Received: 1 July 2022 | Revised: 29 November 2023 | Accepted: 12 February 2024

DOI: 10.1111/agec.12846

ORIGINAL ARTICLE

AGRICULTURAL ECONOMICS
The Journal of the International Association of Agricultural Economists
IAAE
WILEY

Changing attitudes through information exposure: Experimental evidence on reducing agricultural burning in rural Nigeria

Efobi Uchenna[1,2]

[1]Personal Social Services Research Unit, The University of Kent, Canterbury, UK

[2]Development Economics Research Centre at Kent, The University of Kent, Canterbury, UK

Correspondence
Efobi Uchenna, Personal Social Services Research Unit, The University of Kent, Canterbury, United Kingdom.
Email: ucefobi@gmail.com; u.efobi@kent.ac.uk

The author conducted the study's fieldwork while affiliated with the Centre for the Study of the Economies of Africa, Nigeria.

Abstract

This study investigates the effectiveness of an education intervention that targets low-income farmers regarding the consequences of agricultural burning. Agricultural burning is a major contributor to carbon emissions, second only to those from the energy sector. Using three treatment arms and a control group, I provided rural farmers in Nigeria with information on the social (health impacts, wildfire spread, biodiversity loss) and economic (income implications) consequences of agricultural burning. The third group received information that combined aspects from the first and second treatments, offering a comprehensive view of the effects of agricultural burning. The analysis suggests that exposure to this information prompts farmers to view agricultural burning as unacceptable, reducing their likelihood of engaging in this practice during the upcoming planting season. In addition, exposed farmers demonstrate a higher willingness to pay nominal fees for government services, such as weed disposal. This outcome demonstrates their support for sustainable farming practices, rather than resorting to burning. The influence of economic information is particularly noteworthy; farmers exposed to it demonstrate a higher willingness to pay such fees. Furthermore, the interventions led to a shift in farmers' perceptions regarding the primary drivers of climate change, with increased recognition of human activity as the dominant factor. The study highlights how the gender of the farmer and their religious beliefs influence attitudes towards environmental protection. Specifically, male and less religious farmers tend to be more responsive to the interventions. These findings provide valuable insights into the effectiveness of "low-cost" educational interventions in promoting sustainable agricultural practices among low-income communities.

KEYWORDS
agricultural burning, climate change, environment, farming practices, rural studies

JEL CLASSIFICATION
P25, Q1, Q53, Q54, Q57

1 INTRODUCTION

To achieve global sustainable development goals, agricultural practices that ensure food security while safeguarding the environment are critical. However, agricultural burning remains a pervasive and unsustainable practice, particularly among resource-constrained farmers in developing countries, who often perceive this practice as the most cost-effective method for land preparation. This practice significantly contributes to atmospheric greenhouse gas concentrations, making up over one-third of all black carbon emissions that worsen air pollution and contribute to climate change (UNEP, 2021). Thus, in regions where agricultural burning is prevalent, with inadequate institutional frameworks to enforce sustainable practices, the primary policy dilemma is to identify cost-effective and scalable solutions to change farmers' attitudes toward reducing agricultural burning (Singh et al., 2021).

This study utilizes a low-cost educational intervention to assess its influence on farmers' attitudes toward agricultural burning, considering the economic and social consequences of the practice. Previous research on behavioral changes for climate change mitigation has identified various factors influencing these changes, including farmer identity, perceived benefits of new techniques, social network influence, and farm characteristics (Albizua et al., 2021; Connor et al., 2020; Groth-Joynt et al., 2020; Wuepper et al., 2020). Experimental studies have addressed liquidity and information constraints by offering farmers access to micro-credit and organizing communications regarding climate change (Grolleau et al., 2022; Knook et al., 2022). Other studies such as Ferraro et al. (2011) analyzed the effects of social norm messages on energy and water consumption, while Nielsen et al. (2016) and Carlsson et al. (2021) conducted nudging experiments related to environmental concerns. While these studies demonstrate a positive influence on pro-environmental behavior, it is yet unclear how effective they are in changing attitudes toward long-standing farming practices, especially among those with limited capacity to adopt sustainable environmental protection measures.

This study employs an issue-based information intervention to familiarize farmers with the specific social and economic consequences of agricultural burning.[1] The intervention consists of three informative treatments: The first focuses on the social consequences, highlighting health problems from air pollution and biodiversity loss. It also emphasizes the potential risk of property damage due to uncontrolled fires resulting from agricultural burning. The second treatment concentrates on the economic ramifications of agricultural burning, underscoring the long-term storage of carbon in the atmosphere, which triggers extreme weather events that negatively impact farm yield and agricultural income. The third treatment combines elements of both social and economic information.

The design involves randomly assigning farmers to receive any of the treatments (or none), presented as curated newspaper articles. The sample consists of smallholders, who are the primary decision-makers for their farmland activities and typically own less than 5 ha of land. Following the intervention (exposure to the treatment or participation in the control group), farmers' attitudes toward agricultural burning are assessed through both subjective and objective responses.

Even though traditional beliefs are often resistant to change, the study's findings, however, demonstrate that learning about the long-term negative effects of this practice, even for a common agricultural activity with detrimental consequences, can lead to significant short-term changes in attitudes. Participants in the treatment group were more likely to view agricultural burning as unacceptable. They reported a lower likelihood of participating in agricultural burning in the upcoming planting season and showed a higher willingness to financially support alternative local government interventions for the disposal of farm residue rather than engaging in agricultural burning. Given that 73% of the surveyed farmers had previously engaged in this practice and over 95% believed that factors other than human activity had triggered climate change, this finding is particularly striking.

The findings also indicate that some of the effects recorded depend on the content of the information presented. Specifically, farmers in the treatment group that focused on the economic effects of climate change resulting from agricultural burning showed a significantly higher willingness to financially support local government

[1] Agricultural burning is a common practice in Nigeria, which has a significant impact on regional air pollution. According to a report by the United Nations Environment Programme in 2019, there is evidence linking these pollution events to negative impacts on rainfall patterns in West Africa (UNEP, 2019). In response to this widespread issue, the Nigerian government has taken decisive action by establishing a National Action Plan that primarily focuses on implementing agricultural emission reduction strategies. Additionally, there has been a growing push from development partners to promote the use of residue retention and low-cost labor-saving agricultural equipment for land preparation.

intervention. This response reflects a stated willingness to pay for such a service. Overall, the findings highlight the effectiveness of educating low-income farmers about the negative impact of their farming practices on the environment. It has significant implications for agricultural development policies and programs, particularly the emphasis on promoting environmental conservation and sustainable livelihoods (Bajracharya et al., 2021; Bhuvaneshwari et al., 2019).

Further analysis provides additional evidence explaining why treated respondents were more likely than the control group to report positive changes in attitudes toward reducing agricultural burning. Notably, this improvement was predominantly observed among less religious farmers—those who questioned their religion or their religious leaders' teachings. This finding suggests that individuals who are more critical of established beliefs are more receptive to new information about environmental practices. This aligns with the literature suggesting that an individual's religiosity can influence various traits, including aspirations, locus of control, and belief in fatalism, which influences their receptivity to new approaches to doing things (Kahsay et al., 2022). The analysis also reveals that the information treatment influenced respondents' perceptions of human activity as a significant contributor to climate change. This indicates a shift toward acknowledging human activity's role in driving climate change following exposure to the provided information.

The literature on agricultural burning in developing countries has predominantly focused on examining its scale and effects (Gupta et al., 2004; Lin & Begho, 2022; Liu et al., 2020; Shyamsundar et al., 2019), as well as its drivers (e.g., Bajracharya et al., 2021; Lopes et al., 2020). Other recent studies have investigated the effects of policy interventions to mitigate this practice. An experimental study conducted in India found that providing cash compensation and using nudges based on positively framed societal norms and environmental awareness had a significant impact on reducing agricultural burning (Lopes et al., 2023). Similarly, Jayachandran et al. (2023) applied a randomized controlled trial to investigate the impact of conditional cash transfers on agricultural burning in India. The findings revealed that providing a portion of the money upfront unconditionally improved compliance and led to a substantial reduction in agricultural burning. A separate research conducted in Ghana found that farmers were more likely to adopt conservative agriculture methods, such as reducing agricultural burning when they received financial incentives and were provided information about the social and environmental consequences of this farming method (Ambler et al., 2023).

This study adds to the existing research by highlighting the use of inexpensive information framing to educate farmers about the diverse consequences of agricultural burning, such as its impact on farmers' livelihoods and health. It further delves into the effectiveness of this approach across diverse farmer demographics and explores the mechanisms influencing behavior change. By examining these aspects, this study offers valuable insights into how to design targeted, cost-effective information campaigns for promoting sustainable practices in developing countries.

A growing body of research investigates how to encourage pro-environmental behavior. Studies by Grolleau et al. (2022) and Knook et al. (2022) demonstrate that priming individuals to take energy efficiency actions and using relatable euphemisms in describing pro-environmental behaviors can influence attitudes toward environmental protection actions. Conversely, Nielsen et al. (2016) and Carlsson et al. (2021) emphasize the importance of nudging individuals toward pro-environmental behaviors, drawing from a comprehensive examination of the literature.

However, this study takes a distinct approach. It addresses the climate information gap among socioeconomically disadvantaged farmers with limited education, whose traditional burning practices significantly contribute to environmental problems. Specifically, it distinguishes itself in two key respects. First, it addresses the climate-related information deficit among socioeconomically disadvantaged individuals with poor education, whose continued conventional agricultural burning practices have significant environmental consequences. Second, when investigating the social and economic repercussions of agricultural burning, the experimental design takes the specific local context into account. By leveraging participants' emotional engagement to encourage changes in attitudes through the intervention, this study analyzes the individualized consequences of environmental pollution on agricultural earnings, farmer well-being, and biodiversity decline, particularly among game animals. This approach has the potential to have substantial and diverse impacts on their pro-environmental attitudes. Consequently, this research offers valuable insights for developing future pro-environmental campaigns in resource-constrained contexts like rural Nigeria, with the aim of shifting attitudes toward promoting sustainable agricultural practices.

2 | RESEARCH DESIGN

The study utilizes data from a randomized experiment conducted with rural farmers in five Nigerian states. The subsequent sub-sections provide a detailed discussion of the experimental design.

TABLE 1 Unexposed farmers' views on agricultural burning (by gender).

	All farmers	Female	Male
Only God determines climate events	.955	.957	.953
Climate is changing because God approves of it	.953	.979	.937
Climate is changing but human activities have nothing to do with it.	.771	.801	.752

Note: *The issues* "Only God determines climate events" and "Climate is changing because God approves of it" were asked in a non-obfuscated manner by asking respondents whether they think changes in rainfall or the rising temperature were determined by God or approved by God.

2.1 | Study setting

Nigeria serves as an illustrative example of a lower-middle-income African country with a large subsistence farming population. These farmers, who make up about 80% of the agricultural workforce,[2] primarily cultivate annual crops. This practice requires a significant amount of farm labor allocation for pre-planting season weeding activities, often involving burning.[3] This practice is widespread across rural Nigeria, as farmers rely on it to make weeds decompose faster. The process involves subjecting weeds to intense heat to facilitate water evaporation from the plant cells, thereby disrupting their moisture content and photosynthesis.

The experiment involves farmers from five Nigerian states (Ekiti, Cross River, Ebonyi, Kwara, and Taraba) representing the different geopolitical zones[4] (see Figure A1 for a map of Nigeria). These states were chosen for several reasons. First, agricultural burning is prevalent in the majority of sampled states, particularly in Ekiti, Ebonyi, Kwara, and Taraba (International Cryosphere Climate Initiative, 2020). Second, this practice is primarily carried out by farmers who rely on rain-fed irrigation and cultivate annual crops, which require extensive weeding before planting. Farmers in these states are significant cultivators of at least one of these annual crops, including maize, cassava, sorghum, rice, and millet. Thus, it is likely that the experimental sites consist of farmers who engage in agricultural burning. Third, approximately two-thirds of the population in the selected states resides in rural areas, with a significant proportion employed in agriculture. Fourth, there is almost unanimous consensus among the population in these states regarding the factors contributing to climate change, attributing it to divine control, including the agreement that the changing climate only exists because "God" determines and approves of it (see Table 1). These views are consistent among both female and male farmers, making these settings ideal for examining how messaging about the consequences of agricultural burning could influence farmers' attitudes toward this practice.

2.2 | Target population

This study focuses on smallholder farmers in Nigeria who rely on agriculture as their main source of income. To be included in this experiment, smallholders' farmland must be less than 5 ha, and the respondent must be the primary decision-maker for the farmland's activities. Additionally, the farmland must rely heavily on rainfed irrigation, and the respondent must be at least 18 years old. Randomization in this study occurs at the individual/farmer level.

2.3 | The experiment

This study evaluates the effectiveness of an informational intervention that exposes farmers to a detailed illustration of the consequences of agricultural burning (Appendix B discusses the exact implementation). The experiment involved 780 farmers randomly assigned to either a treatment group (T) or a control group (C). The treatment group (T) was further divided into three subgroups (T1, T2, T3) with 130 participants each (see Figure 1). While additional analyses explore heterogeneous treatment effects, the overarching focus of the paper is to investigate whether exposure to the treatment influences farmers' attitudes toward agricultural burning.[5]

The structure of the experiment is as follows (see Appendix C for additional treatment design): Farmers were randomly assigned to one of three treatment groups (T1, T2, T3) or a control group (C) (see Figure 1). Those in T1 received localized information about the negative consequences of agricultural burning on farmers' health and the environment—such as details on biodiversity loss due to air pollution from burning and uncontrolled fires. Those in T2 received information focused on the economic consequences of agricultural burning for farmers. It

[2] Anderson et al. (2017) and FAO (2022).

[3] Approximately 87% of farm labor is dedicated to weeding and planting activities. Farmers heavily depend on bush burning to expedite the planting cycle, clear farmland for cultivation, and manage weeds, pests, and diseases (Anderson et al., 2017; Barnabas et al., 2019; UNEP, 2019).

[4] Locations in Northwest Nigeria were not considered, despite the prevalence of agricultural burning, because of the heightened insecurity at the time when the survey was conducted.

[5] The primary reason for dividing the sample in half is to determine if there is a significant difference in outcomes between the farmers in the treatment (T) and control (C) groups.

AGRICULTURAL ECONOMICS
The Journal of the International Association of Agricultural Economists
IAAE

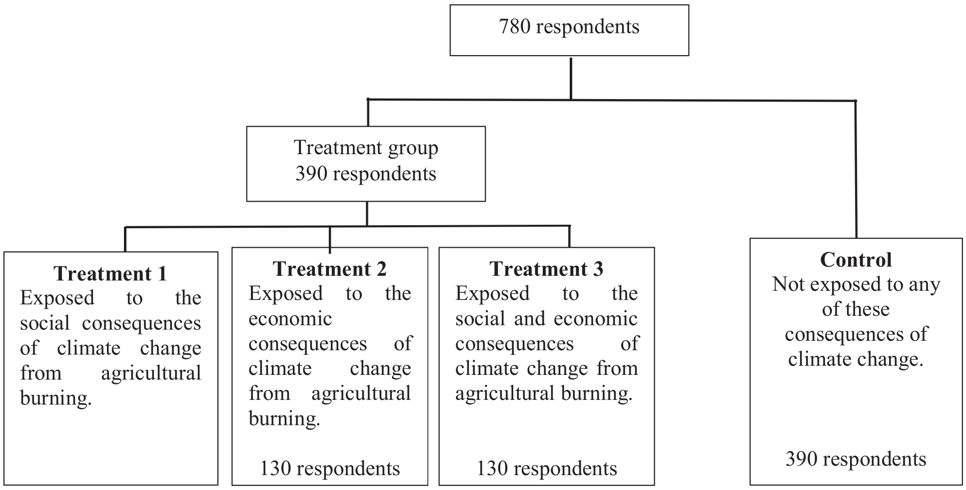

FIGURE 1 Design of the experiment.

explained how burning can negatively affect farm income through increased pests, weather variability, and reduced soil fertility. Farmers in T3 received a combination of the information presented in T1 and T2. The control group (C) did not receive any additional information beyond the introductory statement about burning being a common practice in the farming cycle.[6]

The information was presented to the farmers, curated as a newspaper article, as "A newspaper excerpt by a reputable non-government organization says that agricultural burning is a regular practice in the farming cycle." Farmers in T1, also known as the social information group, received information about the effects of agricultural burning on other social issues. The information provided to them read:

> *The carbon emitted from bush burning activities is stored in the atmosphere for a long period and causes extreme climate events that affect human health (through respiratory and cardiovascular disease), food insecurity (through weather variability), biodiversity loss (including loss of species of mammals, amphibians, birds, marine fish, and reptiles), and bush fire that spreads can affect the wellbeing of neighboring communities or farmlands.*

Those in the economic consequence treatment (T2) were presented with the following text:

> *The heat from bush fire destroys the organic matter for soil fertility, and carbon emitted from bush burning is stored in the atmosphere for a long period, causing extreme climate events. These two issues from bush burning will eventually cause a decline in farm yield, an increase in pest and disease outbreak that destroys crops and farm productivity, and the potential to affect household agricultural income adversely.*

Those in T3, also referred to as the mixed information group, include elements of the information presented in the first and second treatments as follows:

> *Carbon emission from bush-burning activities are stored in the atmosphere for an extended period and causes extreme events that adversely affect respiration, causing cardiovascular disease, food insecurity, and biodiversity loss. Bush fire can also affect the well-being of neighboring communities or farmlands. The heat from the fire destroys the organic matter for soil fertility, and carbon emitted from bush burning is stored in the atmosphere for an extended period, causing weather variability. The eventual effect is decreased farm yields and increased pests and disease that destroys crops and farm productivity, potentially affecting agricultural income adversely.*

The information was revised after the pilot phase to enhance readability and comprehension. The key difference between the treatment groups lies in how the information is presented. It is framed as a hypothetical newspaper article, without specifying a publisher. This approach was chosen to ensure information acceptability, considering that 75.7% of rural Nigerians obtain their news from this source (Afrobarometer, 2020).

[6] The design of the treatments was meticulously planned, including a pilot phase to ensure that smallholders understood the message and to clarify key points. The pilot involved randomly selecting smallholders to assess the extent to which they comprehended the key messages from the treatments before their full deployment.

The study's control group comprised smallholders who did not receive any of the previously described treatment information. They were only provided with the following statement in their survey instrument, framed as a newspaper excerpt:

> *A newspaper excerpt by a reputable non-government organization says that agricultural burning is a regular practice in the farming cycle.*

At the time of this study, there were no known informational campaigns or localized interventions targeting farmers about the negative effects of agricultural burning. Consequently, it was unlikely that participants in our experiment were exposed to other factors that could have weakened the treatment effect of interest.

2.4 | Data and measurement

A sample of 780 low-income farmers participated in the experiment, ensuring sufficient statistical power to detect an effect (details on power calculations, sample design, and treatment administration are provided in Appendix D and Appendix E). The survey was conducted between March (a month following the peak agricultural burning period in January) and May (when burning activities typically decrease) of 2022.[7] Participants answered basic sociodemographic questions and provided information about their household, agricultural involvement, and other characteristics related to climate change awareness. This information was collected before the treatment and outcome variable inquiries.

2.4.1 | Outcome variables

We assess farmers' attitudes immediately after the interventions to see if the information influenced their short-term views on agricultural burning. Two attitudinal measures were used: **(a) Views on Agricultural Burning**: Farmers were asked on a 5-point Likert scale (strongly disagree = 1, strongly agree = 5)[8] to what extent they agree with the statement: *"It is acceptable for a farmer to burn weeds from their farmland or flame their field to prepare for the planting season quickly."* **(b) Likelihood of Engaging in Burning**: A separate question asked farmers to indicate, on a 0–10 scale, how likely they are to engage in agricultural burning during the next planting season, with higher numbers indicating a greater chance of using this practice.

In addition to attitudes, I explored other outcomes: **(c) Pledge to Reduce Burning**: I measured farmers' willingness to sign a pledge to reduce or avoid agricultural burning in the next season. Signing the pledge was coded as 1, and not signing was coded as 0. This is a significant indicator because making commitments is a well-established method for promoting pro-environmental behavior (Lokhorst et al., 2013).[9] **(d) Joining Activist Group**: A binary variable capturing consent to join a localized activist group campaigning for reduced agricultural burning in the respondent's community. A "yes" response was coded 1, and a "no" response was coded 0. The final outcome variable, **(e) Willingness to Pay (WTP) for Weed Removal**: This variable assessed behavioral intention by eliciting a monetary value from respondents regarding their willingness to pay for a local government service to collect and dispose of weeds from farmland. Respondents were asked to choose the amount they would be most willing to pay for this service, with options ranging from $0 USD (or 0 Naira) to $2 USD (or 831.7 Naira and above) in increments of $0.2 USD (or 83.17 Naira). This approach is commonly used in behavioral and environmental research to elicit monetary preferences for future policy initiatives (Shao et al., 2018).

The WTP approach differed by considering the tangible monetary worth for farmers. I set a threshold of $2 USD to accommodate the diverse income levels among farmers in this context. According to the World Bank (2020), the poverty line in Nigeria is around $381.75 USD per year, which translates to roughly $1 USD per day. Since 73% of smallholder households in Nigeria fall below this poverty line (Anderson et al., 2017), these monetary values were chosen to align with the average farmer's income level.

3 | RANDOMIZATION SUCCESS, DATA ANALYSIS, AND SUMMARY STATISTICS

3.1 | Randomization success[10]

Table A1 in Appendix A compares the control group to treatment groups on various characteristics (covariates) to assess randomization success. The table presents the

[7] According to a report from the International Cryosphere Climate Initiative (2020), agricultural burning in Nigeria exhibits a seasonal pattern, with a rise in activity from October to June. January experiences the highest burning incidence, and March still has a significant prevalence compared to other months.

[8] For the analysis, this variable was converted to a binary variable (0 = strongly disagree, disagree, neutral; 1 = agree, strongly agree). The treatment effect is not sensitive to this recategorization.

[9] This approach is yet to gain tract in developing countries.

[10] Table A2 in Appendix A reports an alternative test that regresses the treatment dummy (T, T1, T2, and T3) on the covariates and tests for the joint significance of the variables. Again, none of the regressors is significantly different from zero, and the F-test for joint significance always yields p-values greater than .10.

AGRICULTURAL ECONOMICS
The Journal of the International Association of Agricultural Economists

mean values for each characteristic in each group, along with *p*-values testing for significant differences between the means and the normalized difference.[11] Overall, the data suggests the randomization process created balanced groups.[12] All the normalized differences have absolute values below .126, which is considered a good indication of balance according to Hidrobo et al. (2022)—a threshold of less than .25 is recommended.

3.2 | Treatment compliance

Treatment compliance is important because it tells how well participants understood the information presented in each treatment group. To assess this, the survey instrument included a factual verification question to determine if participants paid attention to the material. For example, participants in Treatment 1 (T1) were asked to identify the correct outcomes associated with agricultural burning from a list containing both accurate and inaccurate options. Those who correctly identified the accurate outcomes were considered to have paid attention to the treatment information. Similar verification questions were included for Treatments 2 and 3 (T2 and T3). A later section will discuss a robustness check using instrumental variable regression analysis that relies on treatment assignment to generate exogenous variation in the probability of farmers providing accurate responses to the question.

In addition to the verification questions, the treatment delivery was timed to accommodate readers with varying speeds. On average, farmers took 5 min to read the treatment material, with a range of 1 to 16 min.[13] Reading speed will be included as an explanatory variable in the robustness check to account for potential comprehension differences based on how long participants spent reading the information (Wallot et al., 2014).

3.3 | Data analysis and summary statistics

The average treatment effect (ATE) formally represents the causal impact of the information treatments on the outcome variables. It is estimated using the following equation:

$$Y_i = \beta_0 + \beta_1 T_i + \varepsilon_i \quad (1)$$

where Y_i is the response variable for respondent *i*. β_0 is the intercept, indicating the response when holding the treatment constant, while β_1 captures the average difference in the outcome variables between respondents in the treatment and control group.[14] ε_i is the standard error. The experimental design, including the planned visit to Kaduna state, was pre-registered in the EGAP registry (https://osf.io/7uwgj). Due to conflict and security concerns, Kaduna was replaced with another northern state, Taraba, for data collection, with approval secured for this change.

I addressed the potential for multiple inferences when analyzing the effects of T1, T2, and T3 on different outcomes. Because analyzing multiple treatment groups and their effects increases the chance of incorrectly rejecting a true null hypothesis, I employ a family-wise error rate (FWER) correction. A FWER controls the probability of making one or more false positive errors when analyzing multiple hypotheses.[15]

Figure 2 presents a graphical analysis of the response variables. It displays the means and 95% confidence intervals for the treatment and control groups, visually illustrating potential improvements in response following random assignment to each information treatment. However, this mean comparison does not account for the experimental design. Therefore, the regression results discussed in the next section will provide more robust estimates with and without including covariates.

4 | TREATMENT EFFECTS

4.1 | Main treatment effect

This section examines how exposure to any of the information treatments influenced farmer attitudes and behaviors regarding agricultural burning reduction (see Table 2). The results are presented in two columns: column "a" reports the main regression of ATE without adjusting for additional factors (covariates), while column "b" includes covariates in the analysis.

Exposure to the treatment significantly impacted farmer attitudes. Farmers who received the treatment were

[11] We rely on this metric as the primary measure of balance, along with the rule of thumb that normalized differences below .25 in absolute value indicate good balance (Hidrobo et al., 2022).

[12] The estimates suggest that there are no differences between the two groups of farmers (those not exposed to any of the information treatment and those exposed) for any of the observable characteristics tested.

[13] See Appendix B for additional information regarding the treatment administration.

[14] The covariates to improve the precision of the analysis are included in a supplementary analysis.

[15] I define three mutually exclusive families of hypotheses encompassing the treatment variables for each outcome after which the family-wise adjusted *p*-values based on 1000 bootstraps is computed.

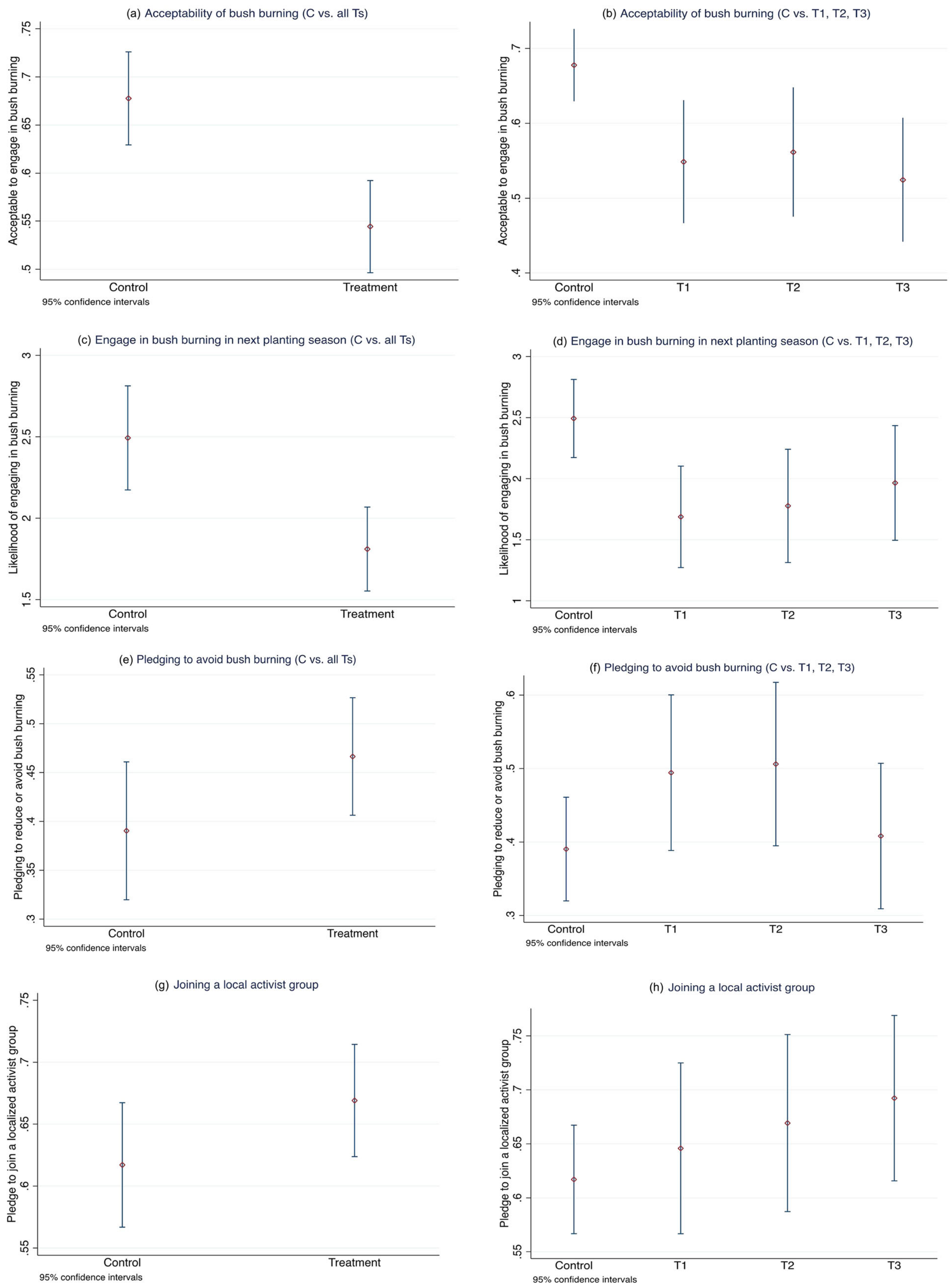

FIGURE 2 Outcome variables by the treatment status.

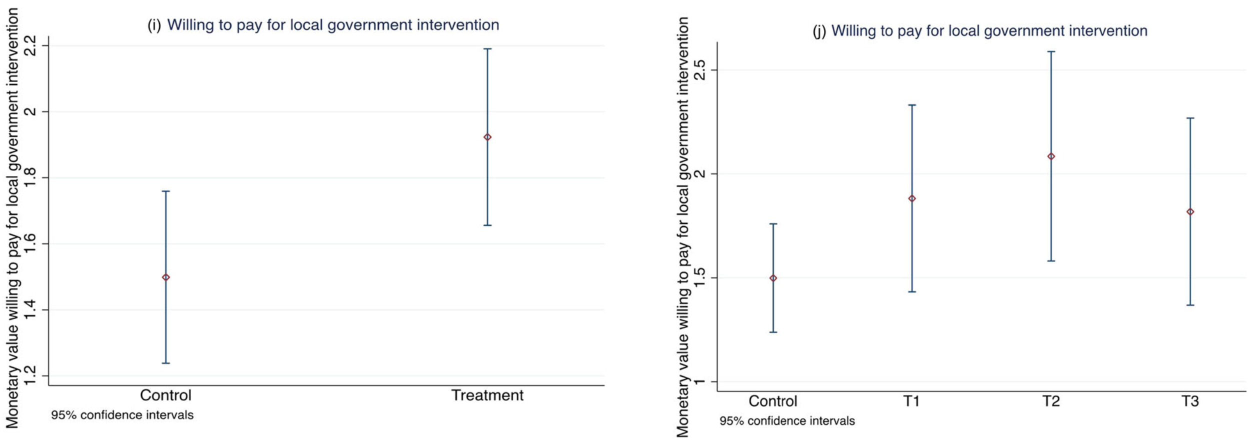

FIGURE 2 Continued

TABLE 2 Impact of treatment (with or without covariates).

	Bush burning is acceptable		**Engage in bush burning in the next planting season**		**Pledging to avoid bush burning**		**Join a localized activist group**		**Willing to pay for local government intervention**	
	(1a)	**(1b)**	**(2a)**	**(2b)**	**(3a)**	**(3b)**	**(4a)**	**(4b)**	**(5a)**	**(5b)**
Treatment	−.133***	−.107***	−.683***	−.752***	.076	.068	.052	.039	.425**	.161**
	(.035)	(.034)	(.207)	(.180)	(.047)	(.048)	(.034)	(.032)	(.191)	(.071)
Covariates		Yes		Yes		Yes		Yes		Yes
R-squared	.019	.132	.014	.301	.006	.105	.003	.181	.006	.249
Obs.	780	774	780	774	780	774	780	774	780	774
Control group mean	.678	.678	2.493	2.493	.390	.390	.617	.617	1.499	1.499

Note: Estimates in column b include the covariates for farmers'/households' characteristics (education level, gender, age, marital status, household size, decides over earnings, the total number of children, number of residencies in the current location, total household consumption, the household is connected to electricity, total asset, and information access) and farmland characteristics (rainfed agriculture, own agric. land, farming experience, total farm asset, own farmland, workers in the past harvest, workers in past planting, number of crops, engaged in bush burning, know about climate change, decides over planting, and decides over harvest). Standard errors are in parenthesis.

Abbreviation: obs., observations.

*$p < .1$; **$p < .05$; ***$p < .01$.

13 percentage points less likely to agree that agricultural burning is an appropriate practice (column 1a), representing a substantial 20% reduction compared to unexposed farmers. This finding is particularly significant considering that around two-thirds of farmers historically engaged in burning. Additionally, these farmers were significantly less likely (by 27%) to report they would engage in burning during the next planting season (column 2a) compared to the control group. These results suggest a notable shift in farmer perspectives toward agricultural burning practices.

Table 2 (columns 3–5) shows how exposure to the information treatments influenced additional farmer attitudes regarding the reduction in agricultural burning activities. While the effects on pledging and joining activist groups were not statistically significant (see columns 3 and 4), there was a significant increase in the amount farmers were willing to pay for a weed disposal program offered by the local government (column 5). This suggests that farmers exposed to the information treatment were 28% more willing to invest in alternatives to burning.

These results are particularly significant because farmers in this region often resort to burning due to labor and financial constraints (Anderson et al., 2017; Barnabas et al., 2019; UNEP, 2019). The increased willingness to pay for weed disposal suggests that by understanding the environmental consequences, farmers may be more willing to make a financial investment in the present to avoid potentially higher future costs associated with their current farming practices. This conclusion aligns with research by Bhuvaneshwari et al. (2019) and Bajracharya et al. (2021) who emphasize that farmer awareness and education about the environmental consequences of this practice are crucial for effecting change. Similarly, studies in Kenya (Channa et al., 2019) and other developing countries

(Lybbert et al., 2018; Waldman et al., 2014) show that informed farmers are more likely to invest in new technologies that offer long-term benefits.

4.2 | Additional analysis

Our initial results assumed that all participants had a complete understanding of the information they were presented with. However, some farmers might not have fully understood the material, risking an upward bias in our estimate. To address this concern, the subsequent analysis includes a robustness test on the primary results presented in Table 2 by relying on the response to the compliance check, which asks respondents to provide the correct response to an obvious question after exposure to the treatment information. Consequently, I estimated an instrumental variable specification using the treatment assignment as the instrument[16,17] based on the following Equations (2) and (3) for the first- and second-stage regression:

First-stage regression:

$$Manipulation\ check_i = \beta_0 + \beta_1 \widehat{Treatment\ assignement_l} + \varepsilon_i \quad (2)$$

Second-stage regression:

$$Y_i = \beta_0 + \beta_1 \hat{T}_i + \varepsilon_i \quad (3)$$

Table 3 includes the results of the first- and second-stage regressions and other estimates to show the instrument's strength—i.e., Cragg-Donald Wald *F*-statistic. Overall, the estimates indicate that the treatment assignment effectively explains farmers' correct answers to the check.[18] The estimates reported in columns 1b and 2b are consistent in signs and significance values with those in columns 1a and 2a of Table 2, and the estimates for the other attitudinal outcomes are consistent as well (see Tables 2 and 3). However, for the variables related to the likelihood of agreeing to sign up to join a localized activist group in the respondent's community and the monetary commitment of farmers to local government intervention, the results in columns 4b and 5b of Table 3 demonstrate a significant impact compared to those in Table 2. Overall, the consistency in signs and significant values suggest that for compliers,[19] the treatment shifted farmers' responses toward sustainable farming practices. Table 4 also indicates a consistent effect when considering individuals' ability to absorb treatment information, as measured by the time it takes to read through the treatment material.

4.3 | Treatment effects by specific information treatment

With the main result demonstrating consistency even after subjecting it to various robustness checks, the subsequent results focus on identifying which treatment is primarily driving the outcomes reported in Section 4.1. The first row of Table 5[20] (column 1a) demonstrates that farmers who participated in the "social information" treatment are, on average, 13 percentage points more likely to disagree that agricultural burning is an acceptable farming practice.[21] The second and third rows of column 1 indicate that farmers exposed to the economic and mixed information are 12 and 15 percentage points, respectively, less likely to concur with the statement regarding the acceptability of agricultural burning. These effects are significant at the 1% or 5% level using either conventional or family-wise inference.

Although the coefficient of the mixed information treatment shows a higher effect relative to the coefficient of the other two treatments, the effect size is small when comparing differences across treatment arms based on Cohen's criteria (See Table A3 in Appendix A for the Cohen's *d* difference in effect sizes by treatment arms).

Column 2 further demonstrates that the effects on the farmers' likelihood of engaging in agricultural burning in the next planting season are more pronounced for farmers exposed to the information on the social and economic consequences of agricultural burning (see first and second rows). However, weaker effects are observed for those exposed to the mixed information, despite the consistent sign (see third row).[22] Again, based on Cohen's *d* criteria,

[16] The random assignments meet the exogeneity criteria, which qualifies them for a valid instrument.

[17] The IV regression is also beneficial because the instrument helps mitigate the likelihood of social desirability bias influencing the response variable (Cooper et al., 2020) and allows for the recovery of the causal effect of the treatment on the outcome, addressing potential internal validity issues, including potential false response bias.

[18] Furthermore, the validity of the instrument is supported by the Cragg-Donald Wald *F*-statistic, which exceeds the commonly accepted criterion of 10. Keane and Neal (2023) suggest that at this threshold, the two-stage least squares regression would usually suffer from very low power.

[19] Those who concentrated on the information presented in the treatment.

[20] The concern of multiple inference, which arises when testing numerous hypotheses, is addressed by controlling for FWER. Further details on this approach were previously discussed in Section 3.7.

[21] This decline is significant after adjusting for the three treatments in this family (family-wise $p = .009$).

[22] While the various treatment arms exhibited different significant effects on this outcome variable compared to the control group, the differences in effects by treatment arm are minimal, as indicated in Table A3 in Appendix A.

TABLE 3 IV regression: Impact of understanding the treatment.

	Bush burning is acceptable		Engage in bush burning in the next planting season		Pledging to avoid bush burning		Join a localized activist group		Willing to pay for local government intervention	
	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)	(5a)	(5b)
Instrument	.525***		.526***		.503***		.526***		0.525***	
	(.012)		(.013)		(.016)		(.012)		(0.012)	
Compliance check		−.195***		−.327***		.093		.110**		1.100***
		(.052)		(.019)		(.069)		(.052)		(0.293)
R-squared		.031		.009		.007		.002		0.022
Obs.	518	518	518	518	518	518	518	518	518	518
Cragg-Donald Wald *F*-statistic.		405.758		405.758		223.612		405.758		

Note: The outcome variable for column 'a' is the response to the compliance check, which is a binary indicator if the farmer's response to the question asked is correct and 0 otherwise. For column 'b', the outcome variables are displayed at each column's top. The instrument is the treatment assignment of the farmers. The standard errors are in parentheses. The control group mean is not reported for space.

Abbreviation: obs., observations.

*$p < .1$; **$p < .05$; ***$p < .01$.

TABLE 4 Impact of treatment, including session time in the preferred regression.

	Bush burning is acceptable	Engage in bush burning in the next planting season	Pledging to avoid bush burning	Join a localized activist group	Willing to pay for local government intervention
	(1)	(2)	(3)	(4)	(5)
Treatment	−.377***	−.329	.158**	.091*	.764**
	(.056)	(.355)	(.068)	(.053)	(.344)
R-squared	.059	.016	.011	.004	.009
Obs.	780	780	780	780	780

Note: The outcome variables are displayed at the top of each column. Standard errors are in parenthesis.

Abbreviation: obs., observations.

*$p < .1$; **$p < .05$; ***$p < .01$.

the effect size is small when comparing effects across the three treatments (see Table A3 in Appendix A).

Farmers exposed to economic information show a higher likelihood of pledging and signing their commitment to avoid agricultural burning in the upcoming planting season (only statistically significant at the 10% level—see column 3, second row). They were 39% more likely than those in the control group to pay for local government intervention in weed collection (significant at the 5% level). While some effects on farmer behavior were statistically significant (the two subjective measures and willingness to pay), the difference in effect size across the treatment groups was not substantial (see Table A3, Appendix A). However, the findings suggest that exposure to the economic consequence of agricultural burning had the strongest influence.

4.4 | Study limitations

While the results presented show the potential of pro-environmental attitudes with exposure to information, the attitudinal changes and willingness to pay recorded in this study may not translate to actual changes in farm practices. The farmers' responses may represent potential "cheap talk." These subjective measures may not fully capture the complexities of farmers' decision-making processes. Hence, while this study establishes a treatment effect in this context, it remains uncertain whether these changes will be sustained over the long term. Future studies would benefit from investigating the potential long-term effects of similar treatments to understand their lasting impact on farmers' behavior. Such exploration would help mitigate doubts about the observed effects, which

TABLE 5 Impact of treatment by the kind of information exposure.

	Bush burning is acceptable (1)	Engage in bush burning in the next planting season (2)	Pledging to avoid bush burning (3)	Join a localized activist group (4)	Willing to pay for local government intervention (5)
T1: Social info.	−.129***	−.806***	.104	.029	.383
	(.048)	(.266)	(.064)	(.047)	(.263)
	[.009]	[.005]	[.097]	[.542]	[.144]
T2: Economic info.	−.116**	−.716**	.116*	.052	.586**
	(.050)	(.285)	(.066)	(.049)	(.287)
	[.024]	[.015]	[.077]	[.287]	[.031]
T3: Mixed info.	−.153***	−.528*	.018	.075	.320
	(.049)	(.288)	(.061)	(.046)	(.263)
	[.001]	[.064]	[.759]	[.112]	[.225]
R-squared	.019	.015	.010	.004	.007
Obs.	780	780	780	780	780
Control group mean	.677	2.493	.390	.617	1.498

Note: Standard errors are in parenthesis. Family-wise *p*-values, reported in brackets, are adjusted for the number of treatment variables in each family and are estimated using 1000 bootstraps.
Abbreviations: info., information; obs., observations.
$^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$.

could be influenced by biases and experimenter demand effects.

Additionally, future research could incorporate a separate treatment focused on biodiversity loss,[23] thereby providing a more comprehensive evaluation of shifts in attitudes resulting from exposure to social, economic, and environmental information, thus better aligning with the three dimensions of sustainability.

4.5 | Mechanisms

To explore how the information treatment might have influenced farmers' responses beyond the directly measured outcomes, I examine the treatment effect on a climate change-related intermediate outcome. That is, whether the farmers believe that human activities cause or contribute to climate or environmental change. The hypothesis posits that exposure to the information, which emphasized the role of human activity like agricultural burning in climate change, may shift farmers' perceptions of the underlying cause of climate change (Carter et al., 2011; Chong & Druckman, 2007; Clark et al., 2018). I assess this pathway by examining how exposure to the information shapes opinions about the contributors to climate change. It is important to note that in the absence of a baseline period for this specific question, we draw baseline inferences from the beliefs of the untreated group. Statistical data from this group reveals that a majority of surveyed farmers (over 95%) maintain the belief that climate events are solely determined by a divine entity. Additionally, approximately 77% of these farmers acknowledge the occurrence of climate change but do not attribute it to human actions.

Figure 3 shows the results of estimating the treatment effect on farmers' beliefs about human activities contributing to climate change. The findings support the hypothesis, with statistically significant effects (at the 5% level) that farmers exposed to any of the treatments are 8.1 percentage points less likely to agree to the statement that the climate is changing but human activities have nothing to do with it. This estimated effect is driven by farmers exposed to the social and economic information treatment. While the coefficient estimate for the mixed information treatment also suggests an influence, it is not statistically significant at the traditional 1% and 5% levels.

Focused group discussions (FGDs) with farmers who received the information treatment (details in Appendix B) provide further insights into the mechanism. During these sessions, farmers actively participated in discussions aimed at exploring how the information treatment influenced their perception regarding agricultural burning. Given that the treatment and control groups differ only in the information provided in their survey instruments, I can infer that the treatment intervention likely altered farmers' perceptions of the consequences of agricultural burning. Exposed farmers expressed intentions to reconsider their burning practices due to the potential

[23] Thanks to one of the reviewers for suggesting this.

AGRICULTURAL ECONOMICS
The Journal of the International Association of Agricultural Economists
WILEY

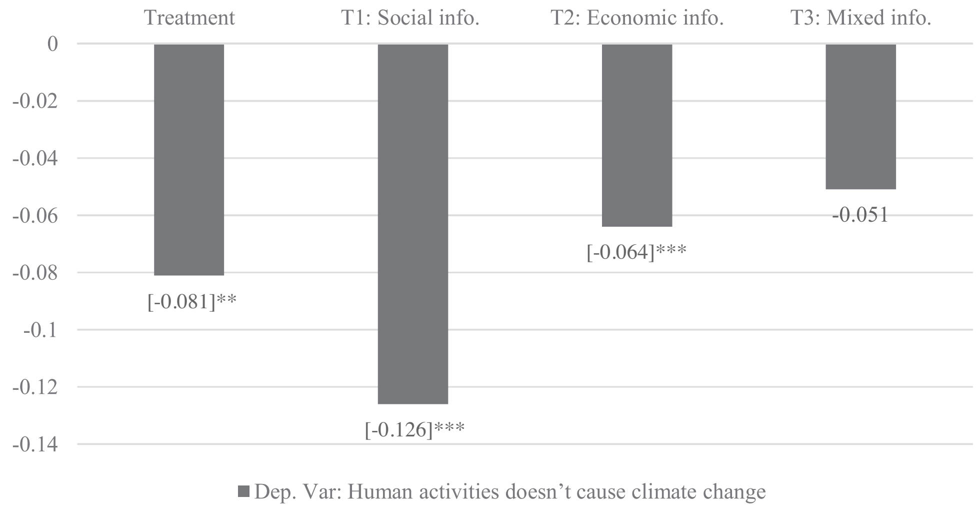

FIGURE 3 Impact of treatment on farmers' views of climate change.

Note: These are the point estimates for the regression of the treatment or the different treatment arms on the response whether human activities contribute to climate change. The exact question asked is whether the respondents agree with the statement that the climate is changing but man has nothing to do with it. The superscripts, $^*p < .1$; $^{**}p < .05$; $^{***}p < .01$.

long-term consequences on their well-being and income. Quotes from the FGD[24] participants exemplify this shift in perspective:

> *I never knew about the consequences of the carbon emission from bush burning on my health, but now that I know, I will want to protect my health, and I will work towards reducing bush burning.*

> *Since bush burning has such harsh consequences on my income, I will pay the government for help since farming is the source of my income, and it is through money that you make money.*

> *We will be willing to pay for government services because we want to be free from sickness, especially that terrible smoke goes into our lungs when we engage in bush burning. As a result of this, we will pay.*

> *We've learned from what you have shown us so far, and now that we know it causes damage to the health and our income, we have to change.*

> *Yes, we will stop bush burning now that we know its negative consequences. Because we should avoid anything that will adversely affect our health.*

> *I have no choice as this is the only means of burning bush trash. But I wish I am aware of other means of disposing of this trash so I don't engage in this practice with severe consequences.*

Next, I explore potential moderators of the treatment effect. Preexisting characteristics of farmers, such as gender and religion, might influence how receptive they are to the information provided. On the one hand, studies in a similar context demonstrate significant gender inequalities in the adoption of new agricultural practices due to differences in access to and control of agricultural inputs (Doss & Morris, 2001; Doss et al., 2015). Furthermore, gender roles in agriculture explain why farmers choose to follow normative practices. According to Das et al. (2023), women are more likely than men to choose a different agricultural production path, owing to social norms that limit women's roles in more profitable agricultural engagement and the challenges women face when deviating from such normative agricultural practices. On the other hand, recent studies show that farmers' religiosity influences other traits such as aspirations, locus of control, and fatalism belief, which is a key determinant factor of technology adoption (Kahsay et al., 2022). For example, Bénabou et al. (2015) argue that increased religiosity,

[24] The focus group discussion asks selected participants, "Now that you are aware of this information, what will you do with the information you are now exposed to?" These are direct quotes from the participants, with only minimal revisions made for typos.

TABLE 6 Treatment effect conditioned on farmers' gender.

	Bush burning is acceptable		Engage in bush burning in the next planting season		Pledging to avoid bush burning		Join a localized activist group		Willing to pay for local government intervention	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)	(5a)	(5b)
Treatment × Female	−.037		.223		−.189*		−.102		−.620	
	(.072)		(.431)		(.098)		(.071)		(.392)	
T1: Social info. × Female		−.001		−.041		−.127		−.145		−.946**
		(.098)		(.519)		(.133)		(.098)		(.479)
T2: Economic info. × Female		−.041		−.133		−.208		−.057		−.985*
		(.108)		(.568)		(.142)		(.108)		(.505)
T3: Mixed info. × Female		−.067		−.611		−.232*		−.089		−.045
		(.102)		(.611)		(0.124)		(.100)		(.534)
Female	.110**	.110**	−.400	−.400	.012	.012	−.023	−.023	−.630**	−.630**
	(.052)	(.049)	(.310)	(.324)	(.073)	(.073)	(.051)	(.053)	(.282)	(.255)
Obs.	780	780	780	780	780	780	780	780	780	780

Note: Columns 'a' are the estimates for the effect of being assigned to any of the treatment arms, while columns 'b' show effects by the treatment arms. Standard errors are in parenthesis. Family-wise p-values were not calculated. R-squared is available upon request.
Abbreviations: info., information; obs., observations.
$^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$.

which impacts attitudes, social norms, preferences, and incentives for innovation, is consistently and significantly associated with less favorable views of innovation.

Table 6 presents results showing how farmers' gender moderates the treatment effect. Specifically, a binary indicator is used to identify female farmers, who constitute 36% of the sample.[25] The direction of some of the coefficients suggests that the treatment was consistently more effective for male farmers than for female farmers. Specifically, the significant and negative coefficient of the social information in column 5b, suggest that male farmers exposed to this treatment were more likely to pay more for the local government service to reduce agricultural burning, unlike female farmers. Plausibly, this difference could be attributed to male farmers being twice as likely as female farmers to be solely responsible for decisions on the farmland,[26] which may have caused them to evaluate changes in farming practices differently. This result is consistent with the literature on gender inequalities in agricultural technology adoption due to differences in decision-making power over farmland activities (Doss et al., 2015).

Table 7 explores how farmer's religiosity moderates the treatment effect. A binary indicator was used to categorize farmers based on how often they question their religion or the teachings of their religious leaders (occasionally, frequently, or always).[27,28] Twenty-six percent of the sample occasionally, frequently, or always contest their religion's doctrine and preaching.[29] The findings, particularly for the social and economic information treatment (columns 1a–5b), suggest that the treatment was more impactful for those less adherent to their religion's doctrines. Regardless of the significance of the coefficients for the interaction variable, the results indicate that religious devotion might influence how receptive farmers are to the information provided.

Another factor influencing the information's impact might be resource endowment. This consideration rests on the argument that farmers in this particular setting resort to agricultural burning due to resource constraints (Anderson et al., 2017; Barnabas et al., 2019; and UNEP, 2019). As a result, the extent to which farmers respond to the treatment may depend on their capacity to adopt sustainable environmental protection measures. The study considers

[25] A closer examination of the mean statistics for this indicator for the treatment arms in comparison to the control group reveals no statistically significant difference. These analyses can be provided upon request.
[26] For example, male farmers are twice as likely to be the sole decision-maker regarding what crop to plant on the farm and what to do with the crop harvested from the farm (Anderson et al., 2017).
[27] The selection of this measure is motivated by the interest in examining the fundamental aspect of religious commitment, namely the complete adherence to the beliefs and principles of one's religious faith. At the baseline, 24% of the farmers occasionally, frequently, or always challenge what their religion or religious leaders preach.
[28] Regarding the religious affiliation of the entire sample, 1% of the total sampled farmers are Catholics, 19% are non-Catholic Christians, 68% are Muslims, and 12% are either traditionalist or nonaffiliated with any religion.
[29] Similar to footnote 28.

TABLE 7 Treatment effect conditioned on farmers' religiosity.

	Bush burning is acceptable		Engage in bush burning in the next planting season		Pledging to avoid bush burning		Join a localized activist group		Willing to pay for local government intervention	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)	(5a)	(5b)
Treatment × Less religious	−.053		−.716		.174*		.126*		1.044***	
	(.079)		(.469)		(.100)		(.077)		(.398)	
T1: Social info. × Less religious		−.067		−.883		.170		.207**		1.221**
		(.106)		(.627)		(.132)		(.088)		(.617)
T2: Economic info. × Less religious		−.058		−.314		.283**		.058		1.277*
		(.115)		(.689)		(.138)		(.099)		(.671)
T3: Mixed info. × Less religious		−0.042		−.822		.068		.116		.658
		(0.115)		(.732)		(.138)		(.088)		(.717)
Less religious	−.085	−.085	−1.284***	−1.284***	.005	.005	.160***	.160***	1.892***	1.892***
	(.059)	(.059)	(.350)	(.405)	(.077)	(.077)	(.057)	(.056)	(.297)	(.368)
Obs.	779	779	779	779	779	779	779	779	779	779

Note: Similar to Table 6. *R*-squared is available upon request.
Abbreviations: info., information; obs., observations.

this heterogeneous effect by measuring farmers' endowment as a binary indicator if a farmer falls within the top 90th percentile of selected farmers in terms of asset ownership.[30] Specifically, if a farmer possesses five or more farm assets from the list included in the survey instrument, they are considered to be high resource endowed.[31] The 90th percentile was chosen, as in similar studies such as Aragon et al. (2022), to clearly distinguish top-endowed farmers from others.

Table 8 explores this possibility by comparing the treatment effect for resource-endowed farmers to others. The results in Table 8 suggest that there are no heterogeneous differences in the impact of information exposure based on the farmers' resource endowment. In other words, there are no distinct differences in the response variable resulting from exposure to the intervention between farmers in the 90th percentile of farmland assets and other groups of farmers. Although not reported, this consistency persists even when total farmland labor input is used as an alternative measure of resource endowment. This suggests that the intervention may be effective for a broad range of farmers, regardless of resource constraints.

[30] The 90th percentile was chosen to indicate a clear distinction between top-endowed farmers and others. When farmers' endowment is treated as a continuous variable, the results remain unchanged.

[31] The list of farm assets includes tractor, planting equipment, water pump, irrigation equipment, sprinkler, wheelbarrow, cutlass, hoe, sickle, rake, or generator. The inclusion of the tractor in this list follows the approach of the Living Standards Measurement Study, which incorporates both low- and high-cost equipment in the list of farm assets (The World Bank, 2019b). Additionally, the mean total number of assets remains consistent, whether the tractor, the most expensive equipment, is included (3.27) or excluded (3.26) from the list of farm assets.

5 | CONCLUSION

This study investigated the effectiveness of low-cost information treatment in influencing rural farmers' attitudes toward minimizing agricultural burning. I conducted a survey experiment involving smallholders in selected Nigerian states. Participants received information detailing the social and economic consequences of burning, and their post-treatment responses were observed. The findings demonstrate that information exposure can be effective in reducing farmers' self-reported likelihood of engaging in burning and increasing their willingness to pay for government services related to weed disposal. In information-deficient settings, framing information to address persistent practices can effectively shape farmers' perspectives and potentially lead to more sustainable agricultural practices.

The information provided also revealed interesting nuances in its effectiveness. Exposure to the economic consequences of burning appeared to have a stronger impact compared to the social consequences. This suggests that farmers may be more receptive to information that highlights the potential financial losses associated with burning. The findings from the FGDs with treated farmers further emphasize the importance of economic considerations. Farmers emphasized the need for economic support in order to make a sustainable shift away from burning practices. Quotes from farmers illustrate this point, highlighting the need for government assistance with alternative weed control methods and fertilizer access. Some farmers, for example, note that:

> *If we don't burn bush again, it is good. But the government will have to provide surplus*

TABLE 8 Treatment effect conditioned on farmers' resource endowment.

	Bush burning is acceptable		Engage in bush burning in the next planting season		Pledging to avoid bush burning		Join a localized activist group		Willing to pay for local government intervention	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)	(5a)	(5b)
Treatment × Endowment	−.036		−1.075*		.007		−.077		.929*	
	(.101)		(.609)		(.124)		(.100)		(.549)	
T1: Social info. × Endowment		.011		−.692		.064		−.151		1.013
		(.133)		(.832)		(.164)		(.135)		(.715)
T2: Economic info. × Endowment		.001		−.895		.111		−.094		.458
		(.141)		(.895)		(.175)		(.143)		(.775)
T3: Mixed info. × Endowment		−.166		−1.773*		−.199		.067		1.382*
		(.153)		(.986)		(.176)		(.154)		(.825)
Endowment	−0.241***	−.241***	.881**	.881**	.019	.019	.272***	.272***	1.272***	1.272***
	(.071)	(.070)	(.428)	(.437)	(.091)	(.091)	(.070)	(.071)	(.386)	(.375)
Obs.	780	780	780	780	779	780	780	780	780	780

Note: Similar to Table 6. *R*-squared is available upon request.
Abbreviations: info., information; obs., observations.

> *fertilizer that we can use for our crops after planting and make the land fertile....*

> *You see, bush burning is bad, but we that don't have money, bush burning helps us. For instance, if you go to the North now, the government helps them compare to us; we don't have help, and the only easy way for us is to engage in bush burning. We have never received help from the government.*

To delve deeper into this issue, future studies could explore the effectiveness of bundled interventions that combine information provision with other incentives, such as subsidized access to herbicides or mechanical weed removal services. This approach could address the economic considerations highlighted by farmers in the FGDs and potentially lead to a more sustainable shift away from burning practices. Furthermore, research efforts could investigate how to tailor interventions to address the specific challenges faced by different farmer subgroups, such as those with limited access to resources or particular religious beliefs.

The analysis also suggests that religious devotion might moderate the information's impact in the short term, with less religious farmers showing a stronger response. These findings highlight the importance of considering both the framing of information and farmer characteristics when designing interventions.

In a broader context, the information provided may have nudged farmers toward a more nuanced understanding of climate change. By highlighting the environmental consequences of burning, the intervention potentially fostered a shift in awareness that human activities contribute to climate change. This finding calls for further investigation in future research.

Agricultural burning ranks as one of the primary sources of carbon emissions, second only to emissions from the energy sector (World Resources Institute, 2022). Additionally, it accounts for more than a third of all black carbon emissions (UNEP, 2021). Thus, there is a growing imperative to identify cost-effective and scalable interventions to curb this practice. This study offers promising insights by demonstrating that a low-cost information exposure intervention can be effective in shaping farmers' attitudes and potentially reducing burning practices. This approach provides a valuable model for how low-income countries can pursue environmental sustainability, even in the absence of substantial financial resources for large-scale climate financing.

In conclusion, this study demonstrates that a low-cost information intervention can be effective in influencing rural farmers' attitudes toward agricultural burning. Farmers exposed to information detailing the consequences of burning reported a lower likelihood of engaging in the practice. Notably, economic considerations emerged as a key factor influencing farmers' decisions. These findings hold significant policy and research implications. Future research should explore interventions that combine information with economic incentives, such as subsidized weed control, while also tailoring approaches to address the specific needs of different farmer subgroups. Furthermore, the potential for information to nudge farmers toward a broader understanding of climate change warrants further investigation. This study's success in utilizing a low-cost approach offers a valuable model for low-income countries seeking to promote environmental sustainability.

ACKNOWLEDGMENTS

I would like to extend my sincere gratitude to the editors and three reviewers for their invaluable feedback, which significantly improved this work. I am grateful to EGAP (Evidence in Governance and Politics, UC Berkeley) for the grant that facilitated this project. Special thanks to Alyssa Heinze (UC Berkeley) for her superb feedback. I am also thankful to Cyrus Samii, Melina Platas, Mathew S. Winters, Katrina Kosec, Tara Slough, Anna Wilke, and Matthew Lisiecki for their organization, comments, and guidance during EGAP feedback sessions 1 and 2. Their input greatly enhanced the research design and manuscript. I am also grateful for the comments from the participants at the BEDERG-DeRecCK 2024 Workshop at the University of Kent/East Anglia. Finally, I am indebted to Obinna Ogwuike for excellent field coordination and to Adejumo Oluwabunmi for coordinating the focused group interview sessions. All other disclaimers apply. In March 2022, a pre-analysis plan for the survey experiment (which has since been revised) was registered in the Evidence in Governance and Politics (EGAP) registry under registration ID 20220312AA.

REFERENCES

Afrobarometer. (2020). *Summary of results: Afrobarometer round 8 survey in Nigeria*. https://afrobarometer.org/sites/default/files/publications/Summary%20of%20results/afrobarometer_sor_nig_r8_en_2021-01-27.pdf

Albizua, A., Bennett, E. M., Larocque, G., Krause, R. W., & Pascual, U. (2021). Social networks influence farming practices and agrarian sustainability. *PLoS ONE*, *16*(1), e0244619.

Ambler, K., de Brauw, A., & Murphy, M. (2023). Increasing the adoption of conservation agriculture: A framed field experiment in Northern Ghana. *Agricultural Economics*, *54*(5), 742–756.

Anderson, J., Marita, C., Musiime, D., & Thiam, M. (2017). *National survey and segmentation of smallholder households in Nigeria: Understanding their demand for financial, CGAP Working Paper*. Agricultural and Digital Solutions.

Aragon, F. M., Restuccia, D., & Rud, J. P. (2022). Are small farms really more productive than large farms? *Food Policy*, *106*, 102168.

Bajracharya, S. B., Mishra, A., & Maharjan, A. (2021). Determinants of crop residue burning practice in the Terai region of Nepal. *PLoS ONE*, *16*(7), e0253939.

Barnabas, B., Jibril, S. A., & Abubakar, N. B. (2019). Perceived effects of bush burning on arable crop production in Bauchi local government area of Bauchi state, Nigeria. *African Scholar Journal of Agriculture and Agricultural Technology*, *15*(1), 250–260.

Bénabou, R., Ticchi, D., & Vindigni, A. (2015). Religion and innovation. *American Economic Review*, *105*(5), 346–351.

Bhuvaneshwari, S., Hettiarachchi, H., & Meegoda, J. N. (2019). Crop residue burning in India: Policy challenges and potential solutions. *International Journal of Environmental Research and Public Health*, *16*(5), 832.

Carlsson, F., Gravert, C., Johansson-Stenman, O., & Kurz, V. (2021). The use of green nudges as an environmental policy instrument. *Review of Environmental Economics and Policy*, *15*(2), 216–237.

Carter, T. J., Ferguson, M. J., & Hassin, R. R. (2011). A single exposure to the American flag shifts support toward republicanism up to 8 months later. *Psychological Science*, *22*(8), 1011–1018.

Channa, H., Chen, A. Z., Pina, P., Ricker-Gilbert, J., & Stein, D. (2019). What drives smallholder farmers' willingness to pay for a new farm technology? *Evidence from an experimentalauction in Kenya. Food Policy*, *85*, 64–71.

Chong, D., & Druckman, J. N. (2007). Framing theory. *Annual Review of Political Science*, *10*, 103–126.

Clark, J., Garces-Ozanne, A., & Knowles, S. (2018). Emphasising the problem or the solution in charitable fundraising for international development. *The Journal of Development Studies*, *54*(6), 1082–1094.

Connor, M., de Guia, A. H., Quilloy, R., Van Nguyen, H., Gummert, M., & Sander, B. O. (2020). When climate change is not psychologically distant—Factors influencing the acceptance of sustainable farming practices in the Mekong river Delta of Vietnam. *World Development Perspectives*, *18*, 100204.

Cooper, B., Eva, N., Zarea Fazlelahi, F., Newman, A., Lee, A., & Obschonka, M. (2020). Addressing common method variance and endogeneity in vocational behavior research: A review of the literature and suggestions for future research. *Journal of Vocational Behavior*, *121*, 103472.

Das, S., Delavallade, C., Fashogbon, A., Olatunji Ogunleye, W., & Papineni, S. (2023). Occupational sex segregation in agriculture: Evidence on gender norms and socio-emotional skills in Nigeria. *Agricultural Economics*, *54*(2), 179–219.

Doss, C., Kovarik, C., Peterman, A., Quisumbing, A., & van denBold, M. (2015). Gender inequalities in ownership and control of land in Africa: Myth and reality. *Agricultural Economics*, *46*(3), 403–434.

Doss, C. R., & Morris, M. L. (2001). How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana. *Agricultural Economics*, *25*(1), 27–39.

FAO. (2022). *Nigeria at a glance*. https://www.fao.org/nigeria/fao-in-nigeria/nigeria-at-a-glance/en/

Ferraro, P. J., Miranda, J. J., & Price, M. K. (2011). The persistence of treatment effects with norm-based policy instruments: Evidence from a randomized environmental policy experiment. *American Economic Review*, *101*(3), 318–322.

Grolleau, G., Mzoughi, N., Peterson, D., & Tendero, M. (2022). Changing the world with words? Euphemisms in climate change issues. *Ecological Economics*, *193*, 107307.

Groth-Joynt, T. M., Curtis, A., Mendham, E., & Toman, E. (2020). Does rural landowner identity shape the adoption of sustainable farming practices? *Australasian Journal of Environmental Management*, *27*(3), 309–328.

Gupta, P. K., Sahai, S., Singh, N., Dixit, C. K., Singh, D. P., Sharma, C., Tiwari, M. K., Gupta, R. K., & Garg, S. C. (2004). Residue burning in rice–wheat cropping system: Causes and implications. *Current Science*, *87*(12), 1713–1717.

Hidrobo, M., Palloni, G., Gilligan, D. O., Aker, J. C., & Ledlie, N. (2022). Paying for digital information: Assessing farmers' willingness to pay for a digital agriculture and nutrition service in Ghana. *Economic Development and Cultural Change*, *70*(4), 1367–1402.

International Cryosphere Climate Initiative. (2020). *Results from open burning mapping in Nigeria*. ICCI. https://www.ccacoalition.org/en/resources/results-open-burning-mapping-nigeria

Jayachandran, S., Jack, K., Pande, R., & Singh, A. (2023). *Can conditional transfers reduce crop residue burning and improve child health?* Abdul Latif Jameel Poverty Action Lab.

Kahsay, G. A., Kassie, W. A., Medhin, H., & Hansen, L. G. (2022). Are religious farmers more risk-taking? Empirical evidence from Ethiopia. *Agricultural Economics*, *53*(4), 617–632.

Keane, M., & Neal, T. (2023). Instrument strength in IV estimation and inference: A guide to theory and practice. *Journal of Econometrics*, *235*(2), 1625–1653.

Knook, J., Dorner, Z., & Stahlmann-Brown, P. (2022). Priming for individual energy efficiency action crowds out support for national climate change policy. *Ecological Economics*, *191*, 107239.

Lin, M., & Begho, T. (2022). Crop residue burning in South Asia: A review of the scale, effect, and solutions with a focus on reducing reactive nitrogen losses. *Journal of Environmental Management*, *314*, 115104.

Liu, T., He, G., & Lau, A. K. H. (2020). Statistical evidence on the impact of agricultural straw burning on urban air quality in China. *Science of The Total Environment*, *711*, 134633.

Lokhorst, A. M., Werner, C., Staats, H., Dijk, E. V., & Gale, J. L. (2013). Commitment and behavior change: A meta-analysis and critical review of commitment-making strategies in environmental research. *Environment and Behavior*, *45*(1), 3–34.

Lopes, A. A., Tasneem, D., & Viriyavipart, A. (2023). Nudges and compensation: Evaluating experimental evidence on controlling rice straw burning. *Ecological Economics*, *204*, 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.

Lybbert, T. J., Magnan, N., Spielman, D. J., Bhargava, A. K., & Gulati, K. (2018). Targeting technology to increase smallholder profits and conserve resources: Experimental provision of laser land-leveling services to Indian farmers. *Economic Development and Cultural Change*, *66*(2), 265–306.

Nielsen, A. S. E., Henrik, S., Pernille, S., Mikael, K., Peter, M., Emil, P., & Conny, W. (2016). *Nudging and pro-environmental behaviour*. Nordic Council of Ministers. https://norden.diva-portal.org/smash/get/diva2:1065958/FULLTEXT01.pdf

Shao, S., Tian, Z., & Fan, M. (2018). Do the rich have stronger willingness to pay for environmental protection? New evidence from a survey in China. *World Development*, *105*, 83–94.

Shyamsundar, P., Springer, N. P., Tallis, H., Polasky, S., Jat, M. L., Sidhu, H. S., Krishnapriya, P. P., Skiba, N., Ginn, W., Ahuja, V., Cummins, J., Datta, I., Dholakia, H. H., Dixon, J., Gerard, B., Gupta, R., Hellmann, J., Jadhav, A., Jat, H. S., … Somanathan, R. (2019). Fields on fire: Alternatives to crop residue burning in India. *Science*, *365*(6453), 536–538.

Singh, G., Gupta, M. K., Chaurasiya, S., Sharma, V. S., & Yu Pimenov, D. (2021). Rice straw burning: A review on its global prevalence and the sustainable alternatives for its effective mitigation. *Environmental Science and Pollution Research*, *28*, 32125–32155.

UNEP. (2019). *Open burning mapping in Nigeria and West Africa*. https://www.ccacoalition.org/projects/open-burning-mapping-nigeria-and-west-africa#:~:text=Crop%20stubble%20burning%20in%20Nigeria,(IPCC%20AR5%2C%202013)

UNEP. (2021). *Open burning mapping in Nigeria and West Africa*. https://www.ccacoalition.org/en/activity/open-burning-mapping-nigeria-and-west-africa

Waldman, K. B., Kerr, J. M., & Isaacs, K. B. (2014). Combining participatory crop trials and experimental auctions to estimate farmer preferences for improved common bean in Rwanda. *Food Policy*, *46*, 183–192.

Wallot, S., O'Brien, B. A., Haussmann, A., Kloos, H., & Lyby, M. S. (2014). The role of reading time complexity and reading speed in text comprehension. *Journal of Experimental Psychology Learning, Memory, and Cognition*, *40*(6), 1745–1765.

World Bank. (2019a). *General household survey-panel—wave 4 (2018/19) post-planting visit household questionnaire*. https://microdata.worldbank.org/index.php/catalog/3557/download/47668

World Bank. (2019b). *General household survey-panel—wave 4 (2018/19) post-harvest visit agriculture questionnaire*. https://microdata.worldbank.org/index.php/catalog/3557/download/47672

World Bank. (2020). *Nigeria releases new report on poverty and inequality in country*. https://www.worldbank.org/en/programs/lsms/brief/nigeria-releases-new-report-on-poverty-and-inequality-in-country

World Resources Institute. (2022). *Greenhouse gas emissions by country and economic sector*. World Resources Institute.

Wuepper, D., Zilberman, D., & Sauer, J. (2020). Non-cognitive skills and climate change adaptation: Empirical evidence from Ghana's pineapple farmers. *Climate and Development*, *12*(2), 151–162.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Uchenna, E. (2024). Changing attitudes through information exposure: Experimental evidence on reducing agricultural burning in rural Nigeria. *Agricultural Economics*, 1–25. https://doi.org/10.1111/agec.12846

APPENDIX A

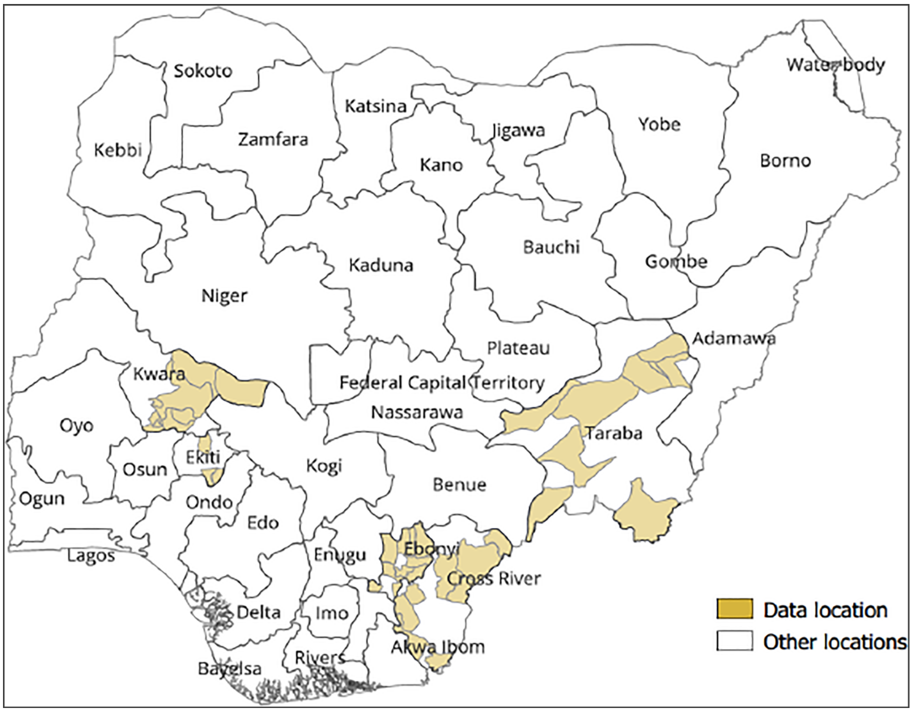

FIGURE A1 Map of Nigeria showing the sites of data collection.

Note: The program sites were drawn from six states. The exact locations are shaded on the map.

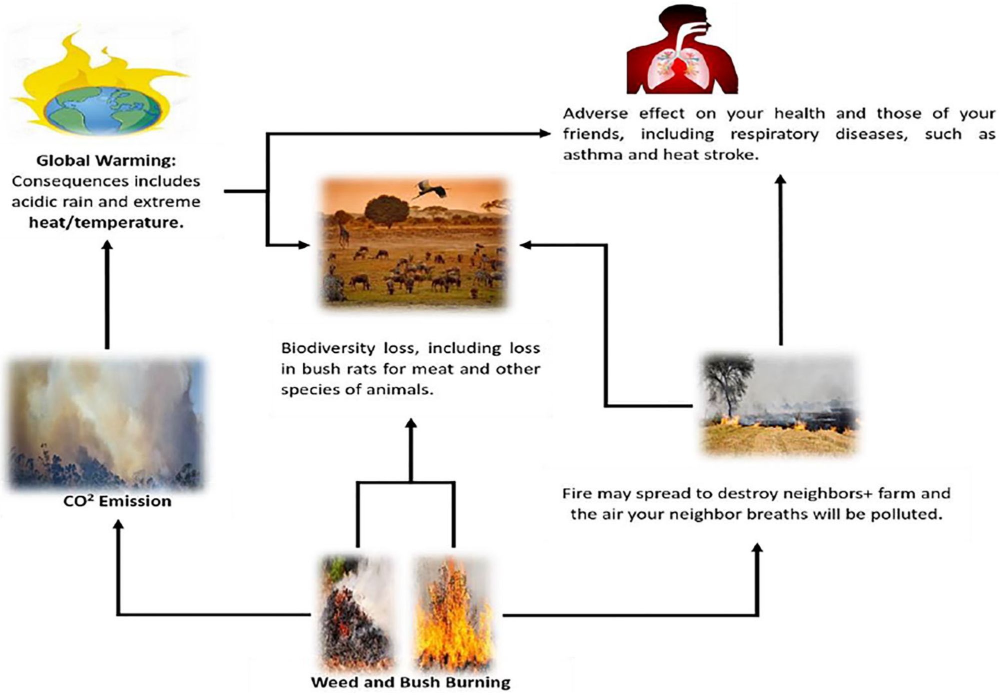

FIGURE A2 Graphics of the content of the social information.

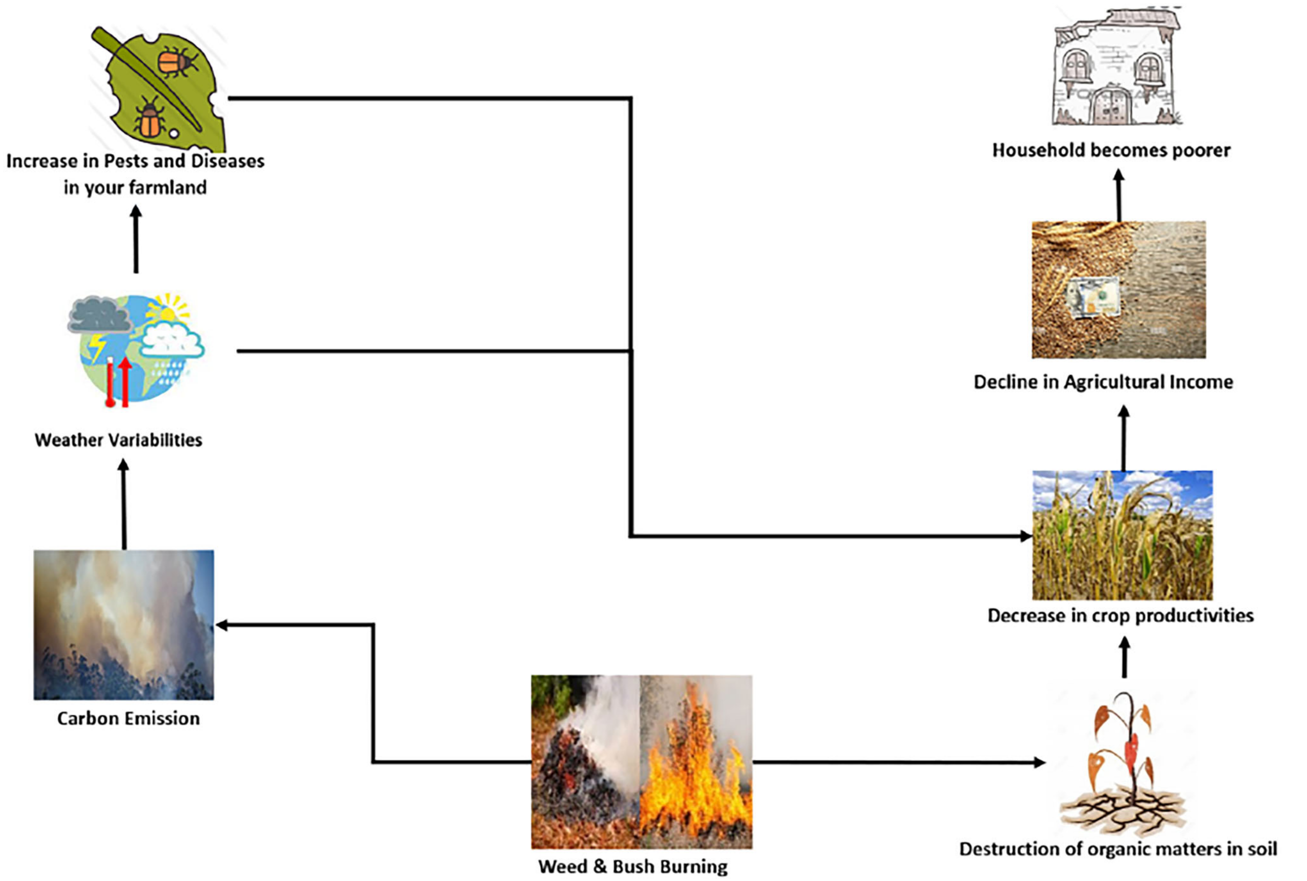

FIGURE A3 Graphics of the content of the economic information.

TABLE A1 Summary statistics, by treatment status.

Variable	Description	*N*	All farmers	Control group farmers	Exposed group farmers	Normalized difference	P-value
Farmers'/households' characteristics							
Education level	'0' no education completion; '1' some primary education completion; '2' completed primary education; '3' some secondary education completion; '4' completed secondary education; '5' completed more than secondary education.	780	2.951	2.893	3.002	−.078	.280
Gender	'1' if male and '0' otherwise.	780	.640	.612	.664	−.110	.126
Age	Actual age of the individual since last birthday (in years).	780	44.073	44.58	43.64	.066	.362
Marital status	'0' never married and '1' otherwise.	780	.881	.898	.866	.100	.165
Household size	The total number of individuals residing within the household.	780	6.579	6.623	6.542	.019	.789
Decides earning	'1' if the respondent is involved in deciding over what to do with own earnings.	776	.582	.564	.599	−.070	.329

(Continues)

TABLE A1 (Continued)

Variable	Description	*N*	All farmers	Control group farmers	Exposed group farmers	Normalized difference	P-value
Children	Total number of children in household	780	3.904	3.876	3.928	−.019	.797
Residence years	Total number of years of residence in current location.	780	30.710	31.03	30.43	.036	.621
Total household consumption	Total household consumption (food and non-food) in LCU (Naira) in a month.	780	32575.47	28165	36415	−.047	.523
Electricity	'1' if the household has electricity connection	780	.735	.7438	.7266	.039	.588
Total asset †	Sum of household's ownership of any of the 14 items—Radio, television, Refrigerator, Car, Motorcycle, Bicycle, Generator, Mattress, Gas cooker, Stove (gas), Stove (kerosene), Fan, Iron, and Computer.	780	3.923	3.835	4.000	−.054	.450
Information access	'1' if the farmer listens to a radio or television or reads a newspaper/magazine at least once a week	780	.519	.521	.518	.005	.940
Farmland characteristics							
Rainfed agriculture	'1' if farmland rely on only rainfall for farmland irrigation.	780	.967	.973	.962	.061	.402
Own agricultural land	'1' if the respondent (or household) own an agricultural land.	780	.785	.776	.791	−.035	.624
Farming experience	Duration (in years) respondent or household has been farming.	780	22.224	22.720	21.790	.068	.343
Total farm asset ‡	The sum of farm ownership of the 11 items—tractor, plant, water pump, irrigation plant, sprinkler, wheel barrow, cutlass, hoe, sickle, rake, and generator.	780	3.274	3.253	3.293	−.035	.626
Own farmland	'1' if the respondent (or household) own the farmland they cultivate.	780	.737	.716	.755	−.089	.216
Workers in past harvest	The average number of workers (both from household and hired) that worked on this farmland in the past harvest season.	780	1.836	1.814	1.856	−.069	.350
Workers in past planting	The average number of workers (both from household and hired) that worked on this farmland in the past planting season.	780	1.806	1.789	1.821	−.069	.455
Number of crops	Number of crops grown on the farmland in the past planting season.	780	4.600	4.711	4.504	.126	.079
Engaged in bush burning	'1' if previously engaged in bush/weed burning or field flaming on farmland.	780	.721	.730	.712	.039	.581
Climate change	'1' if the respondent has heard of climate change from any source.	780	.692	.716	.672	.097	.177

(Continues)

TABLE A1 (Continued)

Variable	Description	*N*	All farmers	Control group farmers	Exposed group farmers	Normalized difference	P-value
Decision over planting	'1' if the respondent is involved in decisions regarding the crops to plant on farmland.	778	.600	.583	.615	−.066	.356
Decision over harvest	'1' if the respondent is involved in decisions regarding what to do with crop harvested from the farm.	777	.584	.565	.601	−.073	.312

Note: Estimates are from the experiment's survey. The normalized difference is the difference in means between the two groups scaled by the average of the within-group standard deviations. *p*-value is from the test of the difference of means between the relevant treatment groups.

†The assets included in this study were selected based on the methodology of the Living Standards Measurement Study. This methodology encompasses both low-cost items such as mats and radios, as well as high-cost items such as fridges, TVs, and inverters in the list (The World Bank, 2019a).

‡The decision to include the tractor, for example, in this particular list adheres to the methodology employed by the Living Standards Measurement Study, which incorporates both low-cost equipment (such as the cutlass, wheelbarrow, and fish net) and high-cost equipment (such as the tractor, trailer, and ridger) as part of the comprehensive inventory of agricultural assets (The World Bank, 2019b).

TABLE A2 Alternative test for randomization success.

	All treatment	Treatment 1	Treatment 2	Treatment 3
Education level	.010	.006	−.002	.006
	(.016)	(.012)	(.012)	(.012)
Gender	.039	−.031	.045	.025
	(.041)	(.032)	(.030)	(.032)
Age	.000	.001	.000	−.000
	(.002)	(.002)	(.002)	(.002)
Marital status	−.139*	−.014	−.107*	−.019
	(.073)	(.057)	(.055)	(.057)
Household size	−.005	−.005	.001	−.002
	(.006)	(.005)	(.004)	(.005)
Decides earning	−.010	.033	−.097*	.054
	(.066)	(.051)	(.059)	(.051)
Children	.010	.007	−.001	.004
	(.010)	(.008)	(.007)	(.008)
Residence years	−.000	−.001	−.000	.001
	(.001)	(.001)	(.001)	(.001)
Total household consumption	.000	.000	−.000	−.000
	(.000)	(.000)	(.000)	(.000)
Electricity	.018	.023	.012	−.018
	(.047)	(.037)	(.035)	(.037)
Total asset	.002	.001	−.004	.005
	(.010)	(.007)	(.007)	(.007)
Information access	−.044	−.058	.002	.012
	(.054)	(.042)	(.040)	(.042)
Rainfed agriculture	−.055	−.099	.026	.019
	(.104)	(.081)	(.077)	(.081)
Own agricultural land	.017	.069	.011	−.063
	(.061)	(.047)	(.045)	(.047)

(Continues)

TABLE A2 (Continued)

	All treatment	Treatment 1	Treatment 2	Treatment 3
Farming experience	−.001	.001	.000	−.001
	(.002)	(.002)	(.002)	(.002)
Total farm asset	−.002	−.009	.017	−.010
	(.020)	(.016)	(.015)	(.016)
Own farmland	.071	.008	.021	.042
	(.050)	(.039)	(.037)	(.039)
Workers in past harvest	−.000	−.000	.000	−.000
	(.001)	(.001)	(.001)	(.001)
Workers in past planting	.002	.002	−.000	.000
	(.005)	(.004)	(.004)	(.004)
Number of crops	−.021*	−.004	−.009	−.009
	(.013)	(.010)	(.009)	(.010)
Engaged in bush burning	−.068	−.044	.016	−.041
	(.048)	(.037)	(.036)	(.037)
Climate change	−.084*	−.022	−.019	−.044
	(.045)	(.035)	(.034)	(.035)
Decision over planting	−.014	.050	−.002	−.063
	(.096)	(.075)	(.072)	(.075)
Decision over harvest	.057	−.023	.115	−.035
	(.102)	(.079)	(.076)	(.079)
Constant	.785***	.291**	.167	.326***
	(.160)	(.124)	(.119)	(.124)
Observations	774	774	774	774
R-squared	.026	.031	.022	.021
P-value *F*-test of joint significance	.673	.611	.803	.878

Note: The dependent variable takes value one if the farmer has been assigned to the treatment or its various arms. Standard errors are in parenthesis.
$^{*}p < .1$; $^{**}p < .05$; $^{***}p < .01$.

TABLE A3 Effect size by treatment arms.

	Bush burning is acceptable	Engage in bush burning in the next planting season	Pledging to avoid bush burning	Join a localized activist group	Willing to pay for local government intervention
T1: Social info. vs. T2: Economic info.	.026	.034	.023	.049	.072
T2: Economic info. vs. T3: Mixed info.	−.074	.068	−.196	.049	−.095
T3: Mixed info. vs. T1: Social info.	.048	−.103	.173	−.099	.023

Note: The results are Cohen's *d* estimates of the standardized effect size that measures the difference in the mean outcome variables between the different treatment groups.
Abbreviation: info., information.

APPENDIX B: THE FIELD IMPLEMENTATION OF THE EXPERIMENT

We conveyed the information in their local languages (primarily Pidgin English, Yoruba, and Hausa) to ensure the farmers, who are predominantly low-education farmers, fully understood it. A multi-modal approach to information dissemination was employed, utilizing infographics (see Figures A2 and A3) to represent the key messages visually. By improving comprehension of the presented information during the sessions, this approach aimed to reduce the number of participants who dropped out of the study (attrition rate).

Pilot surveys confirmed that farmers exposed to both text and infographics displayed a significantly higher understanding of the content compared to those receiving only text (estimates available upon request). Furthermore, in some instances, survey staff were authorized to engage with farmers to clarify textual and infographic information, further enhancing their understanding. Following the information exposure, the survey team ascertained the willingness of the respondent to proceed with subsequent sections of the survey.

APPENDIX C: TREATMENT DESIGN

The information in all three sessions originated from policy documents by reputable organizations including those from reputable organizations such as the Food and Agricultural Organization, the US Environmental Protection Agency, the International Cryosphere Climate Initiative, and the United Nations Environmental Programme. To enhance credibility, the information was attributed to a reputable nongovernmental organization (NGO), as mentioned earlier. A linguist and a professional cartoonist were enlisted to prepare the information treatment, ensuring clarity and effective communication. Other treatment dimensions, such as the format of the information (graphics vs. text) or variation in attribution (e.g., attributing statements to the government vs. international organizations), could be explored in future studies. However, they were not considered in this study to maintain treatment consistency and power.

APPENDIX D: POWER CALCULATION AND SAMPLE DESIGN

A power analysis was conducted using a two-tailed test with a significance level of alpha = .05 and a desired power of .80. The analysis was based on data from a pilot survey (n = 30) administered to a separate group of farmers. The pilot focused on assessing the main outcome variable—the probability of farmers engaging in bush burning during the upcoming planting season. Although the pilot survey provided valuable insights into the efficacy of treatment design and survey instrument, which informed the development of the final survey instrument used in the main study, the relatively small sample size limits the generalizability of its findings. Based on the pilot data, it was determined that a total sample size of 780 farmers, with an equal distribution of 390 in the treatment group and 390 in the control group, would provide sufficient statistical power to detect a change in the probability of burning between .05 and .10 units.

Revised power estimates, based on the same pilot survey data, indicate that the study retains sufficient power to detect a minimum effect size of .10 in the primary outcome variable, even with three treatment groups.

Five states were selected based on predefined criteria outlined in Section 2.1 (e.g., high burning prevalence, crop types) and their distribution across Nigeria's geopolitical zones. Using the sample frame derived from the National Bureau of Statistics (NBS) list of Enumeration Areas (EAs), rural areas within these states were successfully identified.

Due to financial limitations, visits were made to approximately 42 locations, representing nearly half of the rural Enumeration Areas (EAs) within the selected states, according to the National Bureau of Statistics (NBS) sample frame. The number of sites visited in each state was proportional to the number of rural EAs. In Ekiti, with only four rural EAs, all were included.

The survey team conducted the survey through physical visits to a central location within each EA, such as a market or town hall. From this location, a pedestrian path or street was randomly chosen to initiate the survey route.

Interviewers conducted visits to farms in a systematic manner, selecting every third farm for the purpose of interviewing the individuals encountered at each respective farm. In instances where the individual being approached did not hold primary decision-making authority or was not of adult age, interviewers made a formal request to meet with the designated decision-maker, who would then undergo the interview process.

In some EAs where streets were predominantly residential rather than farmland, interviewers adopted a systematic approach by visiting every third household and conducting surveys with the adult member who served as the head of the household within the selected dwelling.

FGD Setup

The FGD was a separate session for farmers interested in participating beyond the main survey. The sample comprised 30 farmers from different communities, selected based on their availability to meet the minimum number required for the FGD to proceed (quorum). Gender representation was a focus, ensuring an equal or greater number of female farmers participated.

After completing the survey, respondents were asked if they would be interested in participating in a follow-up FGD later in the afternoon at a common location, typically the residence of a community leader or a central location familiar to the villagers. Once enough participants (quorum) were confirmed for a session, the specific community with the most available participants was chosen as the location for the FGD. Both men and women participated in the same session, and interviewers were instructed to encourage female participants to speak up more often if the conversation was dominated by male participants.

The session served as an open discussion forum, with the interviewer prompting the conversation based on a standard script designed to assess respondents' perceptions of agricultural burning, particularly in relation to the clarity and effectiveness of the information they received in the treatment. Throughout the session, other concerns were raised by participants, including identifying the challenges and opportunities associated with changing attitudes toward agricultural burning.

APPENDIX E: RISK OF CONTAMINATION

Contamination poses a potential threat in the context of individual-level randomization, particularly due to the proximity of control and treatment farmers within the same village. This risk becomes more significant when control farmers are present during the administration of the intervention to treatment farmers.

To mitigate this potential risk, several measures were implemented in our study design: First, interviews were conducted solely within farmlands and households, minimizing the chance of encountering outsiders who might be part of the control group. Second, after each interview, the third farm or household was visited for inclusion in the sample. This systematic approach helps maintain some separation between control and treatment groups.

It is important to acknowledge that even with these measures, some interaction between farmers following the intervention might still occur. However, the primary outcome variable in our study is measured immediately after exposure to the intervention. Therefore, any potential contamination that may happen after the outcome measurement is unlikely to influence our results.