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**Promoting Adoption of Sustainable Land Management Technologies by
Women and Couples in Ethiopia**

Evidence from a Randomized Trial

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Abstract

Sustainable land management (SLM) technologies including composting and agro-forestry are widely promoted as strategies to counter land degradation and enhance resilience against adverse weather shocks. Given that women are disproportionately vulnerable to such shocks, promoting their uptake of these technologies may be particularly important. We conducted a randomized trial in rural Ethiopia analyzing a bundled intervention providing training and inputs designed to encourage uptake of three interrelated SLM technologies: fruit tree planting, composting, and home gardening. The trial included 1900 extremely poor households in 95 subdistricts, randomly assigned to treatment arms in which women only or couples were included in the intervention. The findings one year post-baseline suggest a positive and large effect on take-up of all three technologies: the probability of reporting any trees increased by eight percentage points, and the probability of reporting a garden and/or composting increased by 20 to 30 percentage points, symmetrically across treatment arms. There are also significant reported increases in household vegetable production and consumption as well as in women's dietary diversity. There is, however, some evidence that tree survival rates and tree health are weakly lower in intervention households compared to control households who spontaneously planted trees. Some positive effects on equitable intrahousehold decision-making and task-sharing are observed, especially in the couples' training arm, but in general there is no robust evidence that either intervention significantly shifted intrahousehold gender dynamics.

Keywords: Land management, gender, climate change, social protection, Ethiopia

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1 Introduction

Sustainable land management (SLM) technologies including composting, agroforestry, and intercropping are widely promoted as strategies for households in low- and middle-income countries to enhance resilience vis-a-vis adverse climatic and environmental conditions by improving soil fertility and water retention, reducing erosion, and storing additional carbon in the soil (Branca et al., 2013). However, the returns to these technologies may be hard for households to estimate *ex ante*, and even if there are positive returns, they may be observed primarily in the long-run and possibly with substantial externalities, suggesting a significant risk of under-adoption (Jack, 2013a; Beaman et al., 2021). Moreover, despite growing evidence that women may be particularly vulnerable to the adverse effects of climate shocks, women’s adoption of such strategies is often observed to be limited due to reduced labor availability, constrained access to required inputs, informational barriers, and restrictive social norms (Peterman et al., 2014; Ngigi et al., 2017; Jost et al., 2016; Ahmed and Kiester, 2021).

In Ethiopia, as in sub-Saharan Africa more generally, widespread adoption of SLM practices is perceived as crucial for reducing or reversing land degradation and increasing agricultural productivity (Sanz et al., 2017; FAO, 2019). However, take-up of SLM technologies remains low (Teklewold et al., 2013). A number of previous interventions have focused on planting trees on communal land as part of land restoration or watershed protection efforts, but little is known about their effectiveness (Fikreyesus et al., 2022). More broadly, the experimental literature analyzing strategies to encourage take-up of SLM-related technologies in low- and middle-income countries remains limited (Haregeweyn et al., 2023), and high-quality evidence on the household-level benefits from SLM technologies is likewise thin (Pretty et al., 2018).

In this paper, we report on a randomized controlled trial assessing a bundled intervention providing training and inputs (tree seedlings, vegetable seeds and tools) in order to encourage extremely poor rural Ethiopian households to adopt three complementary SLM practices: tree planting, composting, and home gardening. In addition, given some previous evidence and substantial policy debate around women’s greater vulnerability to weather shocks and more limited uptake of adaptation strategies (Ngigi et al., 2017), we experiment with two methods of targeting. In the first arm, only women were invited to training; in the second arm, both spouses were invited, and training included an explicit household planning exercise to explore whether joint engagement in optimizing labor and

time allocation would be more effective in encouraging take-up.

Our sample includes 1,900 households in 95 sub-districts (*kebeles*) in Amhara and Oromia regions, Ethiopia; the sample households all take part in Ethiopia's main social safety net program (the Productive Safety Net Program or PSNP) and thus are characterized by high levels of poverty and vulnerability to shocks, and all include a cohabiting couple. Randomization was conducted at the sub-district level; clusters were assigned to the control arm or to receive the bundled intervention targeting either women or couples. Households were surveyed at baseline in 2023, followed immediately by the roll-out of the intervention providing a multi-day training around SLM in conjunction with four to six tree seedlings, vegetable seeds and tools; the follow-up survey was then conducted one year post-baseline, collecting data on knowledge and perceptions of sustainable land management and climate change, adoption of SLM practices, and intrahousehold decision-making. The outcomes of interest were specified at baseline. Primary outcomes include adoption of the target technologies along the extensive margin (that is, whether households adopted them or failed to adopt) and female engagement in SLM tasks; secondary outcomes include adoption along the intensive margin (that is, continuous measures of intensity of adoption), climate change perceptions, intrahousehold decision-making, and dietary diversity (as it is linked to garden production).

Our findings suggest that the intervention was effective in encouraging meaningful take-up of SLM technologies, and these effects were largely consistent across the two treatment arms. Focusing on the prespecified primary outcomes linked to SLM adoption, households show a seven to nine percentage point increase in the probability of reporting any trees (relative to 79% in the control arm), a 32–34 percentage point increase in the probability of reporting any trees under one year (relative to 35%), a 17–20 percentage point increase in the probability of reporting any production of compost over the past year (relative to 56% in the control arm), and a 33 percentage point increase in the probability of a home garden (relative to 58% in the control arm). There is also a minor significant increase in female engagement in SLM tasks (as reported by both men and women) in the couples' arm.

When examining intensive margins of adoption, prespecified as secondary outcomes, we see that households in the treatment arm do not show a significant increase in the total stock of trees (this stock is relatively high even in the control arm, at an average of 42 trees), but do show a very large increase in the number of fruit trees (increasing by more

than a factor of four, from a base of only .6 in the control arm).¹ There are substantial increases in the amount of compost applied to crops over the past year as well as the value of production and consumption from home gardens; the latter also leads to a meaningful increase in women's dietary diversity (around 30% relative to the mean).

Focusing on the intensive margin only, there is some evidence that tree survival and tree quality (as measured by sapling height and enumerator-observed sapling health) is somewhat lower among households in the two treatment arms. These gaps are observed both unconditional and conditional on tree species and the total number planted. However, the amount of compost applied, compost quality, and the value of vegetable production and consumption (conditional on adoption of composting or gardening) are consistent when comparing adopting households in the treatment and control arms. Again, there is little evidence of differential effects across arms with the slight exception of some larger treatment effects in the couples' arm for composting variables. When we probe further channels for the decline in tree quality and survival rates – consistent with some positive selection into tree planting in the control arm – we can document that reported investment in tree maintenance (particularly watering) is in fact significantly higher for treatment households, but households in the control arm that self-select into planting trees do seem to be characterized by much better access to irrigation, and this gap could be consistent with the observed pattern of quality differences.

We also observe small increases in SLM knowledge and some positive shifts in self-reported efficacy around use of SLM practices in both women and men. These effects are symmetric across arms, meaning that men seem to show shifts in knowledge and behavior that are as large when they are not directly exposed to the intervention as when they are directly participating. That being said, the increase in knowledge is not large: on average, respondents in control communities provide correct responses to 40% of questions asked, and this increases by three percentage points in the treatment arms. There are no shifts in overall decision-making patterns, but both men and women report that they are more likely to be engaged in SLM-related decisions (driven by the increase in the reported probability of joint decision-making).

Overall, we interpret these findings as promising evidence that a relatively simple bundled intervention providing knowledge and inputs can encourage meaningful take-up of sustainable land management practices with significant short-term benefits (in terms

¹Households with large tree stocks are generally planting khat, coffee, or eucalyptus trees as cash crops.

of dietary diversity) and some potential for longer-term benefits from trees conditional on their survival to maturity.² Though there is some weak evidence of lower tree survival and health among treatment households, the fruit tree stock nonetheless quadruples even when taking into account slightly differential survival rates. That being said, the evidence here suggests very limited evidence of meaningful gender dynamics: different gender targeting strategies do not shift adoption outcomes, and the intervention itself does not meaningfully shift intrahousehold decision-making or task-sharing, although there are some effects along SLM-specific dimensions.

This paper contributes to several interrelated literatures. First, there is limited, but growing evidence around interventions designed to increase uptake of sustainable land management or climate-adaptive agricultural technologies. In Niger, providing training in constructing demilunes, designed to reduce soil degradation, had large positive effects on adoption as well as agricultural output (Aker and Jack, 2023). In Burkina Faso, Adjognon et al. (2022) show that a cascade training program complemented by financial incentives increased uptake of SLM practices and yielded higher crop productivity and agricultural income within a year. In Indonesia, provision of information and subsidized tree seedlings resulted in more trees planted than providing information only (Brenneis et al., 2023). In Malawi, an auction mechanism providing payments for tree maintenance was effective in increasing tree survival (Jack, 2013b).

We also contribute to a literature exploring gendered patterns of adoption of SLM practices (Perez et al., 2015), where the papers are largely descriptive. In general, women use soil and water conservation practices as well as agroforestry at lower rates than men, primarily due to their limited access to labor and inputs (Jost et al., 2016), poor knowledge about land rights (Quisumbing and Kumar, 2014a), and limited access to agricultural extension services (Tsige et al., 2020). In Ethiopia, a program that established watersheds promoting SLM practices – including soil and water conservation, mulching and manuring – was observed to significantly increase adoption of SLM practices, but only on male-owned and jointly-owned plots as compared to female-owned plots (Kato et al., 2021, 2022). Households in which land is managed by women are also more negatively affected by weather shocks in Malawi, a pattern that may reflect women’s relatively weaker land tenure and inability to make investments in soil and water conservation (Asfaw and Maggio,

²There is some, but limited evidence, that mortality rates for saplings may be highest in the first 12 to 18 months, suggesting a high probability of continued survival conditional on survival to 18 months (Dupraz et al., 2019).

2018). Conversely, there is some evidence that women may have a heightened awareness of climate risks vis-a-vis men (Ngigi et al., 2017), and that a higher risk perception may be associated with a higher probability of adopting conservation strategies (Ginbo and Hansson, 2023).

In comparing the effectiveness of providing training to women only versus couples, we also contribute to a broader recent literature evaluating information provision and training targeted at different household members. In an experiment conducted in Uganda, Lecoutere et al. (2023) conclude that targeting a female co-head alone with agricultural extension services (as opposed to jointly targeting both co-heads) is the most effective strategy to increase women's knowledge, role in agricultural decision-making, and subsequent adoption of recommended practices. However, joint participation of co-heads in extension was found to be more effective in encouraging adoption of soil fertility management practices (vis-à-vis participation by the male or female spouse alone) in the Democratic Republic of Congo (Lambrecht et al., 2016). Evidence from Ethiopia suggests that targeting women directly with an intervention encompassing agricultural training and a financial transfer has no effect on women's adoption of new agricultural technologies (Bedi et al., 2023); targeting men only increases take-up by both men and women, and targeting both spouses increases take-up only by men. In Cote d'Ivoire, including both spouses in a training around rubber production led to significant increases in income when compared to a training including men only (Donald et al., 2022).

2 Evaluation design

2.1 Study context

With more than 85% of land estimated to be affected by moderate or severe land degradation, Ethiopia is the sub-Saharan African country most affected by this phenomenon, and its cost is estimated to be 3.8% of GDP on croplands alone (Gebreselassie et al., 2016; Abera et al., 2020). The most common form of degradation, soil erosion, is driven by overgrazing, removal of forest and vegetative cover, and the use of marginal and steeply sloped lands (Wassie, 2020; Gebreselassie et al., 2016). Massive efforts by the government of Ethiopia and external donors to reverse environmental degradation through sustainable land management strategies – such as the Sustainable Land Management Program between 2008 to 2018 encompassing land management and restoration related public works and large-scale

government-sponsored tree planting (Abera et al., 2020) – have led to some increases in forest and vegetative cover on public land (Hirvonen et al., 2022; Constenla-Villoslada et al., 2022). However, large-scale private adoption of these technologies, and associated reversal of degradation on private land, has not been observed (Kassie et al., 2010; Haregeweyn et al., 2023).

The existing evidence around the benefits of adoption of sustainable land management practices by private households in Ethiopia is drawn from non-experimental studies. Use of compost has been shown to be more profitable than chemical fertilizer (Kassie et al., 2009), and the planting of trees on households' farmland was associated with higher income and consumption levels (Miller et al., 2017); however, in both studies adoption by female-headed households was lower. Evidence from both Ethiopia and Uganda suggests that limited knowledge of land rights significantly affects adaptation of natural resource management practices such as soil conservation and planting of tree crops, and that women's lack of knowledge in particular is a significant barrier to adoption (Meinzen-Dick et al., 2019; Quisumbing and Kumar, 2014a,b; Deininger et al., 2008). This is consistent with a broader literature noting that women are less likely to use a range of adoption strategies, including sustainable land management or conservation strategies, in the face of intensifying climate change in Ethiopia (Conway and Schipper, 2011).

Formative work conducted prior to this trial found that interest in SLM practices has been growing in the study area among both men and women, but important constraints to adoption remain. PSNP households are often engaged in sustainable land management projects on public land as part of their public works obligation, and may then transfer skills and practices to use on their own privately managed land (or, in some cases, use of those practices on private land may qualify as part of their required labor obligation). However, access to inputs and especially fruit tree seedlings is low, information access is not universal, and labor availability is a challenge, especially for practices like compost making (Tefera et al., 2024).

2.2 Sample and randomization

The study is a cluster-randomized controlled trial including 95 kebeles (sub-districts) in 16 woredas (districts) sampled from the geographic area served by SPIR II in Amhara and Oromia Regions in Ethiopia. SPIR II (Strengthen PSNP Institutions and Resilience II) is a multifaceted intervention that supports the implementation of the PSNP, and provides

complementary programming to participating households. The PSNP itself is one of the largest social safety nets in sub-Saharan Africa, providing food or cash transfers targeted to poor households in the form of payments for seasonal labor on public works, or as direct support to households with limited labor availability; it has been shown to reduce household food insecurity and increase asset holdings (Berhane et al., 2014; Hoddinott et al., 2012). SPIR II is funded by USAID’s Bureau for Humanitarian Assistance (BHA) and led by World Vision, in collaboration with the Government of Ethiopia and in partnership with ORDA Ethiopia and CARE.

The clusters in the trial were selected from the broader pool of SPIR II communities, prioritizing kebeles that had not previously been included in any other large-scale impact evaluations as well as those characterized by generally suitable agroclimatic conditions for agroforestry, particularly with respect to the availability of water. Following the identification of the study kebeles, the evaluation sampled 1,900 households (20 per cluster) based on the following criteria: households were required to be current participants of the PSNP, include a cohabiting couple of prime working age, and have use rights over, or lease in, land.³ (Formally, there is no private ownership of land in rural Ethiopia, but land certification bestows a perpetual use right over land – albeit, without the rights to sell or mortgage land (Adamie, 2021).)

The sample was constructed by randomly ordering the sample frame of PSNP beneficiary households in study kebeles and then screening in order; if a household was deemed to fit all pre-specified criteria, it entered the sample, the baseline survey was conducted, and (in treatment communities) the household was subsequently invited to participate in the training and receive inputs. Randomization was conducted prior to the baseline survey, randomizing clusters into three arms (women only SLM intervention, couples’ SLM, and the control arm), stratified by woreda and by a binary variable equal to one if the cluster had been previously included in another SPIR II trial.

2.3 Intervention

The main intervention was a training that lasted three days in the women’s arm and four days in the couples’ arm, and that provided an overview of three main sustainable land management practices: tree planting, composting, and establishing a home garden.

³Prime working age was defined as age 18–60 for either member of the household, the eligible age range for participation in PSNP public works. In addition, households previously included in any other randomized controlled trials conducted by the SPIR research team were ineligible.

First, the training covered timely pit preparation, correct tree planting, maintenance, and long-term benefits of locally adapted fruit trees and other multi-purpose trees. Second, it provided an overview of composting practices: collecting green grasses, brown matter, animal manure, and other inputs for composting, preparing a compost pile and maintaining it, and applying the compost to planted trees and vegetables once ready. Third, the training outlined how to establish and maintain a vegetable garden following intercropping principles. The curriculum was based on an extension strategy that is built on a farmer field school approach and developed by the Ethiopian government.

The trainings were rolled out at existing kebele-level farmer training centers or model farmer demonstration sites. SPIR staff contacted all sample households in treatment clusters to provide an invitation to the training. However, in the women's only arm, male members of the household could not substitute for the target woman. Roughly four weeks post-training, at a point when participants had prepared their planting sites, SPIR implementation organizations delivered them tree seedlings that were raised at SPIR supported government nurseries. Each treatment household received four to six seedlings with some limited choice over the type of tree based on local availability. The tree types distributed were primarily avocado (44% of all seedlings distributed), mango (27%) and papaya (24%), with some limited distribution of apple and coffee trees (both 3%) in clusters of Amhara. Apple was generally the preferred tree type in colder, higher-elevation areas, but since the implementing partners encountered shortages of its seedlings, coffee was distributed as the alternative.

In addition to tree seedlings, all households in women's and couples' arms received vegetable seeds and gardening tools. The primary vegetable types received were carrot (33% of all seeds distributed), Swiss chard (29%) and beetroot (28%), but households also received some Ethiopian kale, lettuce, onion, cabbage and peppers seeds, for a total of 70 seeds on average. For tools, everyone received a shovel, a three finger hoe, and a watering can.

In the treatment arm targeting couples (T2), the additional (fourth) day of training was primarily used to conduct a joint planning exercise that required the participating couples to jointly develop a workplan for tree maintenance, composting and home gardening over the next six to twelve months, and to devise the associated labor allocation. The participants were provided with a planning worksheet including a depiction of all the required phases of work associated with adoption of each SLM technology, allowing participants to indicate who would lead in each phase, or if they would execute a particular

phase jointly. (An image of the planning card is provided in Figure A1.) The participants then participated in a brief planning exercise led by the facilitator and had an opportunity to jointly fill out their plan. In the women only arm (T1), participants also received a simpler card that provided the list of tasks required to implement the SLM practices of interest, ensuring that participants in both treatment arms had access to the same information. However, the card provided in T1 had no columns for assigning tasks, and no planning exercise was conducted.

2.4 Data collection

The baseline survey was conducted in May and June 2023 (approximately one month prior to the rollout of training) and the follow-up survey was conducted twelve months post-baseline, in June 2024. At baseline, only the female respondent was surveyed; topics included knowledge and perceptions of climate risk and SLM practices, current use of SLM practices, agricultural land, household food security, and assets; the female respondent also participated in incentivized games to assess time and risk preferences, and both spouses were invited to participate in incentivized games measuring intrahousehold cooperation. More details about both experimental games are provided in Appendix Section A1. At endline, both the female and male respondents were surveyed on broadly the same set of topics: in particular, both male and female respondents answered questions around use of SLM practices, knowledge and perceptions, intrahousehold decision-making, and task allocation.

2.5 Outcomes of interest

The outcomes of interest were specified in a pre-analysis plan registered at baseline. The primary outcomes include adoption of the three target technologies (tree planting, gardening, and composting) and female engagement in SLM-related tasks. Secondary outcomes include tree health, intensity of adoption of compost and home gardening (the amount produced and compost quality), intrahousehold decision-making (both in general and with respect to sustainable land management), women's dietary diversity, sustainable land management knowledge, and perceptions around climate risk and agency to manage these risks. We also pre-specified an analysis of heterogeneity along several key dimensions including baseline risk and time preferences, intrahousehold cooperation, and baseline perceived climate risk.

2.6 Sample characteristics and baseline balance

Characteristics of the sample at baseline in conjunction with baseline balance tests are reported in Table 1. The characteristics of this sample are consistent with other data around PSNP households: households are concentrated in subsistence agriculture (more than 90% report that male's primary occupation is crop cultivation), characterized by remote locations (on average more than 70 minutes from the closest market), and very low levels of human capital (a majority of both men and women report no education). Virtually all households report ownership of land in the sense of use rights granted by the state.⁴ The primary asset type is livestock, and the typical household owns around one tropical livestock unit (a tropical livestock unit is a harmonized unit of livestock measurement; one cow is equivalent to a TLU, with smaller livestock such as chickens, goats, and sheep constituting a fraction of a TLU.)⁵ Access to irrigation water on households' parcels is low, with less than a fifth having any access, and erosion is widespread: 77% reports that moderate or severe erosion is present on at least some of their land.

Perhaps because of this high level of erosion risk, baseline adoption of the target SLM practices is non-trivial: 70% of households own trees and report around 30 trees on average, though only five of these are young trees (planted within the last three years). Furthermore, only around 1.5 are fruit trees, with 29% of households reporting having any fruit trees.⁶ Around half of households report a home garden, and around a quarter report composting. The hypothesis that these characteristics are balanced at baseline cannot be rejected (p-value on a joint balance test equal to $p = 0.673$).⁷

⁴We did not collect more detailed data on possession of a land certificate, knowledge of land rights, or other related questions.

⁵The standard measure of a TLU is one cattle with a body weight of 250 kg (Jahnke and Jahnke, 1982). TLUs are expressed as ratios relative to this standard unit, where the ratios are based on metabolic weights. For example, six sheep have the same energy requirements as one cattle and therefore translate into one TLU (i.e., one sheep equals 0.13 TLU, while one chicken is 0.013 TLU).

⁶At baseline we did not conduct a full inventory of tree types, but households reporting large number of trees are generally cultivating coffee, khat, or eucalyptus as a cash crop, consistent with previous literature (Miller et al., 2017).

⁷This corresponds to the following procedure: we regress each covariate on binary variables for the two treatment arms and use seemingly unrelated regression to estimate the joint test $\beta_1 = \beta_2 = 0$, across all covariates of interest.

2.7 Program exposure

We can also explore patterns of program exposure as documented in the follow-up survey and summarized in Figure 1. In general, reported adherence to the treatment protocol and participation in the intervention is extremely high: more than 90% of women in both treatment arms report that they were invited to and attended the training, with some minimal (around 10%) reported contamination in the control arm. Women also self-reported attendance of their spouses and here we again observe quite high attendance of over 80% in the couples' arm T2 (though not quite as high as female attendance); there is also some reported contamination in the women's only arm where around 20% of women report their spouses attended. We subsequently cross-checked these reports in a phone survey administered to a subset of men and found that only 5% of men in the women's arm self-reported attendance at the full training, though another 30% reported that they assisted their wives in traveling to or returning from the training site and/or retrieving trees from the nursery (suggesting that women may have been referring to this role when they reported that their husbands joined them).⁸

Receipt of tree seedlings is around 80%, a pattern that primarily reflects lower receipt of trees in two districts in Amhara that were targeted for distribution of apple trees but experienced shortages of fruit seedlings; ultimately, only 10% of households in these two districts reported receiving trees, but in virtually all other districts, reported receipt of trees exceeds 90% among targeted households.⁹ Reported receipt of seeds and tools again exceeds 90%.

3 Empirical findings

Our primary specification follows the randomized design and estimates intent-to-treat effects using the following equation, where i denotes an individual or household, k denotes kebele (or subdistrict, the level of randomization) and s denotes strata. We estimate an ANCOVA model controlling for the baseline value of the dependent variable, when

⁸Due to an oversight, questions about program participation were not posed directly to men in the primary survey instrument, but the subsequent phone survey reached 84% of the targeted respondents (men in households that had reported a phone number in the main endline survey); the majority of non-response was due to phones being turned off.

⁹Moreover, in the two districts with low reported tree receipt, the trees that were distributed were predominantly smaller, multipurpose shrubs rather than apple or coffee trees. One other district in Amhara was able to deliver trees to around 70% of target households.

available (McKenzie, 2012).¹⁰

$$Y_{iks,t=1} = \beta_1 \text{Wom}_{ks} + \beta_2 \text{Coup}_{ks} + \gamma Y_{iks,t=0} + \chi_s + \epsilon_{iks} \quad (1)$$

Wom_{ks} and Coup_{ks} are binary variables equal to one if the kebele is randomly assigned to the women's or couples' SLM arm, respectively; we will also report a p-value corresponding to the hypothesis that $\beta_1 = \beta_2$. All specifications include fixed effects for strata (a combination of woredas and an indicator for the kebele's inclusion in other ongoing trials), χ_s , and standard errors are clustered at the subdistrict level. This specification as well as other elements of the analytical strategy were all prespecified in our analysis plan; we will note any deviations.

3.1 Adoption of sustainable land management technologies

The estimated treatment effects for the primary outcomes of interest are summarized in Panel A of Table 2; Panel A reports findings for binary variables capturing substitution along the extensive margin, and Panels B and C report continuous measures of adoption along the intensive margin that are unconditional and conditional on any non-zero adoption, respectively.¹¹ It is evident in Panel A that treatment households showed a significant increase in the probability of adopting all three targeted practices. Households assigned to treatment arms T1 and T2 are seven and nine percentage points more likely to have any trees, respectively (relative to the mean in the control arm of 79%), and 34 and 32 percentage points more likely to have any trees under the age of one year, relative to the mean in the control arm of 35%.¹²

For compost, enumerators' reports suggest a 11 percentage point increase in the probability of observing a compost heap in the couples' arm relative to the control mean of 29%, while there was no significant increase in an observed compost heap in the women's arm (the difference between the two arms is significant at 10 percent level). This is consistent with the hypothesis that compost making is labor intensive and women are thus

¹⁰In practice, only ten of the outcomes presented had an equivalent baseline value collected: household has any trees, household has a compost pile, household has a home garden, female participation in SLM tasks (reported by female), total tree count, women's dietary diversity, female SLM knowledge, female engagement in decision-making, share of tasks that female does alone, share of SLM tasks that female does alone.

¹¹We also report the estimated effects for a pooled treatment indicator in Table A11 in the Appendix for reference.

¹²This measure is defined with reference to trees planted in the past year and still alive at the time of the endline survey.

constrained in adopting the practice, rendering adoption more likely when both spouses are targeted. However, households in both arms are significantly more likely to self-report that they produced compost in the past 12 months: here, we observe consistent treatment effects across both arms (17 and 20 percentage points, relative to the control mean of 58%). There is also a substantial shift in the probability of a home garden, increasing by 32 and 33 percentage points in the women's and couples' arm, respectively, compared to the control mean of 58%.

Panel A also reports the final prespecified primary outcome of interest, female engagement in SLM tasks; this is defined as the percentage of all SLM-related tasks that the female takes part in, either solely or jointly, as reported by both spouses. Here, the couples' arm yielded a shift in about three to five percentage points in female engagement compared to the control arm, where women were engaged in a third of SLM tasks. By contrast, the women's only arm yielded only small and insignificant increases, though the difference between the two treatment effects is significant only for the male-reported index.

Next, we explore patterns for continuous measures of adoption in Panels B and C. While treatment households were significantly more likely to report any ownership of trees, the findings in Column (1) of Panel B suggest that we cannot reject the hypothesis of a null effect on the total number of trees.¹³ However, the number of fruit trees planted in the last year is significantly higher in both treatment arms and these effects are extremely large: the number of fruit trees planted increases by about four trees relative to a control mean of 0.7 trees.¹⁴ In Column (3), we analyze the amount of compost that households report producing and applying in the past year, and as previously observed, households in the couples' arm report producing more vis-a-vis households in the women's only arm, nearly doubling the production reported by control households; this difference is significant at the ten percent level. Both treatment effects are, however, quite large relative to the control arm, corresponding to a 50% to 86% increase in compost production.

¹³The total number of trees was measured noisily as illustrated by substantial, bidirectional discrepancies between baseline and endline counts, and driven by households who had large quantities of cash crop trees like khat and eucalyptus. Figure A2 presents two histograms capturing the total number of trees, excluding outliers within the top two and 10 percent, respectively: we can see some shifts across treatment arms at the bottom of the distribution, but a long right tail. Interestingly, T1 (the women's only arm) shows a clearer pattern of increased mass immediately above zero, whereas T2 (the couples' arm) seems to show slightly more mass between roughly 10 and 50 trees.

¹⁴Note that this captures trees planted, not all of which may be living; the variables in Column (1) and in Column (2) of Panel A, by contrast, captures trees living, and we will present further detail on differential patterns of tree survival in Table 4 below.

Panel B also reports treatment effects on the value of vegetables harvested in the past year and the value of vegetables consumed, expressed in 2023 nominal dollars. Both treatment arms show large, significant increases along both margins: there are increases of 44% in production and 71% in consumption in the women's arm, and in the couples' arm, 31% and 61%, respectively. (These differences between the two arms are not significant.) The observed increases in vegetable consumption also translate to sizable improvements in dietary diversity: the women's dietary diversity score (WDDS) increases by 0.25 points, interpreted as an increase of around 0.25 additional food groups consumed relative to a mean of three groups in the control arm; women are five to seven percentage points more likely to meet the minimum dietary diversity for women (MDD-W), respectively, a standard met by only 13% of the control arm.¹⁵ Since the fruit trees planted as part of the intervention are too young to produce fruit at follow-up, these effects are entirely driven by increases in consumption of garden produce, as also demonstrated by impacts on individual food groups reported in Table A6: the significant increases are observed for the consumption of green leafy vegetables (a 9–11 percentage point increase compared to a control mean of 14% of women consuming any), vitamin A rich vegetables (a 5–6 percentage point increase), and to a lesser extent nuts and seeds.

Panel C of Table 2 then reports the treatment effects on the intensive margin of adoption only, conditional on a non-zero value; this also allows us to assess additional effects on variables linked to quality of adoption, more specifically tree health and compost quality. We can observe in Columns (1) and (2), respectively, that the effects on number of trees and number of fruit trees remain consistently null and positive, respectively, when conditional on non-zero values. However, it is evident in Column (3) that fruit trees planted by treatment households are generally reported to be less healthy based on enumerators' qualitative assessment of tree health, although the difference is significant only in the women's arm (and narrowly insignificant in the couples' arm); the outcome variable is constructed as a general least squares weighted index, standardized with respect to the control group's mean and standard deviation.

For compost, by contrast, the increase in the amount of compost produced and applied remains positive and significant even conditional on non-zero values in the couples' treat-

¹⁵WDDS and MDD-W are standard survey-based measures for assessing the adequacy of women's diets (FAO and FANTA, 2016). WDDS is a count of food groups consumed in the previous 24 hours and ranges from zero to ten; MDD-W is a dichotomous indicator for at least five out of ten food groups having been consumed.

ment arm, while in the women's treatment arm the increase is insignificant conditional on applying any compost. The findings in Column (5) suggest there is no evidence of quality differences in compost comparing across treatment and control households, although the difference between the two treatment arms again suggests that households in the couples' arm perform slightly better in regard to compost making.¹⁶ Finally, for garden production, there is no treatment effect on the volume of vegetables produced or consumed conditional on non-zero production, as is evident in Columns (6) and (7); the large increases in the value of vegetable production and consumption previously discussed are in fact almost entirely by the higher probability of establishing a garden. Overall, for compost and gardening there is no evidence of any decline in intensity or quality of adoption for treatment households who adopt these practices compared to households in the control arm who spontaneously adopt them; but for tree planting, there is some evidence of declining tree health, a pattern that will be unpacked in further detail below.

3.2 Knowledge, perceptions and decision-making

We then present evidence around the experimental effects on knowledge, perceptions, and decision-making (reported for both men and women) in Table 3. All outcomes are transformed to a scale from zero to one and reported by both spouses with respect to their own knowledge and perceptions, with the exception of Columns (5) and (6): here, we analyze a variable capturing women's decision-making, but reported separately by both men and women. For knowledge around sustainable land management practices (scored as the percentage of eight questions answered correctly), we find marginal increases of around 2 to 3 percentage points across treatment arms and genders; interestingly, it appears that the treatment effect on men's SLM knowledge is of similar magnitude in the arm in which they were not directly targeted for training compared to the arm in which they attended. Knowledge in the control arm is not particularly high (less than 50% of questions answered correctly), but nonetheless, the treatment effects on knowledge seem to be weak.

Given that the SLM technologies of interest are expected to provide benefits in terms of enhanced household resilience vis-a-vis weather shocks over the longer term, both

¹⁶The compost quality index consisted of nine self-reported dimensions of compost making and was adapted from (Hörner et al., 2022). Respondents were asked about their compost production process (e.g. input mix, frequency of aerating the pile) and the characteristics of the final product (e.g. color, texture); the binary indicators corresponding to each item were aggregated into an index using a GLS weighting procedure and standardization with respect to the control arm.

men and women were also asked a series of questions about their perceptions of the consequences of climate change and whether they find climate change to be spatially and temporally relevant to their household. (The survey questions are provided in Tables A3 and A4 in the Appendix.) While the means in the control arm suggest that both men and women are highly aware of climate change (more than 75% report having noticed it) and express concern over the phenomenon (57% of women and 77% of men), we do not find any treatment effects on either women's or men's climate perceptions. (This may be unsurprising in that climate change and its impacts were not an explicit part of the training curriculum.)

We then posed a series of questions measuring women's and men's efficacy along two dimensions: self-efficacy, or the extent to which one feels they are able to perform certain actions – in this case activities such as compost making; and response efficacy, or the extent to which one feels like these actions are effective in producing a certain response – in this case an outcome like reduced erosion.¹⁷ We find increases of 3 to 5 percentage points in both women's self efficacy and response efficacy in both arms, but for men, the gains are slightly smaller and not universally significant. Finally, while there are no effects on women's participation in general household decision-making (Column 5), we do observe a three percentage point increase in the extent to which women participate in SLM decisions, as reported by both women and men, and across the two treatment arms. These effects, however, are observed with respect to the already very high level of female engagement (91%) in the control group.

Another potential risk of the intervention might be increasing women's work burden (particularly in the arm when women alone are targeted), and we assess some data informative of this risk in Table A5 in the Appendix. The treatment does generate an increase in the probability that women report working in the garden daily or regularly (around 10 percentage points), but these effects are not large relative to the mean in the control arm, and the reported duration of each period of garden work is only around 70 minutes.¹⁸ Women are no more likely to report that they engage in SLM tasks alone, though men are less likely to engage in tasks alone (suggestive that couples work jointly); the magnitude of these shifts is also small. Overall, while there is clearly some increase in work burden

¹⁷The survey instruments for these outcomes were adapted from Van Valkengoed et al. (2021a) and van Valkengoed et al. (2021b).

¹⁸Regularly is defined as a few times a week; conditional on reporting a garden, 73% of women in the control arm report regular engagement though daily garden work is very rare at 4%.

associated with the new productive activity, there is little evidence that this is large enough to have major welfare implications.

3.3 Tree quality and selection into adoption

As previously summarized, we find some evidence that young trees (under one year) are characterized by lower health in the treatment arm, as assessed by enumerators; to further investigate these differences, Table 4 reports on the disaggregated measures of tree health used to construct the tree health index. These include tree height (in centimeters), a binary variable equal to one if a tree is assessed to be in normal condition (as opposed to bent, stunted, etc.), a binary variable equal to one if the tree's leaves are assessed to be in healthy condition (as opposed to wilted, infested, etc.), and an aggregate measure of the previous three outcomes (Column 4). The latter is the same variable previously reported in Panel C of Table 2.

This information was assessed for all trees of the target species (avocado, papaya, mango, apple, and coffee) planted in the last 12 months; however, enumerators were not able to measure 22% of all planted trees that were reported to be more than 20 minute walking distance from the household's homestead, where the survey was conducted. (We will further explore any potential bias due to attrition along this dimension in section 3.6 below.) In Table 4, we report treatment effects for these disaggregated variables in three specifications: in Panel A, we estimate the regressions at the tree level; in Panel B, we add control variables for species; and in Panel C, we collapse to a household-level mean.

We can observe in Panels A and B that the effects on each component of tree health are consistently negative – though the effects are largest and most precise for the simple variable capturing whether the tree is in normal condition – and are also consistent (and in some cases larger in magnitude) conditional on species. Importantly, tree height – arguably the simplest and most objective measurement – is in fact significantly lower in T1 conditional on species (in general, there are no meaningful differences comparing across the treatment arms). The species composition of young trees within the target five species is in fact meaningfully different comparing across treatment and control, as is evident in Figure A3a in the Appendix: control households who choose to plant a tree predominantly plant coffee, suggesting their interest in a potentially high-return cash crop and the dominance of coffee in the area, while the trees provided by the intervention and thus planted by treatment households are primarily fruit. Given that coffee saplings

are generally shorter, estimating the height difference conditional on species widens the measured gap in quality across arms.

Panel C of Table 4 then reports the treatment effects at the level of the household, where in addition to tree health we can also assess the overall survival rate for any trees planted in the past 12 months (Column 5) and for any fruit trees planted in the last 12 months (Column 6).¹⁹ Here, the tree health measures on average point to even larger gaps between treatment and control, and moreover, we can observe significant negative effects on tree survival: in the control arm, 72 percent of all trees and 59 percent of fruit trees planted in the past year were alive at follow-up, and this probability decreases by around 10 percentage points in both treatment arms.²⁰ This translates to roughly 50 percent of all trees distributed by the program being alive a year post-intervention. [some reference to other studies here?]

To investigate whether the differences in tree health between treatment and control households are driven by different levels of investment in agroforestry, we can draw on additional self-reported data around investment in tree maintenance. As seen in Table 5, households in both treatment arms are about 20 percentage points more likely to have watered their trees weekly (compared to a control mean of 57 percent); they also show a significant increase in the probability of applying organic fertilizer to trees (15 percentage points). There is no evidence that treatment households reduce investment in tree care: on the contrary, they invest significantly more in watering and fertilizing young trees.

Given this analysis, we hypothesize that the differences in tree survival and tree health that we detect may be driven by a pattern of positive selection in the control arm. Households who spontaneously choose to plant trees may select into tree planting based on certain attributes: they may have more interest in trees, more experience or knowledge, or better access to relevant resources.²¹ To shed light on this channel, we estimate a model of

¹⁹Note the regression in Column (4) replicates the finding for tree health at the household level previously reported in Table 2.

²⁰The majority trees planted by households in the control arm were in fact planted on a similar timeline with the treatment households who received trees in July: 61% of all trees planted by the control group were planted in July, and another 27% in June or August. June to September corresponds to the main rainy season, *mehr*, in Ethiopia.

²¹To access fruit trees, households in the control arm generally either purchase saplings (33% of new planted fruit trees in the control arm are reported to be purchased) or access them from a friend or neighbor or another informal channel (around 22%), though around a third of newly planted trees are reported to be obtained from government/PSNP nurseries, the same nurseries that are the source of SPIR-distributed trees; this presumably corresponds to separate distributions of trees by PSNP staff. The source of trees for households in the control arm by species is summarized in Figure A3b, and there is some heterogeneity across species as

selection based on baseline characteristics.²² We estimate a simple regression in which the dependent variable is tree adoption and the independent variable are baseline characteristics of interest and baseline characteristics interacted with a treatment binary variable. To maximize power, we pool the two treatment arms.

The findings reported in Table 6 suggest that the observable variables examined are generally not strongly correlated with patterns of tree planting among control households, though households in Oromia, larger households, and households characterized by a more educated woman are more likely to plant fruit trees. (We do not assess whether variation in property rights predicts tree planting given that we have virtually no variation in reported use rights over land.)²³ Importantly, it also appears that households who have access to any type of irrigation²⁴ are 18 percentage points more likely to have planted any fruit trees, consistent with previous literature on water access and adoption of SLM in Ethiopia (Bekele et al., 2021); this relationship is only weakly evidence among treatment households. Given the magnitude of this correlation, one plausible interpretation is that this difference in irrigation access leads to better tree outcomes among control households, even conditional on less intensive watering activity. Phrased alternately, the more intensive watering that households in the treatment arm report may in fact be insufficient to fully compensate for reduced access to irrigation, leading to some gaps in tree survival and tree health (though still a meaningful increase in the stock of trees one year post-intervention).

3.4 Context on benefits

In assessing the welfare benefits of this intervention, it is important to note that many of the benefits (particularly of fruit tree production) will only be realized in the long-term. The benefits of home gardening in terms of enhanced production and consumption of vegetables have already been documented; another potential benefit in the short-term is reduced expenditure on inorganic fertilizer. Ethiopia that relies exclusively on imported fertilizers saw a threefold increase in fertilizer prices between 2019 and 2023 (Abay et al., 2024), which is likely a factor in the secular increase of 4 percentage points in the

well: coffee trees are particularly likely to be purchased, consistent with their status as a desirable cash crop.

²²This analysis was not prespecified.

²³We cannot rule out that there may be variation in property rights along dimensions that we unfortunately did not measure: i.e., possession of a land certificate, whether or not the female spouse's name is on the certificate, and knowledge around land rights. Given that we did not measure this variation, we cannot assess if it is predictive of tree planting behavior.

²⁴18% of study households had access to any irrigation at baseline.

control group's fertilizer adoption. The findings reported in Table 5 suggest a roughly six percentage point decline in the probability of using inorganic fertilizer (though only in the women's only treatment arm), although, when those who had produced compost were separately asked whether their use of inorganic fertilizer changed as a result, a third said they reduced their use and another third indicated they ceased to use it entirely (Figure A4). Data from a separate survey conducted also among PSNP households in the same regions in 2017 suggested that the average household who used any fertilizer reported spending 720 birr (around \$30) per the main agricultural season, roughly 120% of the monthly adult equivalent consumption at the time. There are thus some implied savings given reduced fertilizer use, but modest given that the decline is not large.

In the longer-term, fruit trees will mature and begin producing fruit (if healthy) in about two to four years depending on the species, and can be productive for decades. We can conduct back-of-the-envelope estimates for potential fruit tree revenue using market price data from the region (collected in 2021 and 2023) and available estimates for the average amount of fruit produced per tree.²⁵ These estimates suggest that average earnings per tree per year could be in the range of \$33 per tree (for papayas) up to \$108 per tree (for avocados), or roughly one to three times monthly per capita consumption among PSNP households. These estimates should plausibly be considered to be an upper bound as they do not take into account potential post-harvest losses, uncertainties in price and market dynamics, etc., although they are somewhat in line with the scarce existent literature: using LSMS data, Miller et al. (2017) finds that on-farm trees contribute 14% of total income of Ethiopian households who have them. These estimates also do not account for any costs of production; this would likely primarily be the opportunity costs of participants' time (see Section 3.3 for discussion on time use implications of the intervention).

²⁵For each tree type, we established the upper and lower bound of production per tree, and used the midpoint of the two in our calculations. The bounds were established as follows: for papaya, we used 30 fruits/tree/year as the lower bound following <https://regreeningafrika.org/project-updates/carica-papaya-a-tree-that-keeps-on-giving/> and 100 fruits/tree/year as the upper bound following https://www.wifss.ucdavis.edu/wp-content/uploads/2016/10/Papayas_PDF.pdf; for avocado, we established the upper bound as 150 kg/tree/year following Seifu et al. (2022) and the lower bound as 50 kg/tree/year following <https://iopscience.iop.org/article/10.1088/2515-7620/ac81a4/pdf>; for mango, we used the upper bound of 400 following Neguse et al. (2019) and a lower bound of half this number.

3.5 Heterogeneity

We also report a series of prespecified analyses of heterogeneous effects in Tables A7 through A10, assessing heterogeneity with respect to baseline time and risk preference (as reported by the female), baseline perceptions of climate change, and baseline intrahousehold cooperation as measured in a lab-in-the-field game conducted with both husband and wife. For concision, we focus on a subset of simple binary measures of SLM adoption. In general, there is little evidence of meaningful heterogeneity across these dimensions, and the coefficients estimated are small, variable in sign, and generally statistically insignificant.

3.6 Attrition

Attrition at endline in this trial was extremely low, at 2.1%. The primary reported reasons were the respondent being temporarily unavailable (46% of the attrited) and the household having moved (23%). Household level availability was determined by the primary female's availability; the primary male respondent was not available in 8% of households interviewed at endline. Table 3.6 reports the findings from an analysis in which a binary variable for attrition is regressed on a series of baseline characteristics interacted with the treatment variables of interest. There is some evidence of differential attrition, particularly in the women's arm, where households characterized by younger respondents and households reporting any irrigation are less likely to attrite; however, the magnitude of these differences is generally not large.

As documented above, enumerators were not able to measure 22% of all planted trees of the target species due to the trees being more than a 20 minute walking distance from the homestead; in total, 25% of households that had planted trees had at least one that was not measured. We then repeat the same analysis for this variable capturing attrition from tree measurement, and the results are reported in Table A2. Here, again there is some evidence of differential attrition from tree measurement particularly in the women's arm (and to some extent in the couples' arm): in particular, households in which the primary occupation is crop cultivation are more likely to have trees unmeasured (a relationship that is plausible, if their plots are distant), but this relationship is weaker in the treatment households. One interpretation is that enumerators, or respondents, were more motivated to visit distant plots and trees in households that were treated and thus planted more trees recently. Further analysis will explore any potential bias introduced by differential attrition

from tree measurement.

4 Conclusion

This paper provides new evidence around the effectiveness of a bundled intervention seeking to encourage household adoption of multiple sustainable land management practices among extremely poor households in rural Ethiopia. Targeted households received four to six tree seedlings in conjunction with gardening inputs and were invited to a three to four day training providing information about appropriate implementation of sustainable land management practices; in one arm, women only were invited, and in the second arm, both spouses.

We find that one year post-treatment, there is robust evidence of active adoption of the targeted practices and little evidence of any heterogeneity across treatment arms. Treatment households are significantly more likely to report any trees and have more fruit trees, and are significantly more likely to report a compost heap, a home garden, and past-year application of compost. There is also evidence that women's dietary diversity has increased linked to own-consumption of garden produce: the treatment effect of 5-7 percentage point increase in MDD-W is meaningful among these poor households where only 13% of women meet minimum dietary diversity; these dietary impacts provide immediate benefits which may help encourage sustained adoption. These effects also compare favorably to existing evidence in the literature: in Tanzania, a home-gardening intervention led to increases of 14 percentage points in minimum dietary diversity among women, but relative to a much higher mean (27%) one year post-intervention (interestingly, these effects did not persist to three years) (Blakstad et al., 2021, 2022).²⁶

On the intensive margin, there is no evidence that the quality or productivity of compost or gardening has reduced for households in the treatment arm, but they do show evidence of lower tree survival and tree quality, possibly reflecting reduced access to irrigation vis-a-vis households that spontaneously selected into planting trees. Effects on knowledge, climate change perceptions, and intrahousehold gender dynamics are generally weakly positive, but small. Overall, these findings suggest that this intervention was effective in encouraging adoption of a range of beneficial SLM practices, though a full

²⁶A large number of other studies analyzing home gardening interventions evaluate other indicators of interest, such as the probability of a woman being underweight, but do not specifically analyze dietary diversity, for example Bliznashka et al. (2022). A useful overview is provided in Ruel et al. (2018).

assessment of the persistence of these effects and the ultimate benefits of the practices can only be conducted in the longer-term.

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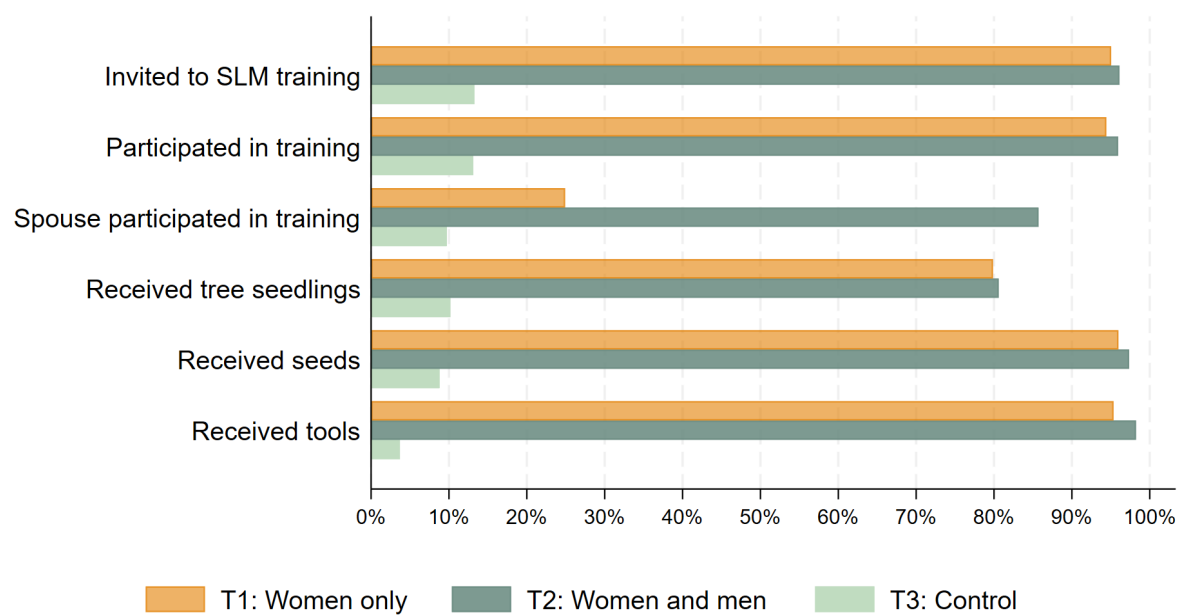
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Table 1: Baseline balance

| | Mean and standard deviation | | | | T1 vs T3 | p-value T2 vs T3 | T1 vs T2 |
|---|-----------------------------|---------------------|---------------------|---------------------|----------|---------------------|----------|
| | All | T1 | T2 | T3 | | | |
| Household size | 5.563 (1.903) | 5.608 (1.863) | 5.452 (1.851) | 5.617 (1.985) | 0.969 | 0.476 | 0.481 |
| Distance to most visited market | 73.432 (49.712) | 73.659 (53.601) | 73.253 (49.004) | 73.362 (46.242) | 0.973 | 0.990 | 0.967 |
| Female's age | 34.570 (9.595) | 34.873 (9.566) | 34.302 (9.358) | 34.503 (9.834) | 0.705 | 0.841 | 0.565 |
| Female has no education | 0.714 (1.570) | 0.711 (0.454) | 0.645 (0.479) | 0.777 (2.585) | 0.537 | 0.226 | 0.185 |
| Female's occupation is crop cultivation | 0.548 (0.498) | 0.582 (0.494) | 0.522 (0.500) | 0.538 (0.499) | 0.314 | 0.743 | 0.233 |
| Male's age | 42.761 (11.607) | 42.938 (11.386) | 42.853 (11.583) | 42.503 (11.859) | 0.702 | 0.763 | 0.942 |
| Male has no education | 0.590 (0.492) | 0.571 (0.495) | 0.581 (0.494) | 0.617 (0.487) | 0.251 | 0.431 | 0.833 |
| Male's occupation is crop cultivation | 0.952 (0.214) | 0.953 (0.212) | 0.921 (0.270) | 0.979 (0.144) | 0.128 | 0.048** | 0.318 |
| Tropical Livestock Units | 1.066 (1.103) | 1.135 (1.133) | 1.022 (1.099) | 1.035 (1.073) | 0.363 | 0.904 | 0.307 |
| Any irrigation | 0.162 (0.369) | 0.165 (0.372) | 0.167 (0.374) | 0.155 (0.362) | 0.749 | 0.736 | 0.951 |
| Any erosion present | 0.771 (0.421) | 0.779 (0.415) | 0.781 (0.414) | 0.753 (0.432) | 0.509 | 0.428 | 0.954 |
| Household has trees | 0.705 (0.456) | 0.705 (0.457) | 0.709 (0.455) | 0.703 (0.457) | 0.977 | 0.905 | 0.934 |
| Number of trees | 33.044 (95.083) | 35.994 (100.794) | 26.997 (65.831) | 35.409 (109.720) | 0.961 | 0.436 | 0.428 |
| Number of trees planted in last 3yr | 5.749 (23.618) | 6.598 (27.685) | 5.062 (20.892) | 5.503 (21.361) | 0.564 | 0.805 | 0.445 |
| Number of fruit trees | 1.560 (6.029) | 1.948 (7.893) | 1.407 (4.553) | 1.306 (4.898) | 0.265 | 0.817 | 0.369 |
| Number of fruit trees planted in last 3yr | 0.791 (4.161) | 1.080 (6.405) | 0.648 (2.241) | 0.626 (2.080) | 0.280 | 0.909 | 0.317 |
| Household has a home garden | 0.483 (0.500) | 0.495 (0.500) | 0.457 (0.499) | 0.492 (0.500) | 0.956 | 0.514 | 0.528 |
| Area of home garden (sq m) | 74.689 (204.400) | 66.907 (188.877) | 76.220 (218.977) | 81.290 (207.473) | 0.736 | 0.919 | 0.844 |
| Household has a compost pile | 0.244 (0.429) | 0.217 (0.412) | 0.262 (0.440) | 0.255 (0.436) | 0.355 | 0.867 | 0.287 |

Notes: Summary statistics are reported from the baseline survey. Standard deviations are in parentheses and clustered at the kebele level. The p-value reported corresponds to the test of difference of means comparing across the treatment arms. Asterisks indicate significance at the 10, 5, and 1 percent level.

Figure 1: Self-reported treatment exposure



N=1861

Table 2: Adoption of sustainable land management technologies

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|--|---------------------|-------------------------------|------------------------|-------------------------|--------------------------|--------------------------------|---------------------------|
| Panel A: Primary outcomes (extensive margin) | | | | | | | |
| | Any trees | Any trees under 1 yr | Compost heap | Produced compost | Home garden | Female SLM tasks Female report | Male report |
| Women only SLM | 0.073*** (0.023) | 0.339*** (0.041) | 0.047* (0.025) | 0.172*** (0.042) | 0.322*** (0.037) | 0.019 (0.012) | 0.019 (0.012) |
| Couples' SLM | 0.092*** (0.022) | 0.322*** (0.038) | 0.108*** (0.030) | 0.204*** (0.038) | 0.328*** (0.037) | 0.030** (0.013) | 0.048*** (0.012) |
| Test: $\beta_1 = \beta_2$ | 0.319 | 0.630 | 0.059* | 0.413 | 0.828 | 0.421 | 0.030** |
| Mean of control | 0.789 | 0.347 | 0.289 | 0.562 | 0.580 | 0.337 | 0.310 |
| N | 1,861 | 1,861 | 1,861 | 1,861 | 1,861 | 1,841 | 1,702 |
| Panel B: Secondary outcomes (continuous variables) | | | | | | | |
| | Number of trees | Number of fruit trees planted | Compost amount applied | Value garden production | Value garden consumption | Dietary diversity score | Minimum dietary diversity |
| Women only SLM | -5.962 (5.242) | 3.827*** (0.370) | 132.767** (50.528) | 14.431*** (5.022) | 13.068*** (2.771) | 0.254*** (0.081) | 0.073*** (0.018) |
| Couples' SLM | -1.250 (4.643) | 3.998*** (0.366) | 228.910*** (48.170) | 10.114** (4.972) | 11.225*** (2.838) | 0.225*** (0.078) | 0.045*** (0.016) |
| Test: $\beta_1 = \beta_2$ | 0.294 | 0.603 | 0.090* | 0.319 | 0.416 | 0.720 | 0.140 |
| Mean of control | 46.450 | 0.731 | 264.252 | 32.671 | 18.462 | 3.120 | 0.128 |
| N | 1,792 | 1,824 | 1,812 | 1,807 | 1,806 | 1,861 | 1,861 |
| Panel C: Secondary outcomes (intensive margin only) | | | | | | | |
| | Number of trees | Number of fruit trees planted | Tree health index | Compost amount applied | Compost quality index | Value garden production | Value garden consumption |
| Women only SLM | -9.351 (6.354) | 1.705*** (0.375) | -0.285** (0.111) | 96.626 (63.861) | -0.052 (0.077) | -1.492 (6.471) | 5.787* (3.350) |
| Couples' SLM | -4.694 (5.817) | 2.010*** (0.411) | -0.194 (0.118) | 192.547*** (58.069) | 0.076 (0.071) | -5.310 (7.016) | 4.600 (3.661) |
| Test: $\beta_1 = \beta_2$ | 0.330 | 0.251 | 0.173 | 0.121 | 0.050* | 0.431 | 0.619 |
| Mean of control | 59.280 | 4.387 | 0.068 | 482.413 | 0.000 | 61.963 | 35.066 |
| N | 1,499 | 1,048 | 715 | 1,216 | 1,265 | 1,343 | 1,342 |

Notes: Standard errors (in parentheses) are clustered at the kebele level. All models control for strata fixed effects, and for the baseline value of the outcome when available (columns (1), (3), (5) and (6) of Panel A; (1) and (6) of Panel B; and (1) of Panel C). Asterisks indicate significance at the 10, 5, and 1 percent level. In Panel A, columns (1) through (5) are binary variables equal to one if an enumerator observed the respective technology; columns (6) and (7) report the percentage of SLM tasks that female was involved in either solely or jointly. In Panel B, column (1) is the count of all trees living; column (2) is the count of trees of the target species (mango, papaya, avocado, apple, coffee) planted in the previous 12 months; column (3) is the self-reported amount of compost applied (in kilograms) and columns (4) and (5) are the value of garden production and own-consumption (in 2024 nominal dollars, constructed using woreda mean self-reported prices), all reported for the previous 12 months; column (6) is the count of food groups consumed by the female in the previous 24 hours (0-10), and column (7) is a binary variable equal to one for women who achieve minimum dietary diversity. In Panel C, column (3) is a standardized index of all tree health measures for the fruit trees planted in the past year (see Table 4 for further details), and column (5) is a standardized index of self-reported indicators of compost production process and the resulting end product.

Table 3: Knowledge, perceptions, and decision making

| | (1) SLM knowledge | (2) Climate change perceptions | (3) SLM self-efficacy | (4) SLM response efficacy | (5) Female decision-making | (6) SLM decision- making |
|---------------------------|----------------------|--------------------------------------|-----------------------------|---------------------------------|----------------------------------|--------------------------------|
| Panel A: Women | | | | | | |
| Women's only SLM | 0.027* (0.015) | -0.005 (0.006) | 0.035** (0.017) | 0.032*** (0.012) | 0.005 (0.019) | 0.034*** (0.006) |
| Couples' SLM | 0.031** (0.015) | 0.004 (0.007) | 0.042** (0.016) | 0.045*** (0.014) | 0.021 (0.017) | 0.034*** (0.007) |
| Test: $\beta_1 = \beta_2$ | 0.797 | 0.262 | 0.697 | 0.404 | 0.342 | 0.985 |
| Mean of control | 0.397 | 0.768 | 0.566 | 0.701 | 0.714 | 0.876 |
| N | 1,861 | 1,861 | 1,861 | 1,861 | 1,861 | 1,858 |
| Panel B: Men | | | | | | |
| Women's only SLM | 0.021 (0.013) | -0.001 (0.006) | 0.035*** (0.013) | 0.024** (0.012) | 0.015* (0.008) | 0.025*** (0.008) |
| Couples' SLM | 0.026* (0.015) | 0.003 (0.007) | 0.022 (0.016) | 0.026** (0.013) | 0.008 (0.008) | 0.026*** (0.007) |
| Test: $\beta_1 = \beta_2$ | 0.743 | 0.556 | 0.376 | 0.887 | 0.378 | 0.930 |
| Mean of control | 0.447 | 0.775 | 0.773 | 0.769 | 0.938 | 0.909 |
| N | 1,714 | 1,714 | 1,714 | 1,714 | 1,714 | 1,713 |

Notes: Standard errors (in parentheses) are clustered at the kebele level. All models control for strata fixed effects, and for the baseline value of the outcome when available (columns (1) and (5) of Panel A). Asterisks indicate significance at the 10, 5, and 1 percent level. All outcomes have been scaled to range from zero to one. Column (1) reports the percentage of all SLM knowledge questions that were answered correctly; column (2) is the percentage of all statements related to climate change and its consequences that the respondent found salient; column (3) is the percentage of all SLM-related activities that the respondent thinks s/he can accomplish, while column (4) is the percentage of these same activities that the respondent finds effective in mitigating certain environmental challenges; column (5) is the percentage of all household decisions that the female participates in (reported separately by women and men); column (6) is the percentage of SLM-specific decisions that the respondent participates in within the household.

Table 4: Tree health

| | (1) Height of tree (cm) | (2) Tree is in normal condition | (3) Leaves are in in healthy condition | (4) Index of tree health | (5) Survival rate of all trees | (6) Survival rate of fruit trees |
|--|-------------------------------|--|---|-----------------------------------|---|---|
| Panel A: At tree level | | | | | | |
| Women's only SLM | -0.731 (4.570) | -0.119*** (0.035) | -0.076** (0.035) | -0.162 (0.149) | | |
| Couples' SLM | 1.392 (4.817) | -0.074* (0.040) | -0.054 (0.040) | -0.062 (0.158) | | |
| Test: $\beta_1 = \beta_2$ | 0.182 | 0.124 | 0.446 | 0.110 | | |
| Mean of control | 47.722 | 0.815 | 0.854 | -0.000 | | |
| N | 2,493 | 2,493 | 2,493 | 2,493 | | |
| Panel B: At tree level, controlling for species | | | | | | |
| Women's only SLM | -5.185* (2.991) | -0.069* (0.041) | -0.051 (0.035) | -0.222** (0.106) | | |
| Couples' SLM | -4.596 (3.313) | -0.043 (0.045) | -0.037 (0.037) | -0.178 (0.119) | | |
| Test: $\beta_1 = \beta_2$ | 0.708 | 0.316 | 0.587 | 0.453 | | |
| Mean of control | 47.722 | 0.815 | 0.854 | -0.000 | | |
| N | 2,493 | 2,493 | 2,493 | 2,493 | | |
| Panel C: At household level | | | | | | |
| Women's only SLM | -4.226 (3.656) | -0.130*** (0.036) | -0.102*** (0.028) | -0.285** (0.111) | -0.175*** (0.030) | -0.099** (0.043) |
| Couples' SLM | -3.104 (3.813) | -0.059 (0.038) | -0.077** (0.033) | -0.194 (0.118) | -0.206*** (0.033) | -0.113** (0.045) |
| Test: $\beta_1 = \beta_2$ | 0.487 | 0.015** | 0.411 | 0.173 | 0.362 | 0.721 |
| Mean of control | 49.319 | 0.794 | 0.888 | 0.068 | 0.716 | 0.591 |
| N | 715 | 715 | 715 | 715 | 1,241 | 1,085 |

Notes: Standard errors (in parentheses) are clustered at the kebele level. All models control for strata fixed effects (baseline values were not collected for any outcomes reported). Asterisks indicate significance at the 10, 5, and 1 percent level. Columns (1) through (4) are reported for all trees of the target species (mango, avocado, papaya, coffee, apple) planted in the previous 12 months that were sufficiently close to the household for an enumerator to measure. Column (1) reports the height of the tree (in centimeters); column (2) is a binary variable equal to one if the tree is designated as in normal condition, as opposed to thin, stunted, or growing sideways; column (3) is a binary variable equal to one if the tree's leaves are designated as in healthy condition, as opposed to dried, wilted/desiccated, deformed, rolled, prematurely falling off, or having a larvae infestation; column (4) is the aggregated index of the three preceding columns, weighted using a general least squared weighting procedure and standardized with respect to the control arm; columns (5) and (6) of Panel C report the rate of survival for all trees planted in the last 12 months and for all fruit trees of the target species planted in the last 12 months, respectively.

Table 5: Investments in agroforestry

| | (1) Watered trees weekly | (2) Built a fence around trees | (3) Organic fertilizer on tree roots | (4) Inorganic fertilizer on tree roots | (5) Organic fertilizer on plots/garden | (6) Inorganic fertilizer on plots/garden |
|---------------------------|-----------------------------------|---|---|---|---|---|
| Women's only SLM | 0.204*** (0.034) | 0.035 (0.023) | 0.151*** (0.034) | -0.020 (0.023) | 0.186*** (0.040) | -0.074** (0.035) |
| Couples' SLM | 0.198*** (0.034) | 0.022 (0.026) | 0.137*** (0.035) | -0.026 (0.022) | 0.218*** (0.038) | -0.009 (0.036) |
| Test: $\beta_1 = \beta_2$ | 0.796 | 0.573 | 0.495 | 0.707 | 0.387 | 0.043** |
| Mean of control | 0.571 | 0.843 | 0.743 | 0.093 | 0.542 | 0.486 |
| N | 1,333 | 1,333 | 1,333 | 1,333 | 1,861 | 1,861 |

Notes: Standard errors (in parentheses) are clustered at the kebele level. All models control for strata fixed effects (baseline values were not collected for any outcomes reported). Asterisks indicate significance at the 10, 5, and 1 percent level. All outcomes were reported by the female. Columns (1) through (4) are binary variables that equal one if the respective action was taken by the household and were only asked for households that reported planting any trees in the previous 12 months. Column (5) is a binary variable equal to one for any application of compost or other organic fertilizer either on the home garden or on any other plots in the last 12 months; column (6) is the equivalent for inorganic fertilizer applications.

Table 6: Selection into planting trees

| | (1) Any trees | (2) Any trees planted in last 12 months | (3) Any fruit trees planted in last 12 months |
|--|---------------------|---|---|
| SLM treatment | -0.011 (0.199) | 0.060 (0.293) | 0.472** (0.209) |
| Amhara region | 0.026 (0.076) | -0.129 (0.128) | -0.414** (0.168) |
| Household size | 0.002 (0.008) | 0.035*** (0.010) | 0.039*** (0.010) |
| Number of children under 5 years of age | 0.025 (0.026) | 0.004 (0.034) | 0.010 (0.027) |
| Household has a child under 2 years | -0.105 (0.064) | -0.185** (0.072) | -0.062 (0.048) |
| Primary female's age | 0.003 (0.003) | -0.008* (0.004) | -0.006 (0.004) |
| Primary male's age | 0.002 (0.002) | 0.002 (0.003) | 0.004 (0.003) |
| Primary female has primary education or more | 0.001 (0.053) | 0.101 (0.070) | 0.089** (0.044) |
| Primary male has primary education or more | 0.008 (0.034) | -0.028 (0.043) | -0.039 (0.035) |
| Primary female's occupation is crop cultivation | 0.017 (0.033) | 0.075* (0.038) | 0.058* (0.031) |
| Primary male's occupation is crop cultivation | -0.042 (0.086) | -0.197 (0.167) | -0.047 (0.130) |
| Value of productive assets (in 1,000 Birr) | 0.008 (0.015) | 0.026 (0.027) | 0.016 (0.026) |
| Tropical livestock units | 0.017 (0.011) | 0.010 (0.019) | -0.007 (0.018) |
| Total area of land owned/operated (ha) | 0.037 (0.041) | -0.049 (0.051) | -0.087* (0.046) |
| Household has any irrigation | 0.021 (0.031) | 0.119*** (0.045) | 0.180*** (0.054) |
| Female has noticed and is concerned about climate change | 0.069* (0.040) | 0.107** (0.041) | 0.087** (0.034) |
| T x Amhara region | 0.123 (0.047) | -0.060 (0.067) | -0.149 (0.086) |
| T x Household size | 0.018** (0.010) | -0.023 (0.011) | -0.028* (0.011) |
| T x Number of children under 5 years of age | -0.010* (0.031) | -0.003** (0.035) | -0.005** (0.029) |
| T x Household has a child under 2 years | 0.069 (0.076) | 0.159 (0.075) | 0.015 (0.056) |
| T x Female's age | -0.004 (0.003) | 0.008** (0.005) | 0.008 (0.004) |
| T x Male's age | 0.002 (0.002) | -0.001 (0.003) | -0.005* (0.003) |
| T x Female has primary education | 0.005 (0.060) | -0.045 (0.074) | -0.079 (0.050) |
| T x Male has primary education | -0.018 (0.041) | 0.066 (0.049) | 0.047 (0.043) |
| T x Female's occupation is crop cultivation | -0.024 (0.039) | -0.063 (0.040) | -0.046 (0.036) |
| T x Male's occupation is crop cultivation | 0.139 (0.101) | 0.283 (0.183) | 0.185 (0.143) |
| T x Value of productive assets (in 1,000 Birr) | 0.012 (0.020) | -0.003 (0.029) | 0.014 (0.029) |
| T x Tropical livestock units | -0.033 (0.015) | -0.019 (0.020) | -0.000 (0.021) |
| T x Total area of land owned/operated | -0.054** (0.046) | 0.086 (0.058) | 0.142 (0.055) |
| T x Household has any irrigation | 0.013 (0.036) | -0.070 (0.048) | -0.117** (0.058) |
| T x Female has noticed and is concerned about climate change | -0.047 (0.046) | -0.147 (0.043) | -0.133** (0.036) |
| Mean of control | 0.789 | 0.432 | 0.182 |
| N | 1,829 | 1,829 | 1,829 |

Notes: Standard errors (in parentheses) are clustered at the kebele level. All models control for strata fixed effects. Asterisks indicate significance at the 10, 5, and 1 percent level.

Appendix

A1 Experimental protocols at baseline

The incentivized game around time preference entailed a multiple price list in which the respondent made choices across payments of varying magnitude today vis-à-vis two weeks; the incentivized game around risk preference entailed a similar set of choices comparing a computerized lottery with a random payout vis-à-vis a fixed payment. All respondents participated in both incentivized modules, but they were informed ex ante that they would be paid based on their choices in one randomly chosen module (time or risk preference). On average, respondents could earn 50 birr through their choices in these two games, supplementing a base payment of 50 birr provided to all respondents to compensate them for the time required to participate in the survey.

Following the implementation of the household-level survey, a second lab-in-the-field exercise was then convened in each kebele with both spouses from sampled households; the objective was to collect experimental measures of intrahousehold (spousal) cooperation. The (female) respondents were informed of the experimental session and were invited to attend jointly with their spouses; they were advised each individual would earn a minimum of 100 birr for attending, and an average of 300 birr (each). However, couples could only be eligible for the payments if they attended jointly. Two experimental sessions were conducted in each kebele, allowing for an average of 10 couples in each session; in the sessions, men and women were seated separately and guided by a same-gender enumerator to specify their willingness to contribute/donate in the public goods and the dictator game when played vis-à-vis their spouse and vis-à-vis a hypothetical stranger of the same as well as opposite gender. (The experimental choices were also preceded by a detailed explanation of the games to ensure adequate comprehension.) Following the respondents' specification of their choices in these games, one of the games played was randomly chosen as the basis for payment and payments were immediately disbursed in cash. The full experimental protocol is provided as an Appendix.

A2 Appendix tables and figures

Figure A1: Joint planning card





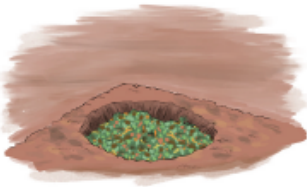


| Activity እንቅስቃሴ | Task ተግባር | Who has primary responsibility? ዋና ኃላፊነት ያለበት ማነው? | |
|-----------------------------------|--|--|--|
| | | ባል Husband  | ሚስት Wife  |
| Home garden የገረ አትክልት ቦታ | <p>Planning the vegetable layout and visiting an agrodealer for seeds</p> <p>የአትክልቱን አቀማመጥ ማቀድና ዘሮችን ለማግኘት ወደ ዘር አቅራቢ መሄድ ::</p>  | | |
| | <p>Preparing the raised or sunken garden bed/soil and doing the first planting</p> <p>የአትክልት ቦታውን ከፍ ወይም ዝቅ ያለ መደብ ማዘጋጀትና የመጀመሪያውን ተክላ ማካሄድ</p>  | | |
| | <p>Finding a location for the compost heap or pit, collecting and setting materials for the first layers of the compost heap or pit</p> <p>ለፍጋፍግ/ለ-በስባሽ የመቆለያ ወይም የማጠራቀሚያ ጉድጓድ ቦታ መፈለግ፣ ለቁልሉ ወይም ለጉድጓዱ የመጀመሪያ ርብራቦች የሚሆኑ ቁሶችን መስብስብና መረብረብ</p>  | | |
| | <p>Laying out the tree system and digging the planting pits</p> <p>ዛፎች የሚተክልበትን ቦታ መቀየስ</p> <p>የአትክልት መትከያ ጉድጓዶችን መቆፈር</p>  | | |
| Trees ዛፎች | <p>Planting the trees following the trainings</p> <p>የአትክልት መትከያ ጉድጓዶችን መቆፈር ዛፎችን መመረያዎችን ተከትሎ መትክል</p>  | | |

Table A1: Attrition from the endline survey

| | Covariate | T1 | T1 X Covariate | T2 | T2 X Covariate |
|--|--------------------|---------------------|----------------------|--------------------|---------------------|
| Household size | -0.000 (0.002) | 0.008 (0.019) | -0.001 (0.003) | 0.047** (0.023) | -0.008** (0.004) |
| Distance to most visited market | 0.000 (0.000) | 0.021 (0.014) | -0.000* (0.000) | 0.023 (0.020) | -0.000 (0.000) |
| Female's age | 0.000 (0.000) | 0.056* (0.028) | -0.002** (0.001) | 0.027 (0.032) | -0.001 (0.001) |
| Female has no education | 0.000 (0.000) | 0.026* (0.015) | -0.035** (0.016) | -0.004 (0.009) | 0.012 (0.010) |
| Female's occupation is crop cultivation | -0.017 (0.012) | -0.018 (0.012) | 0.033** (0.016) | -0.005 (0.011) | 0.016 (0.017) |
| Male's age | 0.001 (0.000) | 0.081*** (0.029) | -0.002*** (0.001) | 0.035 (0.032) | -0.001 (0.001) |
| Male has no education | 0.003 (0.010) | 0.015 (0.012) | -0.024 (0.017) | 0.006 (0.012) | -0.003 (0.018) |
| Male's occupation is crop cultivation | 0.017** (0.007) | -0.004 (0.008) | 0.006 (0.011) | -0.008 (0.007) | 0.014 (0.011) |
| Tropical livestock units | 0.003 (0.008) | 0.009 (0.010) | -0.015 (0.013) | 0.006 (0.010) | -0.004 (0.012) |
| Any irrigation | 0.032* (0.019) | 0.010 (0.007) | -0.056*** (0.019) | 0.004 (0.006) | -0.003 (0.027) |
| Any erosion present | 0.018* (0.010) | 0.015 (0.013) | -0.019 (0.018) | -0.007 (0.007) | 0.013 (0.012) |
| Household has trees | -0.008 (0.009) | 0.001 (0.014) | -0.000 (0.014) | 0.012 (0.018) | -0.011 (0.019) |
| Number of trees | 0.000 (0.000) | 0.001 (0.008) | -0.000 (0.000) | 0.008 (0.008) | -0.000* (0.000) |
| Number of trees planted (last three years) | -0.000 (0.000) | -0.005 (0.007) | 0.001 (0.001) | 0.005 (0.007) | -0.000 (0.000) |
| Number of fruit trees | 0.000 (0.001) | 0.001 (0.007) | -0.000 (0.001) | 0.005 (0.007) | -0.001 (0.001) |
| Number of fruit trees planted (last three years) | 0.003 (0.004) | 0.003 (0.008) | -0.003 (0.004) | 0.007 (0.008) | -0.005 (0.004) |
| Household has a home garden | -0.006 (0.012) | 0.001 (0.012) | -0.000 (0.018) | 0.010 (0.012) | -0.014 (0.016) |
| Household has a compost pile | 0.021 (0.018) | 0.009 (0.008) | -0.033 (0.021) | 0.008 (0.008) | -0.016 (0.021) |

Notes: Each row reports a separate regression where the outcome is a binary variable equal to one if the household attrited from the endline survey, and the right hand side variables include the baseline covariate indicated in the row label, treatment group indicators, and their interactions with the covariate. All models control for strata fixed effects. Standard errors (in parentheses) are clustered at the kebele level. Asterisks indicate significance at the 10, 5, and 1 percent level.

Table A2: Tree measurement by enumerators not conducted

| | Covariate | T1 | T1 X Covariate | T2 | T2 X Covariate |
|---|----------------------|--------------------|----------------------|--------------------|---------------------|
| Household size | -0.006 (0.024) | 0.134 (0.181) | -0.026 (0.026) | -0.104 (0.189) | 0.018 (0.027) |
| Distance to most visited market | 0.001 (0.001) | -0.025 (0.099) | 0.000 (0.001) | 0.093 (0.104) | -0.001 (0.001) |
| Female's age | 0.003 (0.005) | 0.324* (0.193) | -0.009 (0.006) | 0.342* (0.184) | -0.009* (0.006) |
| Female has no education | 0.119 (0.093) | 0.207** (0.079) | -0.306*** (0.111) | 0.127* (0.071) | -0.176* (0.100) |
| Female's occupation is crop cultivation | -0.030 (0.106) | -0.040 (0.097) | 0.035 (0.117) | -0.047 (0.101) | 0.088 (0.121) |
| Male's age | -0.000 (0.004) | 0.207 (0.193) | -0.005 (0.005) | 0.206 (0.184) | -0.005 (0.004) |
| Male has no education | -0.065 (0.081) | -0.037 (0.080) | 0.029 (0.099) | 0.010 (0.079) | -0.012 (0.094) |
| Male's occupation is crop cultivation | 0.209** (0.087) | 0.260** (0.128) | -0.283** (0.137) | 0.468** (0.195) | -0.467** (0.212) |
| Tropical Livestock Units | 0.001 (0.053) | -0.033 (0.069) | 0.024 (0.061) | -0.024 (0.074) | 0.057 (0.072) |
| Any irrigation | -0.106* (0.063) | -0.035 (0.060) | 0.051 (0.094) | -0.024 (0.066) | 0.133 (0.091) |
| Any erosion present | 0.057 (0.134) | 0.052 (0.134) | -0.085 (0.144) | 0.043 (0.134) | -0.042 (0.143) |
| Household has trees | -0.309** (0.128) | -0.142 (0.134) | 0.136 (0.138) | -0.177 (0.136) | 0.211 (0.137) |
| Number of trees | -0.001*** (0.000) | -0.076 (0.071) | 0.001*** (0.000) | -0.042 (0.075) | 0.001** (0.000) |
| Number of trees planted in last 3yr | -0.002** (0.001) | -0.034 (0.063) | 0.002* (0.001) | -0.008 (0.067) | 0.002 (0.001) |
| Number of fruit trees | -0.020** (0.009) | -0.063 (0.066) | 0.020** (0.010) | -0.041 (0.072) | 0.022** (0.011) |
| Number of fruit trees planted in last 3yr | -0.032** (0.013) | -0.066 (0.063) | 0.038*** (0.014) | -0.018 (0.069) | 0.017 (0.014) |
| Household has a home garden | 0.007 (0.101) | 0.033 (0.083) | -0.093 (0.110) | 0.050 (0.091) | -0.081 (0.115) |
| Household has a compost pile | 0.034 (0.098) | -0.007 (0.052) | -0.041 (0.115) | 0.015 (0.059) | -0.025 (0.118) |

Notes: Each row reports a separate regression where the outcome is a binary variable equal to one if at least one of the trees planted by the household in the past 12 months was not measured due to distance from the household, and the right hand side variables include the baseline covariate indicated in the row label, treatment group indicators, and their interactions with the covariate. All models control for strata fixed effects. Standard errors (in parentheses) are clustered at the kebele level. Asterisks indicate significance at the 10, 5, and 1 percent level.

Figure A2: Total tree count

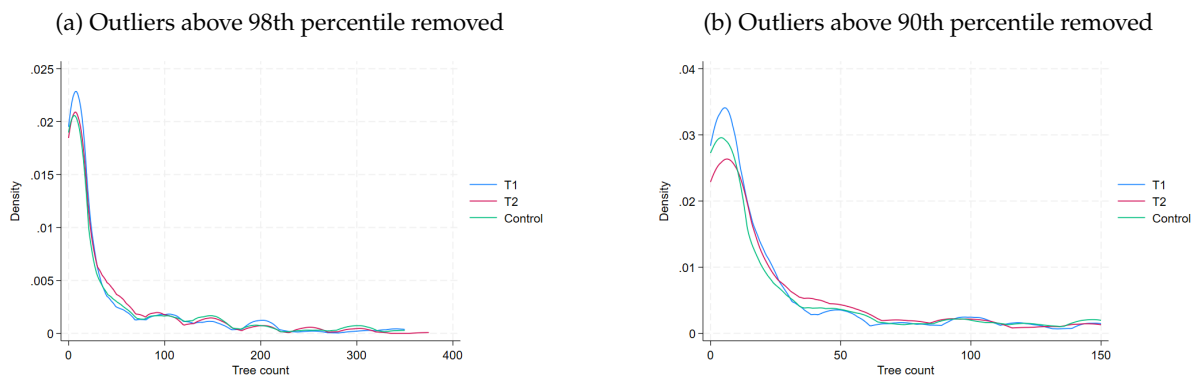


Figure A3: Patterns of tree planting

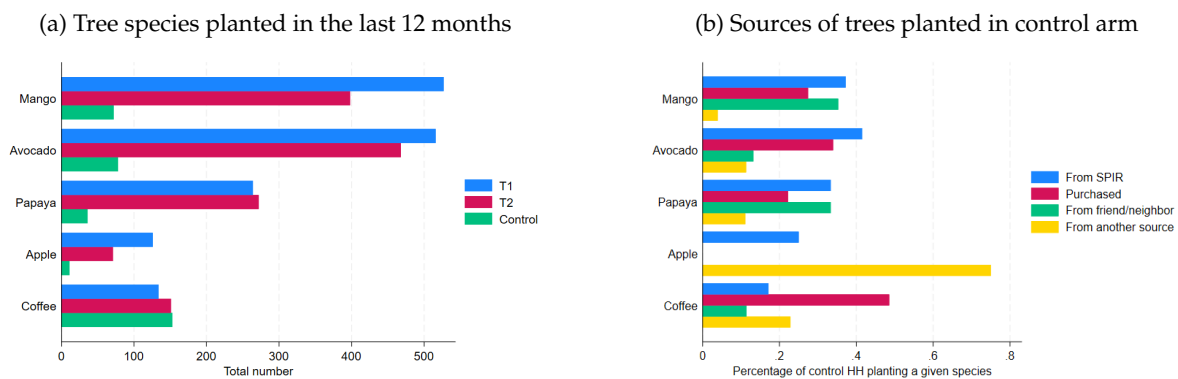
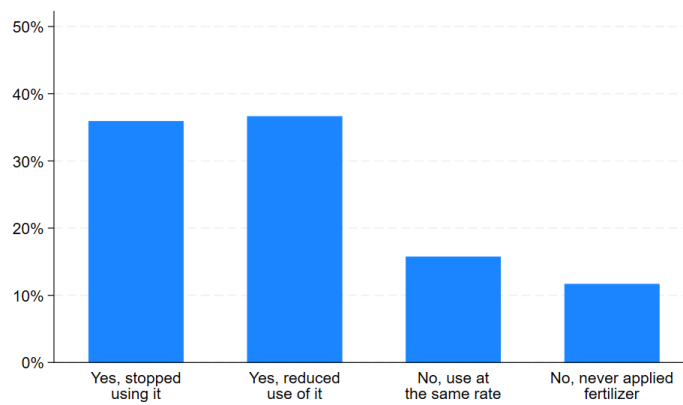


Figure A4: Reported shifts in fertilizer use among compost producers



This figure captures the responses to the survey question, "did you change your use of inorganic fertilizer as a result of applying compost", posed only to those respondents who had produced compost.

Table A3: Survey question modules: Perceptions of climate change

| Statement |
|--|
| <p>Do you agree or disagree with the following statement?</p> <p>Consequences Changes in weather patterns have mostly positive impacts. People are more likely to face food insecurity due to changing weather. Changes in weather patterns are making less water available. Droughts are making it easier to grow food for livestock. New weather patterns are making it more difficult to grow crops.</p> |
| <ol style="list-style-type: none"> 1. Disagree 2. Neither agree or disagree 3. Agree |
| <p>Spatial Distance Changes in rainfall and temperature affect my household. Unpredictable weather is making daily life a challenge in our community as well. Distant areas are more vulnerable to floods and droughts than we are here. More unpredictable rainfall affects only other, distant areas. More extreme weather events are a bigger problem in other countries.</p> |
| <p>Temporal Distance The weather's been making it harder to grow crops than in the past. I have noticed that weather patterns are becoming more unpredictable. Future weather is expected to make growing crops more difficult. It will be a long time before we experience any real consequences of changing weather patterns. Our descendants will experience the consequences of changing climate, but we will not.</p> |

Table A4: Survey modules capturing self-efficacy and response-efficacy

| Please indicate how much confidence you have in your ability to [ACTIVITY]? | |
|---|-------------------------------|
| Produce more or better-quality compost for your plots | 1. No confidence at all |
| Apply more mulches, manure or other organic materials to your crops | 2. Slight confidence |
| Construct soil structures (for example, terraces or bunds) | 3. Some confidence |
| Plant more trees on eroded land | 4. A great deal of confidence |
| Plant trees around your crops in an agroforestry system | 5. Complete confidence |
| To what extent do you feel . . . | |
| . . . you producing more compost will be effective in making soil more drought resistant? | 1. Not at all effective |
| . . . you applying more organic materials will be effective in increasing soil fertility on your plots? | 2. Not very effective |
| . . . you constructing soil structures will be effective in reducing erosion and increasing drought resistance? | 3. Somewhat effective |
| . . . you planting more trees will be effective in reducing erosion? | |
| . . . you planting trees in an agroforestry system will be effective in increasing soil fertility? | 4. Extremely effective |

Table A5: Women's time use

| | (1) Works on garden daily | (2) Works on garden regularly | (3) Time worked (min) | (4) Tasks female does alone | (5) SLM tasks female does alone | (6) Tasks male does alone | (7) SLM tasks male does alone |
|---------------------------|------------------------------------|--|--------------------------------|--------------------------------------|--|------------------------------------|--|
| Women's only SLM | 0.091*** (0.018) | 0.133*** (0.027) | -6.171 (4.871) | -0.004 (0.009) | 0.006 (0.012) | 0.002 (0.007) | -0.019 (0.012) |
| Couples' SLM | 0.063*** (0.018) | 0.133*** (0.028) | -7.950 (5.153) | -0.005 (0.009) | -0.003 (0.012) | -0.018** (0.008) | -0.048*** (0.012) |
| Test: $\beta_1 = \beta_2$ | 0.139 | 0.990 | 0.597 | 0.857 | 0.473 | 0.017** | 0.030** |
| Mean of control | 0.039 | 0.730 | 70.867 | 0.499 | 0.135 | 0.385 | 0.690 |
| N | 1,363 | 1,363 | 1,363 | 1,861 | 1,841 | 1,713 | 1,702 |

Notes: Standard errors (in parentheses) are clustered at the kebele level. All models control for strata fixed effects, and for the baseline value of the outcome when available (columns (4) and (5)). Asterisks indicate significance at the 10, 5, and 1 percent level. Columns (1) and (2) are constructed from a categorical variable of frequency of working on the home garden; column (3) is the average amount of time worked each time; columns (4) and (6) report the share of all tasks asked about that the female and the male do on their own, respectively; columns (5) and (7) report the same for SLM related tasks specifically.

Table A6: Food groups consumed by female

| | (1) Grains, tubers, roots | (2) Pulses | (3) Nuts, seeds | (4) Dairy | (5) Meat, fish | (6) Eggs | (7) Dark leafy vegetables | (8) Vitamin A rich fruit/ vegetables | (9) Other veget- ables | (10) Other fruits |
|---------------------------|------------------------------------|-------------------|-----------------------|-------------------|----------------------|-------------------|------------------------------------|---|---------------------------------|-------------------------|
| Women's SLM | 0.003 (0.002) | 0.003 (0.016) | 0.034* (0.018) | 0.020 (0.017) | -0.002 (0.009) | -0.010 (0.014) | 0.110*** (0.025) | 0.045** (0.020) | 0.036 (0.027) | 0.016 (0.011) |
| Couples' SLM | 0.001 (0.003) | -0.011 (0.017) | 0.056*** (0.019) | -0.000 (0.015) | 0.006 (0.009) | 0.005 (0.015) | 0.089*** (0.026) | 0.063*** (0.020) | 0.022 (0.026) | 0.008 (0.010) |
| Test: $\beta_1 = \beta_2$ | 0.340 | 0.457 | 0.262 | 0.222 | 0.290 | 0.282 | 0.436 | 0.380 | 0.577 | 0.551 |
| Mean of control | 0.997 | 0.914 | 0.117 | 0.153 | 0.028 | 0.103 | 0.137 | 0.094 | 0.542 | 0.035 |
| N | 1,861 | 1,861 | 1,861 | 1,861 | 1,861 | 1,861 | 1,861 | 1,861 | 1,861 | 1,861 |

Notes: Standard errors (in parentheses) are clustered at the kebele level. All models control for strata fixed effects and the baseline value of the outcome. Asterisks indicate significance at the 10, 5, and 1 percent level. All outcomes are binary indicators equal to one if the primary female consumed a food item from the respective food group within the previous day.

Table A7: Heterogeneity with respect to time and risk preference

| | (1) Any trees | (2) Any trees under 1yr | (3) Compost heap | (4) Produced compost | (5) Home garden | (6) Female SLM tasks F report | (7) M report |
|----------------------------------|---------------------|-------------------------------|---------------------|----------------------------|---------------------|-------------------------------------|---------------------|
| Panel A: Risk preferences | | | | | | | |
| Women | 0.075** (0.031) | 0.367*** (0.047) | 0.033 (0.033) | 0.156*** (0.050) | 0.310*** (0.039) | 0.008 (0.017) | 0.008 (0.015) |
| Couples | 0.098*** (0.032) | 0.364*** (0.041) | 0.149*** (0.040) | 0.218*** (0.049) | 0.311*** (0.039) | 0.011 (0.017) | 0.032** (0.016) |
| Risk tolerance above median | 0.029 (0.028) | 0.069* (0.041) | 0.040 (0.037) | 0.004 (0.036) | -0.039 (0.027) | -0.027 (0.020) | -0.009 (0.021) |
| Women x Risk tolerance | -0.018 (0.035) | -0.079 (0.061) | 0.024 (0.051) | 0.040 (0.049) | 0.027 (0.032) | 0.030 (0.024) | 0.027 (0.027) |
| Couples x Risk tolerance | -0.013 (0.035) | -0.093* (0.049) | -0.099* (0.055) | -0.041 (0.048) | 0.052 (0.035) | 0.058** (0.025) | 0.046* (0.026) |
| Test: $\beta_1 = \beta_2$ | 0.437 | 0.948 | 0.008*** | 0.201 | 0.971 | 0.878 | 0.151 |
| Mean of control | 0.789 | 0.347 | 0.289 | 0.562 | 0.580 | 0.337 | 0.310 |
| N | 1,861 | 1,861 | 1,861 | 1,861 | 1,861 | 1,846 | 1,702 |
| Panel B: Time preferences | | | | | | | |
| Women | 0.076** (0.033) | 0.329*** (0.050) | 0.029 (0.037) | 0.211*** (0.050) | 0.353*** (0.038) | 0.011 (0.017) | 0.003 (0.015) |
| Couples | 0.096*** (0.032) | 0.311*** (0.049) | 0.102*** (0.035) | 0.239*** (0.042) | 0.360*** (0.038) | 0.038** (0.019) | 0.048*** (0.018) |
| Patience above median | 0.013 (0.037) | -0.000 (0.042) | 0.042 (0.040) | 0.055* (0.033) | 0.079** (0.037) | 0.002 (0.018) | -0.021 (0.018) |
| Women x Patience | -0.018 (0.043) | 0.016 (0.050) | 0.024 (0.058) | -0.091* (0.054) | -0.081* (0.044) | 0.017 (0.026) | 0.037 (0.025) |
| Couples x Patience | -0.009 (0.049) | 0.042 (0.055) | 0.018 (0.060) | -0.089* (0.045) | -0.074* (0.043) | -0.011 (0.028) | 0.007 (0.026) |
| Test: $\beta_1 = \beta_2$ | 0.512 | 0.658 | 0.083* | 0.555 | 0.788 | 0.185 | 0.015** |
| Mean of control | 0.789 | 0.347 | 0.289 | 0.562 | 0.580 | 0.337 | 0.310 |
| N | 1,861 | 1,861 | 1,861 | 1,861 | 1,861 | 1,846 | 1,702 |

Notes: Standard errors (in parentheses) are clustered at the kebele level. All models control for strata fixed effects, and for the baseline value of the outcome when available (columns (1), (3), (5), and (6)). Asterisks indicate significance at the 10, 5, and 1 percent level. The dependent variables are identical to those in Panel A of Table 2. Levels of risk tolerance and patience were constructed based on incentivized experimental games that the female respondent played as part of the baseline survey (see Section A1).

Table A8: Heterogeneity with respect to female's climate change perceptions

| | (1) Any trees | (2) Any trees under 1yr | (3) Compost heap | (4) Produced compost | (5) Home garden | (6) Female SLM tasks F report | (7) M report |
|---------------------------------|---------------------|-------------------------------|---------------------|----------------------------|---------------------|-------------------------------------|-------------------|
| Women | 0.123*** (0.042) | 0.425*** (0.052) | 0.014 (0.048) | 0.155** (0.072) | 0.369*** (0.055) | 0.002 (0.023) | 0.005 (0.018) |
| Couples | 0.128*** (0.042) | 0.325*** (0.052) | 0.140** (0.055) | 0.189*** (0.063) | 0.378*** (0.056) | 0.027 (0.023) | 0.036 (0.023) |
| Strong climate perceptions | 0.088** (0.041) | 0.084** (0.040) | 0.052 (0.040) | 0.004 (0.041) | 0.079** (0.038) | -0.023 (0.020) | -0.029 (0.019) |
| Women x Strong perceptions | -0.083* (0.048) | -0.135** (0.052) | 0.044 (0.057) | 0.026 (0.067) | -0.074 (0.053) | 0.028 (0.028) | 0.023 (0.026) |
| Couples x Strong perceptions | -0.055 (0.057) | -0.006 (0.054) | -0.048 (0.063) | 0.023 (0.063) | -0.081 (0.055) | 0.011 (0.027) | 0.018 (0.029) |
| Test: $\beta_1 = \beta_2$ | 0.910 | 0.055* | 0.041** | 0.655 | 0.846 | 0.290 | 0.150 |
| Mean of control | 0.789 | 0.347 | 0.289 | 0.562 | 0.580 | 0.337 | 0.310 |
| N | 1,861 | 1,861 | 1,861 | 1,861 | 1,861 | 1,846 | 1,702 |

Notes: Standard errors (in parentheses) are clustered at the kebele level. All models control for strata fixed effects, and for the baseline value of the outcome when available (columns (1), (3), (5), and (6)). Asterisks indicate significance at the 10, 5, and 1 percent level. The dependent variables are identical to those in Panel A of Table 2. Female's strong climate perceptions are defined as the female a) having noticed climate change over their lifetime, and b) being concerned or very concerned about changes in climate as reported in the baseline survey.

Table A9: Heterogeneity with respect to woman's willingness to cooperate

| | (1) Any trees | (2) Any trees under 1yr | (3) Compost heap | (4) Produced compost | (5) Home garden | (6) Female SLM tasks F report | (7) M report |
|-----------------------------------|---------------------|-------------------------------|---------------------|----------------------------|---------------------|-------------------------------------|----------------------|
| Panel A: Public goods game | | | | | | | |
| Women | 0.069** (0.029) | 0.305*** (0.046) | 0.083*** (0.030) | 0.162*** (0.043) | 0.291*** (0.041) | 0.025 (0.018) | 0.030 (0.018) |
| Couples | 0.066** (0.030) | 0.293*** (0.040) | 0.128*** (0.035) | 0.210*** (0.040) | 0.308*** (0.039) | 0.032* (0.018) | 0.061*** (0.017) |
| Contributed above median | -0.028 (0.035) | -0.067* (0.036) | 0.029 (0.037) | 0.001 (0.041) | -0.040 (0.033) | -0.011 (0.017) | 0.009 (0.017) |
| Women x High contribution | 0.003 (0.044) | 0.070 (0.042) | -0.118** (0.047) | 0.012 (0.052) | 0.067* (0.038) | -0.022 (0.027) | -0.031 (0.025) |
| Couples x High contribution | 0.064 (0.041) | 0.074 (0.051) | -0.047 (0.056) | -0.023 (0.060) | 0.040 (0.040) | -0.006 (0.027) | -0.032 (0.027) |
| Test: $\beta_1 = \beta_2$ | 0.894 | 0.771 | 0.209 | 0.242 | 0.613 | 0.724 | 0.068* |
| Mean of control | 0.789 | 0.347 | 0.289 | 0.562 | 0.580 | 0.337 | 0.310 |
| N | 1,812 | 1,812 | 1,812 | 1,812 | 1,812 | 1,797 | 1,659 |
| Panel B: Dictator game | | | | | | | |
| Women's | 0.086*** (0.026) | 0.330*** (0.042) | 0.047 (0.030) | 0.151*** (0.041) | 0.313*** (0.041) | 0.025* (0.014) | 0.027** (0.013) |
| Couples | 0.079*** (0.029) | 0.330*** (0.040) | 0.123*** (0.032) | 0.224*** (0.039) | 0.321*** (0.040) | 0.040** (0.016) | 0.067*** (0.013) |
| Contributed above median | 0.041 (0.039) | 0.039 (0.049) | 0.052 (0.043) | 0.058 (0.046) | -0.018 (0.050) | 0.013 (0.021) | 0.047** (0.019) |
| Women's x High contribution | -0.060 (0.052) | 0.005 (0.064) | -0.047 (0.064) | 0.054 (0.062) | 0.018 (0.057) | -0.035 (0.026) | -0.039* (0.024) |
| Couples x High contribution | 0.046 (0.047) | -0.029 (0.061) | -0.048 (0.067) | -0.086 (0.062) | 0.010 (0.059) | -0.034 (0.032) | -0.071*** (0.026) |
| Test: $\beta_1 = \beta_2$ | 0.760 | 0.993 | 0.030** | 0.053* | 0.803 | 0.414 | 0.005*** |
| Mean of control | 0.789 | 0.347 | 0.289 | 0.562 | 0.580 | 0.337 | 0.310 |
| N | 1,812 | 1,812 | 1,812 | 1,812 | 1,812 | 1,797 | 1,659 |

Notes: Standard errors (in parentheses) are clustered at the kebele level. All models control for strata fixed effects, and for the baseline value of the outcome when available (columns (1), (3), (5), and (6)). Asterisks indicate significance at the 10, 5, and 1 percent level. The dependent variables are identical to those in Panel A of Table 2. Female's willingness to contribute was calculated as her mean contribution from the dictator game and the public goods game that were part of the incentivized games that both the female and the male played following the baseline survey (see Section A1).

Table A10: Heterogeneity with respect to man's willingness to cooperate

| | (1) Any trees | (2) Any trees under 1yr | (3) Compost heap | (4) Produced compost | (5) Home garden | (6) Female SLM tasks F report | (7) M report |
|-----------------------------------|---------------------|-------------------------------|---------------------|----------------------------|---------------------|-------------------------------------|---------------------|
| Panel A: Public goods game | | | | | | | |
| Women | 0.060* (0.032) | 0.340*** (0.050) | 0.060* (0.032) | 0.189*** (0.036) | 0.335*** (0.045) | 0.027 (0.018) | 0.041** (0.017) |
| Couples | 0.105*** (0.029) | 0.341*** (0.050) | 0.103*** (0.038) | 0.201*** (0.043) | 0.371*** (0.042) | 0.032 (0.020) | 0.064*** (0.017) |
| Contributed above median | -0.013 (0.029) | 0.029 (0.039) | 0.013 (0.034) | 0.030 (0.032) | 0.010 (0.037) | 0.001 (0.017) | 0.020 (0.021) |
| Women x High contribution | 0.020 (0.036) | -0.016 (0.050) | -0.050 (0.049) | -0.045 (0.049) | -0.034 (0.044) | -0.023 (0.025) | -0.047* (0.027) |
| Couples x High contribution | -0.027 (0.040) | -0.037 (0.054) | 0.013 (0.049) | -0.001 (0.047) | -0.093** (0.044) | -0.003 (0.026) | -0.031 (0.027) |
| Test: $\beta_1 = \beta_2$ | 0.108 | 0.991 | 0.304 | 0.772 | 0.210 | 0.802 | 0.162 |
| Mean of control | 0.789 | 0.347 | 0.289 | 0.562 | 0.580 | 0.337 | 0.310 |
| N | 1,812 | 1,812 | 1,812 | 1,812 | 1,812 | 1,797 | 1,659 |
| Panel B: Dictator game | | | | | | | |
| Women | 0.058** (0.028) | 0.349*** (0.049) | 0.033 (0.032) | 0.149*** (0.039) | 0.295*** (0.042) | 0.013 (0.017) | 0.020 (0.015) |
| Couples | 0.064** (0.030) | 0.331*** (0.046) | 0.106*** (0.038) | 0.209*** (0.039) | 0.314*** (0.040) | 0.013 (0.019) | 0.042*** (0.015) |
| Contributed above median | -0.038 (0.033) | 0.044 (0.036) | -0.005 (0.033) | -0.033 (0.036) | -0.016 (0.038) | -0.037* (0.020) | -0.011 (0.018) |
| Women x High contribution | 0.026 (0.038) | -0.037 (0.050) | 0.005 (0.050) | 0.042 (0.052) | 0.052 (0.046) | 0.007 (0.029) | -0.007 (0.026) |
| Couples x High contribution | 0.059 (0.044) | -0.019 (0.053) | 0.009 (0.053) | -0.017 (0.050) | 0.020 (0.044) | 0.039 (0.031) | 0.013 (0.028) |
| Test: $\beta_1 = \beta_2$ | 0.815 | 0.647 | 0.080* | 0.097* | 0.475 | 0.983 | 0.164 |
| Mean of control | 0.789 | 0.347 | 0.289 | 0.562 | 0.580 | 0.337 | 0.310 |
| N | 1,812 | 1,812 | 1,812 | 1,812 | 1,812 | 1,797 | 1,659 |

Notes: Standard errors (in parentheses) are clustered at the kebele level. All models control for strata fixed effects, and for the baseline value of the outcome when available (columns (1), (3), (5), and (6)). Asterisks indicate significance at the 10, 5, and 1 percent level. The dependent variables are identical to those in Panel A of Table 2. Male's willingness to contribute was calculated as his mean contribution from the dictator game and the public goods game that were part of the incentivized games that both the female and the male played following the baseline survey (see Section A1).

Table A11: Pooled treatment effects on primary outcomes

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|--|---------------------|-------------------------------|------------------------|-------------------------|--------------------------|--------------------------------|---------------------------|
| Panel A: Primary outcomes (extensive margin) | | | | | | | |
| | Any trees | Any trees under 1 yr | Compost heap | Produced compost | Home garden | Female SLM tasks Female report | Male report |
| Pooled SLM | 0.082*** (0.020) | 0.331*** (0.035) | 0.076*** (0.023) | 0.187*** (0.035) | 0.325*** (0.034) | 0.024** (0.011) | 0.033*** (0.010) |
| Mean of control | 0.789 | 0.347 | 0.289 | 0.562 | 0.580 | 0.337 | 0.310 |
| N | 1,861 | 1,861 | 1,861 | 1,861 | 1,861 | 1,841 | 1,702 |
| Panel B: Secondary outcomes (continuous variables) | | | | | | | |
| | Number of trees | Number of fruit trees planted | Compost amount applied | Value garden production | Value garden consumption | Dietary diversity score | Minimum dietary diversity |
| Pooled SLM | -3.720 (4.447) | 3.908*** (0.330) | 178.089*** (41.301) | 12.371*** (4.521) | 12.189*** (2.573) | 0.240*** (0.069) | 0.060*** (0.014) |
| Mean of control | 46.450 | 0.731 | 264.252 | 32.671 | 18.462 | 3.120 | 0.128 |
| N | 1,792 | 1,824 | 1,812 | 1,807 | 1,806 | 1,861 | 1,861 |
| Panel C: Secondary outcomes (intensive margin only) | | | | | | | |
| | Number of trees | Number of fruit trees planted | Tree health index | Compost amount applied | Compost quality index | Value garden production | Value garden consumption |
| Pooled SLM | -7.161 (5.637) | 1.844*** (0.371) | -0.245** (0.111) | 144.284*** (53.413) | 0.012 (0.067) | -3.225 (6.283) | 5.248 (3.289) |
| Mean of control | 59.280 | 4.387 | 0.068 | 482.413 | 0.000 | 61.963 | 35.066 |
| N | 1,499 | 1,048 | 715 | 1,216 | 1,265 | 1,343 | 1,342 |

Notes: Standard errors (in parentheses) are clustered at the kebele level. All models control for strata fixed effects, and for the baseline value of the outcome when available (columns (1), (3), (5) and (6) of Panel A; (1) and (6) of Panel B; and (1) of Panel C). Asterisks indicate significance at the 10, 5, and 1 percent level. In Panel A, columns (1) through (5) are binary variables equal to one if an enumerator observed the respective technology; columns (6) and (7) report the share of SLM tasks that female was involved in either solely or jointly. In Panel B, column (1) is the count of all trees living; column (2) is the count of trees of the target species (mango, papaya, avocado, apple, coffee) planted in the previous 12 months; column (3) is the self-reported amount of compost applied (in kilograms) and columns (4) and (5) are the value of garden production and the value of what was consumed from the garden (in 2024 nominal dollars, constructed using woreda mean self-reported prices), all reported for the previous 12 months; column (6) is the count of food groups consumed by the female in the previous 24 hours (0-10). In Panel C, column (3) is a standardized index of all tree health measures for the fruit trees planted in the past year (see Table 4 for further details), and column (5) is a standardized index of self-reported indicators of compost production process and the resulting end product.

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