Contract Farming Can Bridge Knowledge and Productivity Gender Gaps: Evidence from an Experimental Study in Benin.

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Abstract

Contract farming can improve productivity and the adoption of technology by providing better access to inputs, information, markets, and financial services. Limited evidence exists, however, regarding the role of contract farming in bridging gender disparities in agricultural productivity. We evaluate the impact of a pilot contract-farming intervention that offers inputs on credit, technical advice, and a sales guarantee to soy producers in Benin. We designed a randomized experiment involving 760 households across thirty-eight villages. We expect knowledge of recommended agricultural practices and use of soy-specific inputs (certified seeds and inoculum) to increase soybean yields. We also assess the impact of a women-focused targeting approach (requiring farming women to be direct beneficiaries) against a household targeting mechanism (in which the household chooses the direct beneficiary). Contract farming results in statistically significant increases in knowledge scores (1.1-1.3 standard deviations) and yields (42% to 73%) for men and women farmers. With women-focused targeting, the impact on yield and, to a lesser extent on knowledge, is higher for women than for men as compared with household-targeting. Overall, women-focused contract farming benefits both producers in the household and reduces within-household gender disparities in knowledge and productivity.

Keywords: agriculture, gender gap, intrahousehold knowledge sharing, contract farming

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I. Introduction

In most of Africa, agriculture faces a number of challenges: limited access to quality inputs (e.g., certified seeds, crop-specific fertilizers, and pesticides), credit constraints, and limited access to agricultural markets. These challenges are often more pronounced for women who farm, with disparities in access to production resources resulting in marked gender differences in production outcomes. Contract farming has the potential to address many of these challenges, but rigorous evidence regarding its effectiveness is limited.

Can contract-farming that targets farming women simultaneously improve farmers' knowledge of recommended agricultural practices, result in higher yields, and reduce disparities between men and women? We designed and conducted an experiment to test the impact of a pilot contract-farming arrangement and the effectiveness of a women-focused targeting mechanism on reducing the gender gaps in knowledge on agricultural practices and productivity in Benin. In Benin, soybeans are produced by both men and women farmers and offer opportunities as a cash crop and as a nutritious food product. The pilot intervention was designed by the Benin National Union of Soybean Producers (Union Nationale des Producteurs de Soja du Bénin, hereafter UNPS), a major stakeholder in the sector.

The UNPS contract-farming intervention bundles a number of benefits into two main components: technical training and delivery of soybean-specific inputs with the option of deferred payment and a sales guarantee. Technical training is offered to groups of farmers, and monthly follow-ups are delivered by phone to individual farmers. The main innovation in the training curricula is in the use of recommended techniques for two types of soy-specific inputs: 1) inoculum to fertilize soils with bacteria that help soybeans capture nitrogen at the time of planting; and 2) certified seeds, locally selected, produced, and packaged to guarantee high yields in Benin's specific agro-climatic conditions.

Inoculum requires special care in transportation, handling, and storage for the symbiosis between bacteria and plant to occur. The same is true for seeds to ensure germination. But both certified seeds and inoculum are available only at the district-level market. The UNPS intervention offers to deliver inputs to villages directly to reduce farmers' transaction costs. Another innovation in the delivery of soybean-specific inputs is that farmers have the option to pay for them immediately or to sign a contract for deferred payment at the time of harvest. The deferred-payment plan is set as a zero-interest loan. In addition, in this contract, UNPS commits to find buyers at harvest time who will pay the government-guaranteed soy price.

For this study, we recruited farm households with (at least) two spouses of opposite gender involved in soybean production. Our experiment took place in two stages. In the first, we randomly assigned villages to either an intervention or a no-intervention (pure control) group. This first randomization was used to assess the overall effectiveness of the intervention, independent of the targeting approach. At the second stage, within each intervention village, we randomly assigned households into a women-focused targeting group or a household-focused targeting group. In the women-focused targeting arm, farming women were the direct beneficiary of training and monthly phone follow-ups. They also received inputs for use on the plots they managed and decided whether to sign the contract with UNPS for deferred payment with a price guarantee. In the household-targeted arm, the choice of the beneficiary producer was left to the household.

Our working hypotheses were that contract farming (1) improves the knowledge of farming men and women in a beneficiary household and (2) increases the direct beneficiary's soy yield per hectare, and (3) that women-focused targeting results in higher yields for women farmers than does household-focused targeting.

If these hypotheses were supported by evidence, the implication would be that farming women can learn and use newly acquired knowledge as well as farming men despite the barriers that women face. To assess knowledge, we objectively tested men and women farmers on recommended soy practices. We also assessed within-household spillovers in knowledge under the two targeting approaches (women-focused and household). Assuming that knowledge can be shared within a household, we expected that both men and women in the intervention groups would benefit from the training component. For this hypothesis to hold, farming women should be as competent and credible in passing knowledge to their spouses as are farming men, and we compared the extent of sharing within the household under the two approaches. Finally, we anticipated that the input package would mainly benefit the direct beneficiary and improve yield on his or her plot and that women-focused targeting would reduce gender disparities in yield.

For its pilot program, the UNPS spent considerable time explaining the benefits to farmers and convincing them to take them up. In our experiment, all farmers in the intervention villages fully participated in the project, and we could therefore estimate the average impact of the contract-farming intervention on beneficiaries. In order to design effective solutions for full participation, caution should be used in in the transition to scale.

We collected data at baseline (December 2019) and endline (December 2020) right after harvest, limiting recall bias regarding agricultural production. Randomization was conducted after baseline data collection (January 2020). The main interventions took place during the planting season (June-July 2020). Knowledge testing took place during the endline survey five months after the end of training.

Based on the theory of change for the intervention, we identified knowledge and yields as the two main outcomes of interest. We constructed a standardized score that objectively measured knowledge of recommended agricultural practices, an understudied outcome in the literature on agricultural innovations (Lopez-Aval et al., 2017). The test assessed knowledge on twenty-nine items that covered all the key stages of production during the soy season; see Kondylis et al. (2016) regarding bias in self-reports for recommended agricultural practices in Mozambique.

The second outcome was soy yield per hectare, obtained as the ratio of quantity harvested over acreage for the main plot cultivated in soy. Both outcomes were measured separately for men and women within the same household. Finally, because the time frame of the study was limited to one agricultural season, we also collected data on farmers' plans for the following soy season in order to assess the potential sustainability of the intervention.

We found that the UNPS contract-farming intervention had similar positive impacts on farming men's and women's technical knowledge regarding recommended practices for soy production (1.2-1.3 standard deviations increases). Impacts on their productivity were also positive, but they differed across gender (42% to 73% increases). The women-focused targeting mechanism had a positive within-household spillover effect on men farmers' knowledge and productivity. The magnitude of the spillover on knowledge was slightly smaller than the direct effect on women beneficiaries and substantively smaller on their productivity. Men farmers benefited even when they were not the direct recipient of the intervention, but they fared better if the choice of the target was left to the household than they did under women-focused targeting.

Under women-focused targeting, outcomes for women and men converged. The convergence was much more pronounced for productivity than for knowledge. This is consistent with smaller knowledge gaps because, even in the absence of the intervention, most men and women soy producers exchange advice and discuss production within the household. We also found that most farmers intended to plant soybean in the subsequent season. The intervention strongly affected farming women's intentions to plant soy in the subsequent season (the effect was also positive for men but of a lesser magnitude). Women-focused targeting reinforced this effect for women and cancelled it out for men.

This study contributes to two strands of the literature. First, we offer additional evidence on the effectiveness of contract-farming arrangements. Deutschmann, Bernard, and Ouambi (2021) provided rigorous evidence of the effectiveness of a contract-farming arrangement for Senegalese groundnut farmers (396 farmers in forty villages). As in our experimental study, the contract bundled price guarantees with training and credit for input purchases. In their case study, however, the contract was only for products that met a higher quality standard (with a premium-price guarantee). The authors found that farmers who were offered the contract were 12% more likely to comply with the stricter standards. In our study, there is no price premium but rather a commitment by UNPS to find a buyer at the government-guaranteed soy price. In our context, the main motivation for taking-up the contract was the delivery of soy-specific inputs with the option of deferred payment at zero interest.

We also offer new field-experimental evidence that bundling interventions in a contract-farming arrangement is highly effective in increasing farmers' technical skills and productivity. Our work is close to that of Arouna, Michler, and Lokossou (2021) for rice farmers in Benin, which offered evidence from a multiple-arm contract-farming experiment that unbundled different effects (price guarantees, price guarantees plus extensions, and price guarantees plus extensions plus input loans). They found that neither extension nor extension combined with input loans contributed to an increase in the effectiveness of the contract-farming arrangement. Our study context is different because we studied producers of soybeans, a fairly recent crop in Benin. Prior to the intervention, farming men (women) in our study sample had six (four) years of experience in soybean cultivation out of seventeen (ten) years in agricultural production. At baseline, in addition, few farmers had ever participated in technical training for soy production (11% of men and 3% of women), and very few used soy-specific inputs such as inoculum.

To the best of our knowledge, our study is the first to investigate the role of contract farming in reducing gender disparities in agricultural productivity through women-focused targeting, and we therefore contribute to the literature on gender mainstreaming in agricultural projects. The literature documents gender differences in productivity, with farming women having limited access to resources and training (see Banerjee et al., 2014 for a review based on LSMS-ISA production data on plots managed by men or by women).

The papers closest to ours in regard to the investigation of gender differences in the impacts of agricultural projects are Karamba and Winters (2015) for Malawi and Buehren et al. (2019) for Ethiopia. Both were non-experimental impact evaluations of agricultural projects. Karamba and Winters (2015) assessed the Malawi input-subsidy program and found that both men and women experienced an increase in productivity. Unlike our study, however, the input-subsidy project included no special features intended to reduce gender gaps, and improvements in yield did not translate into a narrowing of the gender gap. The second study assesses a large agricultural extension program in Ethiopia. The project in Ethiopia offered more women as extension agents, while ours did not change the pool of extension agents but rather the identity of the direct beneficiary (women vs. household choice). Buehren et al. (2019) found improvements in agriculture-extension-service delivery (regularity of meetings with extension agents, satisfaction with advice received) for both farming men and farming women but found no effect either on productivity or on gender disparities in agricultural outcomes.

Another finding from our study that differ from the existing evidence relates to the hypothesis that women lack the capacity to translate theoretical knowledge into practice (Ragasa, 2014; Banerjee et al., 2014). Two main explanations have been put forward. First, that knowledge provided by agricultural extension agents may not be adapted to women's farming needs and, second, that communication to farming women was less effective when agricultural extension agents were men (Kondylis et al., 2016).

Our evidence does not support this hypothesis: women acquire knowledge as effectively as men and can translate it into higher yields (at a higher rate than men) in an intervention in which the same agents offer the same advice regardless of the gender of the recipient. Moreover, our evidence is consistent with the findings of BenYishay et al. (2020) from Malawi where not only did farming women learn and use the information they were provided as well as farming men, they were also as good as men at communicating what they had learned. While BenYishay et al. (2020) provided evidence regarding the diffusion of information across gender groups, our study is the first to document within-household diffusion of technical information in agriculture.

Two other more minor contributions are worth mentioning. We assessed the potential for sustainability of the intervention by analyzing whether farmers intended to plant soybeans in the next rainy season (see also Abate et al., 2018. for a similar analysis of a wheat technical package initiative in Ethiopia). Finally, even though the use of mobile phones was not part of the initial design of the study, the intervention relied on phone services to provide individualized technical support to farmers (a necessity because of COVID-19 restrictions on mobility). Extensive mobile-phone ownership creates an opportunity to facilitate technological adoption via information-and-communication-technology-based agricultural-extension programs in developing countries (Aker, 2011). In relation to this literature, we tested mobile-phone-call extension services built into a contract-farming arrangement.

While we provide evidence that contract farming coupled with a women-targeted approach can improve gender equity, information on the impact on women's empowerment or changes in household consumption are beyond the scope of our study. Another limitation of our work is that we relied on self-reported data in which measurement errors for agricultural outcomes are known to exist (e.g., acreage cultivated, quantity harvested). Future research to confirm our results should employ a larger cluster-RCT with more reliable measurement approaches. In this larger framework, a cost-benefit analysis of the intervention should also be carried out, with special attention to resources required to limit take-up issues. Further research should also explore which specific component of contract farming (group training, extension services by phone, credit, local delivery of inputs, price guarantees) matter the most.

The remainder of the paper is organized in five sections describing the context of the study (section 2), the methodology (section 3), and the results (section 4). In section 5, we offer a discussion of the findings and conclude.

II. Context

2.1. Soybean Production in Benin

Soybean production around the world has evolved dramatically over the past few decades. Between 1991 and 2019, the world production of soybeans increased by more than 1,140% (from 26,883,158 tons to 333,671,692 tons) while harvested area and yield increased by more than 400% (23,818,820 ha to 120,501,628 ha) and 145% (1,128.7 kg/ha and 2,769.0 kg/ha), respectively (Food and Agriculture Organization of the United Nations, 2021). In Benin, in contrast, the production of soybeans increased by more than 17,250% (from 1,279 tons to 221,977 tons) with increases of more than 9,850% in the harvested area (2,008 ha to 199,844 ha) and about 75% in yield alone (637 kg/ha and 1110,8 kg/ha) between 1996 and 2018 (Food and Agriculture Organization of the United Nations, 2021).

Some 40% of Benin's population lives below the poverty line, and about 44% is located in rural areas (Institut National de la Statistique et de l'Analyse Économique, 2020). About 74% of the rural population lives in food insecurity (World Food Program, 2014). Their diets are poorly diversified with major deficiencies in foods rich in animal proteins, fruits, milk, and dairy products.

While changes in the harvested area and production of soy do show exponential increases over the years, changes in yield are rather small and not always progressive. Current yield, for example, lags behind the world average. In some production areas in Benin, soy yields are still as low as 500 kg/ha against an expected average of about 3,000 kg/ha (Agnoro, 2008; Kpenavoun et al., 2018). Though climate conditions are favorable for production, lack of access to agricultural credit, poor knowledge of good farming practices, lack of access to soybean-specific inputs (e.g., the inoculum that is a substitute for nitrogenous fertilizers and has proven to increase yields when used in combination with potassium), and subsequent low use of inputs remain key challenges that drive low productivity in Benin, especially for women who farm (Ollabode et al., 2017; Brulé-Françoise et al., 2016). As a result, interventions that policy makers should consider to increase soybean productivity include transferring technical knowledge, increasing availability of and access to soy-specific inputs, and encouraging adoption of higher-yield agricultural technology with particular attention to women who farm.

2.2. Contract Farming and the UNPS Intervention

2.2.1. Evidence on Contract-Farming and Interventions to Reduce Gender Gaps in Agriculture

Contract farming is broadly defined as an agreement between farmers and buyers typically made before production starts. As Bellemare and Novak (2017) have explained, contract farming refers to an institutional arrangement that allows buyers to contract the production of agricultural commodities to farmers while ensuring a consistent supply of quality inputs. Over the past decades, governments and international organizations have become increasingly interested in promoting contract farming as a means to facilitate technology adoption (Swinnen & Kuijpers, 2019; Wiggins & Keats, 2013), facilitate smallholder market participation (Wiggins & Keats, 2013; Meemken & Bellemare, 2020), reduce transaction costs (Bellemare, 2012), facilitate access to financial services (Carletto, Kilic & Kirk, 2011), and improve access to information and to reliable markets (Bellemare, Lee & Novak, 2021; Casaburi & Reed, 2019). All this can increase productivity, improve household welfare and promote rural development (Key & Runsten, 1999; Khan et al., 2019; Wiggins & Keats, 2013; Bellemare & Bloem, 2018; Meemken & Bellemare, 2020).

Despite the limited number of studies that have attempted to rigorously measure the impact of contract-farming interventions (Lopez-Aval et al., 2017), the evidence (e.g., Mulatu et al., 2017; Alemu et al., 2016; Ton et al., 2017; Wang, Wang & Delgado, 2014; Ton et al.,

2018) suggests that contract farming has positive impacts on welfare indicators such as household income, farm productivity, and food security. A few studies (e.g., Olounlade et al., 2020) have suggested negative impacts while others (Khan, Nakano & Kurosaki, 2019; Michelson, 2013; Isager, Fold & Nsindagi, 2018) have raised the concern that contract farming may lead to higher inequality because of the exclusion and further marginalization of the poorest population.

Besides the need for more rigorous evidence of the role of contract farming, its impact on reducing gender disparities in agriculture has received little attention. Alleviating gender differences in agricultural productivity is vital for poverty reduction (Karamba & Winters, 2015). Women contribute more than half of the agricultural labor and are involved in all crop production activities (Akter et al., 2016; Akter et al., 2020), but they are often excluded from innovation adoption and from extension services (Quaye et al., 2019), including related benefits and gains. Gender disparities in agricultural productivity have been shown to vary from between 8% to 46% (Aguilar et al., 2015; Ali et al., 2016; Nur Fauziah, 2017) and women are known to have a limited access and/or control over productive resources among other constraints. A 2020 study by Apedo-Amah, Djebbari and Ziparo showed that conflicting interests in consumption of public goods may lower husbands' incentives to allocate productive resources to women-controlled plots. Additionally, communication failures within farm households could be a barrier to access information and innovation, especially for women (Apedo-Amah, Djebbari & Ziparo, 2020).

Previous studies (e.g., Duflo, Kremer & Robinson, 2011; Gates, 2014; Kabeer & Natali, 2013; Klasen, 2018) have argued that empowering women may lead to economic benefits for women themselves and for their households and communities. Anderson et al. (2021) suggested two channels through which such benefits could accrue: eliminating differences between women and men in such areas as input access or leveraging risk, time, and social preferences that lead women to allocate resources differently.

2.2.2. Design and Implementation of the UNPS Contract-Farming Intervention

The intervention was designed by UNPS Benin, a non-governmental organization that has supported soybean farmers in Benin for more than a decade. UNPS is an important stakeholder in soybean production and marketing alongside the Department of Agriculture (Ministère de l'Agriculture de l'Elevage et de la Pêche, hereafter MAEP). The intervention is aimed at responding to such issues as farmers' limited technical knowledge regarding recommended farming practices for soybean production (in particular, inoculum use), liquidity constraints at the onset of the rainy season, availability of quality inputs in the villages, price volatility at harvest, and women's limited access to resources and inputs. The intervention was based on a contract between UNPS and individual farmers that integrated two components:

- **Technical training**: Farmers were trained on best (recommended) farming practices to produce soybeans. The main training on the technical aspects of soybean production, from soil preparation to harvesting and storage, including the use of inoculum, was carried out in groups at the village level. One training session was conducted per treatment village with about twenty participants each. Each training was interactive and conducted by a qualified UNPS Benin officer with audio-visual aids and demonstrations of specific practices. In addition to the training, continuous technical support was provided via monthly phone calls. Calls were initiated by UNPS officers following a specific protocol that involved checking on how farmers were doing and where they stood with regard to production activities, reminders of recommended agricultural practices for forthcoming activities, and discussions regarding any technical issues that the farmer might be facing.

- **Delivery of soy-specific inputs with the option of deferred payment and a sales guarantee**: Conditional on their successful completion of the training, UNPS Benin provided participants soy-specific production inputs on credit at zero percent interest. The full package of inputs included certified seeds and soybean inoculum.[1] At this pilot stage, farmers were allowed to subscribe only for a 0.25 ha inputs package, a cost of about $15 USD. To account for liquidity constraints, repayment

[1]The full package normally includes soybean-specific fertilizers and pesticides. Because of COVID-19 however, only certified seeds and soybean inoculum were provided to farmers.

was not expected until harvest. Volunteer farmers signed a formal commitment form with UNPS Benin that bound them to repay the cost of the inputs they received.[2] The cost of inputs provided through the contract was based on harmonized national input prices and allowed an economic return even if the production was sold at the minimum guaranteed soy price. Farmers were offered the option to pay for the inputs immediately or to sign a contract for deferred payment at the time of harvest. The deferred-payment plan was set as a zero-interest loan. In this contract, UNPS commited to finding buyers at harvest time who would pay the government-guaranteed soy price. In each treatment village, inputs were delivered to a pre-identified point before planting started, typically the house of the village head. Farmers were not allowed to buy or receive additional inputs on credit from UNPS Benin, though they could purchase additional inputs from local markets if they chose, an unlikely event because soybean-specific inputs were not available and the production system was based on low-input use of capital.

2.3. Theory of Change

Training farmers on recommended farming practices for soybean production should help improve awareness, knowledge, and attitudes among smallholder farmers and increase their likelihood to adopt better farming practices. Technical training coupled with timely delivery of quality inputs should result in increases in yields, which may translate into increases in income and better livelihoods. Figure 1 shows the simplified theory of change of the intervention.

Within the framework of our impact evaluation, we focused on farmers' knowledge and yields as indicators of the effectiveness of the intervention. In addition to the impact pathways described above, we considered another in which gender-related gaps in knowledge and

[2] UNPS envisions including a market-access component intended to facilitate interactions between soybean producers and potential buyers. This component is still under development and discussions favour establishing a clustering system to make marketing easier. It is important to note that farmers will be able to choose whether to sell their crop to UNPS or at higher prices on the market.

yields could be reduced by ensuring that farming women were the beneficiaries of the intervention (Anderson et al., 2021). As knowledge is non-rival, both women and men within the farming household should experience increased knowledge if knowledge is shared within the household. The targeting may affect knowledge sharing within the household, with higher spillovers from the direct beneficiary to his spouse under women-focused targeting than with no-targeting (household choice of beneficiary). Finally, a reduction in yield is only expected on plots cultivated by the direct beneficiary, resulting in a reduced gender gap in yield under women-focused targeting in comparison to the no-targeting protocol.

III. Methodology

3.1. Study Zone, Sampling, and Randomization

The pilot project was conducted in the Pole de Développement Agricole 4 (PDA4) in Benin, a zone that contains sixteen municipal areas organized into four administrative departments. PDA 4 is known as the cotton-food zone of Benin with cashew and cotton representing the main production sectors (Ministère de l'Agriculture de l'Elevage et de la Pêche, 2017). The soybean sector has recently been identified by the government as a priority in PDA4. Most importantly, PDA 4 is identified as the leading pole for soybean development in the country because it provides close to half of Benin's soybean production with a high concentration in the Borgou Department.

For the purpose of the impact evaluation, we considered a household eligible if it had (at least) a couple in which both the husband and wife cultivated soy on a plot they individually managed. In polygamous households with more than one wife cultivating soy, the household had to choose whom to include in the study sample.

In order to determine the sampling frame, we listed all 102 soy-producing villages free of previous UNPS-Benin intervention. We then conducted paired-wise matching of the 102 villages based on village-level climate and soil-condition data. We randomly selected nineteen pairs of villages from a total of fifty-one. After a field visit, we confirmed that the nineteen selected pairs of villages were eligible for the intervention based on the number of soy-farming households and accessibility of the villages. As such, at the Primary Sampling Unit, the sample is representative of soy-producing villages in the Borgou Department.

In a second stage, we listed soy producing households with both farming men and farming women who cultivated on their own plots and offered to enroll them into the study. We told them that, by participating in the study, they might be able to benefit from a UNPS intervention if their village were to be assigned to the treatment group. Finally, we randomly selected twenty volunteer households in each village. Note that the sampled households were only representative of soy-producing households in which a farming man and one farming-woman partner were cultivating soybeans on separate plots.

Our experiment was designed as a two-stage Randomized Controlled Trial (RCT), involving thirty-eight villages and 760 households organized into three groups:[3]

i) **Women-targeted group:** A treated group in which the farming woman was the direct beneficiary of the intervention (i.e., she was eligible for a UNPS contract and received training and the input package);

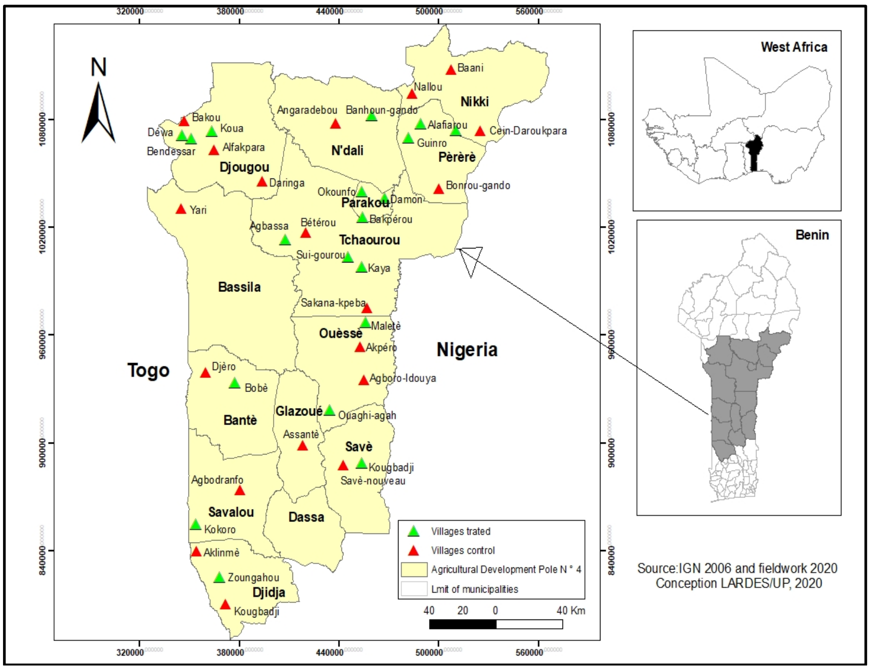
ii) **Household-choice group**: A treated group in which decisions regarding who would be targeted by the intervention was left to the household;

iii) **Control group:** A pure control group in which households did not receive the UNPS intervention.

The first random assignment was done at the village-level. Within each pair of villages, we randomly assigned one village to the treatment group where the intervention was delivered and the other to the pure control group. This was done using a public lottery. Figure 2 shows the village status after the first random assignment.

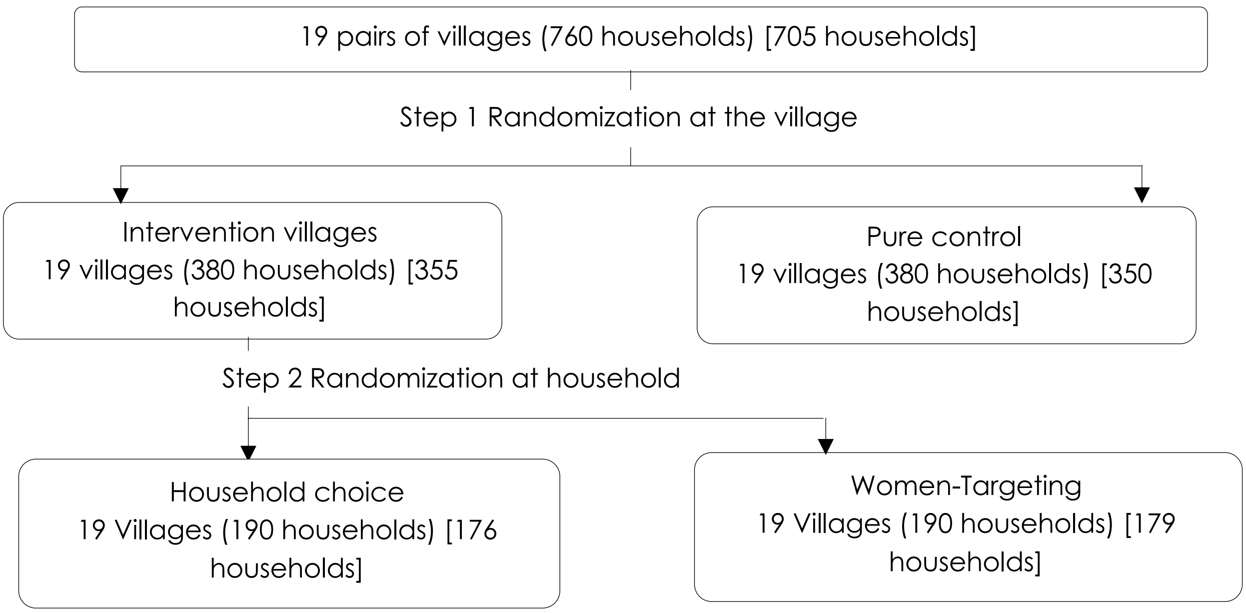
[3] Our power calculations suggested that we could detect an effect size as small as 0.58 when comparing the pure control group and the pooled treatment group. In comparisons of the two treatment groups, we were able to detect an effect size as small as 0.35 standard deviations.

Figure 2: Map of the Study Villages after Village-Level Randomization



The second randomization was conducted at the household-level in each of the nineteen villages assigned to the treatment group to assign household to one of the two treatment groups - women-focused targeting or household-choice - through a public lottery meeting in each village. Figures 3 illustrates the randomization process and details on power calculations are presented in Appendix 1.

Figure 3: Illustration of the Randomization Approach

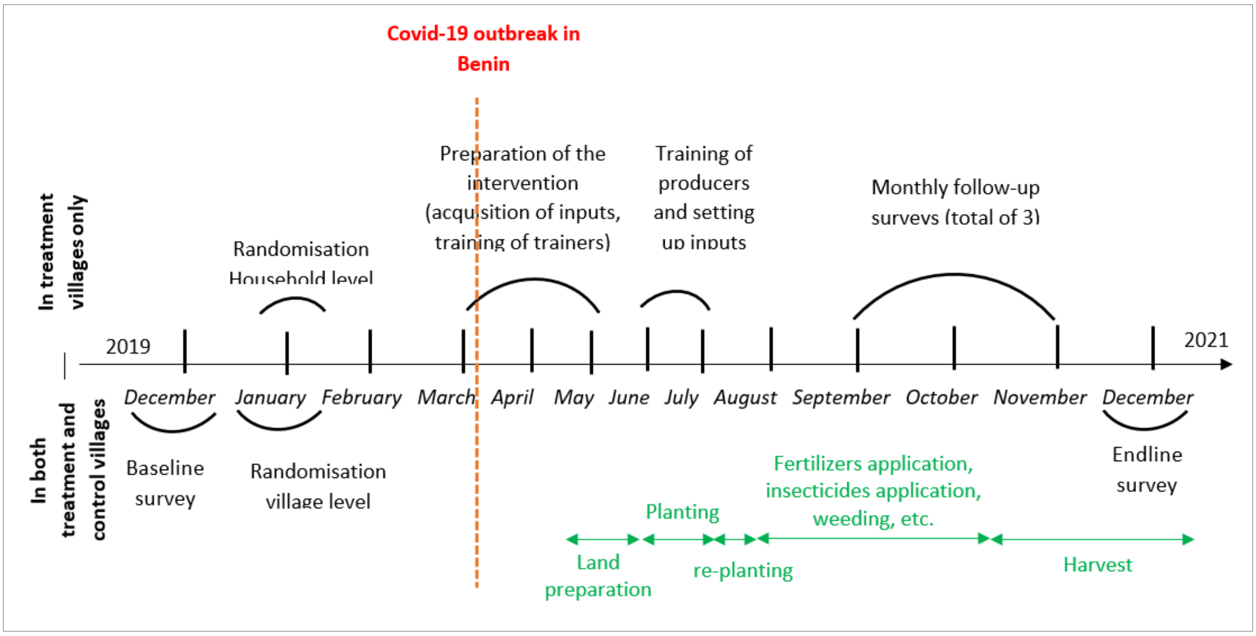


Note: Values in parentheses are # of households at baseline and values in brackets refer to the number of households at endline.

3.2. Data Collection

Data were collected at baseline from December 2-18, 2019 (the reference period was the 2019-2020 rainy season) and endline from December 13-24, 2020 (the reference period was the 2020-2021 rainy season). For each survey, a team of thirty experienced investigators was hired and trained for four days. Figure 4 shows the timeline of the study.

Figure 4: Timeline of the Study



Data collection was conducted using Computer Assisted Personal Interview on tablets. Each farming man and woman in the household was interviewed separately. Each survey lasted forty-five minutes on average and started with an informed consent question. At endline, we recorded attrition to account for whole households migrating outside the study zone or being lost to follow-up, as well as for cases in which farming men or women in the household left the study area or were lost to follow-up. The attrition rate was found to be the same across experimental arms and stood at 7.2% (see Appendix 2).[4] Participation in the pilot intervention (here defined as participation in the one-time group training and receipt of the inputs package) was quite high thanks to the UNPS Benin's pre-intervention mobilization

[4] We checked balance for households without attrition and the results remained consistent.

and information campaign. About 90% of the targeted farmers in the treated group participated in the group training and about 91% of them collected the input package.

At each baseline and endline, we collected primary data on the household and on individual farming men and women. Accordingly, the questionnaire was organized in three main modules: household, farming men, and farming women. The household module was addressed to the head of household and covered general household information such as household size, importance of soybeans with respect to household consumption and income, assets owned, etc. Each module for men and women farmers covered information such as age; education; experience in agriculture; access to credit; knowledge, attitudes, and practices with respect to soybean production; soy production inputs (land, fertilizers, herbicides, etc.); and outputs for the 2019-2020 (at baseline) and 2020-2021 (at endline) rainy seasons.

Our main outcome indicators were the Knowledge Score (KS) and Yield (Y).[5] For KS, we separately tested men and women farmers on their knowledge of recommended practices using a list of twenty-nine items/practices, ranging from land preparation to post harvest and storage.[6] Knowledge testing took place during the endline survey (five months after the end of training). For each practice, we gave a score of 1 if the respondent knew the recommendation and 0 otherwise. Outcome KS was then computed as the sum of the individual item/practice score with equal weights. For the estimation of impact, we used standardized knowledge scores.[7] Given the way we measured knowledge, our findings on the impact of the intervention on knowledge scores were estimated with high confidence.

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[5] We were unable to consider repayment as an outcome indicator because of our study timeline. Repayment was still ongoing when we closed the study and was up to 70%, with good prospects to meet the 100% target.

[6] Test questions measured knowledge over the following twenty-nine items: 1= Type of ploughing, 2= Type of soil, 3= Depth of sowing, 4= Type of sowing, 5= Distance between holes for sowing, 6= Number of grains per hole, 7= Number of plants after germination, 8= Type of varieties, 9= Sowing dates, 10= Type of fertilizers, 11= Dosage of TSP-NPK fertilizers, 12= Dosage of TSP-KCL/K2SO4 fertilizers, 13= knowledge of inoculum, 14= Dosage of inoculum, 15= Number of weeding, 16= Dates of first weeding, 17= Dates of second weeding, 18= Dates of third weeding, 19= Pre-germination herbicide, 20= Post-germination herbicide, 21= Dosage of Kalifor G, 22= Dosage of Faaba, 23= Use of insecticides, 24= Type of insecticides, 25= Dates of harvest, 26= Method of harvest, 27= Method of threshing, 28= Method of seed storage/conservation, 29= Method of harvest storage/conservation.

[7] For each individual i, the standardized score is as follows: $KS_i^{SD} = (KS_i - \overline{KS}_0)/SD_0$ where KS_i is the measured knowledge score, and $\overline{KS}_0$ (SD_0) is the mean (SD) for the control group.

As for the other primary outcome of interest (i.e., soybean yield), we measured land productivity and constructed the yield outcome as the ratio of harvested soybean output to area cultivated in soybeans. Yields were likely to be measured with errors, but standard measurement errors should be balanced across experimental groups. The main issue with self-reported yields in our study was possible overestimation of the impact on yield if treatment-group farmers were subject to social-desirability bias. Finally, in order to assess total gains at the household level, individual data were aggregated as the sum over men and women farmers from the same household.

3.3. Descriptive Statistics and Balance Tests

- *Sample Descriptive Statistics and Gender Gaps*

The descriptive statistics presented in Table 1 show that, overall, gender disparities were relatively modest (34 kg/ha, 4% lower for women as compared to men), although actual yields around 800 kg/ha were much lower than potential yields. In endline data for the control group (Table 3 below), however, both farming men and women showed lower yields and larger gender disparities (110 kg/ha) among farmers in the control group. Such variation in yields in two subsequent years is large and suggest that yields on women-managed plots are hit harder in a bad year.

Another possibly surprising finding is that there was no gender gap in knowledge. This may be explained by the fact that, in most of the households, farming men and women also worked together on a family plot. In addition, most of the respondents mentioned that they discussed production-related issues with their partners, with a tendency for farming men to give more advice to their partners than they received from them.

Table 1: Descriptive Statistics According to Gender of Producer

Variables	Men (N = 705)	Women (N = 705)	Gender gap (Men/Women)
Outcome variables			
Knowledge score (0 – 29)	11.85 (5.28)	10.42 (5.24)	1.42** (* (.28)
Soybean yield (kg/ha)	821.49 (288.95)	787.03 (290.90)	34.46* (* (15.51)
Covariates			
Age (in years)	41.40 (11.35)	33.77 (9.55)	7.63*** (.56)
Duration of life together ((# of years)	16.23 (9.39)	15.63 (9.05)	.59 (.49)
Non-formal education (yes/no)	.33 (.55)	.07 (.30)	.26*** (.02)
Formal education (yes/no)	.41 (.49)	.23 (.42)	.17*** (.024)
Duration of formal education (# of years)	3.52 (4.82)	6.19 (2.67)	-2.66*** (.39)
Professional training (yes/no)	.10 (.30)	.09 (.29)	.01 (.015)
Side activity (yes/no)	.32 (.47)	.47 (.49)	-.15*** (.02)
Agriculture as main activity (yes / no)	.96 (.19)	.89 (.31)	.07*** (.013)
Experience in agriculture ((# of years)	17.98 (10.67)	10.44 (7.67)	7.53*** (.49)
Experience in soybean production ((# of years)	6.05 (3.73)	4.15 (2.72)	1.89*** (.17)
Any association membership (yes / no)	.27 (.44)	.11 (.32)	.16*** (.02)
Soybean association membership (yes / no)	.11 (.31)	.06 (.24)	.04*** (.01)
Access to credit (yes/no)	.11 (.32)	.02 (.16)	.089*** (.01)
Ever enjoyed soy-related support (yes/no)	.11 (.31)	.03 (.18)	.079*** (.01)
Enjoyed soy-related support in 2019 (yes/no)	.04 (.21)	.009 (.09)	.03*** (.008)
Knew ALL (100%) of the best practices (yes / no)	.001 (.03)	0 (0)	.001 (.001)
Nutritional importance of soybeans (yes/no)	.97 (.16)	.96 (.18)	.008 (.009)
Economic importance of soybeans (yes/no)	.98 (.11)	.99 (.09)	-.005 (.005)
Social importance soybean (yes/no)	.84 (.36)	.77 (.41)	.06*** (.02)
Environmental importance soybean (yes/no)	.93 (.23)	.90 (.29)	.03*** (.014)
Work with partner (yes / no)	.86 (.34)	.97 (.15)	-.11*** (.014)
Discuss practices with partner (yes/no)	.87 (.33)	.88 (.32)	-.012 (.017)
Gave advice to partner (yes/no)	.91 (.28)	.77 (.42)	.14*** (.019)
Received advice from partner (yes/no)	.77 (.41)	.91 (.27)	-.140*** (.018)
Made decisions on labor allocation (yes/no)	.88 (.31)	.22 (.42)	.65*** (.019)
Made decisions on the plot of land (yes/no)	.901 (.29)	.22 (.41)	.68*** (.019)
Made decisions on land acreage (yes/no)	.89 (.30)	.27 (.44)	.61*** (.020)
Made decisions on purchases of inputs (yes/no)	.89 (.30)	.21 (.41)	.68*** (.019)
Made decisions on purchases of equipment (yes/no)	.89 (.30)	.13 (.34)	.76*** (.017)
Average risk score †	606.94 (269.45)	545.32 (260.01)	61.61*** (20.42)

† *We used the staircase approach as proposed by Falk et al. (2016) to assess respondents' attitudes towards risk. The staircase approach includes a sequence of lottery choices. Respondents all start with the same first question, and the choice of the lottery or the safe-payment option determines the next question in the sequence. (Values in parentheses in the first two columns are standard deviations. (Values in parentheses in the last column are standard errors. P values in the last column are regression-based estimated with village-pair dummies and standard errors clustered at village level.*
**p <.10; **p <.05; ***p <.01.*

Farming men were an average age of forty-one years old, about eight years older than farming women. Spouses had been living together fifteen to sixteen years, and less than half of households were polygamous. Though 40% of farming men had acquired some formal education, only 22% of farming women had. Farming men had six years of experience in soybean production, two years more than did farming women. Respondents' perceptions of nutritional economics, and of the environmental and social importance of soybeans was nonetheless high. Men were more likely to belong to farmers associations and had more access to credit than did farming women (11% for men, 2% for women). Farmers had received very little support for soybean production in the past (11% for men, 3% for women). Men were more likely than women to make production choices (on agricultural inputs and equipment, on land allocation, etc.) on their own. These gender gaps are consistent with evidence found in other countries in sub-Saharan Africa (Aguilar et al., 2015; Ali et al., 2016; Nur Fauziah, 2017).

- *Experimental Integrity*

We used baseline data to check for balance at each of the two levels of random assignment (see balance-test tables in Appendix 3). At the village-level randomization, balance tests suggested that intervention and control groups were roughly similar based on baseline data on the outcome of interest (knowledge and yield) and a selected set of covariates (Table 1, Appendix 3). A few statistically significant differences were noted, however: household assets (i.e., numbers of radios, bicycles, and motorbikes), socio-linguistic group, whether farming women had acquired informal education, whether farming men worked with their spouses, the identity of the person who determined the size of the woman-managed plot, and the availability of fertilizers (NPK).[8]

The balance tests for household-level randomization (Table 2, Appendix 3), indicated that both treatment groups were also well balanced on the outcome of interest and most of the covariates. In the estimation model, we controlled for the covariates for which we observed imbalance.

- *Household-targeting: who is the beneficiary farmer?*

Looking at Table 2 below, the beneficiary farmer in the household-choice experimental

[8]Full balance tables are available upon request.

arm is in 85% the man. This person is on average five years older than his/her partner, three times as likely to have received non-formal education but as likely to have benefitted from professional training. The beneficiary farmer is less likely to be involved in a second income-generating activity, is more likely to report agriculture as his/her main activity and has spent more years in farming (a little more than one additional year farming soybean) compared with his/her partner. His/her knowledge score and yield at baseline are similar to the one of the partner.

The differences between the beneficiary farmer and his/her partner in the household-choice arm are often larger than the ones between men and women farmers in the women-targeted one, reflecting the fact that in 15% of household, the farmer chosen to benefit from the UNPS intervention is the woman farmer. Such choice is more likely for women who do not have a side activity (report agriculture as the main activity) and have more experience farming soy.

Table 2: Descriptive Statistics of the Characteristics of Beneficiaries and Their Partners (baseline data)

	Household choice (N=176)		Women-targeted (N= 179)	
	Household choice	**Partner**	**Men farmers**	**Women farmers**
Outcome variables				
Knowledge score (0-29)	12.38 (.38)	11.59 (.39)	12.62 (.41)	11.11 (.42)
Yield (kg/ha)	819.32 (22.38)	802.12 (21.39)	831.33 (21.52)	807.81 (20.95)
Covariates				
Gender (1=Man/0=Woman)	.85 (.02)	.14 (.02)	-	-
Age in years	39.41 (.87)	34.32 (.81)	41.38 (.90)	33.13 (.74)
Man has another wife (yes/no)	.32 (.035)	.35 (.03)	.37 (.03)	.37 (.03)
Non-formal education (yes/no)	.30 (.03)	.10 (.02)	.33 (.03)	.02 (.01)
Formal education (yes/no)	.36 (.03)	.23 (.03)	.48 (.03)	.23 (.032)
Duration of formal education (# of years)	3.57 (.40)	4.98 (0.59)	4.23 (5.02)	6.36 (2.74)
Professional training (yes/no)	.10 (.02)	.10 (.0237)	.12 (.02)	.13 (.02)
Side activity (yes/no)	.32 (.03)	.45 (.037)	.33 (.0357)	.58 (.037)
Agriculture as main activity (yes/no)	.96 (.014)	.89 (.023)	.93 (.01)	.87 (.02)
Experience in agriculture (# of years)	17.40 (.82)	11.02 (.64)	17.14 (.75)	9.68 (.57)
Experience in soybean production (# of years)	6.12 (.33)	4.49 (.25)	6.35 (.29)	3.94 (.18)
Association membership (yes/no)	.32 (.035)	.18 (.02)	.29 (.034)	.13 (.026)
Soybean association membership (yes/no)	.15 (.027)	.09 (.022)	.11 (.02)	.072 (.019)
Access to credit (yes/no)	.11 (.02)	.03 (.01)	.08 (.020)	.01 (.007)
Ever enjoyed soy-related support (yes/no)	.11 (.023)	.05 (.017)	.15 (.026)	.03 (.014)

	Household choice (N=176)		Women-targeted (N= 179)	
	Household choice	Partner	Men farmers	Women farmers
Enjoyed soy-related support in 2019 (yes/no)	.03 (.01)	.01 (.009)	.09 (.021)	.016 (.009)
Knew ALL (100%) of the best practices (yes/no)	0	0	0	0
Nutritional importance of soybeans (yes/no)	.97 (.012)	.96 (.013)	.97 (.012)	.96 (.013)
Economic importance of soybeans (yes/no)	.98 (.008)	.99 (.005)	.99 (.005)	.98 (.009)
Social importance of soybeans (yes/no)	.85 (.026)	.82 (.029)	.85 (.027)	.76 (.032)
Environmental importance of soybeans (yes/no)	.97 (.009)	.92 (.01)	.94(.017)	.87 (.024
Work with partner (yes/no)	.86 (.02)	.92 (.01)	.79 (.03)	.95 (.014)
Discuss practices with partner (yes/no)	.85 (.02)	.90 (.02)	.90 (.022)	.89 (.023)
Gave advice to partner (yes / no)	.77 (.03)	.90 (.02)	.91 (.021)	.77 (.031)
Received advice from partner (yes / no)	.87 (.024)	.78 (.031)	.78 (.031)	.91 (.021)
Made decisions on labor allocation (yes/no)	.79 (.030)	.29 (.034)	.88 (.024)	.29 (.034)
Made decisions on the plot of land (yes/no)	.77 (.031)	.34 (.036)	.90 (.021)	.21 (.031)
Made decisions on land acreage (yes/no)	.87 (.025)	.39 (.037)	.90 (.021)	.33 (.035)
Made decisions on purchases of inputs (yes/no)	.79 (.030)	.33 (.035)	.90 (.021)	.22 (.031)
Made decisions on purchases of equipment (yes/no)	.74 (.033)	.27 (.0337)	.90 (.022)	.16 (.027)
Average risk score	547.95 (29.29)	542.03 (20.59)	615.65 (31.88)	535.28 (19.96)

Note: Values in parentheses are standard deviations.

- *Estimation strategy*

We used the exogenous variation created by the pair-wise matching and random assignment done at the village level to identify the overall impact of the contract-farming intervention. In addition, we used the within-village random assignment done at the household level to identify the impact of the women-focused targeting mechanism against the household targeting approach. In our empirical models, we included the set of covariates that were not balanced at baseline. We included village-pair dummies and village-level clustered error terms.[9] In order to identify the overall impact of the contract-farming intervention, we used OLS to estimate the following equation separately for men and women producers:

$$Y_{ijv} = \alpha + \beta T_v + \delta Z_{ijv} + \rho_v + e_{ijv} \qquad \text{[Eq. 1]}$$

[9]Balance test also use the same structure for the error terms.

where

Y_{ijv} is the outcome variable for individual $i$living in village v, Tv is the intervention treatment status ($T_v =$ 1for intervention villages, 0 for control villages), Z_{ijv} are the unbalanced covariates, ρ_v are village − pairs fixed effects, and e_{ijv} is the error term that is clustered at village level. We estimate by OLS the effect of targeting women for benefits based on Eq. 2 and using data from the intervention villages:

$$Y_{ijv} = \alpha + \gamma F_{jv} + \delta Z_{ivj} + \sigma_v + e_{ijv} \qquad \text{[Eq. 2]}$$

where $F_{jv} =$ 1 if the farming woman was the direct beneficiary in household$j$, 0 if household j is in household − choice treatment arm; σ_v are village fixed effects, and e_{ijv} is the error term that is clustered at village level. All o is the effect of targeting the intervention to farming women vs leaving the choice of beneficiary to the household.

- *Preliminary Results from Endline Data*

Table 3 presents descriptive statistics of outcome variables for each group in our experiment at endline. For each outcome, we show men (column 1), women (column 2) average, and household (column 3) total in the control group (line 1), women-targeted group (line 2), and household-targeted group (three last lines). In the household-targeted group, we provide distinct statistics according to the endogenous choice of beneficiary (Choice Men/Choice Women) and also show pooled statistics.

Because knowledge scores were standardized, the average for the control group was close to 0 (and the standard deviation was close to 1). In the women-targeted group, men's scores were one standard deviation above the mean, similar to women's scores in the household-targeted group. Women's scores were 1.36 standard deviations above the mean in the women-targeted group (higher by 0.36 standard deviations) as compared to men in the same group. This estimate was similar to estimates for average men's scores in the household-choice group. From this first look at the data, the intervention did increase the scores of both men and women under women-targeting and when the choice of beneficiary was left to the household. In both cases, the extent of within-household spillover was similarly large (the sum across men's and women's scores was the same at around 2.40 standard deviations), but the direct beneficiary of any gender still experienced a slightly larger impact than the spouse of any gender (1.30 standard deviations vs 1 standard deviations).

Preliminary results on yields were similar in that the intervention resulted in higher yields for both men and women, regardless of the targeting mechanism. But the sizes of the effects were much different for men and women according to the targeting mechanism. First, the women-focused intervention almost doubled yields on the plots women cultivated (84% increase from 559 kg/ha to 1030 kg/ha). The effect is still sizeable for women in the household-choice group (a relative increase of 57%). Gender disparities in yields in the control group were larger than at baseline (110 kg/ha). Men in the household-choice group also experienced a large increase, amounting to a 68% increase in yields on their plots (669 kg/ha to 1125 kg/ha), but the gain was much more modest when spouses were targeted (19% increase). Overall, gains across spouses (last column) were similar in the women-targeted group and household-choice group, but women-targeting was more advantageous to farming women.

Table 3: Descriptive Statistics of Key Outcomes at Endline

Groups		**Knowledge score (standardized)[a]**			**Yield (kg/ha)**		
		Men	**Women**	**Households**	**Men**	**Women**	**Households**
Control (N=350)		0.0001 (1)	0.0001 (.99)	0.0001 (1.93)	669.59 (418.313)	559.65 (291.788)	1276 (610.17)
Women-targeting (N=179)		1.11 (.73)	1.36 (.82)	2.47 (1.50)	797.60 (137.15)	1030.70 (296.66)	1824.3 (318.88)
Head of household-choice	Choice Men (N=151)	1.34 (.80)	1.10 (.96)	2.44 (1.60)	1173.56 (291.20)	875.68 (189.77)	2049.24 (400.97)
	Choice Women (N=25)	1.11 (.59)	1.29 (.77)	2.41 (1.22)	808.49 (158.25)	892.81 (217.72)	1689.23 (328.69)
	Men/Women (N=176)	1.30 (.77)	1.13 (.93)	2.44 (1.55)	1125.17 (303.47)	879.24 (194.92)	1996 (414.34)

Note: [a]: Standardized using the mean and standard deviations of the pure control group. Values in parentheses are standard deviations.

IV. Econometric Results

4.1. Overall Impact of the Contract-Farming Intervention

Table 4 presents the estimates of the intervention impacts. We pooled observations from the two treatment arms (intervention under women-targeted and household-targeted approaches). We provide impact estimates for farming men and women separately on both outcomes of interest. The first column shows the control group average. Impact estimates with no control (respectively, controlling for unbalanced covariates) are in the second (respectively, third) column. The intervention is clearly beneficial to both farming men and women on both outcomes.

The impact on standardized knowledge score is roughly the same for men and farming women. The UNPS training component of the intervention is clearly effective with a 1.2-1.3 standard deviations increase in scores. The impact on soy yield is sizeable. Though the intervention impact was much larger for farming women than for farming men, both in absolute terms (slightly more than 400 kg/ha increase for women, slightly less than 300 kg/ha for men) and in relative terms (73% increase for women, 42% increase for men), the pilot program of this contract-farming intervention, through its combination of innovations, holds potential for scale.

Table 4: Impact Estimates of the Intervention
(Pooling Women-Targeted and Household-Targeted Groups)

Outcome/Observation unit	Control group mean	Impact estimate (no controls)	Impact estimate (with controls)	No. of observations
	(0)	(1)	(2)	(3)
Knowledge score (standardized)				
Farming man	-1.84e-07 (.05)	1.21*** (.12)	1.24*** (.13)	705
Farming woman	1.92e-07 (.05)	1.25*** (.13)	1.34*** (.12)	705
Yield (kg/ha)				
Farming man	669.59 (23.49)	297.06*** (48.09)	274.91*** (45.33)	647
Farming woman	559.65 (19.49)	421.46*** (31.88)	424.50*** (31.54)	647

Values in the first column are mean and standard deviation (in parenthesis). Values in second column (resp. third column) are obtained from Eq. 1 with no controls (resp. with controls). Controls are as measured at baseline: cotton production; ownership of assets such *as a radio, bike, or motorcycle; soybean association membership; work on the wife's soybean plot; work on the husband's soybean plot; sociolinguistic groups; availability in the village of seed, NPK, and/or urea; and nature of the soybean field soil. All coefficient estimates are obtained from a model with village-pairs fixed-effect and village-clustered error terms. *p <.10; **p <.05; ***p <.01.*

4.2. Impact of the Targeting Mechanism

Table 5 presents the impact estimates for the intervention under the two distinct targeting mechanisms (women-targeted and household-targeted) for farming women and men (lines 1 and 2) and on a household aggregate (line 3). We provide impact estimates for farming men and women separately on both outcomes of interest (knowledge in Panel 1 and yield in Panel 2). In each Panel, the first column provides the mean estimate for the household-targeting group, and the second and last show impact estimates for the beneficiaries of the women-targeted group (with and without controls).

Table 5: Impact of the Targeting Mechanism

Observation unit	Impact of women-targeting on knowledge score (standardized)			Impact of women-targeting on yield (kg/ha)			No. of observations
	Household-targeted group mean	No controls	Controls	Household-targeted group mean	No controls	Controls	
	(0)	(1)	(2)	(0)	(1)	(2)	
Farming man	3.04e-07 (.07)	-.27*** (.08)	-.23*** (.09)	1125.17 (23.55)	-327.24*** (25.60)	-325.94*** (25.44)	330
Farming woman	6.60e-07 (.07)	.22** (.08)	.24*** (.08)	879.24 (18.93)	155.97*** (29.96)	152.26*** (31.44)	271
Household (sum)	4.82e-07 (.06)	-.02 (.08)	0.27 (.08)	1996.99 (41.02)	-157.91*** (44.71)	-176.50*** (45.28)	345

*Values in parentheses are standard errors. Impact estimates obtained from Eq. 2. Controls are as measured at baseline: cotton production; ownership of assets such as a radio, bike, or motorcycle; soybean association membership; work on the wife's soybean plot; work on the husband's soybean plot; sociolinguistic groups; availability in the village of seed, NPK, and/or urea; and nature of the soybean field soil. All coefficient estimates are obtained from a model with village fixed-effects and robust error terms. *p <.10; **p <.05; ***p <.01.*

The pattern of results is different for the two main outcomes of interest according to the gender of the farmer. Compared with a household-targeted intervention, the women-targeted intervention positively affected the knowledge scores of women farmers (+.22-.24 S.D.) and negatively affected those of farming men (-.27 to -.23 S.D.). However, overall (last line), the household neither benefited nor lost from targeting women (the effect of the intervention was positive; see Table 4 above).

The pattern of effects on yield was much different. Impacts were reduced for men under women-targeting (around -330 kg/ha, significant at 1%) as compared to household-targeting. They were larger for farming women under women-targeting as compared to household-targeting (+155 kg/ha, significant at 1%). At the aggregate-level (sum across plots managed by men and women), the household benefitted less from the intervention with the women-targeting approach as compared to household targeting (-158-176 kg/ha). The loss represents 8-9% of the aggregate yield for the household-targeting group. Under both targeting approaches, however, yields increased for men and women (see Table 4), and gender disparities in yields were reduced with women-targeting.

Targeting women acted as a constraint to the household: when the choice was left to the household to make, the men farmer was chosen in 85% of the cases. Targeting women did not prevent knowledge accumulation, though it favored women. Farming women experienced higher yields in the women-targeted treatment as compared with the household-targeting arm. The opposite was found for men. This could be explained by a within-household reallocation of other productive resources to the advantage of women farmers when they were designated as the beneficiary of the intervention. This reallocation was nevertheless constrained for fixed resources such as land with higher agricultural potential, which, in turn could explain the overall loss under women-targeting in terms of aggregate yields.

All in all, together with the gender-differentiated findings from Table 4, these findings suggest that targeting such an intervention to farming women (as opposed to no intervention) yielded gains to both farming men and women in the household and, at the same time, reduced gender disparities in productivity.

4.3. Estimates of the Effects of the Intervention on Farmers' Future Plans

In addition to our two outcomes of interest, we provide some evidence regarding soybean crop prospects in our study sample. We examined the likelihood that both farming men and farming women intended to plant soybeans in the next rainy season. We were interested in estimating these likelihoods for the control group and the impact from exposure to the intervention. Table 6 summarizes the results.

Table 6: Farmers' Plans to Plant Soybeans in the Next Rainy Season

Observation unit	Control group mean	No controls	Controls	No. of observations
	(0)	(1)	(2)	(3)
Pooled treated group (coded as 1) vs. control group (coded as 0) †				
Farming man	.74 (.02)	.09 (.04)	.07* (.04)	705
Farming woman	.49 (.02)	.25*** (.05)	.17*** (.05)	705
Women-targeting (coded as 1) vs. Household choice (coded as 0) B				
Farming man	.86 (.02)	-.07** (.03)	-.07** (.03)	355
Farming woman	.70 (.03)	.06 (.04)	.07* (.04)	355

† *Specification with treatment variable, co-variates, pairs dummies, and clustered error terms.* ††*Specifications with treatment variable, co-variates, village fixed effects, and robust error terms. Models were estimated by using OLS. Explanatory variables included treatment status (depending on the level of random assignment) and baseline socioeconomic characteristics: cotton production; ownership of assets such as a radio, bike, or motorcycle; soybean association membership; work on the wife's soybean plot; work on the husband's soybean plot; sociolinguistic groups; availability in the village of seed, NPK, and/or urea; and nature of the soybean field soil. Values in parentheses are standard errors. *p <.10; **p <.05; ***p <.01.*

In the control group, we found a high interest in planting soybeans during the subsequent season for men (74% of them reported an intention to plant soy in the subsequent season) and a lower one for women (49%). Being exposed to the intervention did not affect farming men's intentions as much as it did farming women's intentions to continue cultivating soy (+7 against +17-25 percentage points). The effect was stronger if women were the direct beneficiary of the intervention as compared with the household-choice scenario (+7 percentage points). The effect on men was offset when the wife was the beneficiary and also when this choice was left to the household to make (-7 percentage points). A contract-farming intervention targeted to women can help reduce the gender gap in farmers' intention to cultivate soybeans in the subsequent season.

Table 7 shows the effects of the intervention on knowledge sharing between farming men and women within households. The intervention did encourage discussion and exchanges between farming men and women, but the effects of the women-targeting mechanism as compared with the household-targeting remain insignificant, highlighting the fact that targeting farming women neither stopped nor increased communication and exchange between farming men and women in the household. This last result is consistent with our finding in Table 4 that both men and women held better knowledge on recommended practices as a result of the intervention.

Table 7: Effects of the Intervention on Interactions between Men and Women Farmers

Observation unit	Control group mean	No controls	Controls	No. of observations
	(0)	(1)	(2)	(3)
Pooled treated group (coded as 1) vs. control group (coded as 0) †				
Farming men				
1. discussed production techniques with spouses	.85 (.018)	.10*** (.02)	.09*** (.02)	705
2. gave advice to spouses to produce more on the plot	.82 (.020)	.104*** (.035)	.093** (.03)	705
3. received advice from spouse on how to produce	.74 (.023)	.165*** (.040)	.164*** (.039)	705
Farming women				
1. discussed production techniques with spouse	.85 (.01)	.07* (.04)	.083** (.041)	705
2. gave advice to spouse to produce more on the plot	.74 (.023)	0.147*** (.050)	.130*** (.041)	705
3. received advice from spouse on how to produce	.83 (.01)	.061 (.04)	.061 (.039)	705
Women-Targeting Approach (coded as 1) vs. Household Choice (coded as 0) ††				
Farming men				
1. discussed production techniques with spouses	.94 (.01)	.024 (.02)	.020 (.02)	355
2. gave advice to spouses to produce more on the plot	.93 (.019)	-.003 (.026)	-.001 (.027)	355
3. receive advice from husbands on	.90 (.02)	-.01 (.03)	-.02 (.03)	355

how to produce				
Farming women				
1. discussed production techniques with husbands	.93 (.019)	.006 (.02)	.008 (.02)	355
2. gave advice to husbands to produce more on the plot	.86 (.02)	.03 (.03)	.032 (.03)	355
3. received advice from husbands on how to produce	.90 (.02)	-.01 (.03)	-.010 (.033)	355

† *Specification with treatment variable, co-variates, pairs dummies, and clustered error terms.* ††*Specifications with treatment variable, co-variates, village fixed effects, and robust error terms. Models were estimated by using OLS. Explanatory variables included treatment status (depending on the level of random assignment) and baseline socioeconomic characteristics: cotton production; ownership of assets such as a radio, bike, or motorcycle; soybean association membership' work on the wife's soybean plot; work on the husband's soybean plot; sociolinguistic groups; availability in the village of seed, NPK, and/or urea; and nature of the soybean field soil. Values in parentheses are standard errors.* *$p < .10$; **$p < .05$; ***$p < .01$.

V. Discussion

Our evidence is consistent with a number of previous studies that have shown contract farming to have positive impacts on household income, farm productivity, and food security (e.g., Mulatu et al., 2017; Alemu et al., 2016; Ton et al., 2017; Wang, Wang & Delgado, 2014; Ton et al., 2018).Through a women-focused targeting mechanism, contract farming can also generate net economic benefits through the pathways suggested by Anderson et al. (2021), equalizing access to productive resources and leveraging differences between women and men. This holds true when the intra-household dynamics support knowledge exchange between farming men and women. Indeed, we noted that spouses shared knowledge from technical training, and social-learning gains within the household were almost as large as those achieved through direct learning. Targeting men or women does not matter much for technical training, at least when the focus is on a new crop regarding which experience is limited and technical knowledge and demand are growing. In such settings, both men and women within the farming household seek knowledge regardless of the way that knowledge is transferred to them.

Our evidence also supports that when women have limited access to and control over production resources, a contract farming can lead to economic benefits from increased productivity (Anderson et al., 2021). When farming women were targeted, they experienced higher productivity gains from contract farming than did men. Overall, both spouses benefited from the UNPS contract-farming intervention when farming women were targeted. This also means that gender disparities in productivity decreased. Men gained much more, however, if the choice of the direct beneficiary was made by the household because in more than 80% of the cases men were selected.

In sum, the intervention, when targeting farming women, is win-win: it yields benefits to both men and women in a farming household and reduces gender disparities in knowledge and land productivity. Our experimental design did not allow us to test which component of the intervention was the most effective, though we saw some evidence that extension services by phone, inputs, and market support were appreciated. Additionally, we have no evidence regarding possible consequences of the intervention on allocation decisions on the consumption side, in particular for expenses on public goods or, for a program at scale, on intrahousehold bargaining. Women-focused targeting will be socially accepted and viable if productivity gains are further translated in equal consumption decisions and strengthened intra-household dynamics in communication, mutual support, etc.

For the transition to scale, ensuring the success of the intervention may require convincing men to allow their wives to participate, as we learned was necessary in our study. Because trainings are held outside the home and because they take time that wives previously spent in other activities, some husbands were reluctant; some also feared that their authority would be threatened as their wives became empowered.

VI. Conclusion

We tested the impact of a contract farming-based intervention for a cash crop and the effectiveness of a women-focused targeting mechanism on reducing gender gaps in knowledge regarding agricultural practices and on productivity. Our results show that contract farming improved both knowledge of best practices for soybean production and yields at the farm-level, though there was still room for improvement in both outcomes. Women-focused targeting improves outcomes for farming women while farming men fared better if the choice of the target was left to the household. The results are consistent with a convergence in women's and men's outcomes, resulting in higher gender equity from women-targeting. With regard to the targeting mechanism, engagement with farming men is necessary, possibly through sensibilization activities. Future research could explore the impact on consumption decisions of a targeting approach focused on farming women, including if additional components for empowerment of women are included. Providing continuous technical support via phone calls also paves the way to testing how information and communication technologies can be used to improve or replace traditional in-person visits.

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Appendix 1: Attrition Figures

Table 1: Overall Attrition at the First Level and Randomization

	Attrition		
	No	Yes	Total
Control group	350 (46.05)	30 (3.95)	380 (50)
Treated group	355 (46.71)	25 (3.29)	380 (50)
Total	705 (92.76)	55 (7.24)	760 (100)
	Pearson chi² (1) = 0,4900; p = 0.484		

Table 2. Group-Wise Attrition at the First Level and Randomization

		Full sample (760)	No-intervention (380)	Intervention (380)	Difference	p-value
Attrition	M	.06 (.008)	.05 (.01)	.06 (.01)	.01 (.02)	0.680
(1=yes,	W	.06 (.009)	.07 (.01)	.06 (.012)	-.01 (.02)	0.730
0=no)	Total	.07 (009)	.07 (.01)	.06 (.012)	-.01 (.025)	0.603

*Note: p-values are estimated using a model with village-pair dummies and standard errors clustered at village level. *p <.10; **p <.05; ***p <.01. (Values in parentheses in the first three columns are standard deviations. (Values in parentheses in the last column are standard errors. Men are denoted by M; women are denoted by W.*

Table 3: Overall Attrition at the Second Level and Randomization

	Attrition		
	No	Yes	Total
Control group	176 (46.32)	14 (3.68)	190 (50)
Treated group	179 (47.11)	11 (2.89)	190 (50)
Total	355 (93.42)	25 (6.58)	380 (100)
	Pearson chi² (1) =0,3854; p = 0.535		

Table 4: Group-Wise Attrition at the Second Level and Randomization

		Full sample (760)	No-intervention (380)	Intervention (380)	Difference	p-value
Attrition	M	.06 (.01)	.07 (.01)	.05 (.016)	-.015 (.02)	0.472
(1=yes,	W	.06 (.01)	.07 (.019)	.05 (.016)	-.02 (.02)	0.339
0=no)	Total	.06 (.01)	.07 (.01)	.05 (.016)	-.01 (.02)	0.472

*Note: p-values are estimated using a model with village-pair dummies and standard errors clustered at village level. *p <.10; **p <.05; ***p <.01. (Values in parentheses in the first three columns are standard deviations. (Values in parentheses in the last column are standard errors. Men are denoted by M; women are denoted by W.*

Appendix 2: Power Calculations with Baseline Data

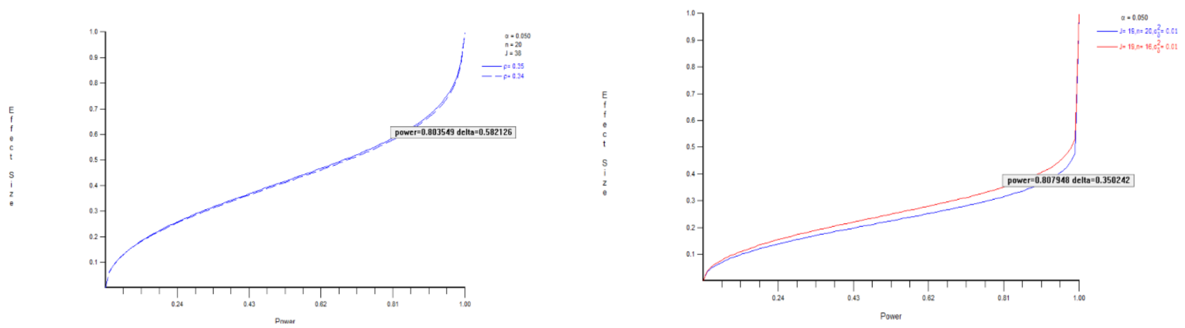
The descriptive statistics suggest that the baseline yield levels (827,16 ± 284.55 kg/ha and 796.23 ± 287.62 kg/ha for farming men and women, respectively, were lower than our assumptions for power calculations (1063 ± 550 kg/ha). We performed power calculations for each random assignment level. Here, we determine MDEs based on the baseline data summarized as follows:

Table 1: Baseline Data for Power Calculations

Item	Assumption
Step 1: Comparing groups 1/2 to 3 (Clustered RCT)	
Number of households in each village	16 to 20
Number of villages (clusters)	38
ICC	0.34 (for women) and 0.35 (for men)
Alpha	0.05
Beta (power)	80%
Step 2: Comparing Group 1 to Group 2 (individual level RCT)	
Number of households in each village	16 to 20
Effect-size variability	0.01 (> 0 to assume random site effects)
Explained variance by blocking	0
Alpha	0.05
Beta (power)	80%

The following figures illustrate the results of the power calculations:

Figure 1: Graphs of Power Calculations Using Baseline Data



Step 1: Comparing Groups 1/2 to Group 3 (Clustered RCT)

Step 2: Comparing Group 1 to Group 2 (individual level RCT)

For the first level of random assignment to compare groups 1/2 and 3, the baseline yield levels are 827,16 ± 284.55 kg/ha and 796.23 ± 287.62 kg/ha for men and farming women, respectively. We should be able to detect an effect size as small as 0.58 (changes in yield around 165.01 kg/ha and 166.81 kg/ha for men and farming women, respectively) against 0.63 to 0.72 (changes in yield between 350 kg/ha to 400 kg/ha) as assumed in our initial power calculations.

For the second level of randomization to compare Groups 1 and 2, the baseline yield levels are 827,16 ± 277.96 kg/ha and 813.06 ± 274.80 kg/ha for men and farming women, respectively. We should be able to detect an effect size as small as 0.35 (changes in yield around 97.28 kg/ha and 96.18 kg/ha for men and farming women, respectively) against 0.36 to 0.45 (changes in yield between 200 kg/ha to 250 kg/ha) as assumed in our initial power calculations.

Appendix 2: Balance Tests

Table 1: Balance Tests (Village-Level Assignment)

		Full sample (38 villages)	No-intervention (19 villages)	Intervention (19 villages)	Difference ᵅ
Outcome variables					
Knowledge score (standardized)	M	.21 (.14)	.03 (.20)	.38 (.21)	-.35 (.29)
	W	.21 (.13)	.03 (.18)	.39 (.19)	-.35 (* (.27)
Yield (kg / ha)	M	828.79 (28.83)	814.32 (43.02)	843.25 (39.28)	28.93 (48.74)
	W	794.53 (29.23)	794.53 (29.23)	816.99 (36.78)	44.92 (47.28)
Covariates					
Age in years	M	41.35 (.65)	41.53 (1.04)	41.17 (.80)	-.35 (.92)
	W	33.67 (.69)	34.13 (1.02)	33.21 (.95)	-.92 (.63)
Duration of life together (# of years)	M	16.10 (.58)	16.40 (.84)	15.80 (.82)	-.59 (.83)
	W	15.50 (.55)	15.80 (.80)	15.21 (.77)	-.58 (.84)
Non-formal education (yes/no)	M	.33 (.03)	.33 (.04)	.33 (.06)	-.0007 (.07)
	W	.07 (.01)	.10 (.03)	.04 (.01)	-.06 (.03)
Formal or formal education (yes/no)	M	.40 (.04)	.38 (.06)	.42 (.05)	.04 (.05)
	W	.22 (.03)	.23 (.05)	.21 (.05)	-.02 (.04)
Duration of formal education (# of years)	M	3.44 (.38)	3.10 (.51)	3.78 (.56)	.67 (.49)
	W	7.16 (.40)	7.38 (.54)	6.92 (.62)	-.36 (.65)
Professional training (yes/no)	M	.09 (.02)	.08 (.02)	.10 (.04)	.01 (.02)
	W	.09 (.02)	.06 (.01)	.11 (.03)	.05 (.04)
Side activity (yes/no)	M	.32 (.035)	.34 (.04)	.29 (.05)	-.04 (.06)
	W	.48 (.03)	.43 (.05	.53 (.05)	.10* (.05)
Agriculture as main activity (yes / no)	M	.963 (.009)	.975 (.011)	.950 (.015)	-.025 (.020)
	W	.89 (.01)	.90 (.02)	.88 (.02)	-.01 (.03)
Experience in agriculture (# of years)	M	17.87 (.78)	18.21 (1.34)	17.53 (.86)	-.68 (1.44)
	W	10.41 (.62)	11.01 (1.02)	9.81 (.73)	-1.20 (1.21)
Experience soy production (# of years)	M	6.14 (.30)	5.74 (.32)	6.53 (.50)	.79 (.59)
	W	4.20 (.23)	4.26 (.28)	4.15 (.37)	-.10 (.43)
Association membership (yes/no)	M	.28 (.04)	.25 (.06)	.31 (.06)	.05 (.06)
	W	.12 (.03)	.08 (.03)	.16 (.05)	.08 (.05)
Soybean association membership (yes/no)	M	.11 (* (.03)	.13 (.05)	.09 (.04)	.04 (.02)
	W	.07 (.02)	.04 (.02)	.09 (.05)	.04 (.04)
Access to credit (yes/no)	M	.11 (.02)	.12 (.03)	.10 (.02)	-.01 (.03)
	W	.03 (.01)	.04 (.01)	.02 (.01)	-.02 (.02)
Ever enjoyed soy-related support (yes/no)	M	.10 (.03)	.08 (.02)	.13 (.056)	.04 (.04)
	W	.03 (.01)	.02 (.01)	.03 (.02)	.01 (.01)
Enjoyed soybean-related support in 2019 (yes/no)	M	.04 (.01)	.02 (.01)	.06 (.02)	.04 (.02)
	W	.009 (.003)	.008 (.004)	.010 (.006)	.002 (.004)
Knew ALL (100%) of the best practices (yes / no)	M	.001 (.001)	.003 (.003)	0	-.003 (.003)
	W	0	0	0	
Nutritional importance of soybeans (yes/no)	M	.97 (.01)	.97 (.01)	.97 (.01)	.004 (.021)
	W	.96 (.01)	.96 (.01)	.96 (.02)	-.002 (.029)
Economic importance of soybeans (yes/no	M	.986 (.006)	.980 (.012)	.991 (.004)	.011 (.013)
	W	.991 (.003)	.994 (.003)	.989 (.004)	-.005 (.006)
Social importance of soybeans (yes/no)	M	.84 (.03)	.83 (.05)	.85 (.05)	.01 (.08)
	W	.783 (.041)	.772 (.059)	.795 (.060)	.022 (.093)
Environmental importance of soybeans (yes/no)	M	.94 (.01)	.93 (.02)	.94 (.01)	.00 (.026)
	W	.906 (.025)	.906 (.034)	.906 (.038)	-.000 (.042)
Work with partner (yes / no)	M	.85 (.04)	.92 (.02)	.77 (.07)	-.14* (* (.07)
	W	.974 (.007)	.979 (.008)	.970 (.012)	-.008 (.016)

Discuss practices with partner (yes/no)	M	.87 (.02)	.86 (.04)	.88 (.02)	.02 (.05)
	W	.88 (.02)	.87 (.03)	.89 (.03)	.02 (.05)
Gave advice to partner (yes/no)	M	.91 (.02)	.92 (.03)	.91 (.02)	-.009 (.038)
	W	.77 (.03)	.77 (.05)	.76 (.05)	-.01 (.06)
Received advice from partner (yes/no)	M	.78 (.03)	.79 (.05)	.77 (.04)	-.01 (.06)
	W	.92 (.01)	.91 (.02)	.92 (.02)	-.01 (.04)
Made decisions on labor allocation (yes/no)	M	.88 (.02)	.89 (.03)	.88 (.04)	-.01 (.03)
	W	.23 (.03)	.20 (.03)	.26 (.05)	.06 (.06)
Made decisions on the plot of land (yes/no)	M	.90 (.02)	.90 (.03)	.90 (.04)	-.004 (.021)
	W	.21 (.03)	.21 (.05)	.21 (.05)	.002 (.061)
Made decisions on land acreage (yes/no)	M	.89 (.02)	.90 (.03)	.89 (.04)	-.007 (.023)
	W	.28 (.04)	.23 (.05)	.33 (.05)	.099* (* (.04)
Made decisions on purchases of inputs (yes/no)	M	.89 (.02)	.89 (.03)	.90 (.04)	.009 (.020)
	W	.21 (.03)	.19 (.04)	.22 (.05)	.02 (.05)
Made decisions on purchases of equipment (yes/no)	M	.90 (.02)	.91 (.03)	.89 (.04)	-.02 (.02)
	W	.13 (.02)	.12 (.03)	.14 (.04)	.02 (.04)
Average risk score	M	593.90 (15.97)	607.93 (20.26)	586.88 (22.01)	-89.64** (* (19.98)
	W	540.46 (23.248)	559.74 (30.79)	521.18 (35.10)	-38.55 (37.42)

[a] Estimated *using a model with village-pair dummies and standard errors clustered at village level. *p <.10; **p <.05; ***p <.01. (Values in parentheses in the first three columns are standard deviations. (Values in parentheses in the last column are standard errors. Men are denoted by M; women are denoted by W.. We estimated q-values using Michael Anderson's code to compute sharpened False Discovery Rate (FDR). All the estimated q-values equal 1 except for the average risk score that indicates a value of 0.001.*

Table 2: Balance Tests (Household-Level Randomization)

		Intervention villages (N=380 households)	**Household targeting (N=190 households)**	**Women targeting (N=190 households)**	**Difference (col. 4-col. 3)[a]**
Outcome variables					
Knowledge score (standardized)	M	-.005 (.05)	-6.46e-07 (.075)	-.010 (.07)	-.008 (.05)
	W	-.01 (.05)	3.82e-07 (.075)	-.03 (.08)	-.03 (.07)
Yield (kg / ha)	M	832.52 (15.17)	833.71 (21.44)	831.33 (21.52)	-4.93 (25.02)
	W	807.08 (14.73)	806.36 (20.78)	807.81 (20.95)	.57 (24.97)
Covariates					
Age in years	M	41.27 (.61)	41.14 (.82)	41.40 (.90)	.31 (1.20)
	W	33.36 (.51)	33.44 (.70)	33.29 (.74)	-.07 (.95)
Duration of life together (# of years)	M	16.02 (.50)	15.86 (.69)	(16.17 (.74)	.35 (.97)
	W	15.41 (.49)	15.45 (.68)	15.38 (.71)	-.03 (.95)
Non-formal education (yes/no)	M	.34 (.02)	.35 (.04)	.33 (.03)	-.007 (.049)
	W	.04 (.01)	.06 (.01)	.02 (.01)	-.04 (* (.02)
Formal education (yes/no)	M	.43 (.02)	.39 (.03)	.47 (.03)	.08 (* (.047)
	W	.22 (.02)	.20 (.03)	.23 (.03)	.02 (.03)
Duration of formal education (# of years)	M	3.86 (.26)	3.48 (.38)	4.23 (.37)	.78 (.48)
	W	6.35 (.32)	6.33 (.49)	6.36 (.42)	.28 (.53)
Professional training (yes/no)	M	.11 (.01)	.09 (.02)	.12 (.02)	.02 (.02)
	W	.12 (.01)	.11 (.02)	.13 (.02)	.01 (.03)
Side activity (yes/no)	M	.31 (.02)	.29 (.03)	.33 (.03)	.03 (.04)
	W	.53 (.02)	.48 (.03)	.58 (.03)	.10** (.048)
Agriculture as main activity (yes / no)	M	.94 (.01)	.96 (.01)	.93 (.01)	-.03 (.02)
	W	.88 (.01)	.87 (.02)	.88 (.02)	-.009 (.033)
Experience in agriculture (# of years)	M	17.76 (.55)	18.37 (.81)	17.14 (.75)	-1.27 (1.07)
	W	9.87 (.41)	10.05 (.58)	9.68 (.57)	-.39 (.77)
Experience soy production (# of years)	M	6.43 (.22)	6.51 (.34)	6.35 (.29)	-1.27 (1.07)
	W	4.08 (.15)	4.22 (.23)	3.94 (.18)	-.27 (.25)
Association membership (yes/no)	M	.31 (.02)	.33 (.03)	.29 (.03)	-.04 (.03)

	W	.15 (.01)	.17 (.02)	.13 (.02)	-.03 (.03)
Soybean association membership (yes/no)	M	.13 (.01)	.15 (.02)	.11 (.02)	-.04 (* (.024)
	W	.08 (.01)	.10 (.02)	.07 (.01)	-.03 (.01)
Access to credit (yes/no)	M	.10 (.01)	.13 (.02)	.08 (.02)	-.04. (03)
	W	.019 (.007)	.028 (.012)	.011 (.007)	-.018 (.014)
Ever enjoyed soy-related support (yes/no)	M	.138 (.018)	.125 (.025)	.150 (.026)	.025 (.026)
	W	.042 (.010)	.045 (.015)	.039 (.014)	-.005 (.017)
Enjoyed soy-related support in 2019 (yes/no)	M	.07 (.01)	.04 (.01)	.09 (.02)	.04* (* (.024)
	W	.011 (.005)	.005 (.005)	.016 (.009)	.010 (.011)
Knew ALL (100%) of the best practices (yes / no)	M	0	0	0	
	W	0	0	0	
Nutritional importance of soybeans (yes/no)	M	.974 (.008)	.977 (.011)	.971 (.012)	-.006 (.015)
	W	.962 (.010)	.959 (.014)	.965 (.013)	.006 (.017)
Economic importance of soybeans (yes/no	M	.991 (.004)	.988 (.008)	.994 (.005)	.005 (.010)
	W	.988 (.005)	.994 (.005)	.982 (.009)	-.011 (.011)
Social importance of soybeans (yes/no)	M	.85 (.01)	.85 (.02)	.85 (.02)	-.01 (.02)
	W	.78 (.02)	.80 (.03)	.76 (.03)	-.04 (.03)
Environmental importance of soybeans (yes/no)	M	.94 (.01)	.97 (.01)	.91 (.02)	-.05* (* (.02)
	W	.90 (.01)	.92 (.01)	.87 (.02)	.04 (.02)
Work with partner (yes/no)	M	.80 (.02)	.82 (.02)	.77 (.03)	-.052 (* (.02)
	W	.968 (.009)	.977 (.011)	.959 (.014)	-.017 (.018)
Discussed practices with partner (yes/no)	M	.887 (.016)	.873 (.025)	.902 (.022)	.030 (.032)
	W	.89 (.01)	.90 (.02)	.89 (.02)	-.01 (.02)
Gave advice to partner (yes/no)	M	.91 (.01)	.90 (.02)	.91 (.02)	.006 (.028)
	W	.764 (.022)	.758 (.032)	.770 (.031)	.009 (.039)
Received advice from partner (yes/no)	M	.770 (.022)	.758 (.032)	.781 (.031)	.024 (.040)
	W	.913 (.015)	.913 (.021)	.913 (.021)	.001 (.028)
Made decisions on labor allocation (yes/no)	M	.87 (.01)	.86 (.02)	.88 (.02)	.01 (.02)
	W	.25 (.02)	.22 (.03)	.28 (.03)	.06 (.04)
Made decisions on the plot of land (yes/no)	M	.89 (.01)	.88 (.02)	.90 (.02)	.02 (.02)
	W	.22 (.02)	.23 (.03)	.21 (.03)	-.01 (.03)
Made decisions on land acreage (yes/no)	M	.89 (.01)	.87 (.02)	.90 (.02)	.02 (.02)
	W	.32 (.02)	.32 (.03)	.32 (.03)	-.01 (.03)
Made decisions on purchases of inputs (yes/no)	M	.89 (.01)	.89 (.02)	.90 (.02)	.01 (.02)
	W	.23 (.02)	.24 (.03)	.22 (.03)	-.01 (.03)
Made decisions on purchases of equipment (yes/no)	M	.88 (.01)	.86 (.02)	.90 (.02)	.03 (.02)
	W	.15 (.01)	.14 (.02)	.16 (.02)	.01 (.03)
Average risk score	M	598.85 (22.34)	582.53 (31.41)	615.65 (31.88)	39.82 (46.62)
	W	531.81 (14.05)	528.33 (19.84)	535.28 (19.96)	6.48 (23.72)

[a] Estimated *using a model with village-pair dummies and standard errors clustered at village level. *p <.10; **p <.05; ***p <.01. (Values in parentheses in the first three columns are standard deviations. (Values in parentheses in the last column are standard errors. Men are denoted by M; women are denoted by W. We estimated q-values using Michael Anderson's code to compute sharpened False Discovery Rate (FDR). All the estimated q-values equal 1.*