Can Land Registration Increase Willingness to Pay for Agricultural Inputs? Short-Term Experimental Evidence from Women Farmers in Mozambique*

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Abstract

Most rural land in Africa is not formally documented, potentially leading to low tenure security and limited land investment incentives. We test whether subsidies for women farmers in Mozambique can boost the impact of land registration on agricultural investment. In a first stage, half of study participants were offered assistance obtaining a no-cost land registration certificate. In a second stage, all participants were offered a package of agricultural inputs, at a randomly selected subsidy. While we find high demand for land registration, it did not significantly increase willingness to pay for the agricultural inputs, regardless of subsidy level. In contrast, subsidies had a large effect on willingness to pay: every 2,000MZN increase in subsidy increased purchase probability by 11 percentage points. Our findings cast doubt on the land registration-investment policy argument and suggest that liquidity constraints are a more important constraint undermining women farmers' investment incentives.

JEL: O12, O17, P48, Q15, J16

1 Introduction

Most rural land in Africa is not formally documented. Many governments are trying to change this with land registration programs. An important argument is that formalization of land rights improves the security of tenure of poor farmers, and through that their incentives to invest on the land. Land registration programs are also seen as an opportunity to promote a more equitable distribution of land rights between men and women.

Yet, experimental evidence on the impact of land registration on agricultural investment is both incipient (two trials so far) and heterogeneous. Golstein et al. (2018) show that a land registration program in Benin increased tree planting and the cultivation of perennial crops, while Huntington and Shenoy (2021) find that a similar program in Zambia had (precisely estimated) zero impacts across a range of agricultural investments.

One explanation for why land registration does not necessarily translate into increased agricultural investment may be that farmers also face liquidity constraints, in addition to insecurity of tenure. Hence, even if land registration were to create better incentives to invest on land, poor farmers may not have the liquidity needed to invest. This can be particularly true in many African countries where individuals are only granted usership (rather than full ownership) rights over land, and thus cannot use formally documented land as collateral for credit.

Using a field experiment with about 500 women farmers in Mozambique, we test the hypothesis that relaxing liquidity constraints increases the impact of land registration on agricultural investment. In a first stage, a randomly selected *half* of participants were offered assistance in obtaining a land registration certificate at no cost. In a second stage, *all* participants were offered a package of agricultural inputs for sale, at a randomly selected price (subsidy). These two cross-cutting experimental variations allow us to test the impact of price subsidies on the effect land registration on farmers' willingness to pay for agricultural inputs. If cost of inputs is a major reason why land registration does not translate into higher demand (due to liquidity constraints), then we should see land registration to have a stronger impact among farmers offered lower prices.

We find that demand for land registration was very high. Vast majority (92.2%) of women offered our assistance registered the land. However, land registration did not significantly increase willingness to pay for the agricultural inputs *regardless* of subsidy level. In contrast, subsidies had a large effect on willingness to pay: purchase probability increased by 11 percentage points for every 2,000 MZN increase in price subsidy ($p < 0.01$). This null result casts doubt on the policy argument that rural land registration necessarily leads to greater agricultural investment. Liquidity constraints appear to be a more important constraint undermining women farmers' investment incentives.

The rest of the paper is organized as follows. Section 2 introduces the context and

details the interventions. Section 3 details the experimental design and the data sources. Section 3 presents the results and explores potential mechanisms. Section 4 concludes with additional discussion.

2   Context and Interventions

2.1   Land Rights in Mozambique

The legal framework governing land rights in Mozambique follows a participatory approach, acknowledging community land use rights and customary practices as outlined in the 1997 Mozambique Land Law. The Government of Mozambique has exclusive ownership of all land, as stated in the 1995 and 1997 Land Laws and the 2004 Constitution, but land use-right certificates, known as DUATs, can be transferred between individuals through inheritance or the sale of existing infrastructure on the land. However, the land itself cannot be sold. DUATs can be acquired through three different methods: i) occupation based on customary norms and practices; ii) occupation by individuals who have used the land in good faith for at least 10 years without objection; or iii) by legal request from individuals, local communities, or entities.

Despite the legal provision of DUATS at low costs, they remain relatively uncommon: According to data from the 2012 IAI (Inquirito Agricola Integrado), fewer than 3% of plots had a DUATs. Instead, customary norms and practices of land acquisition prevail, with 50.8% of plots being inherited or allocated by parents, 21.8% occupied, and only 8.6% purchased, with an additional 8.7% allocated by local authorities.

While the Land Law ensures equal land rights for both men and women, women still face discrimination in practice, especially within customary tenure arrangements prevalent in rural areas. Even within matrilineal communities where descent is traced through women and assets are inherited accordingly, social dynamics generally remain patriarchal, with male dominance. Consequently, in cases where land is jointly held by spouses, social norms often result in men exercising their joint rights individually. If the process of legalization is not conducted in a manner that acknowledges and respects the distinct relationships of a matrilineal kinship system, it may result in men being listed as the 'landowners' (either husbands or brothers) and potentially be done at the expense of women and their matrilineage. Peters (2010) cautions that this practice could lead to the displacement of women in matrilineal-matrilocal areas, who currently enjoy highly secure and privileged rights in comparison to men.

2.2 Study Location

This study is located in the district of Molumbo, in the Province of Zanbezia, where matrilineal kinship prevails, with 70% of the sampled women reporting being from a matrilinear descent. Today, there exists little quantitative study on tenure security in matrilineal areas, despite 15% of societies in Sub-Saharan Africa practicing matrilineal kinship [Ethnographic Atlas].

2.3 Interventions

We partnered with two NGOs, NCBA-CLUSA and the Cadasta Foundation, to conduct a randomized experiment in Molumbo, Mozambique. The experiment focus on two core components of NCBA-CLUSA's Promotion of Climate Smart Agriculture (PROMAC) II development program for smallholder farmers: (i) registration of household farm land and (ii) an agricultural input bundle subsidy.

The registration component assists farmers throughout all steps of the process to obtain a formal land-use certificate (DUAT) for their largest plot of land, at no cost. This intervention includes an initial discussion of the benefits of land registration, demarcation of the plot, submission of demarcated plots to regional authorities (to prevent overlap with existing claims), public posting of plot registration claims, assistance adjudicating disputes with nearby neighbors, and the eventual hand-delivery of the certificates. The intervention thus reduces the monetary and transaction costs associated with land registration.

The agricultural input bundle subsidy offers farmers a package of maize and sugar bean seeds (to cover 0.25 hectares each), cassava and sweet potato cuttings, fruit-tree seedlings, as well as complimentary inputs such as fertilizers and pesticides. The bundle was designed by program agronomists to be locally appropriate and simultaneously offer short-term (through the annual crop inputs) and long-term (through the fruit trees) investment opportunities. At the time of the study, the total market value of the bundle was around US$330. Prior to the study, the PROMAC program had subsidized 80% of the bundle cost.

NCBA-CLUSA modified their standard implementation approach in two ways for this study. First, building on their goal of empowering women: (i) the land registration assistance was offered conditional on the land being registered in the name of the head women in the household (either alone or jointly with their husbands), and (ii) the input bundle subsidy was also targeted to the woman. Second, to better understand how demand for the input bundles changes over various subsidy amounts, we randomly varied the size of the subsidy offered to each household.

3 Experimental Design and Data Sources

3.1 Experimental Design

The original sample for the study comprises 534 women in smallholder farming households identified by the PROMAC program lead farmers, though in this paper we focus on the subset of 459 married women. In a first-stage, women were randomly assigned into one of two groups (stratified by their associated program lead farmer): a treatment group that was offered our land registration assistance, and a control group where such assistance was not offered. In a second stage, women in both groups were offered the input subsidy bundle for sale at one of six randomly selected price subsidy levels. Figure 1 summarizes the study timeline and design.

Following the identification of eligible plots for each household and the randomization of households across study arms, a PROMAC service provider implemented the land-registration component for households assigned to the land-use title treatment arm. The service provider worked closely with the Cadasta Foundation to collect government-compliant geospatial data for submission to the regional land-use authorities. The administrative land-registration data includes detailed information on the land demarcation visit including whether the household agreed to the conditional offer and the names registered for the land-use title.

The willingness to pay component was implemented as a take-it-or-leave-it offer for the input bundle, presented to the household's head woman together with her husband, if married. Specifically, representatives of NCBA-CLUSA visited each woman, noted that their visit is part of the PROMAC program, introduced the agricultural inputs bundle contents, and detailed why women may want to purchase it.[1] After detailing the bundle, the representatives presented the women with an opportunity to commit to purchasing the bundle at one of six randomly selected subsidy levels: 96%, 87%, 79%, 71%, 63%, and 54%.[2] The women were only presented with one of the prices and were told that they would not have another opportunity to purchase the bundle. We noted that the women would not have to pay anything at the time of their decision but would receive a ticket confirming their choice and then need to pay 50% at the delivery of the maize inputs and the remaining 50% at the delivery of the bean inputs. After confirming that the respondents understood the offer and the market value of the bundle, the representatives presented the women with the final offer and recorded the purchase decision.

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[1] If both spouses were not available during the first visit, representatives rescheduled visits at a time to meet with them both.

[2] Respondents were offered the bundles at prices of 1000, 3000, 5000, 7000, 9000, and 11000 meticais. We dropped the 1000 and 11000 meticais prices (96% and 54% subsidy offers) after the first community due to limited acceptance variation at these prices, randomizing subsequent communities across the remaining four price/subsidy levels.

3.2 Data Sources

We rely on three main data sources for this study. First, prior to randomization, we administered a short baseline survey to all women in the sample and their spouses. We use this data to verify balance across treatment groups and conduct analysis of heterogeneity in treatment effects. Second, we draw on administrative land-registration data collected by the land titling service provider to confirm take-up of the land registration intervention. Third, we draw on administrative bundle subsidy acceptance data to confirm which households chose to purchase the bundle.

The baseline survey confirmed program eligibility and also collected detailed demographic and agricultural data from the women and, if married, their spouses. The final sample is spread across 5 sub-regions of Molumbo District. Before randomization, we used baseline plot roster data to identify each household's largest plot, which would be eligible to receive the land-use title conditional on including the household's head woman on the title.[3]

Attrition between the baseline and bundle-offer components is low: 91% of the baseline sample were tracked for the willingness-to-pay experiment and attrition is uncorrelated with treatment.

4 Results

4.1 Econometric Framework

Our goal is to test the impact of land registration, price subsidies, and their interaction on the willingness to pay for agricultural inputs. To do this, we estimate the following OLS specification:

$$\text{Purchase}_i = \alpha + \beta \text{Land}_i + \gamma \text{Subsidy}_i + \delta(\text{Land}_i \times \text{Subsidy}_i) + \lambda_{is} + \varepsilon_i, \qquad (1)$$

where Purchase_i is a dummy equal to one if participant i choses to purchase the input bundle; Land_i is a dummy equal to one if the participant was offered land registration assistance; and $\text{Subsidy}_i \in \{1, ..., 6\}$ is the magnitude of the subsidy offered to the participant, in units of 2,000 MZN. Both the Land_i and Subsidy_i treatment variables are de-meaned, so that the coefficients β and γ can be interpreted as average treatment effects. The coefficient γ in turn identifies the interaction effect between the two treatments. λ_{is} are randomization strata (i.e. lead-farmer) fixed effects. Standard errors are corrected for heteroscedasticity throughout.

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[3]In the event that the household had several plots of equal size, the plot closest to the household was eligible to receive the land-use title.

4.2 Baseline Characteristics and Balance Tests

Table 1 shows baseline characteristics of participant couples (in Column 1) and tests for balance across treatment groups (in Columns 2-4). The average woman (husband) is 35 (42) years old and has finished 2.5 (3.8) years of schooling. The mean household size is 5.8 persons, and 27% of couples reported their household experienced food insecurity in the past twelve months. About 30% of the couples fear losing their land if they were to leave it fallow, and 62% of the women privately reported to fear loosing the right to use the land in case of divorce or husband's death.

To test for balance across treatments we use specification (1) replacing the outcome variable with each of these nine characteristics. We estimate the system of nine equations jointly using seemingly unrelated regression (SUR). We cannot reject the null hypothesis that these observables are jointly orthogonal to the land registration treatment dummy ($p = 0.20$), the price subsidy level ($p = 0.50$), and their interaction ($p = 0.74$). Couples assigned to the land registration treatment have significantly higher levels of education, but our results are robust to controlling for all these covariates.

4.3 Take Up of (Joint) Land Registration

Demand for land registration was overwhelming. Of the 225 women that were offered our land registration assistance, 205 (about 91%) accepted it. Column 1 of Table 2 shows that the baseline variables listed in Table 1 have very little predictive power for which women take-up the land registration intervention. We cannot reject the null hypothesis that these variables are jointly orthogonal to the acceptance decision ($p = 0.68$).

Conditional on taking up the land registration intervention, a majority (153 out of 205, i.e. about 75%) of women chose to register the land in both their own and their husbands' names, rather than in their own names alone. Column 2 of Table 2 shows that the likelihood of joint (rather than sole) registration is 17 percentage points lower if the woman inherited the land ($p = 0.02$), and 25 percentage points higher if the couple is concerned about loosing the land ($p < 0.01$).

4.4 Willingness to Pay for Agricultural Inputs

Overall, 232 out of 416 (about 56%) of the women in the sample chose to purchase the agricultural input bundle. Tables 2 presents the estimated impacts of the two treatments and their interaction on this purchase probability. We find no evidence that the land registration impacts the purchase probability on average: the coefficient on the land registration treatment dummy is close to zero and not statistically distinguishable from

zero ($p = 0.86$).[4] In contrast, we find highly significant evidence that subsidies affect the purchase probability: on average each additional 2,000 MZN subsidy increases probability of purchase by 10.7 percentage points ($p < 0.01$). At the bottom of the table we report the p-value of the test for equality between the two treatment effects: we can reject they are equal ($p = 0.04$). Finally, we find no evidence of an interaction effect between the two treatments: the coefficient on the interaction term is close to zero and statistically insignificant ($p = 0.87$).[5]

4.5 Mechanisms

Having found no evidence that the land registration treatment changes the purchase probability on average (and across price subsidies), we conclude the analysis by exploring the heterogeneity of this treatment effect to provide some insights into the null result. To do so, we add interactions between the land registration treatment variable and a particular baseline covariate to equation (1), along with controlling for the baseline value of the covariate. The results are presented in Table 4.

If the mechanism through which land registration increases investment is by improving the security of tenure of the household, as predicted by economic theory, then we should see stronger willingness-to-pay impacts for couples who felt insecure at baseline. Recall that at baseline about 23% of the couples feared losing the land if left fallow. Column 1 of Table 4, however, shows that there is no significant heterogeneity with respect to this variable. In fact, the coefficient indicates that that those who felt insecure before appear to be less likely to purchase in response to the land registration treatment – the opposite sign to what the security-of-tenure theory would predict.

Columns 2 and 3 of Table 4 examines heterogeneity with respect to the intrahousehold distribution of land rights. Our offer of assistance for land registration was made conditional on the land being registered in the woman's name, either alone or jointly with the husband. In a standard model of intrahousehold bargaining where property rights shape spouses' disagreement payoffs, this conditionality may have shifted the balance of power in favor of the woman. This increased bargaining power results in a higher share of the return on household investments for the woman and hence better incentive to purchase the inputs.

This empowerment effect predicts that women with a weaker 'outside option' at baseline should be more responsive to the intervention. Yet we see no heterogeneity with respect to whether the wife fears losing the land in case of divorce or the husband's death. Somewhat

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[4]We note however that the 95 percent confidence interval is somewhat wide, only ruling out a greater than 9.2 percentage point increase in the purchase probability.

[5]These three coefficient estimates and their standard errors are qualitatively identical if we use the Probit estimator (see Table A1).

surprisingly we find evidence that the land registration treatment had a larger impact if the women inherited the land: this variable raises the treatment effect on the purchase probability by 25.6 percentage points ($p = 0.03$). This contradicts the empowerment theory prediction. However, recall that the likelihood of joint registration was significantly lower if the women inherited the land. Hence, it is possible that greater ownership of the land (vis-a-vis their husbands) prior registration may have enabled women to keep their husbands' names out of the titles, allowing them to experience the security of tenure effect.

5 Conclusion

This paper presents evidence from a field experiment in Mozambique testing two interventions targeted to women farmers – price subsidies and land registration – designed to increase demand for agricultural inputs. The price subsidies aimed at alleviating liquidity constraints. The land registration aimed at improving tenure security. The two interventions were cross-randomized, allowing us to test the impact of price subsidies on the effectiveness of land registration. We find that land registration has no impact on demand, regardless of the subsidy level. In contrast, subsidies directly increase demand. At face value, these findings suggest that liquidity, rather than tenure insecurity, is the main binding constraint undermining women farmers' investment incentives.
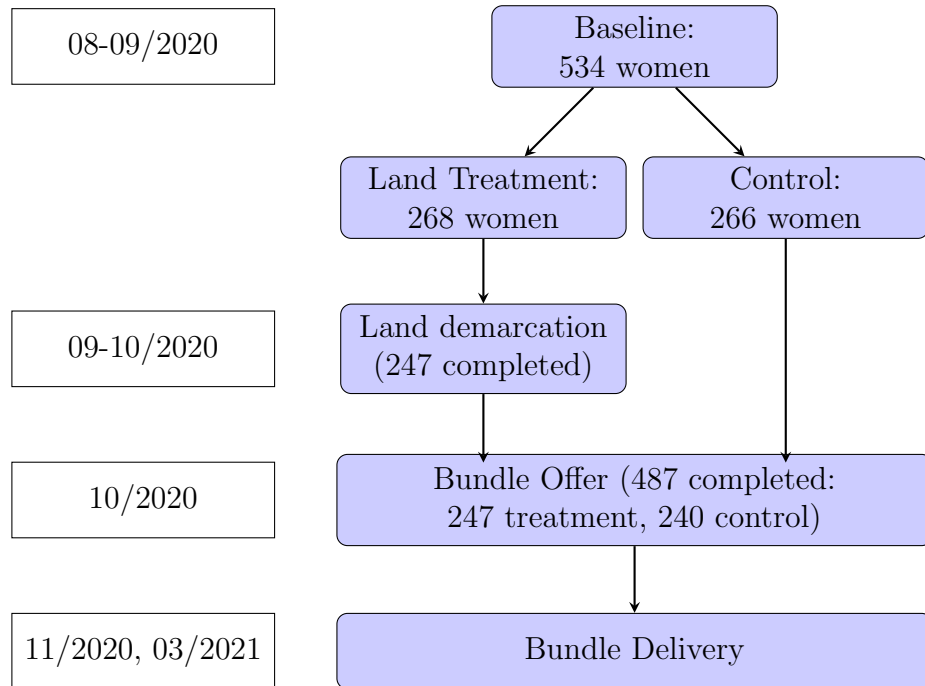
There are several possible explanations - other than liquidity constraints – for why land registration did not translate into higher demand for agricultural inputs. The most obvious is the short time frame of our experiment. Elicitation of willingness to pay for the inputs took place on average a month after our offer of assistance for land registration, when the title certificates had not been issued yet. Farmers may need additional time to update their perceptions of tenure security and readjust their investment decisions.

It is also possible that land registration affected other types of agricultural investments not captured in our agricultural input bundle, such as the uptake of soil conservation measures or the fallowing of land (Ali et al., 2014; Goldstein et al., 2018). Or perhaps land registration encouraged farmers to instead invest in non-farm activities, such as migration or small-scale enterprises (Valsecchi, 2014; De Janvry et al., 2015; Agyei-Holmes et al., 2022). Alternatively, it could simply be that the underlying informal tenure system already provides the security of tenure needed to encourage agricultural investment.

In order to distinguish between these different explanations, the next stage of this study will estimate longer term impacts of the land registration intervention on farmers' perceptions of tenure security, as well as on a wide range of both farm and non-farm outcomes. We will do so using data from two rounds of follow-up surveys, conducted approximately one and two years after this willingness-to-pay experiment.

Tables and Figures

Figure 1: Study design and timeline

08-09/2020	Baseline: 534 women
	Land Treatment: 268 women / Control: 266 women
09-10/2020	Land demarcation (247 completed)
10/2020	Bundle Offer (487 completed: 247 treatment, 240 control)
11/2020, 03/2021	Bundle Delivery

Table 1: Baseline Characteristics and Balance Tests

| | | Balance: OLS Coefficient Estimates | | |
	Sample mean (1)	Registration (2)	Subsidy (3)	Registration x Subsidy (4)
Wife's age	34.8	-.984 (1.11)	-.395 (.462)	-1.15 (.971)
Wife's years of schooling	2.45	.526** (.228)	-.082 (.101)	.037 (.211)
Husband's age	41.5	-1.13 (.128)	.272 (.542)	-1.67 (1.12)
Husband's years of schooling	3.81	.717*** (.265)	.108 (.112)	.143 (.237)
Household size	5.89	-.131 (.203)	-.010 (.082)	.075 (.166)
Household experienced hunger last year	.272	-.033 (.042)	-.013 (.019)	.027 (.038)
Plot obtained from wife's family	.301	.004 (.042)	-.004 (.018)	.021 (.037)
Couple fears losing plot if left fallow	.233	-.021 (.041)	.016 (.017)	.043 (.036)
Wife fears losing plot in case of divorce or husband's death	.617	-.044 (.046)	.028 (.021)	.022 (.042)
Joint orthogonality p-value		[.196]	[.504]	[.742]

Notes: Sample is all married women (N = 459). Robust standard errors in parentheses. *, **, and *** denote significance at 10, 5, and 1 percent levels respectively.

Table 2: Correlates of Take-Up of Land Registration and Co-Titling

	Accepted land registration assistance (1)	Added husband's name to land registration certificate (2)
Wife's age	.004 (.005)	.009 (.007)
Wife's years of schooling	.003 (.012)	.014 (.015)
Husband's age	-.005 (.005)	-.012* (.006)
Husband's years of schooling	-.016* (.009)	.001 (.013)
Household size	.008 (.010)	.009 (.017)
Household experienced hunger last year	.008 (.010)	.014 (.082)
Plot obtained from wife's family	-.019 (.048)	-.171** (.075)
Couple fears losing plot if left fallow	-.014 (.056)	.215*** (.009)
Wife fears losing plot in case of divorce or husband's death	-.000 (.048)	.055 (.069)
Joint significance *p*-value	[.683]	[.049]
Sample mean	.911	.746

Notes: Sample in Column 1 is all married women that were offered our land registration assistance (N = 225). Sample in Column 2 is all married women that were offered our land registration assistance *and* accepted it (N = 206). Both specifications include randomization strata (i.e. lead-farmer) fixed effects. Robust standard errors reported in parentheses. *, **, and *** denote significance at 10, 5, and 1 percent levels respectively.

Table 3: Impacts on WTP for Agricultural Inputs Bundle

	Sample mean (1)	Impacts: OLS Coefficient Estimates		
		Registration (2)	Subsidy (3)	Registration x Subsidy (4)
Purchases bundle	.558	-.000 (.048)	.113*** (.020)	-.005 (.040)

Notes: Sample is all married women (N = 459). Registration and Subsidy are both de-meaned, so their coefficients can be interpreted as average effects. The specification includes randomization strata (i.e. lead-farmer) fixed effects. Robust standard errors reported in parentheses. *, **, and *** denote significance at 10, 5, and 1 percent levels respectively.

Table 4: Heterogeneity in Impacts of Land Registration on WTP for Agricultural Inputs Bundle

	(1)	(2)	(3)
Registration	.035	-.032	-.071
	(.055)	(.080)	(.055)
Interaction with:	*Couple fears losing plot if left fallow*	*Wife fears losing plot in case of divorce or husband's death*	*Plot obtained from wife's family*
Registration x Interaction	-.146	.051	.237**
	(.122)	(.103)	(.111)

Notes: Sample is all married women (N = 459). Each column shows the treatment impact of being offered land registration assistance and its interaction with a specified baseline covariate. All specifications include randomization strata (i.e. lead-farmer) fixed effects. Robust standard errors reported in parentheses. *, **, and *** denote significance at 10, 5, and 1 percent levels respectively.