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How Signboards on the Trained Farmers' Plot Facilitate Farmer-to-Farmer Extension (F2FE): A New Approach to Remove Demand-Side Constraints from Rice Management Training in Rainfed Mozambique

Hassan Sulaiman[*] and Kei Kajisa[†]

Abstract

Low agricultural productivity and persistent yield gaps continue to constrain food security in Sub-Saharan Africa. Supply-side interventions such as agricultural training and demonstration plots enhance adoption of improved rice management practices but are often costly and fail to reach spatially isolated farmers. Farmer-to-farmer extension (F2FE) is a cost-effective alternative promoting social learning, but its effectiveness is constrained when non-trained farmers cannot easily identify trained peers. Conventional approaches provide monetary or non-monetary incentives to trained farmers, but such schemes can be costly and difficult to sustain. This study introduces a new demand-side approach by setting up signboards on trained farmers' plots, displaying the farmer's name, contact details, and practices used, enabling other farmers to identify trained peers and seek information directly. Using a balanced panel of 219 farmers across 16 associations in rainfed Mozambique, we apply Propensity Score Matching Difference-in-Differences (PSM-DID), supported by PSM with Rosenbaum bounds and Inverse Probability Weighting DID (IPW-DID), to estimate the effect of noticing signboards on farming outcomes. Results show that non-signboard farmers who noticed signboards were more likely to adopt improved practices, increasing paddy yield by 302-387 kg/ha (33-43% of non-notice mean) and paddy income by 6,770-8,737 MZN/ha (37-48% of non-notice mean). Signboards also reduced dis-adoption among farmers. However, unlike direct training at demo plots, which raised adoption across all recommended practices, signboard notice enhanced adoption selectively. These findings highlight the potential and limitation of a simple and low-cost demand-side mechanism to strengthen F2FE and improve productivity in resource-constrained farming systems.

Keywords: Technology adoption, Agricultural extension, Rice farming
JEL Codes: O12, Q12, Q16

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1. Introduction

Low agricultural productivity continues to hinder economic growth and food security in Sub-Saharan Africa (SSA), where improved farming practices have not been widely adopted (Pingali 2012; Suri and Udry 2022; Wollburg *et al.* 2024; Takahashi, Muraoka, and Otsuka 2020; Yokamo 2020). Mozambique reflects this challenge clearly, with average rice yields stagnating at approximately 0.61 MT/ha throughout from 2010 to 2025, well below both regional and global averages (USDA 2025). Despite domestic rice consumption increasing rapidly from 86,000 tons in 1990 to over 1,000,000 tons in 2025 (USDA 2025), domestic production has failed to keep pace, increasing reliance on imports and straining foreign reserves (Kajisa and Payongayong 2011; Kajisa and Vu 2023).

One of the most promising avenues for increasing productivity in SSA is the dissemination of improved rice management practices, including seed selection by water, nursery bed preparation, bund construction, land leveling, and straight-row transplanting. While the package of modern varieties and inorganic fertilizer remains central to Asia's Green Revolution, the management practices offer significant productivity gains in contexts where access to modern inputs is limited, enabling farmers to raise yields even under cash constraints and limited market access (Otsuka, Mano, and Takahashi 2023; Otsuka *et al.* 2024). The effectiveness of such management practice was established in Mozambique by the impact evaluation of a management training through randomized controlled trial (Kajisa and Vu 2023).

However, adoption rates remain low, partly due to information barriers and the limited effectiveness of conventional dissemination strategies. This is particularly problematic for technologies involving complex, multi-step practices, where context-specific guidance is essential. Rice management practices exemplify such technologies because they require learning and correctly implementing a sequence of interdependent steps, unlike seed–fertilizer technologies where the essence of the technology is embodied in the input itself. Consequently, adopting management practices demands greater knowledge and sustained behavioral change to realize productivity gains (Takahashi, Mano, and Otsuka 2019; Hörner *et al*. 2022; Kajisa and Vu 2023).

A large body of empirical research has evaluated interventions designed to disseminate agricultural information to smallholder farmers, including training programs (Anderson and Feder 2007; Otsuka and Larson 2015; Nakano, Tanaka, and Otsuka 2018a; Takahashi, Mano, and Otsuka 2019; Mgendi, Mao, and Qiao 2022), extension services (Conley and Udry 2010), demonstration plots (Emerick and Dar 2021), farmer field schools (Davis *et al.* 2012; Larsen and Lilleør 2014; Van den Berg, Phillips, and Dicke 2020; Bakker, Dugué, and De Tourdonnet 2021; Bhuiyan and Maharjan 2022), and performance-based incentives to motivate extension workers (Shikuku 2019; BenYishay and Mobarak 2019). These studies predominantly evaluate supply-side

approaches aimed at expanding farmers' access to information by increasing formal training and extension services. While such efforts have been shown to improve knowledge among participating farmers, traditional channels like extension visits and demonstration plots are costly to implement and maintain. Moreover, they often exclude farmers who are geographically isolated or socially disconnected from key information networks (Anderson and Feder 2004; BenYishay and Mobarak 2019). Thus, identifying scalable and cost-effective approaches to effectively disseminate management practices remains a key area for research for Mozambique as well as for other sub-Saharan African countries (Takahashi, Muraoka, and Otsuka 2020).

As a response to these challenges, farmer-to-farmer extension (F2FE) has received increasing attention as a cost-effective and scalable mechanism for promoting diffusion (BenYishay and Mobarak 2019; Fisher *et al.* 2018; Nakano *et al*. 2018b; Takahashi, Mano, and Otsuka 2019; Kijima 2022). A growing body of evidence suggests that social learning, where farmers acquire knowledge by observing or interacting with their peers, plays a significant role in the adoption of agricultural technologies (Foster and Rosenzweig 1995; Munshi 2004; Bandiera and Rasul 2006; Conley and Udry 2010). By building on existing social networks, this approach has the potential to reach farmers who are often excluded from formal extension systems.

Yet the extent to which trained farmers successfully transfer knowledge to others remains uncertain, as existing studies report mixed levels of diffusion. Some studies report little or no diffusion from trained to non-trained farmers, suggesting that spillovers are not guaranteed (Feder, Murgai, and Quizon 2004; Tripp, Wijeratne, and Piyadasa 2005; Kondylis, Mueller, and Zhu 2017). Others emphasize that trained farmers may lack the incentive to share information unless motivated by financial or social rewards (BenYishay and Mobarak 2019). Moreover, for social learning to occur, non-trained farmers (demand-side of new information) must be aware of who received training and recognize the value of the information. It is commonly observed in fields that farmers appreciate new technologies, but they do not know to whom they should ask (Kijima, Ito, and Otsuka 2012; Ogutu, Okello, and Otieno 2014; Shitaye, Tadesse, and Enkuahone 2025; Abate 2025). When the visibility is absent, diffusion tends to be weak (Takahashi, Mano, and Otsuka 2018). These limitations underline the need for further empirical research to understand how F2FE can reliably support the broader adoption of improved agricultural practices.

To address this gap, our study proposes and tests an approach to remove demand-side constraints that lowers the search costs of the non-trained farmers to acquire information about new technology by setting up visible signboards on the plots of trained farmers. This demand-side approach is a novel approach as existing studies have mainly examined supply-side factors. The signboards set on paddy fields display the farmer's name, contact details, and the set of practices adopted on that field, thereby addressing three key advantages. First, signboards provide a permanent and easily visible source of information, unlike extension visits or seasonal

demonstrations that are sporadic. Second, this approach is particularly suited to the African farming context, where plots may be located far from farmers' residences and neighbors in the field are not always residential neighbors, creating barriers to informal knowledge exchange. Third, signboards are a highly inexpensive intervention, making them scalable and feasible for resource-constrained extension systems. Meanwhile, signboards may not guarantee the comprehensive dissemination of new practices because the signboard shows only the practices used on that plot. Also, even if the full set of practices are used on the signboard plot, noticing farmers may not adopt the full set of practices as a package, rather it can be subject to their own understanding and judgement just based on their observations of the signboard plot. This may be particularly important when recommended practices are complementary, potentially limiting the benefits of the intervention.

This study evaluates whether such signboards can effectively facilitate F2FE by enabling non-signboard farmers to identify and learn from trained peers. Building on a rice training program implemented by the Japan International Cooperation Agency (JICA), rolled out across 16 farmers' associations in rainfed areas of Zambézia Province, Mozambique, signboards were placed on some but not all of the trained farmers' plots in 2020. We exploit this variation to test two hypotheses. First, we examine whether noticing a signboard increases adoption of improved practices and enhances paddy yield and paddy income. Second, we test whether noticing signboards helps reduce dis-adoption among farmers who had adopted improved practices earlier but discontinued their use, given that dis-adoption remains a serious constraint in SSA countries (Teshome *et al.* 2012; Hassen 2015; Acheampong *et al.* 2016; Simtowe and Mausch 2019; Jogo, Bocher, and Grant 2021; Azumah *et al.* 2022; Lamptey *et al.* 2023). Our main empirical strategy relies on difference-in-differences estimation using propensity score matching (PSM-DID), with robustness checks by inverse probability weighting (IPW-DID) and PSM with Rosenbaum bounds, because signboard setup was not perfectly random, albeit it was planned so.

Our findings suggest that the signboard intervention increased adoption of improved rice management practices and raised productivity among the farmers who noticed the signboards in rainfed Mozambique, implying a high potential of demand-side approach as inexpensive and effective means to enhance rice productivity in SSA. Farmers who noticed signboards were more likely to adopt certain improved practices - particularly nursery bed preparation and straight-row transplanting, and to a lesser extent, seed selection, bund construction, and land leveling. Such a selective adoption is a potential drawback of the signboard approach because Kajisa and Vu (2023) found that the direct training at the demo plots raised adoption across all recommended practices as a full package, which raised paddy yield most. In addition, signboards helped reduce dis-adoption among farmers who had previously adopted these practices. Yield increased by approximately 302-387 kg/ha (33-43% of the endline yield of farmers who did not notice a signboard) among farmers who noticed a signboard. Income also increased by 6,770-8,737

MZN/ha (37-48% of the endline income of the non-notice farmers). While non-random signboard placement limits causal precision compared to a randomized trial, our findings highlight the importance of demand-side approaches and provide a foundation for future rigorous studies on F2FE.

The rest of the paper is organized as follows. Section 2 describes the study setting, experimental design, and signboard implementation. Section 3 presents descriptive statistics and summary characteristics and the balance tests of the sample. Section 4 presents our estimation strategies and regression results on the impact of signboard notice. Section 5 provides robustness checks to assess the reliability of the findings. Section 6 concludes the paper.

2. Study site, management training and signboard intervention

2.1 Study site

This study was conducted in Zambézia Province, the leading rice-producing region in Mozambique (Kajisa 2015). The province accounts for 40% of the country's total rice production (USDA 2025). Rice cultivation in this region primarily occurs under rainfed lowland conditions, with less than 2% of arable land equipped for irrigation (Kodama *et al.* 2022; Kajisa and Vu 2023). Farmers in this area manage small landholdings, averaging around 1.2 hectares, with 0.5 hectares typically allocated to rice cultivation (World Bank 2017; Popat *et al.* 2017; Kajisa and Vu 2023). The agricultural system remains predominantly low input, with minimal use of fertilizers and machines. While domestic rice consumption has grown rapidly since the 1990s, production has remained largely flat, resulting in a widening gap that has increased Mozambique's dependence on imports (USDA 2025) (Figure 1). The main rice-growing season in Mozambique runs from November to May, aligning with the rainy season (FAO 2024).

2.2 Management training and experimental design

The timeline of the training implementation and subsequent signboard intervention is presented in Figure 2. A rice management training program was implemented under a project supported by the JICA in collaboration with the Provincial Directorate of Agriculture and Fisheries (Direcção Provincial de Agricultura e Pescas, DPAP). Sixteen farmer associations were selected based on their functionality and involvement in rice production (Figure 3). The training promoted improved cultivation practices suitable for rainfed conditions, including seven key practices: (1) seed selection by water, in which empty seeds floating on the surface are removed to retain only viable seeds, (2) nursery bed preparation, (3) bund construction, (4) land levelling, (5) straight-row transplanting, (6) timely weeding, and (7) harvesting at the base of the plant rather than cutting only the panicles.

The training was delivered in three phases using a cluster randomized controlled trial design at an association level. Treatment 1 (T1) included 5 associations trained in 2017-18, Treatment 2 (T2)

consisted of 6 associations trained in 2018-19, and Treatment 3 (T3) involved 5 associations trained in 2019-20. Within each association, key farmers were selected to receive training at demonstration plots established on common association land. Other members who voluntarily joined the sessions were referred to as replica farmers, while those who did not participate directly were considered ordinary farmers.

Following the completion of all training phases, the signboard intervention was introduced in 2020-21, and randomization was initially planned at the association level; however, the implementation did not follow the initial design (details explained later). Signboards were installed on the plots of selected trained key farmers to make information on improved practices visible to other farmers. From 2020 onward, non-trained farmers could observe these signboards during their farming activities, and by 2023, signboard notice, and adoption outcomes were evaluated.

2.3 Signboard intervention

The signboard intervention was originally designed to be randomized at the association level, but the planned randomization was not implemented as intended. Table A1 in the Appendix summarizes the allocation plan and the actual implementation of signboards by association. Under the original randomized plan, eight associations were randomly assigned to receive signboards, while the remaining eight served as controls. In total, 29 trained key farmers were expected to install signboards across the eight treatment associations. Selection of signboard farmers was not random; they were chosen by the training project team from among the trained key farmers in each association. Installation of signboards and the disclosure of farmers' names and contact information were voluntary, and participating key farmers agreed to display this information without direct or indirect enforcement by the project team.

In practice, however, the implementation deviated from this plan due to miscommunication during the COVID-19 pandemic.[1] Extension agents carried out the assignment in the field, and 11 associations eventually had 16 farmers install signboards. Of the 29 farmers originally designated, 22 did not set up signboards, while 7 did, and nine additional unplanned farmers also established signboards, resulting in 16 in total. This deviation from the randomized plan introduces potential endogeneity concerns, which are addressed in detail in the empirical-strategy section.

2.4 Data collection and key variables

Baseline data were collected in 2017, followed by a midline survey in 2019 and an endline survey

[1] The deviation occurred because the intervention was managed remotely during the COVID-19 pandemic after Japanese experts had returned to Japan, leading to delays, limited field supervision, and miscommunication between project staff and local extension officers.

in 2023 (Fig. 2).[2] To assess the impact of training, the midline survey took place after the first two groups of associations (T1 and T2) received training but before the third group (T3). The endline occurred several seasons later, providing sufficient time to observe both sustained adoption and dis-adoption of improved practices, as well as associated productivity effects.

Through three-rounds of data collection, we generated a household panel, and the analysis uses a balanced panel of farmers successfully tracked across all rounds, resulting in 235 farmers.[3] This consisted of 16 signboard key farmers, 32 non-signboard key farmers, 17 replica farmers, and 170 ordinary farmers.[4] Signboard key farmers directly implemented the intervention and served as the source of information for others, so they are excluded from the analyses this time. The final analysis therefore focuses on the remaining 219 farmers (non-signboard key, replica, and ordinary), who constitute the population exposed to signboards. All surveys were conducted through face-to-face interviews using computer-assisted personal interviewing (CAPI).[5] Household and farming information were self-reported, while rice-plot size was measured by GPS coordinates.

One of the key variables is the variable capturing exposure to signboard. It was measured as a binary indicator based on whether the farmer reported noticing a signboard and observing the information displayed. In addition, social network was captured by calculating the ratio of the number of association members known by each respondent over the total number of association members sampled by this survey. Given that there exist signboard key farmers and non-signboard key farmers, spatial data were used to compute the minimum distance (in kilometers) from each farmer to the nearest signboard key farmer plot and also the nearest non-signboard key farmer plot; when the nearest key farmer was also a signboard key farmer, the two measures become identical. If no signboard farmer is present within an association to which the farmer belongs, the distance was measured to the nearest signboard plot located in a different association. These controls help account for differences in access to visible or accessible information channels.

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[2] An impact evaluation of the management training using the baseline and midline data is reported in Kajisa and Vu (2023)

[3] The initial sample size was determined through a cluster-level power calculation based on pilot data collected by the project prior to the baseline survey (Kajisa and Vu, 2023). The mean paddy yield was set at 1 t/ha with a standard deviation of 1 t/ha, intra-cluster correlation (ICC) at 0.15, and 6 clusters per experimental arm. Assuming a significance level of 0.05 and statistical power of 0.8, a sample size of 15 farmers per association yielded a minimum detectable effect (MDE) of 0.81 t/ha. As the project aimed to increase yield by 1 t/ha, the target sample size per association was set at 15 farmers. Farmers were randomly sampled proportionate to association size at baseline, and the present balanced panel reflects those successfully tracked across all survey rounds.

[4] Since the training project added the key farmers in the later rounds of training, we classified a farmer as a key farmer if they were identified as such in at least one of the three survey rounds.

[5] Baseline and midline surveys used SurveyBe CAPI, and the endline survey used Survey Solutions CAPI, version 23.09.

To assess environmental variability, farmers were asked whether they experienced drought or flooding during the rice season surveyed. In addition to these self-reported measures, high-resolution weather data were obtained for each farmer's plot using geospatial coordinates. Weather variables were extracted from TerraClimate, a monthly climate dataset offering high-resolution (approximately 4 km) gridded climate and water balance data developed by the University of Idaho and recognized for its temporal depth and physical realism (Abatzoglou *et al.* 2018). Key variables include total precipitation (mm), average minimum temperature (°C), and average maximum temperature (°C) during the rice-growing season from November to May.

3. Descriptive statistics

3.1 Farmers characteristics and balance test

Table 1 shows the distribution of signboard farmers, signboard notice farmers, and their practice adoption patterns across the 16 associations. Three features can be derived. First, the spatial pattern reveals that farmers in four associations without any signboard farmers (Associations 1, 8, 11, 13) still reported noticing signboards, indicating cross-association spillover. Conversely, some farmers in associations with signboard farmers reported not noticing signboards. These observations indicate that noticing was not solely determined by geographical proximity but suggest that information extended beyond the immediate surroundings and beyond the original signboard association. This means that noticing varies at the individual level, rather than simply due to proximity within the association.

Second, Table 1 also shows that the average number of practices used by signboard key farmers at endline ranged from 2 to 6 out of 7 practices across associations, indicating that not all signboard key farmers had fully adopted the promoted seven practices.

Third, while some signboard notice farmers made inquiries after noticing the signboards, others adopted new practices without making inquiries, suggesting that adoption decisions may also have been influenced simply by observing signboard key farmers' plots or by obtaining information from extension workers or key farmers closer to the noticing farmers. Since adoption among notice farmers may depend on the practices adopted by key farmers, Figure 4 visualize the average number of practices used by signboard key farmers against that of signboard notice farmers by association in Table 1. Most observations lie below the 45 degree line, indicating that notice farmers consistently adopted fewer practices than key farmers within the same association.

Table 2 presents baseline descriptive statistics for farmers who reported noticing a signboard at endline compared to those who did not. The result shows that individual notice was not random. Farmers who later noticed signboards already differed at baseline, particularly in household size and cultivated paddy area, with signboard-notice farmers cultivating significantly larger areas (0.68 ha vs 0.44 ha). These pre-existing differences indicate that exposure to signboards is not

random, raising concerns about selection bias. Distance to the signboard farmer plot was slightly shorter for signboard-notice farmers than non-notice farmers (1.22 km vs 1.60 km), but the statistical significance of this difference is weak (p-value = 0.18, not reported in the table), indicating that proximity alone was not a critical factor for noticing.

Regarding farmer composition shown at the lower part of the table, farmers who noticed signboards included a higher proportion of key farmers compared to non-notice farmers (22% vs 12%). Correspondingly, a significantly smaller proportion of signboard-notice farmers were ordinary farmers (69% vs 81%). This pattern indicates that farmers with prior training exposure were more likely to notice signboards, though the majority in both groups remained ordinary farmers without direct training contact. Since key farmers received training directly, this compositional difference may raise concerns that observed effects partly reflect prior training exposure rather than signboard notice itself. We therefore conduct a robustness check addressing this concern in Section 5.

The F-tests at the bottom of Table 2 indicate that the two groups could differ significantly across multiple baseline characteristics ($F = 1.60$, $p < 0.10$), confirming the need for statistical methods to account for selection bias.

3.2 Evolution of outcomes

Table 3 presents the evolution of key outcome variables across the baseline, midline, and endline surveys for farmers who reported noticing a signboard and those who did not. The variables include paddy yield (kg/ha), paddy cultivation income, use of five recommended practices (seed selection by water (=1), setup of the nursery bed (=1), bund construction (=1), plot levelling (=1), and lined transplanting (=1)) in Panel A, and dis-adoption of at least one practice (=1) in Panel B.[6] Dis-adoption is defined as having adopted at least one improved practice at midline but discontinuing at least one of those practices by endline. Farmers who had not adopted any practice at midline are excluded from this indicator. Income is defined as the value of paddy sold and consumed evaluated at the prevailing market price minus the paid-out costs of hired labor, rental machinery, draft animals, and other purchased inputs.[7] NA values arise for two distinct reasons. First, income is unavailable at midline because the cost modules required for its computation were

[6] Weeding is not included among the reported practices because baseline data on weeding were not collected reliably. Although recommended, the practice of harvesting at the base of the plant is not included because it is not a yield-improving practice; rather, its adoption may occur in response to yield improvements, leading to potential reverse causality.

[7] Profit, defined as income minus imputed family labor and imputed machinery costs, is excluded from the analysis for two reasons. First, imputing the cost of own machinery use is difficult and unreliable because the machine rental market is thin and local price data are scarce. Second, imputing family labor costs is problematic because many farmers rely on elderly household members and children, for whom market wage equivalents are rarely observed. Since these limitations introduce substantial measurement error in profit, we refrain from using this variable in our analysis.

not administered in that survey round. Second, the dis-adoption indicators measure changes in adoption status from midline to endline and are therefore not defined at baseline or midline.

Table 3 shows that patterns in yield and earnings changed over time between the two groups. Farmers who noticed signboards recorded higher paddy yield at baseline. By midline, the pattern reversed and farmers who did not notice signboards recorded higher yield. However, at endline yield again became higher among farmers who noticed signboards. During the endline rice season there was unusually heavy rainfall, with more than 75% of farmers reporting flooding. Although both groups experienced a decline in paddy yield under these conditions, the reduction was smaller among farmers who noticed signboards. Despite the yield decline, income slightly increased from baseline to endline among signboard notice farmers, partly reflecting a rise in the mean paddy price from 15 MZN/kg at baseline to 24 MZN/kg at endline. Meanwhile, signboard non-notice famers' income slightly decreased. These patterns suggest that the benefit of signboard notice extends beyond productivity gains under favorable conditions to include reduced vulnerability under adverse weather possibly due to improved irrigation water control under new practices.

Practice use also evolved differently across survey rounds. Adoption levels were low at baseline and increased for both groups by midline, without a clear difference between the two groups. By endline, however, farmers who noticed signboards displayed substantially higher adoption of nursery beds, bund construction, plot levelling, and lined transplanting. Dis-adoption patterns reinforce this interpretation. Between midline and endline, practices were discontinued more among farmers who did not notice signboards, while those who noticed signboards continued applying them more consistently. The relatively higher endline yield among farmers who noticed signboards may therefore reflect not only initial adoption but the continued and correct application of recommended practices.

Given the pre-existing differences between groups and the non-random nature of signboard exposure, a statistical approach is needed to account for both spillovers and selection. The next section introduces the empirical strategy used for this purpose.

4. Impact of signboard notice

4.1 Estimation strategy

The descriptive analysis in Section 3 showed that signboard notice varied at the individual level and that the notice occurred even in the associations where the signboard was not placed. This motivates our decision to conduct an individual-level treatment effect assessment using signboard notice as the treatment variable, rather than the originally planned association-level analysis based on signboard placement, same as what Kajisa and Vu (2023) did for the rice farming training assessment. We also find that signboard notice was systematically related to observable farmer

characteristics, indicating non-random exposure to signboard.

To address selection bias arising from non-random notice, we employ propensity score matching (PSM) to balance observable characteristics between notice and non-notice farmers. Taking advantage of the panel structure of the data, we combine PSM with difference-in-differences (DID) estimation. The resulting PSM-DID framework is applied to outcomes observed in multiple periods and allows us to control for time-invariant unobserved farmer-level characteristics and period-specific shocks.

This approach, however, has important limitations. First, PSM identifies the average treatment effect on the treated (ATT) rather than the intention-to-treat (ITT) effect. Our estimates therefore capture the impact of actually noticing a signboard, not the impact of being assigned to a signboard association. Second, PSM relies on the common support assumption, so the estimated effects apply to farmers who noticed a signboard and for whom comparable non-notice farmers exist based on observed characteristics. The estimated effects therefore pertain to a subset of farmers with similar baseline characteristics, that is, those for whom the likelihood of noticing a signboard is comparable between the matched treated and control groups.

In addition to yield and adoption outcomes, we examine dis-adoption as defined in Section 3.2. Dis-adoption captures a single transition from midline to endline, making it unsuitable for analysis within a DID framework. We therefore apply cross-sectional PSM to compare endline dis-adoption rates between signboard-notice and non-notice farmers with balanced baseline characteristics.

To ensure the robustness of our findings, we conduct several sensitivity analyses. First, within the PSM framework, we test alternative matching algorithms including nearest-neighbor and kernel matching with varying specifications. Second, as an alternative panel estimation approach, we employ inverse probability weighting DID (IPW-DID). Third, using cross-sectional data, we apply Rosenbaum bounds tests to examine the sensitivity of the results to potential hidden bias from unobserved selection.

4.2 Propensity score matching with difference-in-differences (PSM-DID)

The impact of signboard notice is estimated using a PSM-DID approach.[8] We estimate the propensity score using a logit model with baseline covariates to predict the probability of signboard notice by endline. The covariates include household and plot characteristics, climatic conditions, and association fixed effects. Distance to the key farmer's plot, distance to the

[8] We assume unconfoundedness, which states that conditional on observable characteristics, treatment assignment is independent of potential outcomes. We also assume overlap, implying that every farmer has a positive probability of treatment and non-treatment for any given observable characteristics (Rosenbaum and Rubin 1983).

signboard farmer's plot, and rice cultivated area, along with their squared terms, are included in the first stage but excluded from the second stage regression, as these variables are time-invariant and drop out under panel fixed effects. Matching is implemented using both nearest-neighbour (calipers 0.01, 0.03, 0.05) and kernel (bandwidths 0.01, 0.03, 0.05) algorithms, with matching conducted with replacement. Matching with replacement is preferred in this setting because the number of control individuals comparable to treated individuals is limited, and allowing controls to serve as matches for multiple treated individuals reduces bias by improving match quality (Dehejia and Wahba 1999; Stuart 2010). A consequence of this approach, however, is that matched controls are no longer independent observations, as some appear in the matched sample more than once. This non-independence is addressed in the outcome analysis by assigning each matched control unit a frequency weight equal to the number of times it was selected as a match and incorporating these weights into the second-stage regression (Stuart 2010).[9] Covariate balance is evaluated through standardized mean differences (SMDs) and visualized using Love plots, while the common-support assumption is verified by inspecting the kernel-density distributions of the estimated propensity scores.

After matching, we estimate treatment effects using a panel fixed effects DID specification. We include time-varying covariates as additional controls alongside the treatment indicators. This is in line with the recommendation of Rubin and Thomas (2000), who show that combining propensity score matching with cross section regression adjustment for prognostic covariates reduces residual confounding bias and improves estimation efficiency relative to matching alone. Including covariates in the post-matching cross section regression is particularly important when matching is inexact, as residual imbalance may persist even after successful matching (Nguyen *et al.* 2017). In empirical studies this practice is applied to a panel data set as a PSM-DID method (Wang *et al.* 2019; Xu *et al.* 2024; Luo, Qiang, and Lee 2023; Fan and Zhang 2021). All covariates included in the outcome regression are time-varying panel versions of variables used in the propensity score estimation, ensuring consistency between the two stages and avoiding the potential bias that can arise from introducing new covariates at the regression stage (Shiba and Kawahara 2021).

The model is expressed as:

$$Y_{ijkt} = \beta_0 + \beta_1\left(SBN_{ijk} \times After2\right) + \beta_2\left(T1_j \times After1\right) + \beta_3\left(T2_j \times After1\right) + \beta_4\left(T3_j \times After2\right) + \mathbf{X_{ijkt}}\boldsymbol{\theta} + \eta_{ijk} + \lambda_t + \varepsilon_{ijkt} \quad (1)$$

where Y_{ijkt} denotes the outcome for farmer plot i in association j, within local unit k,

[9] In nearest-neighbour matching with replacement, the weight assigned to each control unit equals the number of times it was selected as a match across all treated units, following the frequency weighting convention described in Stuart (2010). For kernel matching, the continuous kernel weights derived from *psmatch2* STATA command are applied directly as probability weights in the second-stage regression, as these weights reflect each control unit's contribution to the counterfactual for each treated unit.

observed at time $t = 0,1,2$, corresponding to the baseline, midline, and endline rounds, respectively. η_{ijk} captures farmer fixed effects; λ_t are period dummies; and $\boldsymbol{X_{ijkt}}$ is a vector of time-varying control variables. The time-varying covariates $\mathbf{X_{ijkt}}$ included in equation (1) represent variables that are not affected by signboard exposure, thus avoiding "bad controls" that would block part of the treatment effect (Angrist and Pischke 2009; Cinelli, Forney, and Pearl 2024). The terms SBN_{ijk} = 1 if farmer i noticed a signboard, $After1 = 1$ if $t = 1$ or 2, and $After2 = 1$ if $t = 2$, are time indicators representing the corresponding post-treatment periods. These are interacted with the training group dummies $T1_j$, $T2_j$, and $T3_j$ to capture the differential effects of the three training phases across survey rounds, reflecting the implementation of training over time. The coefficient β_1 for $SBN_{ijk} \times After2$ therefore measures the ATT or the additional impact on outcomes attributable to signboard notice by the endline, after accounting for training, time, and covariates' effects.

For inference, we use wild bootstrap cluster-robust *p*-values following MacKinnon and Webb (2020), Roodman *et al.* (2019) and Wooldridge (2010). This method is particularly suitable given the small number of clusters in our dataset which is below the 42-cluster threshold recommended for conventional cluster-robust standard errors (Angrist and Pischke 2009).

4.3 Estimation results: PSM-DID

The first-stage logit estimation of the determinants of signboard notice is presented at Table A2 in the appendix. Among the covariates, distance to the signboard farmer's plot and its squared term are highly significant, alongside several household and farm characteristics. Matching performance was evaluated by distribution comparison and Love plots. Figure A1 shows the distribution of estimated propensity scores for treated and control groups. While there is substantial overlap in the middle range, the distribution reveals some imbalance, particularly in the upper tail where treated farmers are more concentrated while the control group thins out. This pattern indicates that some control observations are matched to multiple treated farmers. Following Caliendo and Kopeinig (2008), observations outside the common-support region were excluded. Table A3 reports the final matched sample sizes for each matching method. Nearest-neighbor matching resulted in matched samples of 80-93 farmers, while kernel matching retained larger samples of 123-170 farmers due to its use of weighted comparisons.

Figure A2 presents the Love plot showing covariate balance before and after matching. Although matching substantially reduces SMDs for most covariates, some variables remain moderately imbalanced, indicating that the matching procedure, while improving balance, does not achieve perfect comparability between groups. These imperfections in matching performance motivated our decision to include the covariates in DID estimation model and to conduct extensive robustness checks using multiple matching specifications and alternative estimation methods.

Our main results, the ATT from the PSM-DID models, are visualized in Figure 5, evaluating the impact of signboard notice on paddy yield, income, and the adoption of key management practices. Full estimation results are presented in Appendix Tables A4-A5. In each panel, the circles represent point estimates of the ATT, while the vertical lines indicate 95% confidence intervals based on cluster-robust standard errors at the association level. Not only *p*-values but also wild-bootstrap *p*-values are reported for inference robustness. The estimated ATT effects on rice yield are positive across most specifications, ranging from 302-387kg/ha, and are statistically significant under kernel matching at all bandwidths and NN matching at calipers 0.01 and 0.03. These estimates correspond to approximately 33-43% of the endline average yield among non-notice farmers, indicating meaningful improvements in productivity. For rice income, point estimates are positive and statistically significant across all specifications, ranging from 6,770-8,737 MZN/ha, consistent across both kernel and NN matching. These income effects represent approximately 37-48% of the endline rice income of non-notice farmers, suggesting that productivity improvements lead to substantial increases in rice income.

The ATT estimates for nursery bed setup are positive and highly significant across all specifications ($p < 0.01$). Lined transplanting also shows consistent positive effects, significant across most specifications under both kernel and NN matching. Seed selection and bund construction show positive effects under kernel matching at bandwidths 0.03 and 0.05. Plot leveling shows a significant effect only under kernel matching at bandwidth 0.01, suggesting effects are concentrated among more closely matched farmers. Overall, being consistent with the partial adoption behavior in Table 1, signboard notice enhanced adoption of some practices but not all. This selective adoption pattern contrasts with the findings of Kajisa and Vu (2023), who showed that direct training at demo plots led to significant adoption gains across all five recommended practices. Since Kajisa and Vu (2023) found that the adoption of full package resulted in the highest yield increase, the selective adoption could be a potential drawback of the signboard intervention.

5. Robustness checks

5.1 Key farmer compositional imbalance

As noted in Section 3, farmers who noticed signboards included a higher proportion of key farmers compared to non-notice farmers at baseline. Since key farmers received training directly, this compositional difference may raise concerns that some of the estimated effects reflect prior training exposure rather than signboard notice itself. To address this, we re-estimate the PSM-DID model including an interaction term between signboard notice and key farmer status, allowing the effect of signboard notice to differ between key farmers and other farmers (replica and ordinary farmers). Full estimation results are presented in Appendix Tables A6–A7.

The positive effect of signboard notice on rice yield remains positive among replica and ordinary

farmers, though significance is limited to NN matching at caliper 0.01. Rice income remains positive and statistically significant under kernel matching across all bandwidths, while NN matching estimates are positive but insignificant. Regarding practice adoption, nursery bed setup retains highly significant positive effects across all specifications. Seed selection, bund construction, and lined transplanting all remain significant and are robust to the inclusion of the key farmer interaction term. These findings suggest that the core adoption effects are not driven by key farmer composition. Plot levelling does not survive the robustness check, though this result was already the weakest in the main analysis, significant only under kernel matching at bandwidth 0.01. The overall pattern suggests that the core finding of positive adoption and income effects remains supported, with the yield effect less robust in this specification.

5.2 PSM with Rosenbaum bounds

5.2.1 Estimation model

As a further robustness check, we re-estimate treatment effects using cross-sectional PSM. While PSM-DID exploits panel data to control for unobserved heterogeneity and time-invariant confounders, cross-sectional PSM provides a complementary approach that does not rely on the parallel trend assumption but instead estimates treatment effects under the assumption of conditional independence. An additional advantage of cross-sectional PSM is that it allows application of Rosenbaum bounds sensitivity analysis, which cannot be implemented with DID estimates.

We apply the same matching procedures and propensity score specification described in Section 4.2 to endline cross-sectional data. Unlike the PSM-DID estimates, wild cluster bootstrap inference is not available for cross-sectional PSM matching estimators. We therefore report conventional p-values for the cross-sectional PSM results.

To assess robustness to hidden bias from unobserved variables, we apply Rosenbaum bounds (Rosenbaum 2002; Becker and Caliendo 2007). This sensitivity analysis evaluates how strongly an unobserved factor would need to influence both treatment assignment and outcomes to overturn the estimated treatment effects. The method introduces a sensitivity parameter (Γ) representing the odds ratio of differential treatment assignment due to an unobserved covariate. At each level of Γ, a hypothetical significance level is computed based on Wilcoxon signed-rank tests, indicating how the p-value would change if hidden bias were present. Higher critical Γ values (the point at which $p > 0.10$) indicate greater robustness, implying that a relatively large difference in the odds of receiving treatment due to unobserved factors would be required to render the estimated effects statistically insignificant (Rosenbaum 2002; Takahashi and Barrett 2014).

5.2.2 Estimation results: PSM

The ATT results in Table 4 from the PSM model largely reinforce the PSM-DID findings. In the table, NA indicates that Rosenbaum bounds are not applicable because the estimated effect is statistically insignificant, making sensitivity analysis to hidden bias uninformative. Yield effects are positive and statistically significant, with Rosenbaum bounds (Γ values exceeding 2.0) indicating resilience to unobserved bias. The yield coefficients in the PSM model (508-848 kg/ha) are notably larger than those from PSM-DID (302-387kg/ha), likely because PSM, unlike PSM-DID, does not control for time-invariant unobserved heterogeneity. For rice income, the PSM model produces statistically significant effects under all NN specifications and Kernel matching at bandwidth 0.01, while estimates under Kernel matching at bandwidths 0.03 and 0.05 are positive but insignificant. This indicates less consistent evidence than PSM-DID, where income effects were significant across all specifications.

Technology adoption outcomes follow a broadly similar pattern to PSM-DID results. Nursery-bed setup remains the most robust adoption effect, with ATT values ranging from 0.26 to 0.33 and significance under all matching approaches, supported by strong Rosenbaum bounds ($\Gamma > 2.95$). Seed selection shows consistent significance at Kernel matching at bandwidths 0.05 across both methods, with NN matching at caliper 0.05 also significant in PSM but falling just outside the 10% threshold in PSM-DID due to the use of wild bootstrap *p*-values. Bund construction shows significant effects under Kernel matching at bandwidths 0.03 and 0.05, consistent with the PSM-DID results, confirming robustness across both methods. Plot levelling is significant under all Kernel specifications and NN matching at caliper 0.01, representing a broader pattern of significance than in PSM-DID where the effect was limited to Kernel matching at bandwidths 0.01. Lined transplanting is significant only under Kernel matching at bandwidths 0.03 and 0.05, less robust than in PSM-DID, suggesting this practice may be more reliably identified when accounting for time-invariant factors.

Turning to dis-adoption, Table 5 provides evidence that noticing signboards reduces discontinuation of improved practices. Farmers who had not adopted any practice at midline are excluded, resulting in a smaller analytical sample than the main PSM analysis. Table A8 reports the final matched sample sizes, with nearest-neighbor matching yielding 58-80 farmers and kernel matching retaining 88-133 farmers. The ATT estimates are negative and statistically significant across all specifications, indicating that farmers who noticed signboards were significantly less likely to discontinue at least one previously adopted practice by endline. The magnitude of the effect ranges from -0.219 to -0.300, and Rosenbaum bounds exceed $\Gamma = 3.95$ across all specifications, indicating that this result is highly robust to potential unobserved confounding.

Table 6 presents a placebo analysis using baseline data to test whether differences between farmers who later noticed signboards and those who did not exist before signboard exposure.

Across almost all outcomes, the ATT estimates are small and statistically insignificant, confirming that treated and control groups were comparable before signboard notice. The only exception is bund construction, which shows marginally significant ATT under NN but not Kernel matching. Given the small magnitude of this pre-treatment difference and its inconsistency across matching methods, we have judged that it is unlikely to bias the post-treatment results.

5.3 IPW-DID

5.3.1 Estimation model

To further test robustness, we implement an IPW-DID model as an alternative to PSM-DID. IPW-DID retains the entire sample and reweights observations using inverse probability weights to balance the distribution of covariates between treated and untreated groups (Wooldridge 2007; Abadie 2005). This approach is particularly suitable for panels with multiple periods and variation in treatment timing (Avagyan and Vansteelandt 2021; Baker *et al.* 2025; Wen *et al.* 2025; Khan, Schaffernicht, and Stork 2025).

We estimate the probability of signboard notice at baseline using a Logit model with the same covariates specified in Section 4.2. Stabilized inverse probability weights are then computed as the inverse of the predicted propensity score for treated farmers and the inverse of one minus the propensity score for control farmers. These weights are then carried forward across all periods and applied in the second stage DID regression using probability weights. As emphasized by Abadie (2005), this IPW design allows consistent estimation of the ATT under the assumptions of conditional independence and correct specification of the propensity score.

In the second stage, we apply these weights to estimate equation (1) using the same panel fixed effects DID specification and inference procedures described in Section 4.2.

5.3.2 Estimation result: IPW-DID

Table 7 presents the estimated impact of signboard notice using the IPW-DID approach. The first-stage Logit estimates are the same as those reported in Table A2 for PSM-DID and full results in Appendix Tables A9 - A10, including summary statistics of the inverse probability weights. While the mean weights are relatively modest (1.91 overall), the distribution reveals some extreme values, particularly in the control group where the maximum weight reaches 18.06. This indicates limited overlap in propensity scores for certain farmers, suggesting that a small number of control observations are heavily weighted to construct the counterfactual for treated farmers. To assess sensitivity to these extreme weights, we re-estimate all models with weights trimmed at 10. The trimmed results are nearly identical to the untrimmed estimates, confirming that extreme weights do not drive our findings.[10]

[10] Summary statistics of trimmed weights and full IPW-DID results with trimmed weights are presented in Appendix Tables A11 and A12, respectively.

The estimated coefficient for rice yield is positive but not statistically significant, with a point estimate of 317.2 kg/ha comparable to the PSM-DID range of 302-387 kg/ha, though IPW-DID produces wider confidence intervals and lower statistical precision. Rice income is also positive but insignificant, representing a divergence from PSM-DID where income effects were significant across all specifications.

For agricultural practices, the IPW-DID estimates are broadly consistent with PSM-DID results and in some cases stronger. Nursery bed setup and lined transplanting remain significant across both methods, confirming the robustness of these effects. Seed selection and bund construction are also significant under IPW-DID, consistent with their significance under kernel matching in PSM-DID. Plot levelling is statistically significant under IPW-DID, whereas under PSM-DID this effect was limited to fewer specifications, suggesting it gains precision under the IPW-DID framework. The consistency in direction and magnitude across methods strengthens confidence in the core adoption findings.

6. Conclusion

This study investigated whether signboards placed on trained farmers' plots can facilitate farmer-to-farmer extension for non-trained farmers seeking information on improved rice management practices. Drawing on panel data from rainfed Mozambique and applying multiple estimation strategies to address selection bias, the analysis provides suggestive evidence that signboards may function as a low-cost tool to strengthen informal agricultural extension systems.

The findings demonstrate that making trained farmers visible and identifiable through signboards facilitates knowledge diffusion in settings where farmers' plots are dispersed and informal learning networks are limited. Signboard notice increased the adoption of improved practices, with particularly strong effects on nursery bed setup and lined transplanting. Enhancing partial adoption, rather than the adoption of a full package, can be a limitation of the signboard approach when practices are complementary. The evidence on reduced dis-adoption is noteworthy, as the discontinuation of beneficial practices remains a persistent challenge in Sub-Saharan Africa. By providing farmers with continued access to knowledgeable peers, signboards appear to help sustain adoption even after formal training program ends. As a result, signboard notice generated consistent and statistically significant improvements in rice yield and income among farmers who noticed the signboards.

It is important to acknowledge limitations. The signboard intervention was not perfectly randomized, which limits causal precision compared to a fully randomized trial. Our estimates apply only to farmers who noticed signboards and satisfy the common support condition, limiting the generalizability of findings to this specific subpopulation. Nonetheless, the results indicate potential value in demand-side approaches and provide a foundation for future experimental

research that could test scalability and explore how design features such as message content, placement, and visibility affect outcomes.

Overall, our findings highlight the relevance as well as the limitations of demand-side interventions that empower farmers to actively seek and exchange knowledge. As agricultural systems in sub-Saharan Africa continue to face structural and informational barriers, low-cost visibility tools like signboard is worth investigating further as a promising complement to conventional extension models.

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Table 1: Distribution of signboard farmers, signboard notice farmers, and their practice adoption by association

		Signboard key farmer		Signboard notice farmers		
Association ID	**Total number of sample farmers**	**Number of signboard key farmers**	**Average number of practices used by signboard key farmers at the endline (a)**	**Number of signboard notice farmers**	**Number of signboard notice farmers who made inquires**	**Average number of practices used among signboard notice farmers at the endline (b)**
1	15	0		2	0	1.0
2	8	1	3.0	2	0	3.0
3	14	1	6.0	1	1	4.0
4	10	0		0		
5	13	3	5.0	6	4	3.0
6	12	1	4.0	4	0	3.0
7	18	1	4.0	8	0	2.5
8	13	0		8	2	2.9
9	14	1	4.0	6	3	4.2
10	14	1	2.0	0		
11	18	0		3	2	4.7
12	14	1	5.0	2	0	3.0
13	12	0		4	1	3.5
14	16	2	4.0	6	4	1.8
15	21	1	4.0	6	3	3.2
16	23	3	3.7	7	4	2.6
Total	235	16	4.1	65	24	3.0

Note: Signboard farmer refers to farmers on whose plot signboards were installed. Signboard notice farmer refers to a non-signboard farmer who reported seeing a signboard on a signboard farmer's plot. (a) Missing value is reported when associations have no signboard key farmers. Maximum value 7 practices. (b) Maximum 7 practices.

Table 2: Baseline balance of sample households by signboard notice

Variable	(1) Signboard notice (=1) Mean/SE	(2) Signboard notice (=0) Mean/SE	(3) Difference & *t*-test (1)-(2)
Household head's age (years)	43.75	43.66	0.10
	(1.67)	(1.11)	
Household size (number)	4.57	3.96	0.61*
	(0.30)	(0.18)	
Dependency ratio (% of dependents to working age)	42.19	37.01	5.19
	(3.21)	(2.59)	
Share of members in the same association known by the respondent (%)	41.86	46.89	-5.03
	(4.22)	(2.85)	
Distance to key farmer plot (km)	0.48	0.64	-0.16
	(0.09)	(0.07)	
Distance to signboard farmer plot (km)	1.22	1.60	-0.38
	(0.19)	(0.14)	
Uses transport to reach farm plot (=1)	0.11	0.16	-0.05
	(0.04)	(0.03)	
Travel time from home to plot (minutes)	43.85	37.94	5.90
	(5.94)	(3.40)	
Rice cultivated area (ha)	0.68	0.44	0.24**
	(0.12)	(0.04)	
Plot owner (=1)	0.88	0.94	-0.06
	(0.04)	(0.02)	
Experienced flood (=1)	0.35	0.25	0.10
	(0.06)	(0.04)	
Experienced drought (=1)	0.92	0.86	0.07
	(0.03)	(0.03)	
Total rainfall in rice season (mm)	1060.35	1062.92	-2.57
	(14.56)	(8.42)	
Average minimum temperature in rice season (°C)	21.39	21.39	0.01
	(0.06)	(0.04)	
Average maximum temperature in rice season (°C)	31.54	31.56	-0.02
	(0.03)	(0.02)	
Key farmer (=1)	0.22	0.12	0.10*
	(0.05)	(0.03)	
Replica farmer (=1)	0.09	0.07	0.02
	(0.04)	(0.02)	
Ordinary farmer (=1)	0.69	0.81	-0.12**
	(0.06)	(0.03)	
Observations (N)	65	154	
F-test of joint significance (F-stat)			1.60*
F-test, number of observations			219

Notes: *t*-test values report differences in group means; *F*-test values report *F*-statistics; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The sample includes 219 non-signboards (notice = 65 & non-notice = 154), rainfed farmers observed in all survey rounds with complete data. Signboard Notice = 1 if the farmer reported seeing a signboard on signboard farmer's plot. A farmer is classified as a key farmer if they were identified as such in at least one of the three survey rounds; replica farmers voluntarily joined the training sessions, and ordinary farmers did not participate directly in training.

Table 3: Changes in outcome variables by signboard notice across survey rounds (baseline, midline, and endline)

Variable	Baseline	Midline	Endline
Panel A			
Paddy yield (kg/ha)			
Signboard notice (=1)	1562.93 (369.17)	1781.18 (169.16)	1191.68 (164.70)
Signboard notice (=0)	1419.96 (141.81)	2042.61 (143.35)	907.90 (104.74)
Difference (*t*-test)	142.97	−261.43	283.77
Paddy income (MZN/ha)			
Signboard notice (=1)	21687.89 (5332.49)	NA	22804.10 (4208.38)
Signboard notice (=0)	18394.13 (2326.01)	NA	18135.94 (2378.12)
Difference (*t*-test)	3293.76	NA	4668.16
Use of seed selection			
Signboard notice (=1)	0.35 (0.06)	0.48 (0.06)	0.42 (0.06)
Signboard notice (=0)	0.23 (0.03)	0.56 (0.04)	0.33 (0.04)
Difference (*t*-test)	0.12*	−0.08	0.08
Use of nursery bed setup			
Signboard notice (=1)	0.28 (0.06)	0.65 (0.06)	0.65 (0.06)
Signboard notice (=0)	0.34 (0.04)	0.70 (0.04)	0.46 (0.04)
Difference (*t*-test)	−0.06	−0.05	0.19***
Use of bund construction			
Signboard notice (=1)	0.28 (0.06)	0.39 (0.06)	0.60 (0.06)
Signboard notice (=0)	0.19 (0.03)	0.42 (0.04)	0.44 (0.04)
Difference (*t*-test)	0.09	−0.03	0.16**
Use of plot leveling			
Signboard notice (=1)	0.28 (0.06)	0.39 (0.06)	0.57 (0.06)
Signboard notice (=0)	0.16 (0.03)	0.42 (0.04)	0.38 (0.04)
Difference (*t*-test)	0.12*	−0.04	0.19***
Use of lined transplanting[a]			
Signboard notice (=1)	0	0.31 (0.06)	0.35 (0.06)
Signboard notice (=0)	0	0.30 (0.04)	0.21 (0.03)
Difference (*t*-test)	0	0.01	0.14**
Observations (N)	219	219	219
Panel B			
Dis-adoption of at least one practice			
Signboard notice (=1)	NA	NA	0.57 (0.07)
Signboard notice (=0)	NA	NA	0.72 (0.04)
Difference (t-test)	NA	NA	-0.15**
Observations (N)	NA	NA	178

Notes: *t*-test values report differences in group means; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard error in parenthesis. Survey rounds; Baseline, Midline & Endline. The sample in Panel A includes 219 non-signboard (notice = 65 & non-notice = 154), rainfed farmers observed in all three survey rounds with complete data. Panel B restricts to the 178 farmers who had adopted at least one practice at midline (notice = 53, non-notice = 125). NA: No data available. Signboard Notice = 1 if the farmer reported seeing a signboard on signboard farmer's plot.

[a]Lined transplanting was not practiced by any farmer at baseline, so means are zero and standard errors are not reported for that round.

Table 4: PSM results using endline cross-sectional data with Rosenbaum bounds on the impact of signboard notice

	Nearest-neighbor matching						Kernel matching					
	0.01		0.03		0.05		0.01		0.03		0.05	
Outcome	**ATT**	***Γ***	**ATT**	***Γ***	**ATT**	***Γ***	**ATT**	***Γ***	**ATT**	***Γ***	**ATT**	***Γ***
Rice yield (kg/ha)	848***	2.50	760***	2.20	731***	2.20	727***	2.20	582**	1.35	508*	1.20
	(0.001)		(0.001)		(0.002)		(0.010)		(0.049)		(0.087)	
Rice income (MZN/ha)	15,535**	1.80	12,807**	1.40	12,350**	1.40	15,289**	1.75	10,981	NA	9,375	NA
	(0.013)		(0.035)		(0.041)		(0.025)		(0.114)		(0.181)	
Use of seed selection	0.149	NA	0.175	NA	0.200*	1.75	0.145	NA	0.159	NA	0.181*	1.50
	(0.186)		(0.133)		(0.093)		(0.161)		(0.123)		(0.086)	
Use of nursery bed setup	0.277**	2.95	0.263**	3.35	0.283**	3.75	0.321***	2.95	0.313***	2.95	0.326***	3.00
	(0.017)		(0.033)		(0.025)		(0.002)		(0.004)		(0.003)	
Use of bund construction	0.128	NA	0.158	NA	0.167	NA	0.178	NA	0.261**	2.00	0.263**	2.40
	(0.284)		(0.205)		(0.190)		(0.105)		(0.017)		(0.018)	
Use of plot levelling	0.234**	1.45	0.175	NA	0.167	NA	0.258**	1.70	0.229**	1.50	0.224**	1.55
	(0.047)		(0.155)		(0.185)		(0.016)		(0.035)		(0.041)	
Use of lined transplanting	0.085	NA	0.105	NA	0.133	NA	0.088	NA	0.157*	NA	0.190**	1.00
	(0.411)		(0.330)		(0.227)		(0.353)		(0.086)		(0.042)	
N Treated	47		57		60		47		57		60	
N Control	33		33		33		76		99		110	

Notes: ATT = Average Treatment Effect on the Treated. NA = Not applicable. *Γ* = Rosenbaum bounds critical level of odds ratio, reported at the 10% significance level following Rosenbaum (2002). Signboard Notice = 1 if the farmer reported seeing a signboard on signboard farmer's plot. *p*-values are shown in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5: PSM results using endline cross-sectional data with Rosenbaum bounds on the impact of signboard notice on dis-adoption

	Nearest-neighbor matching						Kernel matching					
	0.01		0.03		0.05		0.01		0.03		0.05	
Outcome	**ATT**	***Γ***	**ATT**	***Γ***	**ATT**	***Γ***	**ATT**	***Γ***	**ATT**	***Γ***	**ATT**	***Γ***
Dis-adoption of at least one practice	-0.219*	> 3.95	-0.277**	> 3.95	-0.300**	> 3.95	-0.232*	> 3.95	-0.283**	> 3.95	-0.300**	> 3.95
	(0.087)		(0.018)		(0.012)		(0.052)		(0.014)		(0.012)	
N Treated	32		47		50		32		47		50	
N Control	26		30		30		56		77		83	

Notes: ATT = Average Treatment Effect on the Treated. Γ = Rosenbaum bounds critical level of odds ratio, reported at the 10% significance level following Rosenbaum (2002). Signboard Notice = 1 if the farmer reported seeing a signboard on signboard farmer's plot. Dis-adoption = 1 if the farmer used at least one of the five practices at midline but stopped using at least one of those practices by endline. Dis-adoption = 0 if the farmer used at least one practice at midline and did not stop using any of the practices they had used by endline. Farmers who had not used any practice at midline are excluded. *p*-values are shown in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 6: PSM results using baseline cross-sectional data on the impact of signboard notice (placebo test)

	Nearest-neighbor matching			Kernel matching		
	0.01	**0.03**	**0.05**	**0.01**	**0.03**	**0.05**
	ATT	**ATT**	**ATT**	**ATT**	**ATT**	**ATT**
Rice yield (kg/ha)	345	344	280	378	329	223
	(0.298)	(0.329)	(0.438)	(0.157)	(0.220)	(0.457)
Rice income (MZN/ha)	6,388	5,969	5,040	5,886	4,857	3,322
	(0.114)	(0.154)	(0.236)	(0.112)	(0.219)	(0.434)
Use of seed selection	0.043	0.000	0.017	0.117	0.048	0.061
	(0.707)	(1.000)	(0.890)	(0.250)	(0.626)	(0.540)
Use of nursery bed setup	-0.043	-0.018	-0.033	-0.001	0.045	0.018
	(0.708)	(0.883)	(0.784)	(0.990)	(0.668)	(0.864)
Use of bund construction	0.149*	0.193**	0.183**	0.106	0.112	0.108
	(0.074)	(0.024)	(0.032)	(0.235)	(0.211)	(0.222)
Use of plot levelling	-0.106	-0.035	0.000	-0.051	0.083	0.121
	(0.309)	(0.756)	(1.000)	(0.561)	(0.346)	(0.178)
N Treated	47	57	60	47	57	60
N Control	33	33	33	76	99	110

Notes: ATT = Average Treatment Effect on the Treated. This placebo test uses only baseline data (pre-treatment). Signboard Notice = 1 if the farmer reported seeing a signboard on a signboard farmer's plot. *p*-values are shown in parentheses; . *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 7: IPW-DID estimates of the impact of signboard notice on agricultural outcomes and technology use

VARIABLES	Rice yield (kg/ha)	Rice income (MZN/ha)	Use of seed selection	Use of nursery bed setup	Use of bund construction	Use of plot levelling	Use of lined transplanting
Signboard notice	317.2	4,249	0.361***	0.336***	0.279**	0.194**	0.215**
	(0.310)	(0.520)	(0.001)	(0.000)	(0.037)	(0.060)	(0.017)
	[0.299]	[0.526]	[0.000]	[0.002]	[0.036]	[0.048]	[0.023]
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	588	392	588	588	588	588	588
R-squared	0.168	0.100	0.301	0.378	0.255	0.293	0.418
Number of unique ID	196	196	196	196	196	196	196

Notes: Some Association dummies were omitted due to perfect prediction, resulting in the exclusion of 23 observations. Final sample size is N = 196. *p*-values in parentheses; wild bootstrap *p*-values in brackets. Significance stars are assigned based on wild bootstrap *p*-values. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. See Appendix Table A10 for full regression results.

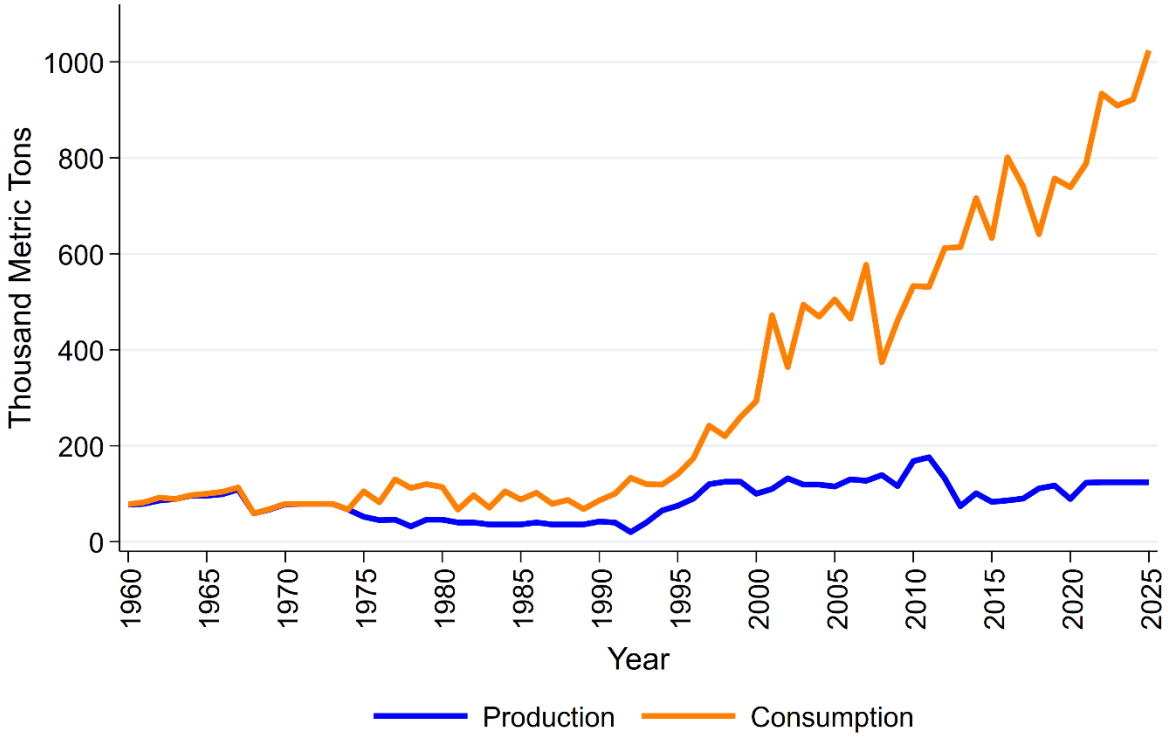


Figure 1: Production and consumption of rice (milled bases) in Mozambique, 1960 – 2025.

Data Source: USDA: PSD Online April 2025

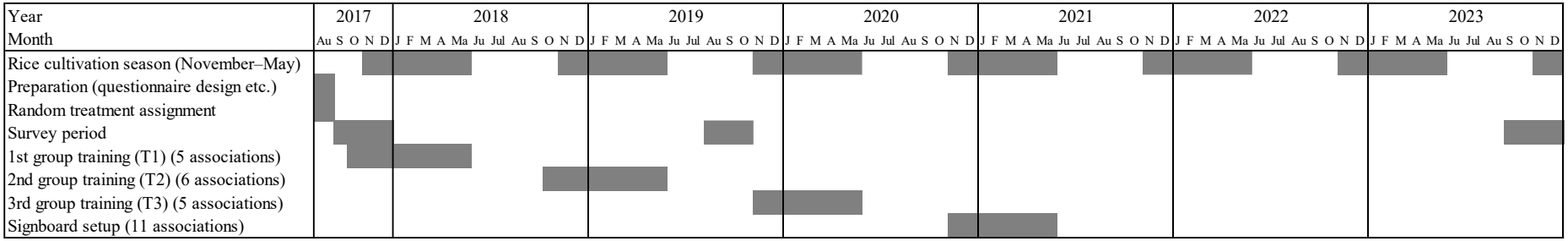


Figure 2: Timeline of implementation

Note: J = January; F = February; M = March; A = April; Ma = May; Ju = June; Jul = July; Au = August; S = September; O = October; N = November; D = December.

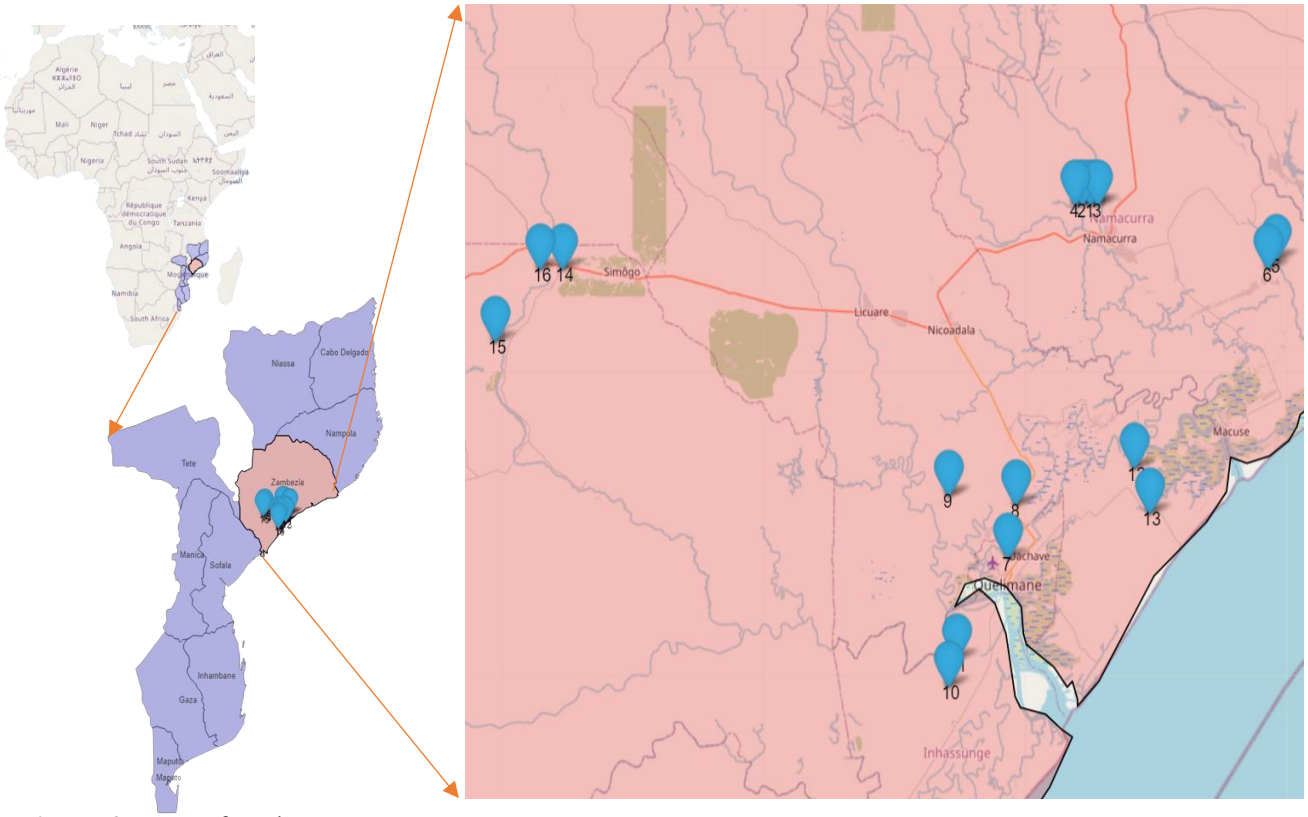


Figure 3: Map of study area

Source: OpenStreetMap. Assessed May 21st, 2024.

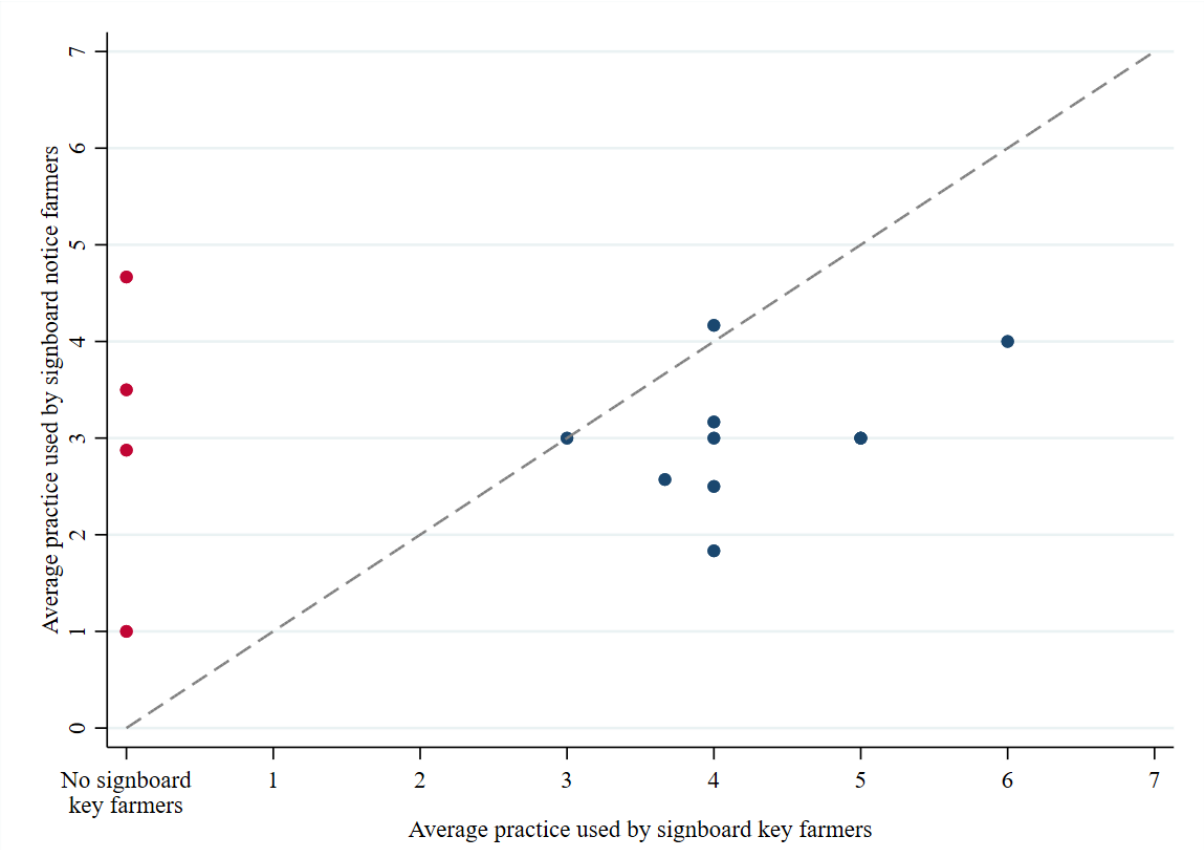


Figure 4: Association between the average number of practices adopted by signboard key farmers and signboard notice farmers at the association level at endline.

Note: Navy dots indicate associations with at least one signboard key farmer, while red dots indicate associations with no signboard key farmers.

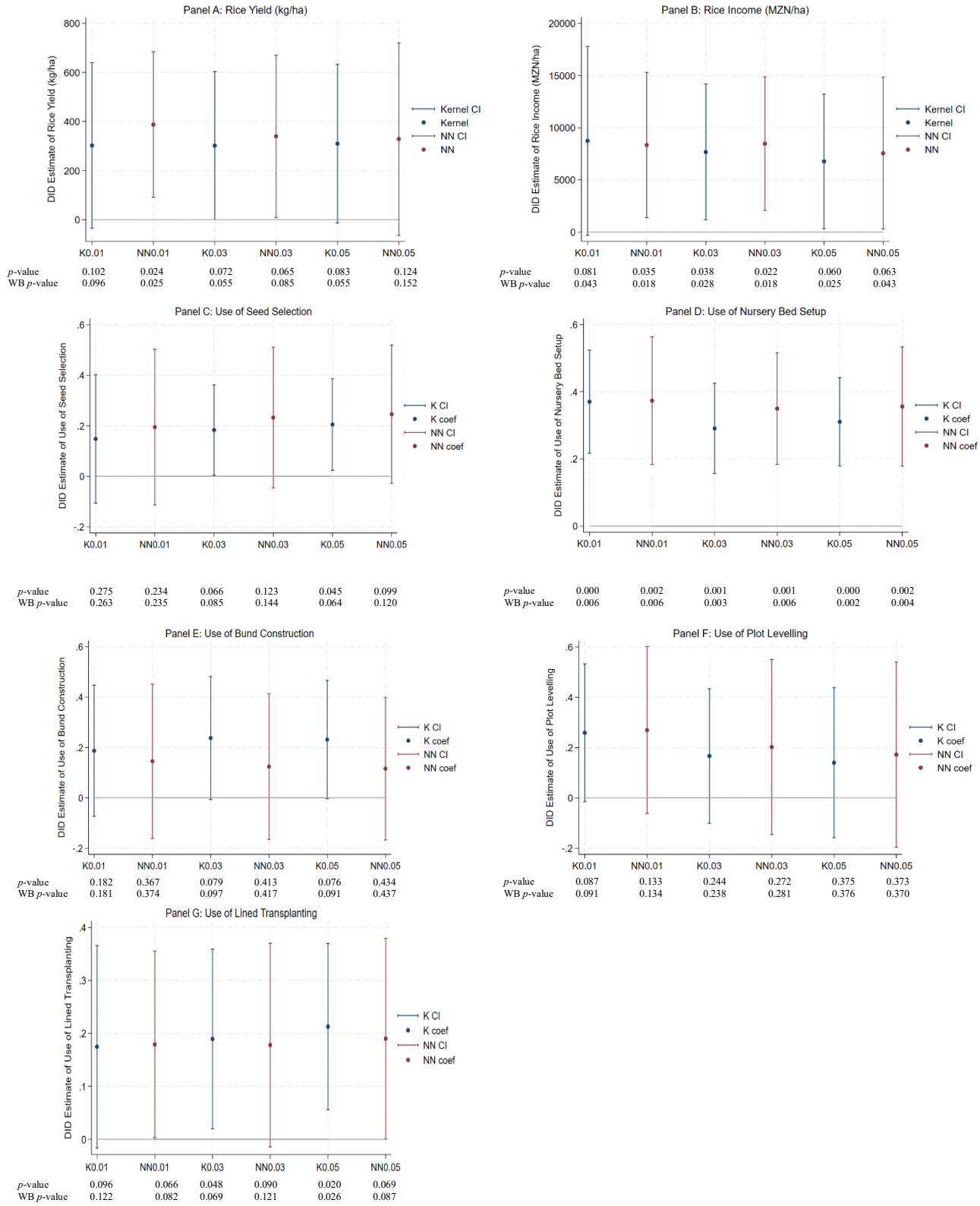


Figure 5: PSM-DID coefficient plots on the effects of signboard notice on agricultural outcomes and technology use

Note: Markers represent ATT coefficients with 95% confidence intervals (CI). Results are reported for nearest-neighbor (NN) and kernel matching (K) with calipers/bandwidths of 0.01, 0.03, and 0.05. WB *p*-values denote wild-bootstrap cluster-robust *p*-values. Significance stars are assigned based on wild bootstrap cluster-robust *p*-values. See Appendix Table A4 – A5 for full regression results.

Appendix

Table A1: Comparison between the randomized plan and the actual implementation of the signboard intervention

Association ID	Planned farmers	Actual farmers
1	2	0
2	5	1
3	0	1
4	0	0
5	6	3
6	4	1
7	0	1
8	1	0
9	3	1
10	5	1
11	3	0
12	0	1
13	0	0
14	0	2
15	0	1
16	0	3
Total	29	16

Table A2: First-stage logit estimation of the determinants of signboard notice

Variables	Average marginal effects	*p*-value
Household head's age (years)	0.00124	0.604
Household size (number)	0.0266*	0.082
Dependency ratio (% of dependents to working age)	0.000539	0.655
Share of members in the same association known by the respondent (%)	-0.00311*	0.086
Distance to key farmer plot (km)	-0.255	0.200
Distance to key farmer plot squared (km²)	-0.0553	0.531
Distance to signboard farmer plot (km)	0.483***	0.003
Distance to signboard farmer plot squared (km²)	-0.0825**	0.019
Uses transport to reach farm plot (=1)	-0.167	0.159
Travel time from home to plot (minutes)	-0.000515	0.513
Rice cultivated area (ha)	-0.413*	0.066
Rice cultivated area (ha²)	0.174*	0.062
Plot owner (=1)	-0.196*	0.078
Experienced flood (=1)	0.0740	0.377
Experienced drought (=1)	0.0842	0.418
Total rainfall in rice season (mm)	-0.0697	0.462
Total rainfall in rice season squared (mm²)	3.14e-05	0.510
Average minimum temperature in rice season (°c)	2.023	0.232
Average maximum temperature in rice season (°c)	-0.425	0.701
Association dummy	Yes	
Observations	196	
Log likelihood	-93.006	
Pseudo R2	0.253	

Notes: Some Association dummies were omitted due to perfect prediction, resulting in the exclusion of 23 observations. The final size is N = 196. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

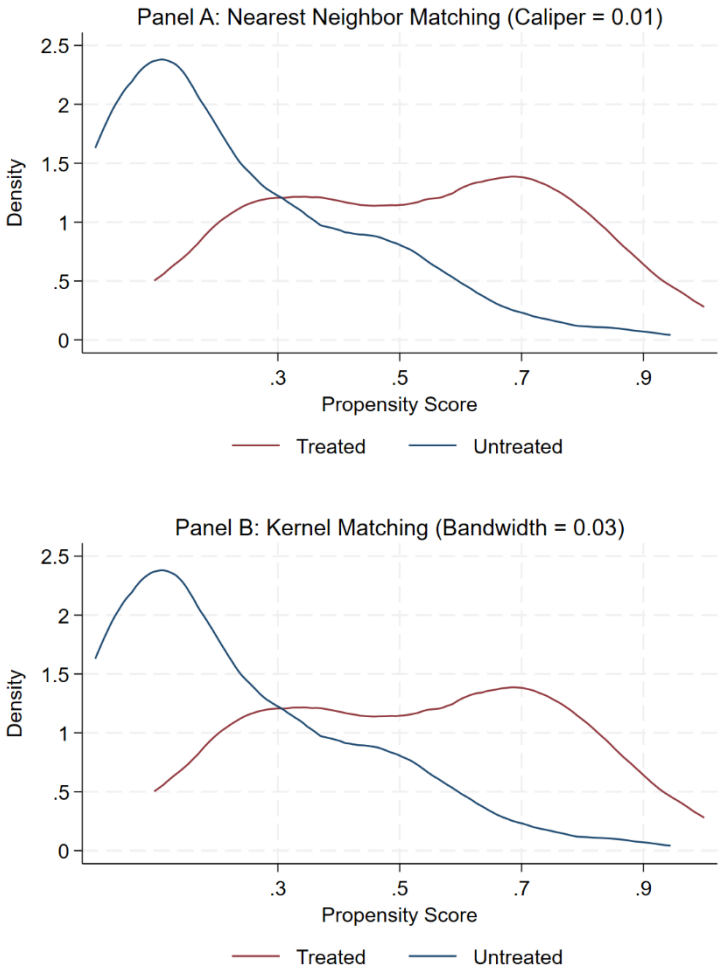


Figure A1: The distribution of estimated propensity scores

Table A3: PSM matched sample sizes by matching method

Matching method	Bandwidth/Caliper	Signboard notice (=1)	Signboard notice (=0)	Matched sample size
Nearest neighbor	0.01	47	33	80
Nearest neighbor	0.03	57	33	90
Nearest neighbor	0.05	60	33	93
Kernel	0.01	47	76	123
Kernel	0.03	57	99	156
Kernel	0.05	60	110	170

Note: Signboard notice (=1) if the farmer reported seeing a signboard on signboard farmer's plot.

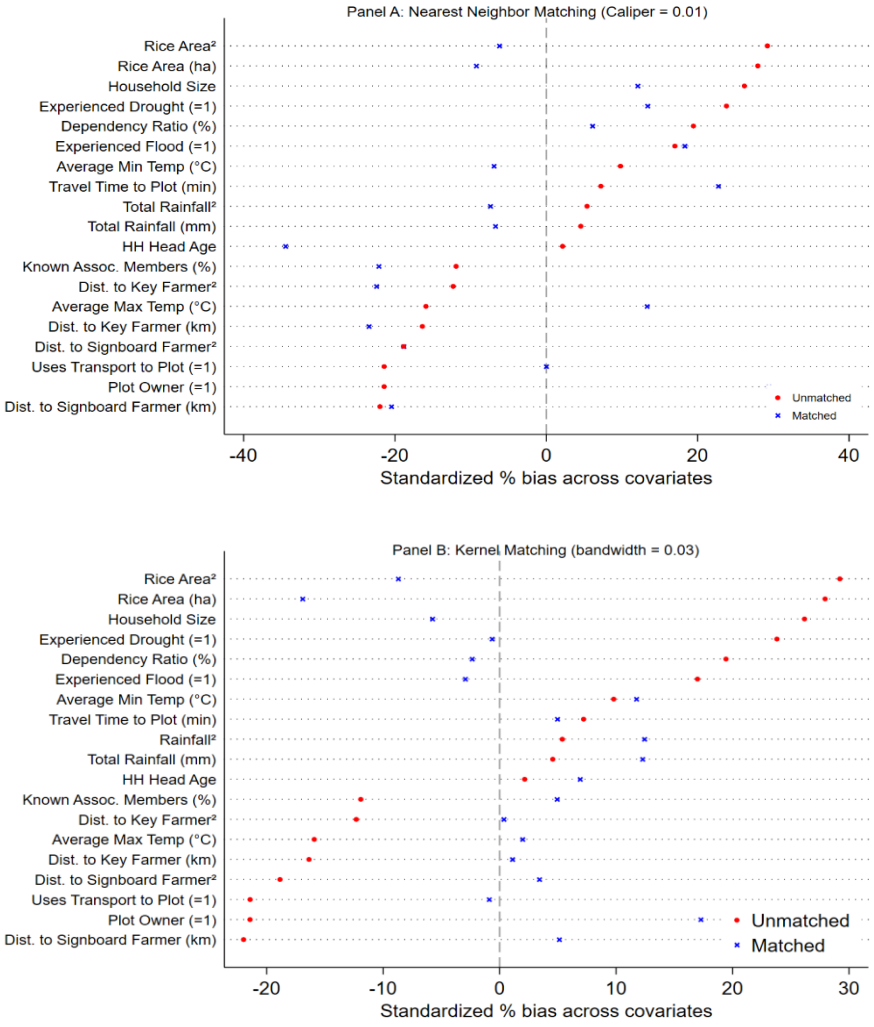


Figure A2: Love plots

Table A4-A: Full estimation result of PSM-DID model on the impact of signboard notice on agricultural outcomes and technology use using nearest neighbor matching (caliper 0.01)

Variables	Rice yield (kg/ha)	Rice income (MZN/ha)	Use of seed selection	Use of nursery bed setup	Use of bund construction	Use of plot levelling	Use of lined transplanting
Midline	4,463		0.157	-0.328	0.595	-2.157*	-1.030*
	[0.207]		[0.851]	[0.870]	[0.536]	[0.086]	[0.058]
Endline	5,280	171,450	-0.122	0.816	0.119	-2.584**	-1.422
	[0.140]	[0.115]	[0.899]	[0.743]	[0.924]	[0.033]	[0.158]
T1 × after 1	621.863	3,114	0.791*	0.208	0.096	0.765***	0.380**
	[0.161]	[0.820]	[0.055]	[0.431]	[0.730]	[0.007]	[0.037]
T2 × after 1	1,226**	24,363	0.535	0.344*	0.077	0.610**	0.306
	[0.019]	[0.100]	[0.122]	[0.053]	[0.723]	[0.035]	[0.181]
T3 × after 2	466.747		0.122	0.296	0.208	0.575*	0.401***
	[0.285]		[0.592]	[0.210]	[0.317]	[0.062]	[0.007]
Signboard notice	387.447**	8,332**	0.195	0.373***	0.145	0.270	0.179*
	[0.025]	[0.018]	[0.235]	[0.006]	[0.374]	[0.134]	[0.082]
Household head's age (years)	11.191	-152.512	0.006	0.006	-0.001	0.001	0.006**
	[0.457]	[0.721]	[0.247]	[0.137]	[0.656]	[0.718]	[0.020]
Household size (number)	-99.245**	-1,118	-0.013	0.012	-0.007	0.009	0.012
	[0.013]	[0.356]	[0.375]	[0.540]	[0.462]	[0.677]	[0.423]
Dependency ratio (% of dependents to working age)	-4.996*	-193.485**	0.001	0.001	0.002	0.001	0.001
	[0.090]	[0.046]	[0.592]	[0.720]	[0.217]	[0.496]	[0.343]
Plot owner (=1)	-35.190	8,208	-0.116	-0.146	-0.146	0.077	-0.037
	[0.885]	[0.386]	[0.442]	[0.313]	[0.108]	[0.502]	[0.722]
Share of members in the same association known by the respondent (%)	5.520	252.062**	0.001	0.004**	-0.000	-0.002	-0.002
	[0.223]	[0.041]	[0.422]	[0.045]	[0.923]	[0.216]	[0.303]
Uses transport to reach farm plot (=1)	350.040	5,749	-0.114	0.193**	0.033	0.217	0.129*
	[0.274]	[0.562]	[0.250]	[0.038]	[0.731]	[0.231]	[0.076]
Travel time from home to plot (minutes)	-0.775	13.489	0.001	0.000*	-0.000	0.001	0.000**
	[0.316]	[0.744]	[0.381]	[0.084]	[0.817]	[0.458]	[0.020]
Experienced flood (=1)	-297.097	-5,079	0.157	0.065	0.250**	-0.056	0.154*
	[0.232]	[0.199]	[0.253]	[0.124]	[0.035]	[0.645]	[0.074]
Experienced drought (=1)	-224.507	-5,595	0.098	0.010	0.099	0.125	-0.050
	[0.518]	[0.610]	[0.321]	[0.926]	[0.436]	[0.393]	[0.268]
Total rainfall in rice season (mm)	-19.704*	-366.090	0.001	-0.002	0.002	0.010*	0.006*
	[0.090]	[0.356]	[0.879]	[0.762]	[0.667]	[0.051]	[0.059]
Total rainfall in rice season squared (mm^2)	0.005*	0.081	-0.000	0.000	-0.000	-0.000*	-0.000**
	[0.099]	[0.493]	[0.871]	[0.916]	[0.595]	[0.073]	[0.045]
Average minimum temperature in rice season (°c)	3,761	250,396	0.969	-2.965	1.471	-0.944	-0.685
	[0.628]	[0.433]	[0.789]	[0.239]	[0.577]	[0.740]	[0.730]
Average maximum temperature in rice season (°c)	-59,188	-1,072,940	20.748	-30.289	10.973	15.623	34.953
	[0.102]	[0.351]	[0.496]	[0.130]	[0.620]	[0.261]	[0.225]
Average maximum temperature in rice season squared ($°c^2$)	828.759	12,975	-0.338	0.478	-0.180	-0.221	-0.531
	[0.163]	[0.420]	[0.469]	[0.103]	[0.582]	[0.299]	[0.236]
Constant	978,418	15,894,845	-339.022	545.035**	-199.618	-260.031	-563.969*
	[0.174]	[0.349]	[0.460]	[0.048]	[0.581]	[0.262]	[0.070]
Observations	282	188	282	282	282	282	282
R-squared	0.279	0.266	0.244	0.372	0.261	0.299	0.47
Matched sample	80	80	80	80	80	80	80

Notes: Matched sample: 80 farmers using nearest neighbor matching with caliper 0.01. The number of observations exceeds three times the matched sample size because nearest neighbor matching is performed with replacement, allowing control farmers to be matched to more than one treated farmer. Observations for rice income are fewer than for other outcomes because income data are unavailable at midline, as the cost survey modules were not administered in that round. Signboard Notice = 1 if the farmer reported seeing a signboard on a signboard farmer's plot. T1, T2, T3 represent treatment assignment. After1 = 1 if survey period is midline or endline; After2 = 1 if survey period is endline. Standard errors clustered at association level. Wild bootstrap cluster robust p-values in brackets. Significant stars are based on wild bootstrap cluster robust p-values. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A4-B: Full estimation result of PSM-DID model on the impact of signboard notice on agricultural outcomes and technology use using nearest neighbor matching (caliper 0.03)

Variables	Rice yield (kg/ha)	Rice income (MZN/ha)	Use of seed selection	Use of nursery bed setup	Use of bund construction	Use of plot levelling	Use of lined transplanting
Midline	3,331		0.020	0.121	0.414	-2.139*	-1.173*
	[0.377]		[0.989]	[0.951]	[0.634]	[0.081]	[0.090]
Endline	3,017	104,890	-0.144	1.204	-0.108	-2.827*	-1.344
	[0.464]	[0.307]	[0.884]	[0.631]	[0.942]	[0.061]	[0.311]
T1 × after 1	333.957	-7,088	0.802*	0.238	0.063	0.758***	0.400***
	[0.435]	[0.673]	[0.051]	[0.306]	[0.769]	[0.008]	[0.003]
T2 × after 1	882.709*	13,622	0.534*	0.375**	0.065	0.585**	0.314
	[0.057]	[0.401]	[0.076]	[0.010]	[0.741]	[0.034]	[0.133]
T3 × after 2	566.678		0.233	0.332**	0.133	0.682**	0.434***
	[0.364]		[0.277]	[0.018]	[0.471]	[0.031]	[0.004]
Signboard notice	339.432*	8,463**	0.233	0.350***	0.124	0.202	0.178
	[0.085]	[0.018]	[0.144]	[0.006]	[0.417]	[0.281]	[0.121]
Household head's age (years)	9.074	-183.173	0.006	0.005	-0.000	0.003	0.006**
	[0.515]	[0.676]	[0.249]	[0.249]	[0.823]	[0.495]	[0.022]
Household size (number)	-61.838*	-331.178	-0.016	0.017	-0.000	0.014	0.018
	[0.094]	[0.683]	[0.266]	[0.356]	[1.000]	[0.450]	[0.382]
Dependency ratio (% of dependents to working age)	-4.769**	-200.801**	0.001	0.001	0.001	0.002	0.001
	[0.035]	[0.031]	[0.450]	[0.454]	[0.439]	[0.397]	[0.316]
Plot owner (=1)	96.300	10,785	-0.188	-0.159	-0.129	0.061	-0.080
	[0.622]	[0.188]	[0.207]	[0.192]	[0.137]	[0.541]	[0.457]
Share of members in the same association known by the respondent (%)	1.646	210.644**	0.001	0.003	-0.000	-0.003**	-0.001
	[0.698]	[0.020]	[0.283]	[0.101]	[0.828]	[0.037]	[0.411]
Uses transport to reach farm plot (=1)	207.381	-292.827	-0.120	0.194**	0.061	0.236	0.146**
	[0.475]	[0.982]	[0.316]	[0.032]	[0.473]	[0.174]	[0.042]
Travel time from home to plot (minutes)	-1.416	-5.573	0.001	0.001*	0.000	0.001	0.001**
	[0.138]	[0.897]	[0.266]	[0.079]	[0.905]	[0.360]	[0.024]
Experienced flood (=1)	-227.233	-2,718	0.147	0.077	0.275**	-0.002	0.156*
	[0.319]	[0.583]	[0.240]	[0.152]	[0.015]	[0.991]	[0.055]
Experienced drought (=1)	-305.882	-8,992	0.073	0.014	0.088	0.148	-0.044
	[0.417]	[0.474]	[0.422]	[0.895]	[0.479]	[0.267]	[0.247]
Total rainfall in rice season (mm)	-18.319*	-208.362	-0.001	-0.001	0.001	0.011**	0.006
	[0.055]	[0.569]	[0.764]	[0.806]	[0.753]	[0.029]	[0.117]
Total rainfall in rice season squared (mm^2)	0.005*	0.039	0.000	-0.000	-0.000	-0.000**	-0.000
	[0.069]	[0.731]	[0.763]	[0.986]	[0.703]	[0.034]	[0.101]
Average minimum temperature in rice season (°c)	1,687	123,212	0.096	-2.068	1.110	-0.706	-1.168
	[0.815]	[0.690]	[0.962]	[0.309]	[0.659]	[0.807]	[0.557]
Average maximum temperature in rice season (°c)	-40,037	-628,800	15.375	-30.943	12.120	19.149	29.575
	[0.259]	[0.521]	[0.595]	[0.137]	[0.583]	[0.305]	[0.348]
Average maximum temperature in rice season squared ($°c^2$)	582.041	7,700	-0.247	0.477	-0.191	-0.273	-0.446
	[0.248]	[0.629]	[0.566]	[0.130]	[0.567]	[0.337]	[0.360]
Constant	663,086	9,734,953	-240.035	547.284*	-216.452	-324.860	-468.396
	[0.281]	[0.534]	[0.565]	[0.063]	[0.551]	[0.229]	[0.154]
Observations	342	228	342	342	342	342	342
R-squared	0.242	0.267	0.296	0.388	0.273	0.301	0.472
Matched sample	90	90	90	90	90	90	90

Notes: Matched sample: 90 farmers using nearest neighbor matching with caliper 0.03. The number of observations exceeds three times the matched sample size because nearest neighbor matching is performed with replacement, allowing control farmers to be matched to more than one treated farmer. Observations for rice income are fewer than for other outcomes because income data are unavailable at midline, as the cost survey modules were not administered in that round. Signboard Notice = 1 if the farmer reported seeing a signboard on a signboard farmer's plot. T1, T2, T3 represent treatment assignment. After1 = 1 if survey period is midline or endline; After2 = 1 if survey period is endline. Standard errors clustered at association level. Wild bootstrap cluster robust p-values in brackets. Significant stars are based on wild bootstrap cluster robust p-values. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A4-C: Full estimation result of PSM-DID model on the impact of signboard notice on agricultural outcomes and technology use using nearest neighbor matching (caliper 0.05)

Variables	Rice yield (kg/ha)	Rice income (MZN/ha)	Use of seed selection	Use of nursery bed setup	Use of bund construction	Use of plot levelling	Use of lined transplanting
Midline	3,259		0.158	0.290	0.527	-2.570**	-1.188*
	[0.358]		[0.873]	[0.890]	[0.461]	[0.044]	[0.082]
Endline	3,031	93,011	-0.113	1.356	-0.015	-3.123**	-1.226
	[0.468]	[0.353]	[0.904]	[0.550]	[0.987]	[0.030]	[0.363]
T1 × after 1	278.225	-6,001	0.911**	0.238	-0.011	0.783***	0.391***
	[0.483]	[0.723]	[0.038]	[0.306]	[0.951]	[0.007]	[0.001]
T2 × after 1	887.501**	16,084	0.607*	0.386**	0.018	0.572**	0.302
	[0.047]	[0.343]	[0.061]	[0.016]	[0.924]	[0.028]	[0.106]
T3 × after 2	517.494		0.262	0.311**	0.075	0.688**	0.418***
	[0.427]		[0.245]	[0.014]	[0.720]	[0.014]	[0.003]
Signboard notice	328.559	7,552**	0.246	0.356***	0.116	0.172	0.190*
	[0.152]	[0.043]	[0.120]	[0.004]	[0.437]	[0.370]	[0.087]
Household head's age (years)	9.314	-105.728	0.008	0.005	-0.000	0.003	0.007**
	[0.487]	[0.810]	[0.153]	[0.152]	[0.769]	[0.398]	[0.020]
Household size (number)	-62.518*	-404.880	-0.020*	0.016	-0.001	0.016	0.017
	[0.084]	[0.581]	[0.087]	[0.415]	[0.930]	[0.394]	[0.387]
Dependency ratio (% of dependents to working age)	-4.542**	-187.545**	0.001	0.001	0.001	0.001	0.001
	[0.033]	[0.047]	[0.436]	[0.469]	[0.413]	[0.432]	[0.355]
Plot owner (=1)	107.443	10,581	-0.183	-0.155	-0.135	0.062	-0.086
	[0.570]	[0.177]	[0.216]	[0.202]	[0.114]	[0.525]	[0.427]
Share of members in the same association known by the respondent (%)	1.412	223.018**	0.001	0.003	0.000	-0.003**	-0.001
	[0.731]	[0.013]	[0.252]	[0.100]	[0.983]	[0.032]	[0.514]
Uses transport to reach farm plot (=1)	217.426	-187.269	-0.115	0.191**	0.042	0.252	0.145**
	[0.453]	[0.982]	[0.370]	[0.028]	[0.625]	[0.162]	[0.036]
Travel time from home to plot (minutes)	-1.637	-8.936	0.001	0.000*	0.000	0.001	0.001**
	[0.106]	[0.830]	[0.203]	[0.097]	[0.896]	[0.295]	[0.018]
Experienced flood (=1)	-213.260	-3,290	0.121	0.063	0.258**	-0.012	0.136*
	[0.347]	[0.541]	[0.290]	[0.260]	[0.031]	[0.930]	[0.083]
Experienced drought (=1)	-291.101	-8,531	0.062	0.013	0.080	0.149	-0.052
	[0.441]	[0.501]	[0.493]	[0.905]	[0.485]	[0.253]	[0.184]
Total rainfall in rice season (mm)	-17.705*	-144.117	-0.001	-0.001	0.000	0.010**	0.005
	[0.057]	[0.700]	[0.837]	[0.755]	[0.928]	[0.026]	[0.176]
Total rainfall in rice season squared (mm^2)	0.005*	0.021	0.000	-0.000	-0.000	-0.000**	-0.000
	[0.073]	[0.851]	[0.864]	[0.982]	[0.887]	[0.040]	[0.136]
Average minimum temperature in rice season (°c)	1,353	103,853	0.626	-1.880	1.068	-1.585	-1.555
	[0.829]	[0.733]	[0.875]	[0.261]	[0.636]	[0.550]	[0.417]
Average maximum temperature in rice season (°c)	-41,559	-515,638	14.851	-33.036	11.362	18.935	26.487
	[0.261]	[0.575]	[0.603]	[0.111]	[0.595]	[0.310]	[0.361]
Average maximum temperature in rice season squared ($°c^2$)	607.828	6,117	-0.244	0.507*	-0.178	-0.260	-0.396
	[0.242]	[0.665]	[0.574]	[0.095]	[0.581]	[0.348]	[0.376]
Constant	692,193	8,104,447	-238.452	579.530**	-203.774	-312.355	-412.103
	[0.259]	[0.564]	[0.570]	[0.044]	[0.557]	[0.234]	[0.177]
Observations	360	240	360	360	360	360	360
R-squared	0.257	0.264	0.314	0.394	0.258	0.326	0.467
Matched sample	93	93	93	93	93	93	93

Notes: Matched sample: 93 farmers using nearest neighbor matching with caliper 0.05. The number of observations exceeds three times the matched sample size because nearest neighbor matching is performed with replacement, allowing control farmers to be matched to more than one treated farmer. Observations for rice income are fewer than for other outcomes because income data are unavailable at midline, as the cost survey modules were not administered in that round. Signboard Notice = 1 if the farmer reported seeing a signboard on a signboard farmer's plot. T1, T2, T3 represent treatment assignment. After1 = 1 if survey period is midline or endline; After2 = 1 if survey period is endline. Standard errors clustered at association level. Wild bootstrap cluster robust p-values in brackets. Significant stars are based on wild bootstrap cluster robust p-values. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A5-A: Full estimation result of PSM-DID model on the impact of signboard notice on agricultural outcomes and technology use using kernel matching (bandwidth 0.01)

Variables	Rice yield (kg/ha)	Rice income (MZN/ha)	Use of seed selection	Use of nursery bed setup	Use of bund construction	Use of plot levelling	Use of lined transplanting
Midline	4,395		0.436	-0.464	0.210	-2.126*	-0.840
	[0.165]		[0.686]	[0.805]	[0.830]	[0.095]	[0.200]
Endline	3,169	146,992	-0.212	0.663	-0.736	-2.302*	-1.036
	[0.394]	[0.202]	[0.855]	[0.796]	[0.503]	[0.093]	[0.226]
T1 × after 1	539.371	-1,457	0.748*	0.260	0.071	0.834**	0.432*
	[0.317]	[0.895]	[0.059]	[0.398]	[0.751]	[0.010]	[0.051]
T2 × after 1	1,052**	17,017	0.519	0.372**	0.166	0.578*	0.340
	[0.026]	[0.266]	[0.134]	[0.046]	[0.425]	[0.054]	[0.106]
T3 × after 2	490.413		0.149	0.304	0.216	0.588*	0.392**
	[0.179]		[0.594]	[0.156]	[0.276]	[0.067]	[0.012]
Signboard notice	302.417*	8,737**	0.148	0.370***	0.187	0.259*	0.175
	[0.096]	[0.043]	[0.263]	[0.006]	[0.181]	[0.091]	[0.122]
Household head's age (years)	10.590	-202.369	0.007*	0.005	0.001	0.000	0.006***
	[0.452]	[0.676]	[0.093]	[0.136]	[0.639]	[0.904]	[0.005]
Household size (number)	-79.115**	-1,382	-0.004	0.007	-0.000	0.010	0.011
	[0.032]	[0.162]	[0.754]	[0.705]	[0.993]	[0.521]	[0.439]
Dependency ratio (% of dependents to working age)	-4.587	-162.360*	0.002	0.001	0.002	0.001	0.001
	[0.109]	[0.050]	[0.221]	[0.316]	[0.213]	[0.571]	[0.267]
Plot owner (=1)	32.751	7,900	-0.139	-0.113	-0.126*	0.115	-0.034
	[0.875]	[0.389]	[0.306]	[0.363]	[0.097]	[0.324]	[0.674]
Share of members in the same association known by the respondent (%)	1.280	166.650	0.001	0.004**	0.000	-0.001	-0.001
	[0.766]	[0.192]	[0.438]	[0.039]	[0.952]	[0.422]	[0.511]
Uses transport to reach farm plot (=1)	318.690	4,545	-0.118	0.209**	0.026	0.233	0.139
	[0.354]	[0.631]	[0.278]	[0.024]	[0.781]	[0.180]	[0.105]
Travel time from home to plot (minutes)	-1.027	12.402	0.001	0.001	-0.000	0.001	0.001**
	[0.178]	[0.704]	[0.333]	[0.146]	[0.367]	[0.477]	[0.016]
Experienced flood (=1)	-284.766	-5,949	0.131	0.063**	0.235*	-0.030	0.138*
	[0.233]	[0.198]	[0.256]	[0.032]	[0.067]	[0.783]	[0.067]
Experienced drought (=1)	-230.853	-5,654	0.076	-0.011	0.071	0.147	-0.039
	[0.523]	[0.691]	[0.348]	[0.931]	[0.491]	[0.161]	[0.469]
Total rainfall in rice season (mm)	-14.361	-498.568	0.002	-0.003	0.003	0.009*	0.006*
	[0.202]	[0.357]	[0.631]	[0.595]	[0.490]	[0.060]	[0.096]
Total rainfall in rice season squared (mm²)	0.004	0.127	-0.000	0.000	-0.000	-0.000*	-0.000*
	[0.246]	[0.417]	[0.647]	[0.721]	[0.493]	[0.079]	[0.081]
Average minimum temperature in rice season (°c)	6,532	151,343	2.445	-3.350*	1.593	-1.210	-0.328
	[0.406]	[0.571]	[0.483]	[0.065]	[0.570]	[0.638]	[0.847]
Average maximum temperature in rice season (°c)	-8,441	-1,177,168	21.628	-23.608	10.704	17.991	29.713
	[0.885]	[0.548]	[0.263]	[0.180]	[0.560]	[0.356]	[0.293]
Average maximum temperature in rice season squared (°c²)	49.245	15,824	-0.361	0.379	-0.167	-0.260	-0.459
	[0.955]	[0.600]	[0.222]	[0.143]	[0.556]	[0.373]	[0.306]
Constant	89,953	18,562,835	-376.820	441.394*	-207.694	-289.376	-478.870*
	[0.913]	[0.316]	[0.287]	[0.076]	[0.486]	[0.209]	[0.050]
Observations	369	246	369	369	369	369	369
R-squared	0.268	0.19	0.257	0.37	0.224	0.292	0.446
Matched sample	123	123	123	123	123	123	123

Notes: Matched sample: 123 farmers using kernel with bandwidth 0.01. Observations for rice income are fewer than for other outcomes because income data are unavailable at midline, as the cost survey modules were not administered in that round. Signboard Notice = 1 if the farmer reported seeing a signboard on a signboard farmer's plot. T1, T2, T3 represent treatment assignment. After1 = 1 if survey period is midline or endline; After2 = 1 if survey period is endline. Standard errors clustered at association level. Wild bootstrap cluster robust p-values in brackets. Significant stars are based on wild bootstrap cluster robust p-values. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A5-B: Full estimation result of PSM-DID model on the impact of signboard notice on agricultural outcomes and technology use using kernel matching (bandwidth 0.03)

Variables	Rice yield (kg/ha)	Rice income (MZN/ha)	Use of seed selection	Use of nursery bed setup	Use of bund construction	Use of plot levelling	Use of lined transplanting
Midline	2,876		0.314	-0.570	-0.230	-1.737	-1.241*
	[0.378]		[0.744]	[0.764]	[0.809]	[0.100]	[0.086]
Endline	88.055	45,461	-0.277	0.549	-1.350	-2.448*	-1.652*
	[0.982]	[0.550]	[0.801]	[0.855]	[0.228]	[0.072]	[0.093]
T1 × after 1	132.751	-9,541	0.772**	0.299	0.077	0.798***	0.478**
	[0.834]	[0.642]	[0.015]	[0.277]	[0.705]	[0.009]	[0.018]
T2 × after 1	695.570	10,349	0.504*	0.349*	0.221	0.517*	0.322
	[0.194]	[0.554]	[0.082]	[0.078]	[0.309]	[0.062]	[0.151]
T3 × after 2	421.996		0.298*	0.280*	0.146	0.650**	0.374***
	[0.187]		[0.096]	[0.081]	[0.368]	[0.036]	[0.006]
Signboard notice	301.536*	7,674**	0.183*	0.291***	0.237*	0.167	0.189*
	[0.055]	[0.028]	[0.085]	[0.003]	[0.097]	[0.238]	[0.069]
Household head's age (years)	9.427	-165.318	0.007	0.007*	0.001	0.001	0.007***
	[0.512]	[0.729]	[0.102]	[0.095]	[0.517]	[0.663]	[0.002]
Household size (number)	-44.329	-729.554	-0.006	0.007	0.008	0.009	0.011
	[0.327]	[0.540]	[0.696]	[0.671]	[0.240]	[0.529]	[0.367]
Dependency ratio (% of dependents to working age)	-4.100*	-161.552*	0.001	0.002	0.001	0.002	0.001
	[0.050]	[0.078]	[0.216]	[0.206]	[0.323]	[0.298]	[0.417]
Plot owner (=1)	1.345	9,611	-0.163	-0.117	-0.069	0.108	-0.042
	[0.994]	[0.142]	[0.246]	[0.242]	[0.392]	[0.296]	[0.559]
Share of members in the same association known by the respondent (%)	-2.499	95.351	0.001	0.003	0.000	-0.004**	-0.002
	[0.579]	[0.549]	[0.298]	[0.127]	[0.799]	[0.042]	[0.274]
Uses transport to reach farm plot (=1)	51.347	-5,250	-0.102	0.230**	0.041	0.242	0.149
	[0.882]	[0.844]	[0.606]	[0.019]	[0.586]	[0.127]	[0.109]
Travel time from home to plot (minutes)	-1.230	-1.483	0.001	0.000	-0.000	0.000	0.001**
	[0.148]	[0.963]	[0.348]	[0.388]	[0.254]	[0.493]	[0.037]
Experienced flood (=1)	-310.954	-6,949	0.131	0.062	0.234*	0.049	0.141*
	[0.178]	[0.177]	[0.207]	[0.249]	[0.082]	[0.776]	[0.054]
Experienced drought (=1)	-239.251	-11,648	0.047	-0.009	0.075	0.176*	-0.025
	[0.451]	[0.489]	[0.519]	[0.936]	[0.462]	[0.052]	[0.520]
Total rainfall in rice season (mm)	-11.420	-231.573	-0.001	-0.003	0.002	0.010**	0.006*
	[0.306]	[0.682]	[0.752]	[0.525]	[0.657]	[0.029]	[0.070]
Total rainfall in rice season squared (mm²)	0.003	0.058	0.000	0.000	-0.000	-0.000**	-0.000*
	[0.333]	[0.729]	[0.715]	[0.589]	[0.712]	[0.032]	[0.074]
Average minimum temperature in rice season (°c)	4,530	82,747	1.234	-3.567*	0.753	-0.034	-0.914
	[0.591]	[0.728]	[0.622]	[0.050]	[0.767]	[0.990]	[0.556]
Average maximum temperature in rice season (°c)	23,281	-129,096	14.464	-20.852	9.666	26.311	30.328
	[0.775]	[0.907]	[0.419]	[0.254]	[0.568]	[0.189]	[0.213]
Average maximum temperature in rice season squared (°c²)	-382.853	1,101	-0.237	0.340	-0.136	-0.393	-0.455
	[0.777]	[0.950]	[0.391]	[0.215]	[0.603]	[0.204]	[0.230]
Constant	-440,217	1,421,605	-245.575	397.821	-186.888	-445.481**	-488.520**
	[0.546]	[0.936]	[0.416]	[0.118]	[0.507]	[0.048]	[0.029]
Observations	468	312	468	468	468	468	468
R-squared	0.228	0.194	0.304	0.346	0.217	0.282	0.429
Matched sample	156	156	156	156	156	156	156

Notes: Matched sample: 156 farmers using kernel with bandwidth 0.03. Observations for rice income are fewer than for other outcomes because income data are unavailable at midline, as the cost survey modules were not administered in that round. Signboard Notice = 1 if the farmer reported seeing a signboard on a signboard farmer's plot. T1, T2, T3 represent treatment assignment. After1 = 1 if survey period is midline or endline; After2 = 1 if survey period is endline. Standard errors clustered at association level. Wild bootstrap cluster robust p-values in brackets. Significant stars are based on wild bootstrap cluster robust p-values. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A5-C: Full estimation result of PSM-DID model on the impact of signboard notice on agricultural outcomes and technology use using kernel matching (bandwidth 0.05)

Variables	Rice yield (kg/ha)	Rice income (MZN/ha)	Use of seed selection	Use of nursery bed setup	Use of bund constructi on	Use of plot levelling	Use of lined transplanting
Midline	2,584		0.432	-0.333	-0.143	-2.134*	-1.324*
	[0.411]		[0.744]	[0.850]	[0.858]	[0.052]	[0.056]
Endline	-402.318	28,242	-0.403	0.716	-1.272	-2.615**	-1.744*
	[0.911]	[0.738]	[0.720]	[0.767]	[0.227]	[0.037]	[0.057]
T1 × after 1	86.665	-8,963	0.833**	0.318	0.003	0.798***	0.458**
	[0.871]	[0.665]	[0.014]	[0.261]	[0.984]	[0.005]	[0.010]
T2 × after 1	704.034	12,131	0.562*	0.367*	0.159	0.485*	0.303
	[0.143]	[0.502]	[0.072]	[0.080]	[0.390]	[0.070]	[0.106]
T3 × after 2	386.251		0.329	0.264*	0.099	0.621**	0.360***
	[0.323]		[0.101]	[0.096]	[0.551]	[0.031]	[0.006]
Signboard notice	309.997*	6,770**	0.205*	0.310***	0.231*	0.140	0.213**
	[0.055]	[0.025]	[0.064]	[0.002]	[0.091]	[0.376]	[0.026]
Household head's age (years)	10.452	-86.060	0.008*	0.007*	0.001	0.002	0.007***
	[0.475]	[0.837]	[0.057]	[0.062]	[0.606]	[0.505]	[0.000]
Household size (number)	-52.454	-1,039	-0.008	0.005	0.006	0.009	0.008
	[0.253]	[0.433]	[0.537]	[0.778]	[0.424]	[0.564]	[0.411]
Dependency ratio (% of dependents to working age)	-3.899*	-152.002*	0.001	0.002	0.001	0.001	0.001
	[0.060]	[0.092]	[0.226]	[0.249]	[0.242]	[0.346]	[0.485]
Plot owner (=1)	-23.413	8,236	-0.172	-0.117	-0.072	0.100	-0.047
	[0.871]	[0.183]	[0.223]	[0.202]	[0.365]	[0.316]	[0.491]
Share of members in the same association known by the respondent (%)	-3.050	99.995	0.001	0.002	0.000	-0.004**	-0.002
	[0.490]	[0.533]	[0.253]	[0.144]	[0.801]	[0.038]	[0.269]
Uses transport to reach farm plot (=1)	30.749	-5,727	-0.107	0.212**	0.012	0.247	0.138
	[0.928]	[0.837]	[0.644]	[0.021]	[0.887]	[0.134]	[0.126]
Travel time from home to plot (minutes)	-1.416	-5.116	0.001	0.000	-0.000	0.000	0.001**
	[0.137]	[0.860]	[0.352]	[0.427]	[0.238]	[0.554]	[0.032]
Experienced flood (=1)	-312.316	-8,175	0.094	0.046	0.222*	0.041	0.119*
	[0.164]	[0.138]	[0.293]	[0.367]	[0.092]	[0.774]	[0.090]
Experienced drought (=1)	-247.227	-11,978	0.024	-0.003	0.071	0.192**	-0.032
	[0.417]	[0.480]	[0.752]	[0.993]	[0.438]	[0.028]	[0.405]
Total rainfall in rice season (mm)	-10.161	-112.951	-0.001	-0.003	0.001	0.010**	0.005*
	[0.336]	[0.874]	[0.879]	[0.482]	[0.812]	[0.027]	[0.092]
Total rainfall in rice season squared (mm^2)	0.003	0.023	0.000	0.000	-0.000	-0.000**	-0.000
	[0.380]	[0.913]	[0.831]	[0.599]	[0.905]	[0.031]	[0.101]
Average minimum temperature in rice season (°c)	4,074	65,480	1.918	-3.295**	0.609	-1.112	-1.262
	[0.588]	[0.751]	[0.559]	[0.044]	[0.763]	[0.591]	[0.369]
Average maximum temperature in rice season (°c)	26,612	57,523	15.571	-23.090	9.156	24.560	28.452
	[0.743]	[0.957]	[0.389]	[0.201]	[0.594]	[0.184]	[0.191]
Average maximum temperature in rice season squared ($°c^2$)	-424.717	-1,626	-0.258	0.372	-0.126	-0.356	-0.422
	[0.742]	[0.926]	[0.360]	[0.168]	[0.625]	[0.205]	[0.212]
Constant	-494,665	-1,468,071	-274.692	431.136*	-176.816	-404.170*	-455.137**
	[0.494]	[0.938]	[0.376]	[0.085]	[0.530]	[0.065]	[0.033]
Observations	510	340	510	510	510	510	510
R-squared	0.24	0.197	0.309	0.351	0.204	0.303	0.419
Matched sample	170	170	170	170	170	170	170

Notes: Matched sample: 170 farmers using kernel with bandwidth 0.05. Observations for rice income are fewer than for other outcomes because income data are unavailable at midline, as the cost survey modules were not administered in that round. Signboard Notice = 1 if the farmer reported seeing a signboard on a signboard farmer's plot. T1, T2, T3 represent treatment assignment. After1 = 1 if survey period is midline or endline; After2 = 1 if survey period is endline. Standard errors clustered at association level. Wild bootstrap cluster robust p-values in brackets. Significant stars are based on wild bootstrap cluster robust p-values. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A6-A: Full PSM-DID estimation results with key farmer interaction on the impact of signboard notice on agricultural outcomes and technology use using nearest neighbor matching (caliper 0.01)

Variables	Rice yield (kg/ha)	Rice income (MZN/ha)	Use of seed selection	Use of nursery bed setup	Use of bund construction	Use of plot levelling	Use of lined transplanting
Midline	4,457		0.142	-0.341	0.564	-2.139*	-1.029*
	[0.202]		[0.852]	[0.860]	[0.604]	[0.091]	[0.061]
Endline	5,293	177,434	-0.093	0.843	0.179	-2.620**	-1.424
	[0.141]	[0.134]	[0.924]	[0.739]	[0.886]	[0.035]	[0.165]
T1 × after 1	621.420	3,080	0.790*	0.207	0.094	0.767***	0.380**
	[0.164]	[0.821]	[0.053]	[0.426]	[0.742]	[0.009]	[0.036]
T2 × after 1	1,223**	24,166*	0.529	0.338**	0.065	0.617**	0.306
	[0.018]	[0.093]	[0.118]	[0.045]	[0.782]	[0.039]	[0.186]
T3 × after 2	473.658		0.139	0.312	0.243	0.554**	0.400***
	[0.267]		[0.530]	[0.138]	[0.245]	[0.040]	[0.005]
Signboard notice	404.501*	9,625	0.236	0.412***	0.230	0.218	0.176*
	[0.065]	[0.106]	[0.205]	[0.008]	[0.186]	[0.279]	[0.092]
Signboard notice x key farmer	-97.503	-6,498	-0.237	-0.218	-0.488*	0.293	0.016
	[0.880]	[0.727]	[0.372]	[0.332]	[0.098]	[0.176]	[0.918]
Household head's age (years)	11.088	-177.881	0.006	0.005	-0.001	0.002	0.006**
	[0.454]	[0.682]	[0.283]	[0.175]	[0.449]	[0.627]	[0.021]
Household size (number)	-99.401**	-1,155	-0.013	0.012	-0.008	0.009	0.012
	[0.013]	[0.392]	[0.347]	[0.551]	[0.395]	[0.677]	[0.424]
Dependency ratio (% of dependents to working-age)	-4.993*	-188.775**	0.001	0.001	0.002	0.001	0.001
	[0.092]	[0.042]	[0.587]	[0.725]	[0.221]	[0.514]	[0.347]
Plot owner (=1)	-37.705	8,785	-0.122	-0.151	-0.158	0.085	-0.036
	[0.889]	[0.377]	[0.436]	[0.274]	[0.102]	[0.470]	[0.730]
Share of members in the same association known by the respondent (%)	5.546	258.657**	0.001	0.004**	0.000	-0.002	-0.002
	[0.227]	[0.040]	[0.393]	[0.045]	[0.974]	[0.207]	[0.299]
Uses transport to reach farm plot (=1)	352.066	5,863	-0.109	0.197**	0.043	0.211	0.128*
	[0.277]	[0.560]	[0.266]	[0.029]	[0.645]	[0.236]	[0.072]
Travel time from home to plot (minutes)	-0.751	18.298	0.001	0.001**	0.000	0.000	0.000**
	[0.282]	[0.720]	[0.313]	[0.038]	[0.799]	[0.505]	[0.018]
Experienced flood (=1)	-299.596	-5,099	0.151	0.060	0.237**	-0.049	0.154*
	[0.241]	[0.196]	[0.285]	[0.189]	[0.042]	[0.688]	[0.072]
Experienced drought (=1)	-227.303	-5,933	0.092	0.004	0.085	0.133	-0.050
	[0.519]	[0.584]	[0.357]	[0.977]	[0.499]	[0.357]	[0.272]
Total rainfall in rice season (mm)	-19.743*	-390.294	0.001	-0.002	0.001	0.010*	0.006*
	[0.079]	[0.306]	[0.875]	[0.746]	[0.708]	[0.058]	[0.057]
Total rainfall in rice season squared (mm^2)	0.005*	0.088	-0.000	0.000	-0.000	-0.000*	-0.000**
	[0.093]	[0.448]	[0.884]	[0.897]	[0.623]	[0.076]	[0.049]
Average minimum temperature in rice season (°c)	3,744	255,548	0.929	-3.002	1.389	-0.894	-0.682
	[0.619]	[0.424]	[0.790]	[0.226]	[0.594]	[0.763]	[0.715]
Average maximum temperature in rice season (°c)	-59,556*	-1,133,590	19.852	-31.110	9.132	16.728	35.014
	[0.091]	[0.343]	[0.518]	[0.134]	[0.699]	[0.275]	[0.223]
Average maximum temperature in rice season squared ($°c^2$)	834.306	13,826	-0.325	0.490	-0.152	-0.238	-0.532
	[0.147]	[0.414]	[0.493]	[0.104]	[0.660]	[0.312]	[0.235]
Constant	984,883	16,868,938	-323.281	559.470**	-167.253	-279.447	-565.027*
	[0.162]	[0.339]	[0.491]	[0.042]	[0.650]	[0.261]	[0.067]
Observations	282	188	282	282	282	282	282
R-squared	0.279	0.269	0.249	0.377	0.291	0.307	0.47
Matched sample	80	80	80	80	80	80	80

Notes: Matched sample: 80 farmers using nearest neighbor matching with caliper 0.01. The number of observations exceeds three times the matched sample size because nearest neighbor matching is performed with replacement, allowing control farmers to be matched to more than one treated farmer. Observations for rice income are fewer than for other outcomes because income data are unavailable at midline, as the cost survey modules were not administered in that round. Signboard Notice = 1 if the farmer reported seeing a signboard on a signboard farmer's plot. T1, T2, T3 represent treatment assignment. After1 = 1 if survey period is midline or endline; After2 = 1 if survey period is endline. Standard errors clustered at association level. Wild bootstrap cluster robust p-values in brackets. Significant stars are based on wild bootstrap cluster robust p-values. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A6-B: Full PSM-DID estimation results with key farmer interaction on the impact of signboard notice on agricultural outcomes and technology use using nearest neighbor matching (caliper 0.03)

Variables	Rice yield (kg/ha)	Rice income (MZN/ha)	Use of seed selection	Use of nursery bed setup	Use of bund construction	Use of plot levelling	Use of lined transplanting
Midline	3,384		-0.060	0.048	0.362	-2.081*	-1.172*
	[0.380]		[0.961]	[0.983]	[0.696]	[0.095]	[0.087]
Endline	3,066	104,869	-0.217	1.137	-0.155	-2.774*	-1.342
	[0.459]	[0.303]	[0.849]	[0.636]	[0.905]	[0.068]	[0.318]
T1 × after 1	333.347	-7,091	0.803*	0.239	0.064	0.757***	0.400***
	[0.442]	[0.690]	[0.051]	[0.284]	[0.766]	[0.008]	[0.003]
T2 × after 1	888.216*	13,654	0.526*	0.368***	0.059	0.591**	0.315
	[0.056]	[0.404]	[0.071]	[0.008]	[0.768]	[0.036]	[0.150]
T3 × after 2	554.135		0.252	0.349***	0.145	0.668**	0.434***
	[0.357]		[0.251]	[0.003]	[0.452]	[0.014]	[0.003]
Signboard notice	303.598	8,298	0.287	0.399***	0.158	0.163	0.177
	[0.211]	[0.135]	[0.110]	[0.007]	[0.338]	[0.423]	[0.116]
Signboard notice x key farmer	184.714	788.627	-0.279	-0.255	-0.179	0.202	0.007
	[0.726]	[0.960]	[0.149]	[0.241]	[0.583]	[0.427]	[0.968]
Household head's age (years)	9.208	-181.462	0.006	0.005	-0.000	0.003	0.006**
	[0.508]	[0.668]	[0.256]	[0.275]	[0.782]	[0.449]	[0.022]
Household size (number)	-62.768*	-340.991	-0.015	0.018	0.001	0.013	0.018
	[0.066]	[0.651]	[0.290]	[0.324]	[0.938]	[0.495]	[0.378]
Dependency ratio (% of dependents to working age)	-4.712**	-201.123**	0.001	0.001	0.001	0.002	0.001
	[0.034]	[0.031]	[0.505]	[0.450]	[0.446]	[0.387]	[0.309]
Plot owner (=1)	95.064	10,664	-0.186	-0.157	-0.128	0.059	-0.080
	[0.633]	[0.240]	[0.205]	[0.182]	[0.148]	[0.550]	[0.456]
Share of members in the same association known by the respondent (%)	1.667	210.328**	0.001	0.003	-0.000	-0.003**	-0.001
	[0.686]	[0.024]	[0.284]	[0.100]	[0.822]	[0.027]	[0.413]
Uses transport to reach farm plot (=1)	205.066	-278.898	-0.117	0.197**	0.063	0.234	0.145**
	[0.485]	[0.984]	[0.315]	[0.029]	[0.457]	[0.180]	[0.043]
Travel time from home to plot (minutes)	-1.444	-5.997	0.001	0.001*	0.000	0.001	0.001**
	[0.131]	[0.883]	[0.222]	[0.051]	[0.753]	[0.379]	[0.024]
Experienced flood (=1)	-228.072	-2,743	0.149	0.079	0.276**	-0.003	0.156*
	[0.314]	[0.596]	[0.235]	[0.201]	[0.012]	[0.984]	[0.057]
Experienced drought (=1)	-301.334	-8,949	0.067	0.008	0.084	0.153	-0.044
	[0.418]	[0.466]	[0.471]	[0.945]	[0.521]	[0.258]	[0.239]
Total rainfall in rice season (mm)	-18.304*	-206.810	-0.001	-0.001	0.001	0.011**	0.006
	[0.052]	[0.571]	[0.754]	[0.784]	[0.757]	[0.027]	[0.119]
Total rainfall in rice season squared (mm^2)	0.005*	0.039	0.000	0.000	-0.000	-0.000**	-0.000*
	[0.066]	[0.740]	[0.729]	[0.995]	[0.705]	[0.034]	[0.099]
Average minimum temperature in rice season (°c)	1,769	122,858	-0.030	-2.183	1.030	-0.615	-1.165
	[0.811]	[0.689]	[0.986]	[0.275]	[0.674]	[0.831]	[0.553]
Average maximum temperature in rice season (°c)	-39,883	-629,280	15.141	-31.156	11.970	19.318	29.580
	[0.261]	[0.520]	[0.592]	[0.145]	[0.597]	[0.337]	[0.357]
Average maximum temperature in rice season squared ($°c^2$)	578.688	7,709	-0.242	0.481	-0.188	-0.277	-0.446
	[0.256]	[0.625]	[0.578]	[0.128]	[0.572]	[0.354]	[0.364]
Constant	659,781	9,748,135	-235.034	551.844*	-213.249	-328.481	-468.516
	[0.285]	[0.537]	[0.583]	[0.060]	[0.560]	[0.238]	[0.154]
Observations	342	228	342	342	342	342	342
R-squared	0.243	0.267	0.304	0.396	0.278	0.306	0.472
Matched sample	90	90	90	90	90	90	90

Notes: Matched sample: 90 farmers using nearest neighbor matching with caliper 0.03. The number of observations exceeds three times the matched sample size because nearest neighbor matching is performed with replacement, allowing control farmers to be matched to more than one treated farmer. Observations for rice income are fewer than for other outcomes because income data are unavailable at midline, as the cost survey modules were not administered in that round. Signboard Notice = 1 if the farmer reported seeing a signboard on a signboard farmer's plot. T1, T2, T3 represent treatment assignment. After1 = 1 if survey period is midline or endline; After2 = 1 if survey period is endline. Standard errors clustered at association level. Wild bootstrap cluster robust p-values in brackets. Significant stars are based on wild bootstrap cluster robust p-values. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A6-C: Full PSM-DID estimation results with key farmer interaction on the impact of signboard notice on agricultural outcomes and technology use using nearest neighbor matching (caliper 0.05)

Variables	Rice yield (kg/ha)	Rice income (MZN/ha)	Use of seed selection	Use of nursery bed setup	Use of bund construction	Use of plot levelling	Use of lined transplanting
Midline	3,302		0.111	0.247	0.497	-2.522**	-1.171*
	[0.360]		[0.897]	[0.898]	[0.497]	[0.046]	[0.085]
Endline	3,062	92,988	-0.146	1.326	-0.036	-3.089**	-1.215
	[0.464]	[0.349]	[0.883]	[0.552]	[0.971]	[0.030]	[0.373]
T1 × after 1	275.563	-6,063	0.913**	0.241	-0.009	0.780***	0.390***
	[0.487]	[0.736]	[0.038]	[0.294]	[0.955]	[0.006]	[0.001]
T2 × after 1	892.649**	16,107	0.602*	0.381**	0.014	0.578**	0.304
	[0.046]	[0.355]	[0.059]	[0.011]	[0.941]	[0.031]	[0.116]
T3 × after 2	509.214		0.271	0.319***	0.080	0.679***	0.415***
	[0.419]		[0.234]	[0.002]	[0.700]	[0.008]	[0.003]
Signboard notice	293.654	7,288	0.283	0.390***	0.140	0.134	0.177*
	[0.282]	[0.189]	[0.116]	[0.005]	[0.395]	[0.531]	[0.098]
Signboard notice x key farmer	179.812	1,301	-0.193	-0.175	-0.123	0.196	0.067
	[0.710]	[0.932]	[0.271]	[0.361]	[0.672]	[0.449]	[0.643]
Household head's age (years)	9.341	-104.529	0.007	0.005	-0.001	0.003	0.007**
	[0.481]	[0.818]	[0.161]	[0.158]	[0.750]	[0.392]	[0.020]
Household size (number)	-63.389*	-423.190	-0.019*	0.017	-0.000	0.015	0.017
	[0.063]	[0.543]	[0.097]	[0.389]	[0.960]	[0.445]	[0.382]
Dependency ratio (% of dependents to working age)	-4.474**	-187.886**	0.001	0.001	0.001	0.002	0.001
	[0.037]	[0.049]	[0.480]	[0.465]	[0.428]	[0.399]	[0.332]
Plot owner (=1)	106.386	10,394	-0.182	-0.154	-0.134	0.061	-0.086
	[0.580]	[0.221]	[0.223]	[0.188]	[0.119]	[0.545]	[0.424]
Share of members in the same association known by the respondent (%)	1.426	222.231**	0.001	0.003	0.000	-0.003**	-0.001
	[0.723]	[0.016]	[0.252]	[0.103]	[0.994]	[0.028]	[0.514]
Uses transport to reach farm plot (=1)	215.084	-162.956	-0.113	0.194**	0.044	0.250	0.144**
	[0.468]	[0.985]	[0.375]	[0.027]	[0.608]	[0.166]	[0.036]
Travel time from home to plot (minutes)	-1.680	-9.530	0.001	0.001*	0.000	0.000	0.001**
	[0.106]	[0.825]	[0.174]	[0.052]	[0.798]	[0.301]	[0.015]
Experienced flood (=1)	-210.065	-3,283	0.118	0.060	0.256**	-0.009	0.137*
	[0.358]	[0.530]	[0.300]	[0.323]	[0.030]	[0.946]	[0.077]
Experienced drought (=1)	-285.460	-8,453	0.056	0.008	0.077	0.155	-0.050
	[0.435]	[0.495]	[0.539]	[0.949]	[0.524]	[0.245]	[0.203]
Total rainfall in rice season (mm)	-17.579*	-143.109	-0.001	-0.002	0.000	0.011**	0.005
	[0.058]	[0.710]	[0.810]	[0.723]	[0.941]	[0.025]	[0.174]
Total rainfall in rice season squared (mm^2)	0.004*	0.020	0.000	0.000	-0.000	-0.000**	-0.000
	[0.077]	[0.860]	[0.822]	[0.991]	[0.909]	[0.040]	[0.137]
Average minimum temperature in rice season (°c)	1,452	103,750	0.520	-1.976	1.000	-1.477	-1.518
	[0.812]	[0.729]	[0.884]	[0.238]	[0.649]	[0.567]	[0.428]
Average maximum temperature in rice season (°c)	-40,914	-514,431	14.157	-33.664	10.921	19.640	26.728
	[0.261]	[0.556]	[0.619]	[0.107]	[0.610]	[0.318]	[0.365]
Average maximum temperature in rice season squared ($°c^2$)	596.781	6,100	-0.232	0.517*	-0.171	-0.272	-0.400
	[0.246]	[0.666]	[0.601]	[0.095]	[0.593]	[0.353]	[0.384]
Constant	680,635	8,085,459	-226.024	590.774**	-195.871	-324.976	-416.413
	[0.262]	[0.567]	[0.595]	[0.039]	[0.573]	[0.231]	[0.176]
Observations	360	240	360	360	360	360	360
R-squared	0.257	0.264	0.318	0.397	0.261	0.33	0.467
Matched sample	93	93	93	93	93	93	93

Notes: Matched sample: 93 farmers using nearest neighbor matching with caliper 0.05. The number of observations exceeds three times the matched sample size because nearest neighbor matching is performed with replacement, allowing control farmers to be matched to more than one treated farmer. Observations for rice income are fewer than for other outcomes because income data are unavailable at midline, as the cost survey modules were not administered in that round. Signboard Notice = 1 if the farmer reported seeing a signboard on a signboard farmer's plot. T1, T2, T3 represent treatment assignment. After1 = 1 if survey period is midline or endline; After2 = 1 if survey period is endline. Standard errors clustered at association level. Wild bootstrap cluster robust p-values in brackets. Significant stars are based on wild bootstrap cluster robust p-values. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A7-A: Full PSM-DID estimation results with key farmer interaction on the impact of signboard notice on agricultural outcomes and technology use using kernel matching (bandwidth 0.01)

Variables	Rice yield (kg/ha)	Rice income (MZN/ha)	Use of seed selection	Use of nursery bed setup	Use of bund construction	Use of plot levelling	Use of lined transplanting
Midline	4,392		0.427	-0.473	0.193	-2.116*	-0.840
	[0.162]		[0.680]	[0.795]	[0.851]	[0.090]	[0.197]
Endline	3,179	152,882	-0.175	0.696	-0.667	-2.342*	-1.037
	[0.402]	[0.210]	[0.878]	[0.785]	[0.580]	[0.085]	[0.226]
T1 × after 1	539.306	-1,663	0.748*	0.260	0.070	0.834**	0.432*
	[0.318]	[0.882]	[0.060]	[0.382]	[0.773]	[0.012]	[0.050]
T2 × after 1	1,050**	16,627	0.512	0.367**	0.154	0.585*	0.340
	[0.024]	[0.271]	[0.137]	[0.035]	[0.480]	[0.053]	[0.113]
T3 × after 2	495.121		0.168	0.321*	0.251	0.568*	0.392**
	[0.174]		[0.541]	[0.099]	[0.153]	[0.066]	[0.011]
Signboard notice	313.075	10,077**	0.191	0.409***	0.267*	0.213	0.174
	[0.160]	[0.049]	[0.213]	[0.007]	[0.091]	[0.223]	[0.123]
Signboard notice x key farmer	-61.704	-7,149	-0.250	-0.224	-0.465*	0.268	0.003
	[0.943]	[0.659]	[0.367]	[0.343]	[0.092]	[0.206]	[0.992]
Household head's age (years)	10.528	-228.000	0.007	0.005	0.000	0.001	0.006***
	[0.461]	[0.641]	[0.132]	[0.179]	[0.785]	[0.824]	[0.005]
Household size (number)	-79.242**	-1,412	-0.005	0.006	-0.001	0.011	0.011
	[0.033]	[0.163]	[0.728]	[0.735]	[0.920]	[0.501]	[0.446]
Dependency ratio (% of dependents to working age)	-4.585	-156.888**	0.002	0.002	0.002	0.001	0.001
	[0.112]	[0.041]	[0.217]	[0.317]	[0.229]	[0.598]	[0.270]
Plot owner (=1)	31.277	8,459	-0.145	-0.118	-0.137*	0.122	-0.034
	[0.880]	[0.382]	[0.309]	[0.332]	[0.091]	[0.309]	[0.678]
Share of members in the same association known by the respondent (%)	1.301	174.556	0.001	0.004**	0.000	-0.001	-0.001
	[0.761]	[0.173]	[0.422]	[0.037]	[0.880]	[0.404]	[0.506]
Uses transport to reach farm plot (=1)	320.057	4,708	-0.113	0.214**	0.036	0.228	0.139
	[0.356]	[0.623]	[0.307]	[0.021]	[0.684]	[0.190]	[0.106]
Travel time from home to plot (minutes)	-1.010	17.685	0.001	0.001*	-0.000	0.001	0.001**
	[0.141]	[0.644]	[0.272]	[0.096]	[0.580]	[0.533]	[0.010]
Experienced flood (=1)	-286.314	-6,027	0.125	0.057*	0.223*	-0.024	0.138*
	[0.244]	[0.196]	[0.287]	[0.069]	[0.079]	[0.833]	[0.068]
Experienced drought (=1)	-232.915	-6,235	0.068	-0.019	0.056	0.155	-0.039
	[0.531]	[0.628]	[0.399]	[0.879]	[0.551]	[0.133]	[0.450]
Total rainfall in rice season (mm)	-14.388	-514.916	0.002	-0.003	0.002	0.009*	0.006*
	[0.203]	[0.335]	[0.642]	[0.590]	[0.539]	[0.053]	[0.091]
Total rainfall in rice season squared (mm^2)	0.004	0.131	-0.000	0.000	-0.000	-0.000*	-0.000*
	[0.242]	[0.416]	[0.664]	[0.705]	[0.550]	[0.072]	[0.078]
Average minimum temperature in rice season (°c)	6,524	158,515	2.415	-3.376*	1.538	-1.179	-0.327
	[0.394]	[0.583]	[0.474]	[0.063]	[0.645]	[0.626]	[0.848]
Average maximum temperature in rice season (°c)	-8,630	-1,221,978	20.863	-24.292	9.282	18.812	29.721
	[0.889]	[0.545]	[0.309]	[0.186]	[0.631]	[0.373]	[0.301]
Average maximum temperature in rice season squared ($°c^2$)	52.026	16,404	-0.350	0.389	-0.146	-0.272	-0.459
	[0.956]	[0.595]	[0.249]	[0.153]	[0.627]	[0.395]	[0.307]
Constant	93,320	19,258,136	-363.176	453.595*	-182.333	-304.005	-479.012**
	[0.909]	[0.304]	[0.315]	[0.063]	[0.544]	[0.207]	[0.048]
Observations	369	246	369	369	369	369	369
R-squared	0.268	0.193	0.262	0.375	0.252	0.299	0.446
Matched sample	123	123	123	123	123	123	123

Notes: Matched sample: 123 farmers using kernel with bandwidth 0.01. Observations for rice income are fewer than for other outcomes because income data are unavailable at midline, as the cost survey modules were not administered in that round. Signboard Notice = 1 if the farmer reported seeing a signboard on a signboard farmer's plot. T1, T2, T3 represent treatment assignment. After1 = 1 if survey period is midline or endline; After2 = 1 if survey period is endline. Standard errors clustered at association level. Wild bootstrap cluster robust p-values in brackets. Significant stars are based on wild bootstrap cluster robust p-values. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A7-B: Full PSM-DID estimation results with key farmer interaction on the impact of signboard notice on agricultural outcomes and technology use using kernel matching (bandwidth 0.03)

Variables	Rice yield (kg/ha)	Rice income (MZN/ha)	Use of seed selection	Use of nursery bed setup	Use of bund construction	Use of plot levelling	Use of lined transplanting
Midline	2,932		0.232	-0.640	-0.277	-1.681	-1.238*
	[0.374]		[0.807]	[0.722]	[0.788]	[0.102]	[0.088]
Endline	136.544	45,426	-0.348	0.489	-1.390	-2.401*	-1.649
	[0.973]	[0.552]	[0.774]	[0.858]	[0.248]	[0.068]	[0.103]
T1 × after 1	130.862	-9,526	0.774**	0.302	0.078	0.796**	0.478**
	[0.832]	[0.652]	[0.017]	[0.274]	[0.706]	[0.010]	[0.018]
T2 × after 1	702.363	10,389	0.494*	0.341*	0.216	0.523*	0.323
	[0.193]	[0.550]	[0.080]	[0.081]	[0.340]	[0.059]	[0.159]
T3 × after 2	408.350		0.318*	0.297**	0.158	0.637**	0.373***
	[0.202]		[0.079]	[0.043]	[0.322]	[0.021]	[0.007]
Signboard notice	261.446	7,538**	0.242*	0.341***	0.271*	0.127	0.187*
	[0.160]	[0.037]	[0.064]	[0.005]	[0.084]	[0.422]	[0.079]
Signboard notice x key farmer	205.224	671.702	-0.300	-0.256	-0.171	0.202	0.013
	[0.747]	[0.965]	[0.131]	[0.306]	[0.504]	[0.439]	[0.935]
Household head's age (years)	9.583	-164.065	0.007	0.007	0.001	0.002	0.007***
	[0.504]	[0.711]	[0.120]	[0.118]	[0.571]	[0.626]	[0.002]
Household size (number)	-45.241	-738.597	-0.004	0.008	0.008	0.008	0.011
	[0.305]	[0.534]	[0.752]	[0.615]	[0.216]	[0.606]	[0.369]
Dependency ratio (% of dependents to working age)	-4.041*	-161.839*	0.001	0.002	0.001	0.002	0.001
	[0.051]	[0.077]	[0.228]	[0.201]	[0.315]	[0.316]	[0.415]
Plot owner (=1)	-0.020	9,510	-0.161	-0.115	-0.068	0.107	-0.042
	[1.000]	[0.174]	[0.263]	[0.235]	[0.417]	[0.300]	[0.552]
Share of members in the same association known by the respondent (%)	-2.490	95.051	0.001	0.003	0.000	-0.004**	-0.002
	[0.578]	[0.562]	[0.315]	[0.148]	[0.813]	[0.041]	[0.280]
Uses transport to reach farm plot (=1)	48.963	-5,234	-0.099	0.233**	0.043	0.240	0.149
	[0.889]	[0.842]	[0.629]	[0.016]	[0.571]	[0.125]	[0.108]
Travel time from home to plot (minutes)	-1.262	-1.812	0.001	0.001	-0.000	0.000	0.001**
	[0.138]	[0.964]	[0.315]	[0.340]	[0.272]	[0.547]	[0.029]
Experienced flood (=1)	-311.418	-6,959	0.131	0.062	0.234*	0.049	0.141*
	[0.172]	[0.175]	[0.214]	[0.323]	[0.084]	[0.761]	[0.053]
Experienced drought (=1)	-233.720	-11,589	0.039	-0.016	0.070	0.182*	-0.024
	[0.457]	[0.475]	[0.571]	[0.905]	[0.481]	[0.059]	[0.520]
Total rainfall in rice season (mm)	-11.374	-230.366	-0.001	-0.003	0.002	0.010**	0.006*
	[0.305]	[0.686]	[0.736]	[0.511]	[0.671]	[0.023]	[0.066]
Total rainfall in rice season squared (mm^2)	0.003	0.058	0.000	0.000	-0.000	-0.000**	-0.000*
	[0.339]	[0.739]	[0.685]	[0.572]	[0.724]	[0.027]	[0.075]
Average minimum temperature in rice season (°c)	4,626	82,343	1.095	-3.686**	0.673	0.060	-0.908
	[0.580]	[0.722]	[0.642]	[0.045]	[0.795]	[0.976]	[0.542]
Average maximum temperature in rice season (°c)	23,350	-129,664	14.362	-20.938	9.609	26.379	30.333
	[0.782]	[0.906]	[0.451]	[0.268]	[0.574]	[0.202]	[0.213]
Average maximum temperature in rice season squared ($°c^2$)	-384.961	1,112	-0.234	0.343	-0.134	-0.396	-0.456
	[0.782]	[0.948]	[0.415]	[0.229]	[0.616]	[0.212]	[0.231]
Constant	-442,374	1,436,450	-242.426	400.510	-185.093	-447.600*	-488.654**
	[0.549]	[0.936]	[0.432]	[0.115]	[0.514]	[0.052]	[0.029]
Observations	468	312	468	468	468	468	468
R-squared	0.229	0.194	0.314	0.354	0.222	0.286	0.429
Matched sample	156	156	156	156	156	156	156

Notes: Matched sample: 156 farmers using kernel with bandwidth 0.03. Observations for rice income are fewer than for other outcomes because income data are unavailable at midline, as the cost survey modules were not administered in that round. Signboard Notice = 1 if the farmer reported seeing a signboard on a signboard farmer's plot. T1, T2, T3 represent treatment assignment. After1 = 1 if survey period is midline or endline; After2 = 1 if survey period is endline. Standard errors clustered at association level. Wild bootstrap cluster robust p-values in brackets. Significant stars are based on wild bootstrap cluster robust p-values. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A7-C: Full PSM-DID estimation results with key farmer interaction on the impact of signboard notice on agricultural outcomes and technology use using kernel matching (bandwidth 0.05)

Variables	Rice yield (kg/ha)	Rice income (MZN/ha)	Use of seed selection	Use of nursery bed setup	Use of bund construction	Use of plot levelling	Use of lined transplanting
Midline	2,634		0.377	-0.378	-0.177	-2.080**	-1.310*
	[0.406]		[0.721]	[0.823]	[0.837]	[0.045]	[0.065]
Endline	-358.779	28,299	-0.451	0.678	-1.302	-2.568**	-1.731*
	[0.927]	[0.736]	[0.698]	[0.774]	[0.231]	[0.029]	[0.062]
T1 × after 1	83.868	-8,985	0.836**	0.320	0.005	0.795***	0.457**
	[0.878]	[0.664]	[0.014]	[0.254]	[0.982]	[0.006]	[0.010]
T2 × after 1	710.674	12,176	0.555*	0.361*	0.155	0.492*	0.305
	[0.139]	[0.509]	[0.072]	[0.077]	[0.423]	[0.067]	[0.106]
T3 × after 2	378.113		0.338*	0.271*	0.104	0.612**	0.358***
	[0.325]		[0.089]	[0.085]	[0.529]	[0.020]	[0.006]
Signboard notice	270.106	6,497*	0.249*	0.346***	0.258*	0.097	0.202**
	[0.203]	[0.078]	[0.063]	[0.005]	[0.087]	[0.551]	[0.039]
Signboard notice x key farmer	198.410	1,355	-0.218	-0.176	-0.135	0.213	0.056
	[0.710]	[0.942]	[0.203]	[0.395]	[0.553]	[0.399]	[0.709]
Household head's age (years)	10.495	-85.161	0.008*	0.007*	0.001	0.002	0.007***
	[0.471]	[0.844]	[0.067]	[0.064]	[0.592]	[0.493]	[0.000]
Household size (number)	-53.337	-1,060	-0.007	0.006	0.006	0.008	0.008
	[0.236]	[0.426]	[0.567]	[0.733]	[0.401]	[0.641]	[0.427]
Dependency ratio (% of dependents to working age)	-3.817*	-152.367*	0.001	0.002	0.001	0.001	0.001
	[0.069]	[0.092]	[0.244]	[0.245]	[0.236]	[0.339]	[0.463]
Plot owner (=1)	-24.042	8,049	-0.172	-0.117	-0.071	0.100	-0.047
	[0.866]	[0.218]	[0.237]	[0.192]	[0.378]	[0.324]	[0.484]
Share of members in the same association known by the respondent (%)	-3.045	99.162	0.001	0.002	0.000	-0.004**	-0.002
	[0.490]	[0.553]	[0.273]	[0.162]	[0.804]	[0.037]	[0.274]
Uses transport to reach farm plot (=1)	29.139	-5,691	-0.105	0.214**	0.014	0.246	0.137
	[0.937]	[0.840]	[0.648]	[0.018]	[0.872]	[0.132]	[0.127]
Travel time from home to plot (minutes)	-1.462	-5.754	0.001	0.001	-0.000	0.000	0.001**
	[0.124]	[0.849]	[0.318]	[0.361]	[0.287]	[0.599]	[0.028]
Experienced flood (=1)	-308.330	-8,151	0.090	0.042	0.220	0.045	0.121*
	[0.171]	[0.132]	[0.337]	[0.479]	[0.107]	[0.739]	[0.084]
Experienced drought (=1)	-240.656	-11,856	0.017	-0.009	0.066	0.199**	-0.031
	[0.433]	[0.476]	[0.806]	[0.947]	[0.465]	[0.036]	[0.423]
Total rainfall in rice season (mm)	-10.027	-112.401	-0.001	-0.003	0.001	0.010**	0.005*
	[0.346]	[0.875]	[0.853]	[0.470]	[0.816]	[0.023]	[0.095]
Total rainfall in rice season squared (mm^2)	0.003	0.023	0.000	0.000	-0.000	-0.000**	-0.000*
	[0.391]	[0.913]	[0.792]	[0.568]	[0.929]	[0.031]	[0.090]
Average minimum temperature in rice season (°c)	4,178	64,939	1.804	-3.387**	0.538	-1.000	-1.232
	[0.585]	[0.746]	[0.564]	[0.038]	[0.804]	[0.610]	[0.364]
Average maximum temperature in rice season (°c)	27,062	56,197	15.077	-23.490	8.850	25.043	28.579
	[0.754]	[0.956]	[0.421]	[0.198]	[0.604]	[0.189]	[0.192]
Average maximum temperature in rice season squared ($°c^2$)	-432.914	-1,602	-0.249	0.379	-0.121	-0.365	-0.424
	[0.754]	[0.924]	[0.381]	[0.173]	[0.642]	[0.203]	[0.214]
Constant	-503,002	-1,439,264	-265.538	438.549*	-171.139	-413.120*	-457.488**
	[0.488]	[0.939]	[0.395]	[0.079]	[0.542]	[0.065]	[0.033]
Observations	510	340	510	510	510	510	510
R-squared	0.241	0.197	0.315	0.355	0.207	0.308	0.42
Matched sample	170	170	170	170	170	170	170

Notes: Matched sample: 170 farmers using kernel with bandwidth 0.05. Observations for rice income are fewer than for other outcomes because income data are unavailable at midline, as the cost survey modules were not administered in that round. Signboard Notice = 1 if the farmer reported seeing a signboard on a signboard farmer's plot. T1, T2, T3 represent treatment assignment. After1 = 1 if survey period is midline or endline; After2 = 1 if survey period is endline. Standard errors clustered at association level. Wild bootstrap cluster robust p-values in brackets. Significant stars are based on wild bootstrap cluster robust p-values. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A8: PSM matched sample sizes by matching method (dis-adoption)

Matching method	Bandwidth/Caliper	Signboard notice (=1)	Signboard notice (=0)	Matched sample size
Nearest neighbor	0.01	32	26	58
Nearest neighbor	0.03	47	30	77
Nearest neighbor	0.05	50	30	80
Kernel	0.01	32	56	88
Kernel	0.03	47	77	124
Kernel	0.05	50	83	133

Note: Signboard notice (=1) if the farmer reported seeing a signboard on signboard farmer's plot. Dis-adoption = 1 if the farmer used at least one of the five practices at midline but stopped using at least one of those practices by endline. Dis-adoption = 0 if the farmer used at least one practice at midline and did not stop using any of the practices they had used by endline. Farmers who had not used any practice at midline are excluded.

Table A9: Summary statistics of inverse probability weights

Group	N	Mean	SD	Min	P25	Median	P75	Max
Overall	196	1.91	1.75	1.00	1.13	1.36	1.94	18.06
Signboard notice = 1	65	2.61	1.88	1.00	1.40	1.84	3.11	10.29
Signboard notice = 0	131	1.57	1.58	1.00	1.08	1.21	1.62	18.06

Notes: Inverse probability weights computed from first-stage logit model (Appendix Table A2). Weights applied to balance covariate distributions between signboard notice and non-notice groups.

Table A10: Full estimation result of IPW-DID model on the impact of signboard notice on agricultural outcomes and technology use

Variables	Rice yield (kg/ha)	Rice income (MZN/ha)	Use of seed selection	Use of nursery bed setup	Use of bund construction	Use of plot levelling	Use of lined transplanting
Midline	1,860		0.843	-0.333	-0.060	-1.304	-1.523*
	[0.400]		[0.741]	[0.828]	[0.934]	[0.140]	[0.054]
Endline	-2,065	66,108	0.272	-0.763	-2.267**	-1.697*	-2.103***
	[0.458]	[0.552]	[0.775]	[0.699]	[0.019]	[0.077]	[0.002]
T1 × after 1	585.4	11,475	0.719**	0.540*	0.160	0.673***	0.463**
	[0.312]	[0.617]	[0.033]	[0.074]	[0.352]	[0.006]	[0.013]
T2 × after 1	927.1**	19,250	0.544*	0.470**	0.235	0.435	0.320*
	[0.011]	[0.324]	[0.058]	[0.044]	[0.204]	[0.127]	[0.050]
T3 × after 2	228.3		0.329	0.373	0.253	0.432*	0.383***
	[0.436]		[0.268]	[0.125]	[0.217]	[0.059]	[0.008]
Signboard notice	317.2	4,249	0.361***	0.336***	0.279**	0.194**	0.215**
	[0.299]	[0.526]	[0.000]	[0.002]	[0.036]	[0.048]	[0.023]
Household head's age (years)	-0.638	-216.6	0.006**	0.008***	-0.001	0.004	0.007***
	[0.960]	[0.584]	[0.014]	[0.004]	[0.756]	[0.293]	[0.000]
Household size (number)	-34.07	-1,093	0.009	0.012	0.007	0.022*	0.012
	[0.127]	[0.202]	[0.341]	[0.330]	[0.463]	[0.076]	[0.160]
Dependency ratio (% of dependents to working age)	-2.675	-114.9*	0.001	0.001	0.002**	0.001	0.001
	[0.107]	[0.083]	[0.286]	[0.201]	[0.039]	[0.327]	[0.329]
Plot owner (=1)	140.2	6,837*	-0.106	-0.083	-0.083	0.043	0.028
	[0.384]	[0.074]	[0.404]	[0.346]	[0.363]	[0.703]	[0.737]
Share of members in the same association known by the respondent (%)	-4.155	48.85	0.002*	0.001	-0.001	-0.003*	-0.002
	[0.278]	[0.698]	[0.080]	[0.170]	[0.585]	[0.096]	[0.127]
Uses transport to reach farm plot (=1)	235.0	5,781	-0.107	0.14	0.057	0.171	0.128*
	[0.358]	[0.532]	[0.302]	[0.111]	[0.501]	[0.210]	[0.099]
Travel time from home to plot (minutes)	-1.51	-26.74	0.001*	4.72e-04	-1.14e-04	0.001	0.001*
	[0.146]	[0.420]	[0.060]	[0.133]	[0.600]	[0.494]	[0.069]
Experienced flood (=1)	-295.5	-8,647*	0.100	0.001	0.219*	0.045	0.090
	[0.258]	[0.065]	[0.324]	[0.991]	[0.068]	[0.706]	[0.161]
Experienced drought (=1)	67.72	5,881	0.069	-0.002	0.035	0.039	0.012
	[0.779]	[0.550]	[0.433]	[0.982]	[0.724]	[0.514]	[0.794]
Total rainfall in rice season (mm)	2.719	262.9	0.001	2.30e-04	0.005*	0.012***	0.006
	[0.743]	[0.714]	[0.832]	[0.949]	[0.059]	[0.002]	[0.110]
Total rainfall in rice season squared (mm^2)	-0.001	-0.088	-2.50e-07	-1.55e-07	-1.19e-06*	-3.49e-06***	-1.54e-06
	[0.787]	[0.669]	[0.849]	[0.875]	[0.098]	[0.000]	[0.127]
Average minimum temperature in rice season (°c)	7,622	311,720	2.838	-0.751	2.944*	1.114	-1.469
	[0.252]	[0.359]	[0.417]	[0.792]	[0.066]	[0.526]	[0.356]
Average maximum temperature in rice season (°c)	60,155	316,687	15.69	2.408	24.70*	22.27*	31.29
	[0.292]	[0.816]	[0.197]	[0.874]	[0.060]	[0.091]	[0.171]
Average maximum temperature in rice season squared ($°c^2$)	-967.7	-8,196	-0.279	-0.026	-0.374*	-0.353*	-0.459
	[0.287]	[0.740]	[0.155]	[0.904]	[0.065]	[0.090]	[0.210]
Constant	-1.098e+06*	-8.644e+06	-278.6	-34.74	-473.2**	-384.7*	-503.5**
	[0.0826]	[0.581]	[0.218]	[0.868]	[0.0358]	[0.0674]	[0.0117]
Observations	588	392	588	588	588	588	588
R-squared	0.169	0.103	0.310	0.383	0.257	0.294	0.417
Matched sample	196	196	196	196	196	196	196

Notes: Matched samples: 196 because some association dummies were omitted due to perfect prediction, resulting in the exclusion of 23 observations. Signboard Notice = 1 if the farmer reported seeing a signboard on a signboard farmer's plot. T1, T2, T3 represent treatment assignment. After1 = 1 if survey period is midline or endline; After2 = 1 if survey period is endline. Standard errors clustered at association level. Wild bootstrap cluster robust p-values in brackets. Significant stars are based on wild bootstrap cluster robust p-values. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A11: Summary statistics of inverse probability weights (trimmed weight)

Group	N	Mean	SD	Min	P25	Median	P75	Max
Overall	196	1.87	1.43	1.00	1.13	1.36	1.94	10.00
Signboard notice = 1	65	2.6	1.86	1.00	1.4	1.84	3.11	10.00
Signboard notice = 0	131	1.51	0.97	1.00	1.08	1.21	1.62	10.00

Notes: Inverse probability weights computed from first-stage Logit model (Appendix Table A2). Weights applied to balance covariate distributions between signboard notice and non-notice groups. Weights exceeding 10 were trimmed to reduce influence of extreme values.

Table A12: Full estimation result of IPW-DID model on the impact of signboard notice on agricultural outcomes and technology use (trimmed weights)

Variables	Rice yield (kg/ha)	Rice income (MZN/ha)	Use of seed selection	Use of nursery bed setup	Use of bund construction	Use of plot levelling	Use of lined transplanting
Midline	2,202		0.566	-0.595	-0.037	-1.296	-1.495*
	[0.389]		[0.775]	[0.703]	[0.956]	[0.147]	[0.056]
Endline	-1,977	63,146	0.085	-0.871	-2.271**	-1.734*	-2.124***
	[0.503]	[0.581]	[0.936]	[0.681]	[0.020]	[0.080]	[0.002]
T1 × after 1	651.4	11,757	0.707**	0.505*	0.17	0.691***	0.480**
	[0.282]	[0.618]	[0.032]	[0.085]	[0.338]	[0.007]	[0.014]
T2 × after 1	954.7***	19,071	0.528*	0.451*	0.239	0.440	0.324*
	[0.009]	[0.328]	[0.063]	[0.055]	[0.215]	[0.128]	[0.051]
T3 × after 2	253.9		0.320	0.357	0.257	0.438*	0.388***
	[0.408]		[0.262]	[0.134]	[0.217]	[0.061]	[0.008]
Signboard notice	327.4	4,028	0.344***	0.326***	0.278**	0.190*	0.214**
	[0.287]	[0.541]	[0.000]	[0.002]	[0.037]	[0.061]	[0.023]
Household head's age (years)	-0.651	-214.7	0.006**	0.008***	-0.001	0.004	0.007***
	[0.953]	[0.588]	[0.015]	[0.006]	[0.761]	[0.287]	[0.000]
Household size (number)	-31.45	-1,082	0.008	0.011	0.008	0.023*	0.012
	[0.155]	[0.202]	[0.371]	[0.385]	[0.449]	[0.079]	[0.152]
Dependency ratio (% of dependents to working age)	-2.901*	-119.6*	0.001	0.001	0.002**	0.001	0.001
	[0.092]	[0.099]	[0.303]	[0.204]	[0.035]	[0.347]	[0.404]
Plot owner (=1)	148.0	6,868*	-0.106	-0.087	-0.081	0.046	0.03
	[0.360]	[0.067]	[0.401]	[0.313]	[0.371]	[0.680]	[0.720]
Share of members in the same association known by the respondent (%)	-4.058	45.86	0.002*	0.001	-0.001	-0.003*	-0.002
	[0.274]	[0.720]	[0.077]	[0.196]	[0.575]	[0.091]	[0.138]
Uses transport to reach farm plot (=1)	220.9	5,732	-0.104	0.147*	0.054	0.167	0.124
	[0.381]	[0.536]	[0.309]	[0.091]	[0.534]	[0.221]	[0.100]
Travel time from home to plot (minutes)	-1.487	-28.06	0.001*	4.49e-04	-1.20E-04	0.001	0.001*
	[0.153]	[0.403]	[0.057]	[0.164]	[0.585]	[0.504]	[0.069]
Experienced flood (=1)	-308.3	-8,633*	0.104	0.009	0.217*	0.041	0.088
	[0.233]	[0.065]	[0.308]	[0.848]	[0.071]	[0.733]	[0.165]
Experienced drought (=1)	51.43	5,854	0.075	0.008	0.033	0.035	0.009
	[0.824]	[0.551]	[0.400]	[0.930]	[0.746]	[0.570]	[0.858]
Total rainfall in rice season (mm)	3.079	261.4	0.001	1.23e-05	0.005*	0.012***	0.006*
	[0.697]	[0.712]	[0.852]	[0.998]	[0.057]	[0.001]	[0.099]
Total rainfall in rice season squared (mm^2)	-0.001	-0.087	-1.58E-07	-7.16E-08	-1.19e-06*	-3.48e-06***	-1.55E-06
	[0.752]	[0.658]	[0.903]	[0.938]	[0.089]	[0.000]	[0.123]
Average minimum temperature in rice season (°c)	8,712	309,138	2.220	-1.488	3.042	1.231	-1.312
	[0.219]	[0.359]	[0.481]	[0.507]	[0.126]	[0.499]	[0.376]
Average maximum temperature in rice season (°c)	62,969	335,653	15.541	1.101	25.02*	23.03*	32.11
	[0.282]	[0.801]	[0.198]	[0.937]	[0.055]	[0.086]	[0.151]
Average maximum temperature in rice season squared ($°c^2$)	-1,021	-8,434	-0.270	0.002	-0.380*	-0.365*	-0.473
	[0.273]	[0.729]	[0.164]	[0.995]	[0.058]	[0.078]	[0.179]
Constant	-1.157e+06*	-8.948e+06	-269.7	-4.611	-479.8**	-398.8*	-519.1***
	[0.0671]	[0.567]	[0.225]	[0.983]	[0.0339]	[0.0585]	[0.00882]
Observations	588	392	588	588	588	588	588
R-squared	0.171	0.102	0.296	0.372	0.258	0.296	0.419
Matched sample	196	196	196	196	196	196	196

Notes: Matched samples: 196 because some association dummies were omitted due to perfect prediction, resulting in the exclusion of 23 observations. Signboard Notice = 1 if the farmer reported seeing a signboard on a signboard farmer's plot. T1, T2, T3 represent treatment assignment. After1 = 1 if survey period is midline or endline; After2 = 1 if survey period is endline. Standard errors clustered at association level. Wild bootstrap cluster robust p-values in brackets. Significant stars are based on wild bootstrap cluster robust p-values. *** $p < 0.01$, ** $p < 0.05$, * $p < 0$.

Abstract (in Japanese)

要約

サハラ以南のアフリカでは、低い農業生産性が食料安全保障の制約要因となっている。農業研修やデモ圃場の設置といった供給側からの介入は、稲作営農技術の普及を促進するが、多額の費用を要することが多く、地理的に孤立した農家にまで届かない場合も少なくない。農家間普及（Farmer to Farmer Extension, F2FE）は、社会的学習を促進する費用対効果の高い代替手段であるが、研修を受けていない農家が研修を受けた農家に容易にアクセスできない場合、その効果は限定的となる。従来の手法では、研修を受けた農家に対して金銭的または非金銭的なインセンティブが提供されてきたが、こうした仕組みはコストがかさみ、持続させるのが困難な場合がある。本研究では、研修を受けた農家の圃場に看板を設置するという、新たな「需要側」のアプローチを導入した。この看板には農家の氏名、連絡先、導入した技術内容が記載されており、他の農家が研修を受けた農家を特定し、直接情報を得られるようにしている。モザンビークの天水農業地域にある 16 の農業者組合に所属する 219 戸の農家を対象としたバランス・パネルデータを用い、傾向スコアマッチング・差の差分析（PSM-DID）を適用して、看板の認識が営農選択とその成果に与える影響を推定した。分析には、ローゼンバウム・バウンズ（Rosenbaum bounds）PSM や、逆確率重み付け DID（IPW-DID）による検証も実施している。その結果、看板を認識した研修を受けていない農家は、改良技術を採用する可能性が高く、その結果として、水稲収量はヘクタールあたり 302～387 kg（未認識グループ平均の 33～43%）、水稲所得は 6,770～8,737 MZN（同 37～48%）増加したことが示された。また、看板の設置は、一度技術を採用した農家が不採用に戻ることを抑制する効果もあった。ただし、デモ圃場での直接研修では、推奨されるすべての技術の採用を促進した一方で、看板による効果は特定の技術の採用を促進するにとどまった。これらの知見は、資源が限られた農業システムにおいて、F2FE を強化し生産性を向上させるための、簡便かつ低コストな「需要側」の仕組みが持つ可能性と限界を浮き彫りにしている。

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