation. We used surface reflectance products from Sentinel-2 MSI (Level 2A) and Landsat Collection 2 Level 2 (Landsat 8/9), obtained from the ESA Copernicus Open Access Hub and the USGS archive, respectively. Figure 3 illustrates Sentinel-2 imagery for Phitphian Subdistrict in Phra Nakhon Si Ayutthaya Province (pre: 9 Feb 2025; post: 1 Mar 2025) and a broader Landsat example for three subdistricts in Nakhon Nayok Province (pre: 15 Jan 2025; post: 31 Jan 2025). Scene identifiers are reported in the figure captions to ensure reproducibility.

Satellite scenes were imported into QGIS and overlaid with plot polygons for plot-level interpretation using visible and near-infrared bands (20 m resolution for Sentinel-2; 30 m for Landsat). Burned plots were identified based on burn-scar signatures appearing in post-event imagery relative to pre-event baselines. Under the visualization scheme used in Figures 3–4, burn scars appear as contiguous dark pink/purple patches. A plot was classified as burned when this signature overlapped the plot polygon. The paired-date approach reduced misclassification associated with single-date imagery, such as confusion with bare soil, harvest residue, or temporary flooding.

To validate satellite classifications, enumerators conducted field verification and documented physical evidence of CRB (e.g., blackened surfaces) through direct observation and photographs. Figure 4 illustrates this linkage for a selected plot in Phitphian Subdistrict, where

field observations correspond closely to satellite-detected burn scars. Field verification also helped resolve discrepancies between self-reported and observed burning behavior, improving the reliability of the final burned/not-burned indicator.

Plots at Phitphian subdistrict, Maha Rat District, Phra Nakhon Si Ayutthaya province:

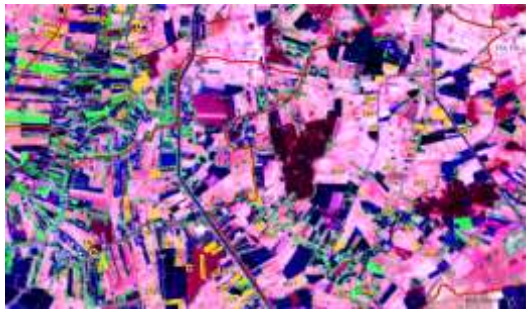


Before burning: February 9, 2025
 (map was derived from a Sentinel-2A MSI image.)
 Tile ID: 47PPS, Scene ID:
 S2B_MSIL2A_20250209T033819_N0511_R061_T47PPS_
 20250209T071508

After burning: March 1, 2025
 Scene ID:
 S2B_MSIL2A_20250301T033559_N0511_R061_T47PPS_
 20250301T061709

The original data was obtained from the ESA Copernicus Open Access Hub. The analysis utilized the visible and near-infrared bands at a 20 m spatial resolution.

Plots at three subdistricts (Dong Lakhon, Tha Ruea, and Pak Phil) in Nakhon Nayok province:



Before burning: January 15, 2025
 (map was derived from a Landsat8 image.)
 Path 129 Row 050, Scene ID: LC08_L2SP_129050_20250115_
 20250127_02_T1

After burning: January 31, 2025
 Scene ID: LC08_L2SP_129050_20250131_20250208_02_T1

The original data was obtained from the USGS (United States Geological Survey) Open Access Hub.

Figure 3: Satellite imagery of select treatment plots showing before and after burning windows.

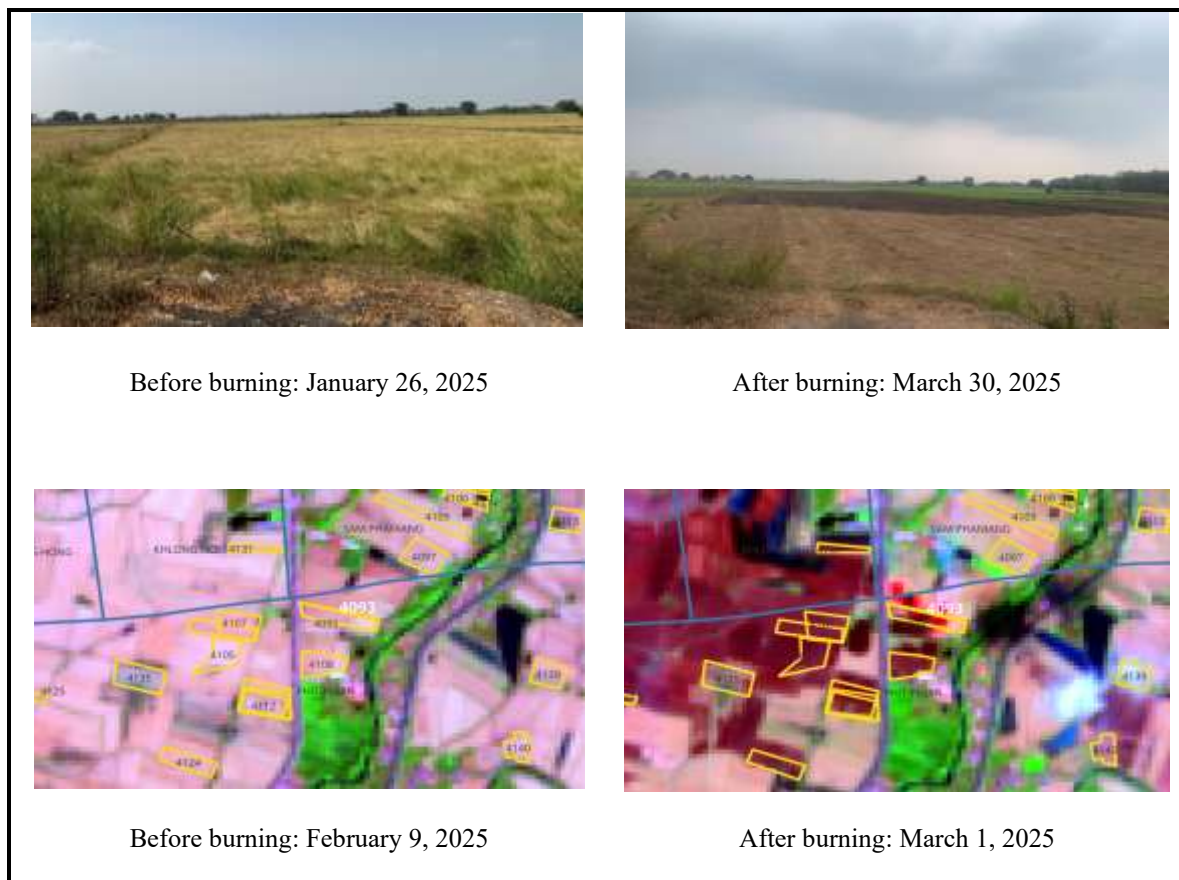


Figure 4: Ground-truthing of satellite imagery for a selected plot (#4093 in Phitphian Subdistrict, Maha Rat District, Phra Nakhon Si Ayutthaya Province)

Outcome Measurement

The primary outcome variable is a binary indicator equal to one if a farmer’s study plot was classified as burned during the post-harvest period and zero otherwise. Burning status was determined using the combined satellite and field-verification procedure described above, capturing actual rather than self-reported behavior. Following verification, incentive payments were disbursed according to each experimental contract.

3. Results

We begin by assessing the success of the randomization through balance tests on baseline characteristics across the control and treatment groups. We then present raw differences in crop residue burning rates by treatment and evaluate their statistical significance using two-sample tests of proportions. Finally, we estimate logistic regression models to confirm the robustness of the treatment effects while controlling for observable farmer and farm characteristics and accounting for geographic fixed effects. This progression—from balance tests to unconditional treatment effects and then to multivariate regression analysis—allows us to transparently evaluate the causal impact of alternative incentive designs on crop residue burning behavior.

3.1 Balance Tests

Table 2 reports baseline characteristics for the Control group (C) and the three treatment groups—Fixed Payment (FP), Lottery Payment (LP), and Group Payment (GP). For each variable, the table presents percentages of farmers in each category by experimental group. Stars indicate statistically significant differences between each treatment group and the control group based on tests of equality of means for binary indicators, while differences in the distribution of soil-quality perceptions are evaluated using a chi-square test. This table summarizes a broad set of pre-treatment characteristics, including prior crop residue burning behavior, farm size and land tenure, access to government support, existing residue-management practices, and farmers' perceptions regarding the health and soil-quality impacts of burning.

Table 2. Baseline Characteristics by Treatment Group

Variable	C	FP	LP	GP
Self-reported CRB in previous season	73.33%	68.83%	72.00%	72.22%
Age	60.95	59.70	58.47	57.82
Education \geq Grade 9	21.33%	27.27%	28.00%	34.72%*
Small farm (< 20 rais)	30.67%	22.08%	37.33%	37.50%
Exclusively rented rice land	18.67%	15.58%	18.67%	18.06%
No government support	81.33%	80.52%	85.33%	81.94%
Use composting	20.00%	16.88%	13.33%	27.78%
Use machinery incorporation	28.00%	36.36%	26.67%	26.39%
Perceive CRB as common practice	74.67%	71.43%	77.33%	80.56%
Perceive adverse health impacts	45.33%	42.86%	48.00%	52.78%
Perceived effects of CRB on soil quality:				
- No effect / Don't know	41.33%	35.06%	46.67%	30.56%
- Improve soil quality	12.00%	15.58%	13.33%	20.83%
- Diminish soil quality	46.67%	49.35%	40.00%	48.61%
Number of farmers	75	77	75	72

Notes: 1) All entries are percentages of farmers unless otherwise stated. *Age* is measured in years. *Education \geq Grade 9* equals one if the farmer has completed at least secondary education. *Small farm* indicates cultivated land of less than 20 rais. *Exclusively rented rice land* equals one if all rice-cultivated land is rented. *No government support* equals one if the farmer reports receiving no government assistance to reduce crop residue burning. *Perceives CRB as common practice* equals one if the farmer reports that burning is “very common” or that “everybody does it” in the village. *Perceives adverse health impacts* equals one if the farmer reports intermediate or severe health impacts on burners and their families. *Soil quality* categories reflect farmers’ perceptions of the effect of burning on soil quality.

2) C = Control; FP = Fixed Payment; LP = Lottery Payment; GP = Group Payment.

3) Stars denote statistically significant differences relative to the control group based on tests of equality of means for binary indicators (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$). Differences in the distribution of soil-quality perceptions are assessed using a chi-square test.

The distribution of observations across experimental arms is balanced, with each group accounting for approximately one quarter of the sample. Importantly, self-reported crop residue burning in the previous cropping season is highly comparable across groups, suggesting that treatment assignment was orthogonal to prior burning behavior. Other key farm characteristics—such as the prevalence of small farms, the share of farmers operating exclusively on rented rice land, and the use of composting or machinery incorporation—also exhibit minimal variation across groups. Likewise, farmers’ perceptions of the health consequences of crop residue burning and beliefs about its effects on soil quality are broadly similar across experimental arms.

Across all baseline variables examined, only one difference—educational attainment in the Group Payment treatment—reaches statistical significance at the 10% level.³ Given the number of balance tests conducted, this isolated difference is consistent with chance rather than systematic imbalance. Taken together, the evidence from Table 2 indicates that randomization successfully generated comparable groups along observable characteristics. This provides a credible foundation for attributing any observed differences in crop residue burning behavior, if present, to the treatment assignment rather than to pre-existing differences among farmers.

3.2 Crop Residue Burning Outcomes by Treatment

We next examine post-treatment crop residue burning outcomes across experimental groups. Table 3 reports the percentage of farmers observed to burn crop residues in each treatment group, along with the tests comparing each treatment to the control group. Figure A1 in the Appendix provides a graphical illustration of these treatment differences.

Table 3. Post-Treatment Observed Crop Residue Burning Rates by Treatment Group

Treatment Group	Burning Rate (%)	Standard Error
Control (C)	29.33	5.26
Fixed Payment (FP)	22.08	4.73
Lottery Payment (LP)	17.33**	4.37
Group Payment (GP)	31.94	5.49

Note: Stars indicate statistically significant differences from the control group (* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$).

³ Using survey data in (Attavanich et al., 2026), higher educational attainment is seen to be positively associated with crop residue burning. In the experimental data analyzed here, educational attainment is not statistically significant in the regression specifications (Tables 3 and A1). To the extent that the Group Payment treatment includes a slightly higher share of more educated farmers, this imbalance would bias against finding a reduction in burning in this group.

Observed burning rates in the control group are 29.3 percent. Burning rates are lower in both the FP and LP treatments, at 22.1 percent and 17.3 percent, respectively. The reduction in burning in the LP treatment is statistically significant at the 5 percent level relative to the control group, while the difference for the FP treatment is not statistically significant at conventional levels. In contrast, the GP treatment exhibits a burning rate of 31.9 percent, which is slightly higher than that of the control group, though the difference is not statistically significant.

Overall, these unconditional comparisons suggest that individual-level incentives—particularly when framed as a lottery—are associated with lower rates of crop residue burning, whereas the group-based incentive does not reduce burning relative to the control group. In the next subsection, we formally assess these patterns using regression analysis that controls for observable characteristics and accounts for geographic variation.

3.3 Regression Analysis

To formally assess the effects of the experimental treatments on post-treatment crop residue burning, we estimate a sequence of logit regression models. Table A1 (in the Appendix) reports the logit coefficient estimates, while Table 4 presents the corresponding average marginal effects, expressed as percentage-point changes in the probability of crop residue burning. Models (1) and (2) include only treatment indicators; Models (3) and (4) additionally control for baseline farm characteristics and farming practices; and Models (5) and (6) further incorporate farmers' beliefs and perceptions regarding crop residue burning. Models (2), (4), and (6) include subdistrict fixed effects, whereas Models (1), (3), and (5) do not. Robust standard errors are clustered at the subdistrict level in all specifications.

Table 4. Average Marginal Effects for Crop Residue Burning

(Binary dependent variable: Using CRB—Yes = 1, No = 0)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Fixed Payment (FP)	-0.070*** (0.018)	-0.083*** (0.017)	-0.084*** (0.026)	-0.096*** (0.018)	-0.078*** (0.029)	-0.093*** (0.030)
Lottery Payment (LP)	-0.126* (0.070)	-0.141* (0.078)	-0.130** (0.066)	-0.143* (0.074)	-0.139** (0.057)	-0.142** (0.070)
Group Payment (GP)	0.023 (0.024)	0.023 (0.029)	0.023 (0.031)	0.022 (0.029)	0.007 (0.027)	0.007 (0.023)
Education \geq Grade 9			0.049* (0.028)	0.033 (0.032)	0.047 (0.042)	0.033 (0.054)
Small farm (< 20 <i>rais</i>)			-0.081 (0.066)	-0.073 (0.064)	-0.076 (0.056)	-0.062 (0.061)
Exclusively rented rice land			-0.151** (0.072)	-0.031 (0.083)	-0.129** (0.060)	-0.043 (0.083)
No government support			0.090 (0.077)	0.125 (0.080)	0.108 (0.074)	0.138 (0.087)
Use composting			-0.038 (0.068)	-0.024 (0.071)	-0.038 (0.073)	-0.023 (0.086)
Use machinery incorporation			-0.026 (0.070)	0.020 (0.037)	-0.024 (0.065)	0.013 (0.038)
Perceive as common practice					0.239*** (0.065)	0.176 (0.117)
Perceive adverse health impacts					-0.008 (0.061)	-0.027 (0.075)
Soil Quality (Diminishes)					0.053 (0.060)	0.064 (0.059)
Soil Quality (Improves)					0.03 (0.071)	0.067 (0.066)
Fixed effects	No	Subdistrict	No	Subdistrict	No	Subdistrict
No. of farmers	299	256	299	256	299	256

Notes: 1) Reported marginal effects are average marginal effects computed from the logit models reported in Table A1 in the Appendix. All control variables are defined as in Table 2.

2) *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

3) Robust standard errors are reported in parentheses and are clustered at the subdistrict level in all models.

4) For soil quality, responses indicating no effect or uncertainty are the omitted base category.

The regression results broadly reinforce the patterns documented in the raw comparisons, while demonstrating that these relationships persist after accounting for observable characteristics and unobserved geographic heterogeneity. The estimated treatment effects remain remarkably stable

across specifications, suggesting that the observed differences in burning behavior are not driven by pre-existing differences in farmer characteristics, farming practices, beliefs, or location.

The FP treatment is associated with a statistically significant reduction in crop residue burning across all six specifications. As reported in Table 4, the estimated average marginal effects range from approximately 7.0 to 9.6 percentage points, with significance at the 1 percent level throughout. The consistency of these estimates after the inclusion of farm-level controls, belief variables, and subdistrict fixed effects indicates that guaranteed individual compensation is effective in encouraging farmers to adopt non-burning residue management practices.

The LP treatment generates even larger effects. Across all specifications, farmers assigned to the LP treatment are approximately 12.6–14.3 percentage points less likely to burn crop residue than farmers in the control group. Relative to the control-group burning rate of 29.3 percent, this corresponds to a reduction of roughly 43–49 percent. The estimated effects remain stable across specifications and are statistically significant at the 5% level in Models (3), (5), and (6), and at the 10% level in the remaining specifications. The magnitude and robustness of the LP effect suggest that lottery-based incentives may be particularly effective in motivating behavioral change, despite having the same expected monetary value as the FP treatment.

In contrast, the GP treatment does not significantly affect crop residue burning in any specification. The estimated effects are small in magnitude and statistically indistinguishable from zero throughout. These findings suggest that the anonymous group-based incentive scheme was ineffective in altering individual burning decisions relative to the control group. A plausible explanation is that farmers could not observe or identify other group members, limiting trust,

coordination, and accountability within the group. As a result, collective incentives may have been insufficient to motivate individual compliance.

Turning to the control variables, few baseline farm characteristics, farming practices, or belief variables exhibit robust associations with post-treatment burning outcomes. Educational attainment is positively associated with burning in Model (3), while farmers cultivating exclusively rented rice land are less likely to burn in Models (3) and (5). Farmers who perceive crop residue burning as a common practice within their community are also more likely to burn in Model (5), consistent with a potential role for local norms in shaping residue-management decisions. However, none of these associations remain statistically significant once subdistrict fixed effects are included. Overall, the effects of the control variables are considerably less robust than those of the experimental treatments, whose estimated impacts remain stable across all specifications.

Taken together, the regression evidence confirms that individual-level incentives can substantially reduce environmentally harmful behavior such as crop residue burning. Both the FP and LP treatments generate economically meaningful and statistically robust reductions in burning across all specifications, with the LP treatment consistently producing the largest effects. The persistence of these estimates after controlling for observable farmer characteristics, farming practices, beliefs, and subdistrict fixed effects strengthens the causal interpretation of the findings. In contrast, the absence of effects for the GP treatment suggests that anonymous collective payment schemes may be less effective than individually targeted incentives in this context, potentially because they weaken individual accountability and create opportunities for free-riding. Overall, the regression results reinforce the unconditional comparisons and indicate that the observed reductions in

burning behavior are driven by the experimental treatments rather than by pre-existing differences among farmers.

4. Discussion

4.1 Incentive Design and Behavioral Responses

This study provides causal evidence that how incentives are designed can matter as much as how much they pay in shaping farmers' crop residue burning (CRB) decisions. The Fixed Payment (FP) and Lottery Payment (LP) treatments significantly reduced burning, while the Group Payment (GP) treatment had no detectable effect. Results point to the importance of incentive framing, salience, and implementation features beyond standard price incentives.

The FP treatment lowered CRB by about 7 percentage points, indicating that farmers respond to a certain, immediate payment for compliance. This aligns with standard economic reasoning: when the reward for non-burning is clear, credible, and directly linked to individual behavior, farmers adjust accordingly. Yet the FP effect was modest relative to LP, despite similar expected payouts.

The LP treatment reduced CRB by around 14 percentage points, suggesting the delivery mechanism itself affected behavior. Under LP, compliant farmers received either 300 THB or 100 THB per rai depending on the last two digits of the official government lottery, with farmers choosing their preferred digit range in advance. Several features likely contributed to this stronger effect. First, the possibility of a larger reward may have made the incentive more salient than a guaranteed payment with the same expected value. Second, allowing farmers to select their number range may have increased engagement and strengthened the perceived connection between action and outcome. Third, using the official government lottery embedded the incentive in a familiar,

transparent, and socially recognized institution. In Thailand, where lottery participation is widespread, this likely enhanced credibility and acceptance. These features plausibly explain why the lottery-based incentive generated larger behavioral responses than the fixed payment, even though expected costs were comparable.

The GP treatment produced no reduction in burning, consistent with the possibility that anonymous collective compensation weakens the link between individual action and personal reward. Because payouts depended on group performance and were implemented anonymously, farmers had limited ability to monitor one another, coordinate actions, or hold each other accountable. The null effect should not be read as evidence against all group-based incentives. Rather, it suggests group payments are unlikely to work well when anonymity prevents peer monitoring, reputational pressure, and a clear perception that individual effort affects the collective outcome.

From a policy perspective, these findings imply that incentive design should not be treated as a secondary detail. The LP results indicate that behavioral features can materially improve program performance without increasing expected fiscal cost. This is especially relevant for environmental policy where governments face tight budget constraints. A practical implication is that programs may benefit from preserving the key elements that made the lottery treatment effective: transparency, credibility, salience, and a direct behavioral link. Farmers do not merely respond to payment size; they also respond to how rewards are structured and communicated.

Implementation feasibility is also important. In Thailand, the Department of Agricultural Extension maintains a comprehensive farmer registry with plot-level GIS information, and satellite imagery can verify burning behavior at scale. These systems create a feasible administrative foundation for incentive schemes conditioning rewards on verified non-burning. A lottery-based

system could therefore be operationalized within existing public infrastructure, making it more realistic than many environmental incentive programs that depend on new, expensive monitoring systems.

The findings also speak to the broader role of institutions in policy design. Incentives that are transparent and tied to familiar public mechanisms may be easier to communicate and generate stronger compliance. In this case, the official lottery likely served as more than a payout device; it may have enhanced perceived program legitimacy. This matters because farmers' willingness to participate in environmental schemes often depends on whether they trust the allocation rule and believe the payment is enforceable. Designs that appear complicated, arbitrary, or poorly monitored may fail even when expected value is attractive.

The policy lesson is not that governments should necessarily scale up literal lotteries as a permanent feature. Rather, environmental programs may benefit from incorporating behavioral design elements that make rewards more salient and credible. A transparent bonus system, a randomized reward component, or a hybrid design combining a guaranteed base payment with an additional salient reward may capture similar advantages. What matters is that the scheme preserves clarity, fairness, and a strong behavioral link between compliance and compensation.

At the same time, the results caution against relying on anonymous group incentives. Collective arrangements may be attractive because crop burning often occurs at the village or landscape level, and policymakers may hope shared payments promote cooperation. However, collective schemes are unlikely to be effective when participants cannot observe one another or identify who is responsible for compliance. Without social visibility, group payments may dilute accountability

and fail to overcome individual incentives to burn. Future collective programs would likely need stronger local governance, visible membership, and peer monitoring.

The study also suggests information alone is insufficient. Farmers may understand that burning has environmental and health costs, yet still burn because private benefits remain substantial and alternatives are costly or inconvenient. Therefore, extension messages about air pollution, public health, or soil degradation should be paired with practical support that lowers compliance costs, such as access to machinery services, straw collection and trading channels, composting facilities, or other residue-management options.

Monitoring and verification are central to any scalable scheme. Satellite-based detection, combined with plot-level registries and targeted field audits, offers a workable hybrid system that helps preserve credibility—critical for sustaining participation and maintaining fairness. If farmers believe cheating is easy or compliant farmers are not reliably compensated, participation will deteriorate quickly.

Overall, the findings show that incentive design, delivery mechanisms, and institutional context jointly shape environmental compliance. The strongest takeaway is that behaviorally informed policy can improve environmental performance without requiring proportionally larger expenditures. This has clear relevance for countries trying to reduce agricultural burning while maintaining fiscal discipline.

4.2 Cost–Benefit Analysis of Scaling Lottery Incentives

Because the LP treatment generates the largest and most consistent reduction in crop residue burning, we use its estimated treatment effect to conduct an illustrative cost–benefit assessment of

scaling the intervention to Thailand’s off-season rice sector. The objective is not to provide a precise estimate of nationwide benefits, but rather to evaluate whether the potential social gains from reduced air pollution are likely to exceed the fiscal costs of implementing the program.

Table 5 presents the resulting calculations. The analysis is based on 546,814 off-season rice-farming households, an average cultivated area of 18.39 rai, and the estimated treatment effect from our experiment. Under the baseline assumptions, the LP intervention reduces the prevalence of crop residue burning by approximately 14.2 percentage points, lowering the expected number of burning households from roughly 160,000 to 138,000 nationwide.

The estimated program cost consists of incentive payments to households that comply with the non-burning condition. Under the observed treatment effect, total annual incentive payments are estimated at approximately USD 46.3 million. To estimate benefits, we begin with Thailand’s annual air-pollution costs and attribute a conservative share of these damages to agricultural burning and rice residue burning specifically.⁴ Under the baseline assumptions reported in Table 5, the reduction in burning behavior is associated with approximately USD 220 million in avoided air-pollution damages.

⁴ Because no study reports a directly observed national annual ambient PM2.5 share attributable specifically to domestic agricultural burning, we use 10% as a conservative annual central assumption, rather than as a literal midpoint of the hotspot evidence. The detailed GISTDA land-use appendix tables show that agricultural classes—rice, maize and shifting cultivation, sugarcane, and other agricultural land—accounted for a substantial share of national fire hotspots during the burning season. However, these figures refer to hotspot counts during January–May, not to annual ambient PM2.5 concentrations, and hotspot counts are not directly proportional to emissions or exposure. Moreover, agricultural burning is highly seasonal, whereas transport and industrial sources emit throughout the year. This implies that the annual contribution of domestic agricultural burning to national PM2.5 exposure should be materially lower than its share in seasonal hotspots. This conservative interpretation is also consistent with source-attribution modeling for Thailand, which finds that crop burning contributes less than 6% of PM2.5 in North Thailand during the haze season, while non-crop burning and transboundary biomass burning are substantially more important (Thongsame et al., 2025). We therefore adopt 10% as a cautious baseline value for the agricultural component alone.

Table 5. The Cost–Benefit Analysis of Implementing Lottery-Based Incentives

Items	Value
Cost items	
1. Total number of off-season rice farming HHs ¹	546,814
2. Average landholding of off-season rice farming (rai) ¹	18.39
3. Incentives not to burn (USD per rai) ²	6.15
4. Baseline burning prevalence (%) ²	29.33
5. Number of HHs that burnt ³	160,381
6. Estimate impact of incentives (reduction in burning) ²	14.2
7. Number of HHs that burnt post treatment ⁴	137,607
8. Number of HHs eligible for incentive payments ⁵	409,207
Total payments (USD)⁶	46,309,697
Benefit items	
9. Thailand's GDP (market prices in 2024) USD ⁷	574,888,769,231
10. Cost of air pollution in USD (@6% of GDP) ⁸	34,493,326,154
11. PM2.5 attributable to agricultural crop burning (%) ⁹	10
12. Contribution of rice (within agriculture) (%) ¹⁰	45
13. Cost of air pollution attributable to rice (USD) ¹¹	1,552,199,677
Averted cost of air pollution due to the program (benefit in USD)¹²	220,412,354
Benefit/cost ratio¹³	4.76

Source: Authors' calculations.

Note: ¹(Economics, 2025); ²Finding from this study; ³Calculated from items 1 & 4; ⁴Calculated from items 5 & 6; ⁵Calculated from items 1 & 7; ⁶Calculated from multiplying items 2, 3 & 8; ⁷(ONESDC, 2025); ⁸(WB, 2022); ⁹(Thongsame et al., 2025) and (GISTDA, 2024, 2025); ¹⁰(GISTDA, 2025); ¹¹Calculated from multiplying items 10, 11 & 12; ¹²Calculated from multiplying items 6 & 13; and ¹³Divided the averted cost of air pollution due to the program by total payments.

Comparing estimated benefits and costs yields a benefit–cost ratio of approximately 4.76, implying that each dollar spent on the LP program generates nearly five dollars in avoided pollution-related damages. While the precise magnitude depends on the underlying assumptions, the results suggest that the social benefits of the intervention substantially exceed its implementation costs.

Several considerations should be kept in mind when interpreting these estimates. First, the superior performance of the LP treatment is particularly noteworthy because it was designed to have the same expected payment as the FP treatment. The larger behavioral response therefore reflects differences in incentive structure rather than higher expected expenditures, suggesting that policymakers may be able to achieve greater reductions in burning without proportionately increasing fiscal costs. Second, the analysis assumes that the treatment effect observed in the study would generalize to a broader population of rice farmers. Program effectiveness may vary across regions with different agronomic conditions, social norms, and residue-management practices. Third, large-scale implementation would require investments in monitoring, reporting, and verification systems, as well as administrative oversight to ensure accurate payment disbursement. However, Thailand's existing farmer registry and satellite-monitoring infrastructure may substantially reduce these implementation costs relative to settings lacking such systems.

The reported estimates should also be viewed as conservative. The analysis focuses on a single agricultural season and does not account for potential longer-run behavioral changes. If repeated participation encourages farmers to adopt non-burning practices beyond the duration of the program, the long-run benefits could exceed those reported here. Moreover, the calculations include only avoided air-pollution damages and therefore exclude other potential benefits associated with reduced crop residue burning, including improvements in soil quality, lower greenhouse-gas emissions, and other environmental and public-health gains. Taken together, these considerations suggest that the estimated benefit–cost ratio should be interpreted as an illustrative but conservative estimate of the potential social returns from lottery-based incentives.

5. Conclusion and Policy Recommendations

Probabilistic incentives can outperform guaranteed payments in reducing environmentally harmful farming practices. In this study, the lottery-based treatment produced the largest decline in crop residue burning while expected fiscal cost remained low. By contrast, anonymous group-based compensation was ineffective. These results suggest conditional incentives can usefully complement conventional regulation and subsidy programs, but only when they preserve individual accountability and are designed to be salient, credible, and easy to understand.

First, crop residue burning cannot be solved through information or enforcement alone. Baseline patterns indicate farmers burn because they face practical constraints and because burning remains socially common. Policy must address the underlying economics of residue management—non-burning practices need to become financially viable and operationally feasible, not simply recommended.

Second, individual conditional payments can reduce burning at scale. Both fixed-payment and lottery-payment schemes significantly lowered burning relative to the control group, supporting results-based environmental support where farmers are rewarded for verified non-burning. The larger treatment effect under the lottery design suggests reward structure matters: a scheme offering the possibility of a larger payoff may generate stronger responses than a certain but less salient payment, even when expected values are similar. A practical model would be an environmental bonus system with clear eligibility rules, credible verification, and a visible reward structure, presented as a clean-air reward rather than a substitute for responsible agricultural policy.

Third, anonymous group incentives should be used cautiously. Their effectiveness depends on visibility, monitoring, and social accountability. Group designs without identifiable responsibility

may be too weak to change behavior. Future programs should avoid purely anonymous collective payments and instead consider hybrid approaches combining individual rewards with community-level components, especially where local institutions support monitoring and reputational pressure.

Fourth, information campaigns should be bundled with practical alternatives. Awareness is unlikely to offset labor, machinery, timing, and liquidity constraints that make burning attractive. Extension efforts should be paired with services and infrastructure that lower compliance costs, including access to machinery operators, straw markets, composting options, and timely payment systems.

Scaling such incentives requires credible, low-cost verification. Satellite-based detection provides an efficient screening tool, complemented by targeted ground-truthing and random audits. A hybrid monitoring system keeps administrative costs manageable while preserving credibility—particularly important in settings with small plots, variable cloud cover, and mixed land uses. This monitoring architecture also strengthens the external validity of the intervention because many rice-growing areas now face a similar policy problem: governments can increasingly observe burning behavior, but still need incentive designs that induce compliance at reasonable fiscal cost.

The scope for scaling these findings extends beyond the three study provinces, but should be understood as conditional on context rather than automatic. The study sites share several features with many other rice-growing areas in Thailand: short post-harvest windows, limited access to timely residue-management services, imperfect enforcement of burning bans, and the growing feasibility of plot-level monitoring using satellite and field verification. In such settings, lottery-based incentives may be especially useful because they make a given expected reward more salient, transparent, and behaviorally engaging, particularly where public lottery draws are familiar

and trusted. This does not imply that policy should promote gambling, nor that lottery incentives are universally superior to fixed payments. Rather, the evidence suggests that a transparent randomized bonus can strengthen compliance when farmers face time, liquidity, and coordination constraints. The mechanism may also be relevant for neighboring Mekong countries, including Myanmar, Lao PDR, Cambodia, and Vietnam, where agricultural burning remains a persistent environmental and public-health challenge and where residue-management constraints are broadly similar. However, cross-country transfer should be preceded by local pilots or preference-elicitation exercises to assess the legality, familiarity, and social acceptability of lottery-like rewards. Thus, the broader policy lesson is not about lotteries per se, but about designing incentive schemes that are credible, locally legible, and behaviorally salient while remaining fiscally affordable.

The cost–benefit results further support policy adoption. With estimated program payments of USD 46.31 million and avoided air-pollution damages of USD 220.41 million, the benefit–cost ratio of 4.76 suggests a lottery-based incentive scheme would be socially profitable. Conditional incentives should be viewed as a transitional instrument rather than a permanent subsidy. The longer-run objective is to reduce dependence on direct payments by building market and institutional infrastructure that makes non-burning privately viable—including competitive machinery-service markets, straw collection and trading systems, biomass and compost value chains, and access to finance for residue-management technologies.

Future research could extend the analysis in three directions. First, examine whether treatment effects persist after incentives are withdrawn. Second, evaluate how conditional incentives can be designed as transitional instruments linked to self-sustaining markets for straw management.

Third, study mechanisms behind the stronger lottery response—reward salience, familiarity with lottery institutions, framing, or other behavioral channels—using experimental designs that vary payment size, probability, timing, and framing.

Taken together, the evidence suggests behaviorally informed environmental policy can deliver meaningful reductions in crop residue burning at relatively low cost. Environmental compliance depends not only on prices and enforcement, but also on the institutional form through which incentives are delivered. Policies that are transparent, credible, and aligned with local norms can generate stronger responses than policies focusing only on payment size. For countries facing severe air-pollution burdens and limited fiscal space, this is a practical and scalable lesson.

Declaration of generative AI and AI-assisted technologies in the writing process:

During the preparation of this work the authors used ChatGPT in order to improve the readability and language of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

References:

- Al-Ubaydli, O., List, J. A., LoRe, D., & Suskind, D. (2017). Scaling for Economists: Lessons from the Non-Adherence Problem in the Medical Literature. *The Journal of Economic Perspectives*, 31(4), 125-144. <https://doi.org/10.1257/jep.31.4.125>
- Attavanich, W., Lopes, A., Tiwari, S., & Viriyavipart, A. (2024). Cash Transfers, Lotteries, and Group Incentives: Experimental Evidence on Reducing Crop Residue Burning in Thailand. In: AEA RCT Registry.
- Attavanich, W., Lopes, A. A., Tiwari, S., & Viriyavipart, A. (2026). Heat after the Harvest: Farmer Choices and Perceptions of Crop Residue Burning in Thailand. *World Development*, 206, 107466. <https://doi.org/https://doi.org/10.1016/j.worlddev.2026.107466>
- Bhuvaneshwari, S., Hettiarachchi, H., & Meegoda, J. N. (2019). Crop Residue Burning in India: Policy Challenges and Potential Solutions. *Int. J. Environ. Res. Public Health*, 16, 832.
- Boonmanunt, S., Pattanaprteep, O., Ongphiphadhanakul, B., McKay, G., Attia, J., Vlaev, I., & Thakkinstian, A. (2023). Evaluation of the Effectiveness of Behavioral Economic Incentive Programs for Goal Achievement on Healthy Diet, Weight Control and Physical Activity: A Systematic Review and Network Meta-analysis. *Annals of Behavioral Medicine*, 57(4), 277-287. <https://doi.org/10.1093/abm/kaac066>
- Börner, J., Baylis, K., Corbera, E., Ezzine-de-Blas, D., Honey-Rosés, J., Persson, U. M., & Wunder, S. (2017). The Effectiveness of Payments for Environmental Services. *World Development*, 96, 359-374. <https://doi.org/https://doi.org/10.1016/j.worlddev.2017.03.020>
- Ciccione, A., Fyhri, A., & Sundfør, H. B. (2021). Using behavioral insights to incentivize cycling: Results from a field experiment. *Journal of Economic Behavior & Organization*, 188, 1035-1058. <https://doi.org/https://doi.org/10.1016/j.jebo.2021.06.011>
- Czibor, E., Jimenez-Gomez, D., & List, J. A. (2019). The Dozen Things Experimental Economists Should Do (More of). *Southern Economic Journal*, 86(2), 371-432. <https://doi.org/https://doi.org/10.1002/soej.12392>
- Dipoppa, G., & Gulzar, S. (2024). Bureaucrat incentives reduce crop burning and child mortality in South Asia. *Nature*, 634(8036), 1125-1131. <https://doi.org/10.1038/s41586-024-08046-z>
- DPA. (2024). *Population Statistics by Province*. Department of Provincial Administration. Retrieved September from <https://stat.bora.dopa.go.th/stat/statnew/statMONTH/statmonth/#/displayData>
- Economics, O. o. A. (2025). *Off-season rice cultivation: Number of households cultivating off-season rice, classified by land area size at the national, regional, and provincial levels, 2024*. <https://oae.go.th/uploads/files/2025/10/02/854a272e840fd323.pdf>
- Erbaugh, J., Singh, G., Luo, Z., Koppa, G., Evans, J., & Shyamsundar, P. (2024). Farmer perspectives on crop residue burning and sociotechnical transition in Punjab, India. *Journal of Rural Studies*, 111, 103387. <https://doi.org/https://doi.org/10.1016/j.jrurstud.2024.103387>
- Fabbri, M., Nicola Barbieri, P., & Bigoni, M. (2019). Ride Your Luck! A Field Experiment on Lottery-Based Incentives for Compliance. *Management Science*, 65(9), 4336-4348. <https://doi.org/10.1287/mnsc.2018.3163>
- Garg, T., Jagnani, M., & Pullabhotla, H. K. (2024). Rural Roads, Farm Labor Exits, and Crop Fires. *American Economic Journal: Economic Policy*, 16(3), 420-450. <https://doi.org/10.1257/pol.20220422>
- GISTDA. (2024). *Summary report on the wildfire and haze situation using space and geospatial technology*. <https://disaster.gistda.or.th/services/download?type=fire>
- GISTDA. (2025). *Summary report on the wildfire and haze situation using space and geospatial technology*. <https://disaster.gistda.or.th/services/download?type=fire>
- Jack, B. K., Jayachandran, S., Kala, N., & Pande, R. (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>

- Jagnani, M., & Mahadevan, M. (2025). Women leaders improve environmental outcomes: Evidence from crop fires in India. *Journal of Public Economics*, 248, 105443. <https://doi.org/https://doi.org/10.1016/j.jpubeco.2025.105443>
- Lopes, A. A., Tasneem, D., & Viriyavipart, A. (2023). Nudges and compensation: Evaluating experimental evidence on controlling rice straw burning. *Ecological Economics*, 204, 107677. <https://doi.org/https://doi.org/10.1016/j.ecolecon.2022.107677>
- Lopes, A. A., Viriyavipart, A., & Tasneem, D. (2020). The role of social influence in crop residue management: Evidence from Northern India. *Ecological Economics*, 169, 106563. <https://doi.org/https://doi.org/10.1016/j.ecolecon.2019.106563>
- Matters, B. (2025). *For most people, buying a lottery ticket is a toss-up between hope and habit. But in Thailand, it's something else entirely—part ritual, part social tradition, and very much a business.* Capital Business Media. <https://bmmagazine.co.uk/business/the-business-of-belief-thai-lotteries-are-more-than-a-game/>
- Meiselman, B. S., Weigel, C., Ferraro, P. J., Masters, M., Messer, K. D., Savchenko, O. M., & Suter, J. F. (2022). Lottery Incentives and Resource Management: Evidence from the Agricultural Data Reporting Incentive Program (AgDRIP). *Environmental and Resource Economics*, 82(4), 847-867. <https://doi.org/10.1007/s10640-022-00690-1>
- Momkaew, C. (2023). *Lottery: The Hope for Upward Mobility.* Chulalongkorn University. <https://www.chula.ac.th/en/highlight/106356/>
- Nian, Y. (2023). Incentives, penalties, and rural air pollution: Evidence from satellite data. *Journal of Development Economics*, 161, 103049. <https://doi.org/https://doi.org/10.1016/j.jdeveco.2023.103049>
- NSO. (2024). *Summary of Key Results: Latent Population in Thailand.* https://www.nso.go.th/nsoweb/storage/survey_detail/2025/20250307115511_20860.pdf
- ONESDC. (2025). *The National income of Thailand.* <https://www.nesdc.go.th/info/thailands-national-income/>
- Parihar, D. S., Narang, M. K., Dogra, B., Prakash, A., & Mahadik, A. (2023). Rice residue burning in Northern India: an assessment of environmental concerns and potential solutions – a review. *Environmental Research Communications*, 5(6), 062001. <https://doi.org/10.1088/2515-7620/acb6d4>
- Pusaksrikit, T., Pongsakornrunsilp, S., Chinchanchokchai, S., & Crosby, E. (2018). The superstitious journey of Thai lottery gamblers. *Journal of Marketing Management*, 34(13-14), 1126-1148. <https://doi.org/10.1080/0267257X.2018.1513420>
- Rommel, J., Hermann, D., Müller, M., & Mußhoff, O. (2019). Contextual Framing and Monetary Incentives in Field Experiments on Risk Preferences: Evidence from German Farmers. *Journal of Agricultural Economics*, 70(2), 408-425. <https://doi.org/https://doi.org/10.1111/1477-9552.12298>
- Thongsame, W., Henze, D. K., Barth, M., Pfister, G., Kumar, R., Macatangay, R., & Hassan Bran, S. (2025). Source Attribution and Health Burden of PM2.5 in Mainland Thailand. *GeoHealth*, 9(9), e2024GH001315. <https://doi.org/https://doi.org/10.1029/2024GH001315>
- WB. (2022). *The Global Health Cost of PM2.5 Air Pollution: A Case for Action Beyond 2021.* *International Development in Focus.* <https://documents1.worldbank.org/curated/en/455211643691938459/pdf/The-Global-Health-Cost-of-PM-2-5-Air-Pollution-A-Case-for-Action-Beyond-2021.pdf>
- Yu, Z., Hao, J., & Si, W. (2025). Enhancing the Local Enforcement of Straw-Burning Regulation by Digital Technology: evidence From China. *Agricultural Economics*, 56(4), 604-621. <https://doi.org/https://doi.org/10.1111/agec.70003>

APPENDIX

Appendix A. Additional Regression Results

Table A1. Logit Regression Results for Crop Residue Burning

(Binary dependent variable: Using CRB—Yes = 1, No = 0)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Fixed Payment (FP)	-0.382*** (0.0704)	-0.462*** (0.0924)	-0.467*** (0.104)	-0.551*** (0.116)	-0.453*** (0.143)	-0.548*** (0.184)
Lottery Payment (LP)	-0.683* (0.349)	-0.786* (0.452)	-0.725** (0.349)	-0.819* (0.438)	-0.809** (0.318)	-0.837** (0.422)
Group Payment (GP)	0.123 (0.138)	0.129 (0.162)	0.126 (0.170)	0.128 (0.170)	0.0433 (0.157)	0.0416 (0.139)
Education ≥ Grade 9			0.272 (0.189)	0.189 (0.187)	0.274 (0.263)	0.195 (0.315)
Small farm (< 20 <i>rais</i>)			-0.453 (0.313)	-0.417 (0.370)	-0.442 (0.278)	-0.362 (0.362)
Exclusively rented rice land			-0.845* (0.488)	-0.180 (0.477)	-0.750* (0.420)	-0.251 (0.501)
No government support			0.500 (0.464)	0.714 (0.474)	0.630 (0.493)	0.812 (0.552)
Use composting			-0.211 (0.364)	-0.137 (0.403)	-0.224 (0.409)	-0.138 (0.507)
Use machinery incorporation			-0.145 (0.389)	0.116 (0.214)	-0.140 (0.375)	0.0746 (0.225)
Perceive as common practice					1.394** (0.564)	1.035 (0.723)
Perceive adverse health impacts					-0.0456 (0.357)	-0.159 (0.440)
Soil Quality (Diminishes)					0.304 (0.378)	0.382 (0.356)
Soil Quality (Improves)					0.179 (0.437)	0.400 (0.410)
Constant	-0.879** (0.413)	-0.710*** (0.0930)	-1.003 (0.761)	-1.088*** (0.378)	-2.350* (1.400)	-2.073* (1.150)
Fixed effects	No	Subdistrict	No	Subdistrict	No	Subdistrict
Pseudo R-Squared	0.0160	0.1163	0.0426	0.1333	0.0827	0.1549
No. of farmers	299	256	299	256	299	256

Notes: 1) All control variables are defined as in Table 2.

2) *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

3) Robust standard errors are reported in parentheses and are clustered at the subdistrict level in all models.

4) For soil quality, responses indicating no effect or uncertainty are the omitted base category.

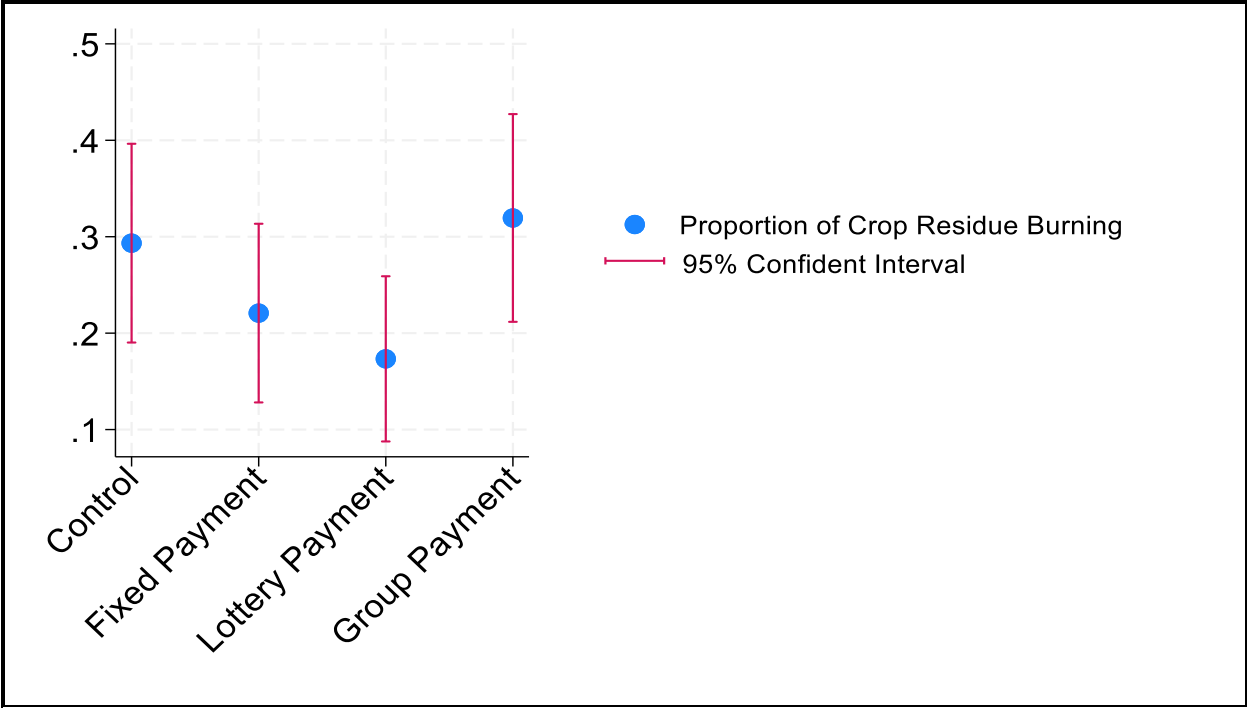


Figure A1: Post-Treatment Observed Crop Residue Burning Rates by Treatment Group

Appendix B. Experimental Implementation Materials

B.1 Enumerator Instructions

Note: The original field materials referred to the treatments as T1, T2, and T3. These correspond to FP, LP, and GP in the main text.

First visit:

1. Read the study's consent form aloud to the participant.
2. Read the consent form regarding the collection and use of personal data from the Farmer Registry.
3. Administer the survey.
4. Walk to the agricultural plot. Record the plot's coordinates using the "Check Laeng" application and take photographs that include identifiable landmarks (e.g., trees, mountains) for spatial reference.
5. Verify the land size with the farmer. The payment is calculated based on this land size (limited to a maximum of 10 Rai).
6. The enumerator fills out the contract with the specified payment amounts. Read the contract aloud to the participant and have them sign both copies. Provide one copy to the participant and retain the other copy for our records.
7. Remind the participant about the second visit, during which we will verify their burning decision.
8. Fill out the receipt for the initial payment of 150 THB. Collect the signed receipt and disburse the payment.

Notes:

- Ask the farmer for their land size and verify it using the "Check Laeng" website. Then, fill in the mutually agreed-upon land size.
- 1Rai = 4 Ngan, and 1 Ngan = 100 Square Wa.
- How to fill in the numbers in the contract: Use the land size (in Rai, up to a maximum of 10 Rai). If the area is X Rai, fill in the figures as follows:
 - T1 (Equal payment for not burning) = 200X
 - T2 (Unequal payment for not burning, via a 2-digit lottery) = 100X | 300X | 100X | 300X (4 fields)
 - T3 (Group formation of 4 people) = 200X | 150X | 100X (3 fields)*(Example: For a 5-Rai area: If T1, T1 = 200*5 = 1,000; If T2, T2 = 100*5 = 500 | 300*5 = 1,500 | 100*5 = 500 | 300*5 = 1,500; If T3, T3 = 200*5 = 1,000 | 150*5 = 750 | 100*5 = 500)*

Phone Call Phase:

1. After the first visit, call each farmer.
2. Remind the farmers about: a) The conditions of the experiment. b) That we will return to verify their burning decision.

Second Visit:

1. Go to the participant's plot and fill out the verification form.
2. Inspect the designated plot: a) Verify whether the farmer has burned the rice straw. b) Take plot-level photos for ground-truth confirmation. c) Complete the verification form and the survey. d) Fill out the receipt for the final payment. Collect the signed receipt and disburse the payment.

B.2 Consent Form

Principal Investigator:

Research Objectives This study aims to understand post-harvest rice straw management practices and explore methods to promote sustainable agriculture.

Research Procedures

1. If you agree to participate, we will visit your rice plot to record its coordinates.
2. After the harvest season, we will return to the selected plot for verification.
3. You will receive a total of 300 THB for your participation, divided into 150 THB during this current visit (1st visit) and 150 THB during the 2nd visit.

Participating in this research poses no risks to you. Your personal information and responses will be kept strictly confidential throughout all stages of the research project, including data collection, data analysis, and the publication of the results. Your participation is crucial to the success of this research, and we highly appreciate your involvement.

Participation in this research is entirely voluntary. You may withdraw from the study at any time without any negative consequences.

I have been informed of and understand the information provided above, and I voluntarily consent to participate in this research.

Signature of Participant: _____

Date: _____

B.3 Participant Agreements

B.3.1 Control Group Agreement

Agreement between participant and research team:

After you give your consent to participate in this study, one of our team members will visit the farm plot with you to geotag it. After the harvesting season, we will revisit the selected plot to check whether you burned your rice crop residue or not. You will receive 300 THB for participating in our study: 150 THB today and 150 THB during our next visit.

What will be considered as **burning** post-harvest crop residue?

- Burning of any standing post-harvest residue.
- Burning of loose straw left by a harvester, if used.
- Burning of post-harvest residue collected in any part of the plot.

If the following conditions are met, it will be considered as not burning:

- There is no evidence of burn marks or charring on the chosen plot.
- The chosen plot has been sown for the next crop without evidence of burn marks.

Signature of participant

Name:

Date: _____

Signature of Principal Investigator

Signature of enumerator

Name:

Date: _____

B.3.2 Fixed Payment (FP) Agreement

Agreement between participant and research team:

After you give your consent to participate in this study, one of our team members will visit the farm plot with you to geotag it. After the harvesting season, we will revisit the selected plot to check whether you burned your rice crop residue or not. You will receive 300 THB for participating in our study: 150 THB today and 150 THB during our next visit.

What will be considered as **burning** post-harvest crop residue? The farmer will **not** be compensated for avoiding burning if **any** of the following is detected by the research team:

- Burning of any standing post-harvest residue.
- Burning of loose straw left by a harvester, if used.
- Burning of post-harvest residue collected in any part of the plot.

If the following conditions are met, it will be considered as not burning:

- There is no evidence of burn marks or charring on the chosen plot.
- The chosen plot has been sown for the next crop without evidence of burn marks.

If our research team finds clear evidence that you **have not burned** the residue, you will receive an **additional payment of** _____ THB.

Signature of participant

Signature of Principal Investigator

Name:

Date: _____

Signature of enumerator

Name:

Date: _____

B.3.3 Lottery Payment (LP) Agreement

Agreement between participant and research team:

After you give your consent to participate in this study, one of our team members will visit the farm plot with you to geotag it. After the harvesting season, we will revisit the selected plot to check whether you burned your rice crop residue or not. You will receive 300 THB for participating in our study: 150 THB today and 150 THB during our next visit.

What will be considered as **burning** post-harvest crop residue? The farmer will **not** be compensated for avoiding burning if **any** of the following is detected by the research team:

- Burning of any standing post-harvest residue.
- Burning of loose straw left by a harvester, if used.
- Burning of post-harvest residue collected in any part of the plot.

If the following conditions are met, it will be considered as not burning:

- There is no evidence of burn marks or charring on the chosen plot.
- The chosen plot has been sown for the next crop without evidence of burn marks.

If there is clear evidence that you **did not** burn the rice straw, you will receive an additional payment of either _____ THB or _____ THB, with both amounts having an equal chance of occurring.

During our next plot verification visit, provided that you have not burned the straw, you will be asked to choose a number range: either 00-49 or 50-99.

- If the last two digits of the next government lottery draw (following that date) **do not** fall within your chosen range, you will receive an additional _____ THB.
- If the last two digits of the next government lottery draw (following that date) **fall within** your chosen range, you will receive an additional _____ THB.

Signature of participant

Signature of Principal Investigator

Name: _____

Date: _____

Signature of enumerator

Name: _____

Date: _____

B.3.4 Group Payment (GP) Agreement

Agreement between participant and research team:

After you give your consent to participate in this study, one of our team members will visit the farm plot with you to geotag it. After the harvesting season, we will revisit the selected plot to check whether you burned your rice crop residue or not. You will receive 300 THB for participating in our study: 150 THB today and 150 THB during our next visit.

What will be considered as **burning** post-harvest crop residue? The farmer will **not** be compensated for avoiding burning if **any** of the following is detected by the research team:

- Burning of any standing post-harvest residue.
- Burning of loose straw left by a harvester, if used.
- Burning of post-harvest residue collected in any part of the plot.

If the following conditions are met, it will be considered as not burning:

- There is no evidence of burn marks or charring on the chosen plot.
- The chosen plot has been sown for the next crop without evidence of burn marks.

You will be randomly assigned to an anonymous group of four farmers. The group members will remain unknown to each other. You may receive an additional payment based on your and your group's actions. Your agreements and other members' agreements will be the same.

- If our research team finds clear evidence that **all four farmers** in the group **have not burned the residue**, you will receive an **additional payment of _____ THB**.
- If our research team finds clear evidence that **three farmers** in the group **have not burned the residue**, you will receive an **additional payment of _____ THB**.
- If our research team finds clear evidence that **two farmers** in the group **have not burned the residue**, you will receive an **additional payment of _____ THB**.
- If **at least three farmers in the group have burned the residue**, you will **not** receive an additional payment.

Signature of participant

Signature of Principal Investigator

Name: _____

Date: _____

Signature of enumerator

Name: _____

Date: _____

Appendix C. Survey Instruments

The questionnaires presented in this appendix were administered electronically using Google Forms on iPads during field visits. Enumerators entered respondents' answers directly into the survey instrument at the time of the interview. The first-visit questionnaire was used to collect baseline information and administer treatment assignments, while the second-visit questionnaire was used to verify crop residue management practices and collect follow-up information.

C.1 First-Visit Questionnaire

Date of the interview				Date checked			
Signature of enumerator:				Signature of supervisor:			
Time started:				Time ended:			
Village name:				Household ID#:			
Location of Farm (Main Plot)	Village:	Subdistrict:	District:	Province:			

1.1	Respondent Mobile no.:					
1.2	Relationship of respondent with person making farming decision	<ul style="list-style-type: none"> • Self • Spouse • Child • Parent • Grandparent 				
	1.x.1 Name	1.x.2 Gender Code A	1.x.3 Age Years	1.x.4 Education Code B	1.x.5 Primary job Code C	1.x.6 Secondary job Code C
1.3	Respondent					
<p>Code A: 1 – Male; 2 – Female</p> <p>Code B: 0 – No education/illiterate; 1 – Semi-literate (never attended school); 2 – Primary (Grade 1-6); 3 – Secondary (Grade 7-9); 4 – Higher Secondary (Grade 10-12); 5 – Vocational education; 6 – High vocational education; 7 – Graduate; 8 – Post graduate</p> <p>Code C : 1– Farming; 2 – Livestock rearing; 3 – Salaried employment; 4 – Self-employed off farm; 5 – Casual labourer on farm; 6 – Casual labourer off farm; 7 – Involved in household chores; 99 – Other (specify)</p>						

What rice variety is planted in this experimental plot?	
<input type="checkbox"/>	RD43
<input type="checkbox"/>	RD47
<input type="checkbox"/>	RD49
<input type="checkbox"/>	RD61
<input type="checkbox"/>	RD79
<input type="checkbox"/>	RD85
<input type="checkbox"/>	RD87
<input type="checkbox"/>	Khao Dawk Mali 105
<input type="checkbox"/>	Flash-flood tolerant Jasmine rice (RGDU99003-1012-B-2-6-B)
<input type="checkbox"/>	Khao Ban Na 432
<input type="checkbox"/>	Phitsanulok 80
<input type="checkbox"/>	Pathum Thani Fragrant rice
<input type="checkbox"/>	Ayutthaya 1 Deepwater rice
<input type="checkbox"/>	RJ22
<input type="checkbox"/>	Other (specify:)

Planting Date: Day..... Month..... Year: 2024

Expected Harvesting Date: Day..... Month..... Year: 2025

Contract Type:

<input type="checkbox"/> Control	<input type="checkbox"/> T1 (Fixed Payment)	<input type="checkbox"/> T2 (Lottery Payment)	<input type="checkbox"/> T3 (Group Payment)
----------------------------------	---	---	---

Land size specified in the contract: rai

C.2 Second-Visit Questionnaire

Date of the interview				Date checked			
Signature of enumerator:				Signature of supervisor:			
Time started:				Time ended:			
Village name:				Household ID#:			
Name of Respondent				Respondent Mobile no.			
Selected Plot Size:				Photo:			

1	Did the respondent burn paddy residue in the selected plot?	Y/N (1/0)	
If YES, answer Q2-5. If NO, answer Q6.			
2	If YES to Q1, provide the reasons why you choose to burn.	1. Clears land the fastest way 2. Not plowable / difficult to plow 3. Weed control 4. Get rid of pests 5. Machines are not available 6. Expensive to hire machine 7. Cannot use/sell paddy residue 8. Not profitable to sell paddy residue 9. No water to use microorganisms to decompose 10. Labor shortage 11. Improve soil quality 12. Other (specify):	
3	Among those chosen in Q2, what is the most important reason why you choose to burn? (Pick only one reason)	1. Clears land the fastest way 2. Not plowable / difficult to plow 3. Weed control 4. Get rid of pests 5. Machines are not available 6. Expensive to hire machine 7. Cannot use/sell paddy residue 8. Not profitable to sell paddy residue 9. No water to use microorganisms to decompose 10. Labor shortage 11. Improve soil quality 12. Other (specify):	
4	If the government provides money to you if you do not burn crop residue, how much money do you need in order not to burn per rai (THB/rai)?		
5	Which method would you use if you receive cash as stated in Q4?	<i>Making straw bale (1)</i> <i>Soil reincorporation (2)</i> <i>Making compost (3)</i>	
6	If NO to Q1, which method did you use to remove paddy residue in the selected plot?	<i>Making straw bale (1)</i> <i>Soil reincorporation (2)</i> <i>Making compost (3)</i>	

Ask all farmers:

7. According to the government's burning ban measures, any farmer who burns crops will be ineligible to participate in all farmer support and development programs from **June 2025 to May 2027**. These programs include financial assistance, such as the Rice Farmer Yield Management and Quality Development Project (1,000 Baht per rai), and access to agricultural loans provided through Ministry of Agriculture funds.

How concerned are you about this policy?

(1 = Not concerned at all, 2 = Slightly concerned, 3 = Moderately concerned, 4 = Highly concerned, 5 = Extremely concerned)

8. In the past, how have you received assistance from the government to encourage and support you to manage non-burning plots?

- (1) No assistance received
- (2) The government helps to find/coordinate the straw baler
- (3) The government helps to find a place to buy straw
- (4) The government trains to provide knowledge on how to manage the plot without burning
- (5) The government helps to find microorganisms to decompose rice stubble
- (6) Others (please specify.....)

9. Have you sold the rice straw this year (Jan-Apr 2025)? (0=No 1=Yes)

10. For those who say "Yes", have you received money from selling rice straw?

(1=Yes, 2=No and no need to pay for the service, 3=No and had to pay for the service)

Financial Literacy Questions:	
1	<p>Suppose you had \$100 in a savings account, and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow:</p> <p>a) more than \$102 b) exactly \$102 c) less than \$102 d) do not know</p>
2	<p>Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?</p> <p>a) more than today b) exactly the same as today c) less than today d) do not know</p>
3	<p>Please tell me whether this statement is true or false. "Growing one type of crop usually provides a safer return than growing multiple crops at the same time".</p> <p>a) True b) False c) do not know</p>

Risk-Preference Elicitation Task:	
<p>Please select one option from the five choices below.</p> <p>Each option has two possible outcomes, each occurring with equal probability (50-50, equivalent to flipping a coin).</p> <p>Please note that this is a hypothetical question, and no real money will be paid. Choose the option that you prefer the most, based on your own preferences.</p>	
Option 1:	You will receive 200 Baht regardless of the outcome.
Option 2:	You have a 50% chance to receive 300 Baht (if heads) and a 50% chance to receive 150 Baht (if tails).
Option 3:	You have a 50% chance to receive 400 Baht (if heads) and a 50% chance to receive 100 Baht (if tails).
Option 4:	You have a 50% chance to receive 500 Baht (if heads) and a 50% chance to receive 50 Baht (if tails).
Option 5:	You have a 50% chance to receive 600 Baht (if heads) and a 50% chance to receive 0 Baht (if tails).

Appendix D. Satellite-Based Verification Procedures

Remote Sensing Using Satellite Imagery: How Figures 3 and 4 were produced in QGIS.

To enhance transparency and replicability, the visualization shown in Figures 3 and 4 reflects a practical workflow that can be summarized as follows:

1. Study plots were delineated and stored as a GIS layer (polygons). These polygons are rendered in yellow and labeled with plot identifiers in the map panels.
2. For each area, at least two images were selected: one representing the pre-burn condition and one representing the post-burn condition, chosen to bracket the likely burning period after harvest. The scene IDs and acquisition dates are provided directly in the figure description.
3. Surface reflectance imagery was used (as implied by the Sentinel 2 Level 2A and Landsat L2SP products listed in the scene IDs). The maps use visible and near-infrared information (and a false-color visualization) to enhance separability between vegetation, bare soil, water, and burned surfaces.
4. In QGIS, the satellite imagery was loaded and displayed consistently between the pre- and post-event panels. Burn scars were then identified through visual comparison across the two dates: areas that appear as newly emerged dark magenta/purple patches in the post-burn scene were interpreted as burned surfaces.
5. A plot is flagged as “burned” when the burn-scar signature is present within (or substantially overlaps) the plot polygon in the post-burn image and is not present in the pre-burn image. This plot-level overlay is the core rationale for including the yellow polygons in the figure.