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What is the sense of gender targeting in agricultural extension programs? Evidence from eastern DR Congo

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What is the sense of gender targeting in agricultural extension programs? Evidence from eastern DR Congo.

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Abstract

Development projects often evaluate their gender strategy by the proportion of female participants. However, female participation not necessarily coincides with reaching program objectives. With data from South-Kivu, we analyze whether targeting female farmers in agricultural extension programs increases the adoption of three technologies: improved legume varieties, row planting, and mineral fertilizer. We find that joint male and female program participation leads to the highest adoption rates, and that female participation is not conducive for the adoption of capital-intensive technologies while it is for (female) labor-intensive technologies, and that targeting female-headed households is more effective for technology adoption than targeting female farmers in male-headed households.

Keywords: gender; agricultural technology adoption; agricultural extension; sub-Saharan Africa; eastern DR Congo; integrated soil fertility management

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1. Introduction

During the past twenty years, gender has steadily risen to the attention of the development community. The third United Nations Millennium Development Goal (MDG) is specifically dedicated to the promotion of gender equality and empowerment of women. The strength of this goal is that it promises significant spillovers to achieve the other MDGs, especially through mutually reinforcing effects with the reduction of poverty and increased food security (MDG1) (Klasen, 2005). Gender is now a focus point in most development projects, also in agricultural and rural development projects.

Interventions that specifically target women and have successful program outcomes, such as the PROGRESA program in Mexico (Adato et al., 2000), have strengthened a common belief that targeting women in development projects leads to beneficial outcomes. The majority of these programs increase household income and women's bargaining power over that income. Positive program outcomes, e.g. on child schooling, health or nutrition, can be related to increased household income, to increased female bargaining power, or to both. If women have stronger preferences than men for these outcomes, an increase in their bargaining power will have additional benefits on schooling, health and nutrition (Doss, 2013). Whether programs specifically targeted to women create such additional benefits and are therefore more effective because of their gender targeting, is an important issue. However, studies that specifically address this issue, and compare the impact of female program participation with a counterfactual situation of male program participation, are very rare. In one of the few studies that compare the impact of male versus female program participation, Pitt and Khandker (1998) find that group-based microcredit programs in Bangladesh have a larger effect on child schooling and health in households of female participants. Maertens and Verhofstadt (2013) find that women's participation in off-farm employment has a higher impact on child schooling than male off-farm employment.

The proportion of women participating in project activities has become a core indicator that quantifies the gender sensitivity of a project proposal or the gender performance of a project (e.g. IFAD, 2012). Project reports often refer to the number of women involved, rather than clarifying explicitly how women benefit from the program or how their participation helps to reach program objectives. Quota for female targeting may conflict with program objectives, and participation of women in program activities does not necessarily guarantee a beneficial outcome for these female participants (Quisumbing and Pandolfelli, 2009).

With a case study from South Kivu, Democratic Republic of Congo (DRC), we estimate the impact of gender differentiated participation in an agricultural extension program that focuses on integrated soil fertility management (ISFM). We look at the adoption of three different components of the composite technology: mineral fertilizer, improved legume varieties, and row planting. We estimate the impact of male, female and joint participation in the program on the adoption of these three technologies at the plot level. We find that joint male and female participation in the extension program leads to the highest rates of adoption of all three technologies. Moreover, we find significant differences in the impact of program participation on technology adoption between female and male farmers in male-headed households, and between female farmers in male-headed households and female farmers in female-headed households. We find that female participation in the extension program is not conducive for the adoption of capital intensive technologies, such as mineral fertilizer, while it is for technologies that use resources that are relatively better available to women, such as row planting that makes intensive use of female labor.

With this paper, we contribute to the literature on agricultural technology adoption, that rarely considers gender or intra-household issues. Empirical studies on agricultural technology adoption sometimes compare male-headed with female-headed households, or women in male-headed households with women in female-headed households (Doss, 2013). There are very few studies that compare male and female farmers in male-headed households (Fisher and Kandiwa, 2014; Peterman et al., 2011). In addition, we contribute to the more general literature on gender and development with insights on the effectiveness of gender targeting in development projects.

2. Motivation

Women make crucial contributions to agriculture, in developing countries as well as in high-income countries. Yet, compared to male farmers, female farmers, especially in developing countries, are more frequently constrained in their access to capital, labor, land, and other agricultural inputs, and have relatively low adoption rates of agricultural technologies (Doss, 2001; Peterman et al. 2010). The FAO has calculated that "closing the gap" between men's and women's access to agricultural resources could increase agricultural production by 20% to 30% (FAO, 2011).

Improved agricultural technologies are important to increase agricultural productivity and agricultural incomes, and reduce food insecurity and poverty (Minten and Barrett, 2008). Agricultural extension programs increase awareness about improved agricultural technologies, provide access to better quality information on cultivation practices that are more appropriate for local conditions, and ensure more accurate expectations about the outcomes of the use of specific agricultural technologies (Lambrecht et al., 2014). This is especially important for female farmers, who are generally more deprived of access to formal and informal information (Doss, 2001). For example, Fletschner and Mesbah (2011) find that information on economic opportunities is not fully shared among spouses in biparental households, and that the husband generally has better access to information. In a study on the adoption of tissue banana culture technology in Kenya, Kabunga et al. (2012) show that female farmers are less likely to adopt the technology, but that they would have an equal chance to adopt innovations, provided that they acquire sufficient knowledge about the innovation. From these observations, gender targeting in agricultural extension would make sense as it reduces the gender knowledge gap.

However, there are also reasons why targeting female farmers may not lead to expected project outcomes, such as the adoption of improved agricultural technologies in the case of extension programs. For example, when female farmers have no or limited decision-making power in agricultural production, technology adoption may only occur when the male spouse chooses to adopt, and female targeting will have limited impact on technology adoption in these households. Even when female farmers have sufficient decision-making power in agricultural production, they may be less able to adopt agricultural technologies than male farmers. If technology adoption requires access to cash or hired labor, and if female farmers (either in female- or male-headed households) are more constrained in their access to these inputs than male farmers, they will be less likely to adopt new technologies (Meinzen-Dick et al., 2011). Even when these resources are available at household level, if female bargaining power over household resources is low, she may not be able to acquire the necessary resources required for technology adoption. Limited access to cash might especially limit the adoption of capital-intensive technologies, such mineral fertilizer by female farmers.

In addition, intra-household differences in preferences may play a role, and male and female farmers may obtain different marginal utilities of technology adoption. (Meinzen-Dick et al., 2011; Quisumbing and Pandolfelli, 2010; Udry, 1996). For example, crop varietal preferences can differ by gender if men and women have different uses for a particular crop (Quisumbing and Pandolfelli, 2010). Female farmers are sometimes shown to be intrinsically more risk averse than male farmers (Doss and Morris, 2001), which is important for the adoption of new and more risky technologies such as mineral fertilizer. Female farmers may have higher marginal substitution rates for consumption over leisure than male farmers, which could increase the adoption of yield-increasing and labor-intensive technologies by female farmers. But, female farmers more often combine household reproductive work with cultivation activities (Udry, 1996), which decreases their abilities to adopt labor-intensive technologies. Which effect dominates remains an empirical question.

Even if female participation in agricultural extension effectively leads to technology adoption, this does not necessarily imply that targeting female farmers leads to higher levels of adoption and is more effective than targeting male farmers. Whether or not targeting female farmers is the most efficient way to increase technology adoption rates depends not only on the gender-differentiated impact of participation but also on the unit cost of targeting male versus female farmers. If there would be full cooperation and full sharing of information and resources in the household, and if spouses had equal preferences, the effect of female participation would be equally large as the effect of male participation. The efficiency of targeting a higher proportion of female farmers would then depend on the relative costs of male versus female program targeting. These costs may differ, for example because of lower levels of education and literacy among female farmers. Low education is an additional constraint for female farmers to receive and grasp adequate information and apply new agricultural technologies (Doss, 2001). On the other hand, with an equal unit cost of program participation for male and female farmers, specific targeting of women makes sense if female program participation is more likely to lead to technology adoption than male program participation.

3. Background and data collection

3.1 The case study

Our research area comprises two territories, Walungu and Kabare, in the highlands of South-Kivu, in Eastern DRC. This is a particularly poor region in an extremely poor country. DRC is currently at the very bottom in the human development index ranking (United Nations Development Program, 2013) and in the GDP per capita ranking (World Bank, 2013b). An estimated 71% of the population in DRC, and 85% in South-Kivu, live below the national poverty line (World Bank, 2013a; Ansoms and Marivoet, 2010). Moreover, according to the gender inequality ranking, DRC is the fifth most gender-unequal country in the world (World Bank, 2013a).

Agriculture accounts for 45% of GDP in the country (World Bank, 2013a). For the rural population in South-Kivu, agriculture is the main income-generating activity. Farmers usually have mixed cropping systems with cassava, common beans, banana, sweet potatoes, maize and sorghum as main food crops (Ouma et al., 2011). Population density is high, with more than 250 inhabitants per km² in Kabare and Walungu territories (Unité de Pilotage du Processus DRSP, 2005), which results in high land pressure. For more than a decade, violent conflict in the region has inhibited research and development initiatives other than emergency relief (Rossi et al., 2006). As in many other parts of Sub-Saharan Africa, yields in the region are low and stagnating. Agricultural intensification and investment in land productivity are urgently needed in the region, but most farmers have no access to information about improved agricultural technologies nor to agricultural inputs such as mineral fertilizer and improved seeds (Pypers et al., 2011).

In 2006, the Consortium for Improving Agriculture-based Livelihoods in Central-Africa (CIALCA)[3] started a research and extension program on integrated soil fertility management (ISFM) in South Kivu. The program is located in selected program villages in four groupements[4]: Burhale and Lurhala in Walungu territory, and Kabamba and Luhihi in Kabare territory. In the selection of program villages attention was paid to include villages that were not targeted by other development programs, and nearby as well as remote villages. Within the villages, farmers' associations were selected based on their willingness to collaborate with the program in trying out new agricultural technologies (Ouma et al., 2011). Within the program villages and associations, a wide range of extension activities were carried out to distribute information on ISFM practices such as radio programs, discussion meetings, demonstration trials, and on-farm trials (Lambrecht et al., 2014). Agricultural associations in general, and program associations more specifically, are mostly mixed-gender associations. Moreover, the association head and the association treasurer can be either male or female.

3.2. The technologies

The program is introducing ISFM in the area. This is a composite technology aiming at improving soil fertility and crop productivity (Vanlauwe et al., 2010). Mineral fertilizer,

[3] The Consortium for Improving Agriculture-based Livelihoods in Central Africa (CIALCA) coordinates projects by Bioversity International, TSBF-CIAT and IITA, and works specifically in DRC, Burundi and Rwanda.

4 The groupement (grouping) is the administrative unit above the village in DRC. A territory comprises sectors, groupings within the sectors, and villages within the groupings.

improved germplasm, improved organic matter management, and good agronomic practices (such as row planting) are main components of ISFM (Place et al., 2003; Vanlauwe et al., 2010) and are promoted in the research area by the program. In our study, we specifically look at three technologies: mineral fertilizer, improved legume varieties and row planting.

Fertilizer interventions have become prominent in rural poverty reduction programs in Africa (Marenya and Barrett, 2009; Sheahan et al., 2013). Many studies find positive returns to mineral fertilizer use (Duflo et al., 2008; Marenya and Barrett, 2009; Sheahan et al., 2013). However, degraded soils can limit the marginal productivity of fertilizer (Marenya and Barrett, 2009), and the use of mineral fertilizer can be unprofitable at high commercial prices (Jayne and Rashid, 2013). Field experiments in the research sites in South-Kivu demonstrate that fertilizer use at small rates is profitable on relatively fertile soils, whereas it is not profitable on the less fertile soils in Walungu territory at local commercial prices (Pypers et al., 2011). However, if prices were to be leveled with other countries in East-Africa, fertilizer use would be highly profitable (Pypers et al., 2011).

Studies have shown that the adoption of improved crop varieties can increase household consumption and household income, and reduce poverty and inequality (Asfaw et al., 2012; Kassie et al., 2011; Mathenge et al., 2014; Mendola, 2007). The improved bean variety used in the trial of Pypers et al. (2011) did not lead to significant yield increases as such, but higher yields were observed compared to the farmers' practice when intercropped at specific spacing with cassava. However, according to CIALCA (2007), for each site new varieties were identified that performed equally well or better than the local varieties (CIALCA, 2007). We include all these new legume varieties in our study.

Finally, Pypers et al. (2011) find that row planting requires more labour at the start of the season when labour is scarce, but reduces labour requirements for weeding. Row planting of cassava can allow a second bean intercrop, and result in additional economic benefits for the farmer.

3.3. Data and sampling

We use data from a quantitative household survey, a village survey, and complementary focus group discussions and stakeholder interviews. Household survey data were collected in the period February - June 2011 in the northern Walungu territory and the southern Kabare territory in South Kivu. A two-stage stratified random cluster sampling strategy was used. We purposively selected the four groupements (Lurhala, Burhale, Kabamba and Luhihi) most intensively involved in the CIALCA program. In the first sampling stage, we constructed a list of villages for each groupement and did a stratified random selection of program villages (villages which are home to a program association), neighboring villages (villages neighbouring program villages), and other villages. In each territory, six program villages, five or six neighboring villages, and three or four other villages were selected.

In the second sampling stage, we constructed a list of households for each selected village with the help of the village head and program agronomists, and made a stratified random selection of program households (a household in which at least one adult participates in a program association) and non-program households. Farmers' associations sometimes cross village borders and hence our sample includes several program households in neighboring villages. To ensure a sufficiently high number of program participants in the sample, program households were oversampled. To correct for this oversampling, we use sampling weights, calculated as the inverse of the probability that the household is selected into the sample. The total sample includes 420 farm-households, with data from 371 male and 404 female respondents, and 1595 plots.

A structured quantitative questionnaire was used with different modules on different topics, including agronomic and socio-economic questions. Recall data were collected for key variables such as land ownership for the year 2006, the year the program initiated. After a general household module, male and female farmers were interviewed separately. Respondents were asked about the history of association membership and the use of improved agricultural technologies. Complementary to the household survey, we conducted a village survey to collect data on village demographics, infrastructure, and institutions. In addition, a comprehensive qualitative study was undertaken in July- August 2010 through in-depth semi-structured interviews with program staff and program association members, and focus-group discussions in program villages.

4. Econometric approach

Our main interest is in the impact of female versus male program participation on the adoption of three different agricultural technologies: mineral fertilizer, improved legume varieties, and row planting. For each plot (j) of all households (i) in the sample we observe a binary adoption variable (T_{ij}) for each of the three technologies, but we have no information on the adoption intensity of the technologies. We estimate the impact of male (P_{im}), female (P_{if}) or joint program participation ($P_{im*}P_{if}$) on the likelihood of agricultural technology adoption at the plot level ($P(T_{ij}=1)$) and control for observed individual characteristics of male and female farmers – the male or female household head and spouse – (X_{if} and X_{im}), household- and farm- specific characteristics (Y_j), plot-level characteristics (Z_{ij}), and village-level characteristics (V_k):

$$P(T_{ij} = 1) = \alpha_m P_{im} + \alpha_f P_{if} + \alpha_b P_{im}{*}P_{if} + \beta_f X_{if} + \beta_m X_{im} + \gamma Y_j + \delta Z_{ij} + v V_k + \eta_i + \mu_{ij} + \varepsilon_{im} + \varepsilon_{if} \quad (1)$$

The error term consists of different components: η_i is a farm-specific component, including unobserved household and village characteristics, μ_{ij} is a plot-specific component, including unobserved plot characteristics, and ε_{im} and ε_{if} include male resp. female unobserved characteristics. The vectors X_{im} and X_{if} include individual characteristics of male and female farmers (age, level of education, association membership) and their access to cash (male and female off-farm income). The vector Y_j includes factors related to household access to cash (an asset index calculated as explained in appendix A.1, land ownership, livestock ownership), labour availability (number of male and female workers), demographic characteristics (number of children, age and gender of the household head), and transaction costs (distance to the market). The vector V_k includes village characteristics that additionally reflect differences in transaction costs (distance to urbanized center, and to the local agricultural research station INERA[5]) and the village type (program or non-program village). Finally, the vector Z_{ij} includes plot level characteristics, such as the bio-physical conditions of the plot (soil fertility indicator based on local classification[6], slope of the plot), distance of the plot to the house, the ownership or tenancy of the plot (male, female or joint ownership/tenancy, and whether the plot is hired or owned), and the agricultural management decisions on the plot (male, female or joint management).

The parameter estimates in the model may suffer from endogeneity bias because program participation is not random and likely correlated with individual- and household-level unobserved heterogeneity. Program associations were selected based on their willingness to cooperate with the program, hence these associations may consist of farmers with a higher intrinsic motivation or ability to adopt new agricultural technologies. This can result in an

[5] INERA is the National Institute for Agricultural Research and Studies (Institut National des Etudes et de la Recherche Agricole). CIALCA and the International Institute for Tropical Agriculture (IITA) have formed a partnership with INERA, and supported scientific skills development. This center is present in the Northern territory of our research area.

[6] Local farmers' classification of soil (the local names given to different types of soil) is shown to robustly reflect the soil quality (CIALCA, 2009).

upward bias of the estimated impact of program participation on the adoption of agricultural technologies. However, research and extension programs sometimes aim to target the poorest households who might have a lower probability of agricultural technology adoption, because the program ultimately aims at contributing to poverty reduction. In addition, there might be adverse selection of farmers who are less motivated/able to apply new technologies, for example because farmers (falsely) expect to receive other (financial) benefits from extension programs (Lambrecht et al., 2014). This may result in a downward bias in the estimates of program participation. In addition, male and/or female program participation may be correlated with unobserved individual characteristics that differ with gender, such as motivation, ability and decision-making power.

To understand and limit this possible endogeneity bias, we use three different estimation strategies. First, we use simple probit models to estimate equation (1) for the three technologies (mineral fertilizer, improved legumes, row planting) separately. We use the full sample of observations, including all agricultural plots of the sampled households. As mineral fertilizer is only available in program and nearby villages, we do not include villages further away from program villages in the estimations on mineral fertilizer adoption. For improved legume variety adoption, the sample is limited to plots where legumes were sown during the past years. This way, we analyze the choice of farmers to sow improved varieties over traditional varieties, instead of (partially) capturing whether a farmer would or would not plant legumes on a specific plot.

Second, we use the same probit models but limit the sample to those households where at least one household member is a program participant. This way we reduce the endogeneity bias related to unobserved heterogeneity in household characteristics – or the error component η_i – that might be correlated with both program participation and technology adoption. Because including P_{if} , P_{im} and $P_{im}*P_{if}$ would lead to perfect collinearity in this case, we only retain P_{if} (female participation) and $P_{im}*P_{if.}$(joint participation).

Third, as a robustness check, we use trivariate probit models on the full sample and on the sub-sample of program households. We include additional identification variables for male, female and joint program participation. These are dummy variables indicating whether five years ago, before the start of the program, the respondent(s) was (were) member(s) of an agricultural association. These are relevant instruments, since they are highly correlated with program association membership[7]. In addition, these instruments are likely less correlated with individual unobserved factors that also influence adoption decisions than the individual program participation variables themselves, since they are pre-treatment variables. Before the start of the program, farmers were unaware about where and with whom, which associations, the program would cooperate. It proved to be difficult to find more suitable instruments and therefore we only use the trivariate probit estimation as a qualitative robustness check. We use Roodman's (2011) conditional recursive-mixed process (cmp) estimator to estimate the trivariate probit models.

In all models, estimations are weighted to account for nonrandom sampling (Solon et al., 2013), robust standard errors are reported, and observations are clustered at household and village level. Certain control variables (female association membership, dummy for a hired plot) cannot be retained in the regressions on the program sample because there is no or not enough variation in the smaller program sub-sample for these variables.

5. Results and discussion

5.1 Farm and farmer characteristics

In table 1, we show the rate of male and female program participation, and some specific characteristics of male and female farmers in our research area. Four percent of male and 4% of female farmers in the sample are member of a program association. Among the program participants, male farmers have been in the program on average 4.5 years while female farmers on average only 3.13 years.

Roughly one out of four male farmers, and one out of five female farmers, is member of an agricultural association. With an average of respectively 4 and 1.5 years of schooling completed, both male and female farmers have received limited education. Yet, female farmers have received significantly less education and are younger than male farmers. Similarly, female program participants have significantly less education and are younger than male program participants. Off-farm income is significantly lower for female farmers compared to male farmers, which is an indication of less access to cash for female farmers (table 1).

[Table 1]

[7] These correlations are R^2= 0.28, p=0.00 for male farmers in the full sample; R^2= 0.36, p=0.00 for female farmers in the full sample; R^2= 0.20, p=0.00 for female farmers in the program sub-sample; and R^2= 0.24, p=0.00 for both spouses in the program sub-sample.

In table 2 we show farm-, household- and village-level characteristics of the households in our research area. One out of ten households is female-headed, and one out of ten households is polygamous (table 2). In this area, the spouses of a polygamous man generally don't live in the same house or compound. Each wife and her children have an own house and plots, the harvest of which is not shared with the other spouse(s) of the husband. Hence, each wife behaves as a separate household, but her spouse only lives part of the time in the household. These households are sometimes called polygynous matrifocal households (Fox, 1967).

[Table 2]

We define households with exclusively female program participants as female participant households, those with exclusively male program participants as male participant households and those with both female and male program participants as joint participant households (table 2). We observe that female participant households are significantly more often households of a polygamous household head, compared to male participant households. A household has on average 1.8 male adults, two adult women, and 2.8 children.

Households own on average 0.71 tropical livestock units (TLU)[8]. They cultivate on average 3.46 plots, and live on average 48 minutes' walking distance from the nearest market. Compared to program households, non-program households have significantly less assets, livestock, and cultivate less plots. Female participant households have significantly less assets and livestock, and cultivate less plots than male participant households (table 2).

Twenty-two percent of households live in a village that is directly targeted by the program, 31% in a neighbouring village, and the remainder in villages further away. Over two thirds of the program participants live in program villages. The remaining participants mostly come from nearby villages. The distance from the village center to the nearest urbanized center (a local village that has a relatively large market and is positioned near a main road) is on average 16.5 km. Only two percent of the households live in villages close (at less than 16km) to the INERA agricultural research station, and over 70% live in Kabare territory (table 2).

In table 3, we show plot-level characteristics. Respondents were asked for each plot about the ownership or tenancy of the plot and the plot management[9]. Plot ownership and

[8] Tropical livestock units, calculated as relative weight to one cow: one cow equals one livestock unit, pig is 0.40, goat/sheep 0.20, chicken/rabbit 0.05, guinea pig 0.005

[9] The plot owner is defined as the person(s) that holds the title of the land. The plot tenant is the person that rents agreement and is responsible for paying the rent to the respective landlord or landlady.

management often varies in one household over the different plots. The majority (57%) of the plots is owned or rented by male farmers, usually the household head, 33% of the plots is owned jointly by male and female spouses, and 9% is owned by female farmers. Only 16% of the plots is mainly male managed, 64% is jointly managed by both spouses, and 20% is mainly female managed. These figures show that land ownership and tenancy is dominated by male farmers but female farmers are involved in agricultural management and decision making. Compared to plots of program households, the plots of non-program households are significantly less likely to be jointly owned or managed, and significantly more likely to be female owned or managed. Evidence from group discussions, in-depth interviews, and the quantitative results from our household survey also show that most plots, crops, and agricultural activities are not gender-separated. An exception is sowing of legumes. Traditionally, with the method of broadcasting, only female farmers sow legumes. However, if legumes are planted in rows, male farmers are also participating in sowing activities on the field.

[Table 3]

Only 19% of the plots are hired. The share of hired plots is significantly higher for female participant households than for male participant households. This can probably be explained by the very thin land sales market in the region and the limited access to owned land for female farmers. The most common way to acquire land is through inheritance in a patrilineal system. Female farmers seeking to increase their cropping area, can either bargain for access to more land within their household or rent in land (table 3).

We find 45% of the plots have good soil fertility according to local farmers' criteria, 41% of the plots are located on a slope, and plots are on average at 17 minutes walking distance from the homestead. We find no significant differences in these biophysical and geographic characteristics between plots of program- and non-program households, and between plots female or joint participant households and male participant households (table 3).

5.2 Trends in technology adoption

Figure 1 shows the increase in adoption of the three agricultural technologies since the start of the program. At the start of the program, mineral fertilizer and row planting were not

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Respondents were asked who made the decisions about the agricultural practices on the plot. We distinguish three categories of plot management: male-dominated, joint, female-dominated.

used by farmers in the research area, and only 9% of the households were sowing improved legume varieties. At the time of the survey, mineral fertilizer was adopted by 6% of all households, improved legume varieties by 38%, and row planting by 12% of all households (table 4). Non-program households have significantly lower household- and plot-level adoption rates of the three technologies (except plot-level adoption of mineral fertilizer). Female participant households have lower adoption rates of mineral fertilizer than male participant household while joint participant household have higher adoption rates of mineral fertilizer and row planting.

[Figure 1]

[Table 4]

In table 5, we report the individual awareness about improved technologies. This is defined as whether the farmer has ever heard about a specific technology. Female farmers are significantly less aware of mineral fertilizer and row planting than male farmers. Among program participants, awareness of improved legume varieties and row planting is complete for both male and female participants, while the awareness of mineral fertilizer is significantly lower for female participants (table 5).

[Table 5]

In table 6, we also show how technology adoption differs with gender differences in plot management and program participation. There is no adoption of any of the technologies on male managed plots in female participant households. Likewise, there is no technology adoption on female managed plots in male participant households. Adoption rates on male and jointly managed plots are highest in joint participant households while for female managed plots adoption rates are similar in joint and female participant households. We need to note that the rate of female managed plots is small, and more than half of the female managed plots are managed by female household heads or by female farmers in a polygamous household.

[Table 6]

5.3 Impact of male and female program participation on technology adoption

In table 7, we report the results of the probit models that estimate the impact of male, female and joint program participation on the likelihood of technology adoption. Marginal effects are reported for each technology (mineral fertilizer, improved legume varieties, and row planting) and for the models on the full sample and the program sub-sample. The results vary importantly across the different technologies.

[Table 7]

First, for mineral fertilizer we don't find significant effects of exclusive male and exclusive female program participation on the likelihood of adoption in the full sample, but joint program participation has a significant positive effect on the likelihood of mineral fertilizer adoption. Joint participant households are 12.5% more likely to adopt mineral fertilizer than non-program households. For the sub-sample of program households, we find a significant negative marginal effect of female program participation, indicating that, compared to male participation, female participation reduces the likelihood of mineral fertilizer adoption. Figures have to be interpreted with care because the sample does not include any female-headed households with male or joint program participation. Therefore the marginal effects of female program participation and the female-headed household dummy should be interpreted together. As such, our results indicate that female program participation in male-headed households reduces the likelihood of mineral fertilizer adoption by 11%, compared to male program participation in male-headed households. Yet, in female-headed households, female program participation increases the likelihood of adoption by 17% (= 28.5% - 11.4%), compared to male program participation in male-headed households. In addition, joint program participation, compared to male program participation, increases the likelihood of adoption by 9.7%.

Second, we find no significant effect of male, female or joint program participation on the adoption of improved legume varieties in the full sample (table 7). This finding is not surprising. Whereas the project was the first and sole organization to introduce mineral fertilizer in the region (Lambrecht et al., 2014), improved legume varieties have been promoted and distributed in the villages and on local markets by seed traders and governmental and non-governmental organizations. Yet, the program has explicitly promoted the use of improved legume varieties among its participants. Within the sub-sample of program households, the impact of exclusive female participation does not differ significantly from exclusive male participation, but in female-headed households, female program participation increases the likelihood of adoption by 42% compared to male program participation in male-headed households. Joint participation, compared to male participation, increases the likelihood of adoption by 22%.

Third, compared to non-program households, we find that female and joint program participation increases the likelihood of adopting row planting by 5.9% and 13.4% respectively, while male program participation does not affect adoption. In the sub-sample of program households, households with joint male and female participation are 11% more likely to adopt row planting than households with only male program participation (table 7).

These results indicate that joint male and female program participation consistently leads to higher rates of adoption of all three technologies. This implies that female targeting in the program in general makes sense when female farmers are targeted together with, and not necessarily instead of, their spouses and male siblings. The impact of female versus male program participation differs for the three technologies: exclusive female participation decreases the likelihood of adopting fertilizer, increases the likelihood of adopting row planting and has no effect on the likelihood of adopting improved legume varieties in male-headed households. These differences can be explained by the characteristics of the three technologies. Mineral fertilizer is a knowledge- and capital-intensive technology. Lifting the knowledge constraints of female farmers through female-targeted agricultural extension does not necessarily lead to the adoption of such technologies if female farmers are capital and credit constrained. In our research area, female farmers generally have less bargaining power over household cash resources, and have virtually no access to credit. In our survey, we asked about the financial decisions in the household and about access to credit. Figures indicate that financial decisions are taken by the male spouse in 25% of the cases, taken jointly in 64% of the cases, and by the female spouse in 11% of the cases. In addition, 43% of the male respondents in our sample borrowed money in the past year while only 30% of female respondents did so, and female farmers have lower access to off-farm income than male farmers (table 1). These cash and credit constraints limit the possibilities of female farmers to adopt a capital intensive technology such as mineral fertilizer.

Row planting is a knowledge- and labor-intensive technology. If women have more decision-making power over on-farm labor allocation than over household cash resources, they are less constrained to adopt a labor-intensive technology such as row planting than a capital intensive technology such as mineral fertilizer. In our research area, a large share of the on-farm family labor comes from women. In our sample, 99% of female farmers worked on the field during the past year and their average number of on-farm labor days is 160 while only 88% of male farmers worked on the farm for an average of 99 days. Women likely have considerable decision-making power over their own labor allocation on the farm, which eases adoption of a labor-intensive technology such as row planting. During focus group discussions, all participants consistently agreed that traditionally, female farmers sow the main subsistence crops, such as legumes, cassava and maize. However, male farmers can decide to assist in sowing activities when new technologies, such as row planting, are used.

There is not much difference in the impact of female versus male program participation on the likelihood of adopting improved legume varieties. While legumes are typically sown by female farmers in the research area, the use of improved varieties requires cash to buy the seeds (although the technology is less capital-intensive than mineral fertilizer use). So, both male and female farmers face constraints for adoption. In addition, overall awareness about legume varieties is high and the gender gap in knowledge about improved legume varieties is less than for other technologies (table 5), likely because this technology has spread in the region through local research institutes. So, lifting knowledge constraints specifically for female farmers through the extension program was less important for this technology.

Finally, as a robustness check, we compare the main results from the probit models on the full sample and the program sub-sample with the results from trivariate probit models in which male, female and joint program participation are instrumented to understand and reduce potential endogeneity bias (table A2 in appendix). We find that the results of the trivariate probit models are qualitatively the same as the results of the probit models[10]. For the estimations of mineral fertilizer and row planting in the program sub-sample, we find that the first-stage error term of female program participation is positively correlated with mineral fertilizer adoption. This could result in an overestimation of the impact of female program participation, compared to male participation, on mineral fertilizer adoption. This implies that the estimated effect is biased upwards and that the true effect of female program participation is even more negative compared to male program participation. For row planting in the program subsample we find that the first-stage error term of joint program participation is negatively correlated with adoption of row planting. Hence, the effect of joint program participation is downward biased and the true effect of joint program participation is higher for row planting. The comparison of the probit and trivariate probit results are an indication of the robustness of the results but nevertheless we should be careful with interpreting our results as true causal effects.

5.4 Other factors affecting technology adoption

Besides program participation, other factors in our model affect the likelihood of technology adoption. We discuss some of these effects. First, we find that the ownership or tenancy and the management of a plot matter for technology adoption. The estimates in table

[10] A more quantitative comparison between the probit and trivariate probit models is difficult because of the difficulty to obtain marginal effects in trivariate probit models.

7 indicate that adoption of mineral fertilizer and row planting is more likely on male owned plots while the adoption of improved legume varieties is more likely on jointly owned plots. Among program households (in the program sub-sample), adoption of all three technologies is more likely on male and jointly managed plots. Male farmers may prefer to direct household resources, especially cash resources, to the plots they own and manage.

In addition, we observe that adoption of mineral fertilizer is zero on hired plots and adoption of row planting is less likely on hired plots (in the program sub-sample) while improved legume varieties have a higher likelihood to be adopted on hired plots (in the full sample). These differences across technologies might be explained by the fact that the return to mineral fertilizer and raw planting is less immediate than the return to improved legume varieties.

Second, we find that wealth and access to cash affect technology adoption. Access to male off-farm income and asset ownership increase the likelihood of mineral fertilizer adoption, which again points to the need for cash to adopt capital-intensive technologies such as fertilizer.

Third, we find that the location of the household matters. Technology adoption is less likely in villages further away from program villages, which shows that the spread of information to more distant villages is slower. Households living closer to the market are more likely to adopt improved legume varieties and row planting and household closer to INERA are more likely to adopt improved legume varieties. This is likely related to lower transaction costs for buying inputs and selling farm produce, and to the spread of improved varieties in the region through local salesmen and local agricultural research centers.

Fourth, access to human capital affects technology adoption. We find that a higher availability of male labor, due to more adult male household members, decreases the adoption of mineral fertilizer and row planting. Although both technologies are labor intensive, availability of male labor is less important, likely because male household members work less on the field. Female labor availability increases the adoption of mineral fertilizer, which is labor intensive at the time of planting, a typical female activity. Yet, we find no impact of education on technology adoption, which is likely related to very low levels of education in the region and a lack of variation in education in the sample (table 2). Further, we find that older farmers are more likely to adopt mineral fertilizers and less likely to adopt row planting. A possible explanation is that mineral fertilizer is a more knowledge intensive and more risky technology that is more easily adopted by more experienced farmers while row planting is less risky but more labour-intensive, and more easily adopted by less experienced farmers and households with a younger labor force.

Finally, total land size (number of plots) and plot characteristics also influence technology adoption. Farmers who cultivate more plots are less likely to adopt improved legume varieties and row planting, likely because a higher land-to-labor ratio limits their need to intensify agricultural production. Further, we find that mineral fertilizer and row planting are more likely on plots with lower soil quality, which is not necessarily beneficial as the impact of technology adoption is likely lower on such plots.

6. Conclusion

It is recognized that gender is a crucial factor that influences the success of policy interventions, and many development projects therefore specifically target women and aim at reaching a minimum number or proportion of women. However, aiming for high female participation rates as such, doesn't automatically guarantee reaching the ultimate project objectives. We studied the impact of female, male and joint participation in an agricultural research and extension program on the adoption of three specific agricultural technologies (mineral fertilizer, improved legume varieties and row planting) by smallholder farmers in Eastern DR Congo. Our study provides a unique case-study in a region that has rarely been studied and valuable insights on gender targeting in agricultural research and extension programs.

A first important finding is that joint participation in the agricultural extension program by male and female farmers within a single (bi-parental) household leads to the highest adoption rates of all three technologies. This calls for extension programs that target female farmers in bi-parental or male-headed households together with, and not instead of, their husbands and male siblings. Such a strategy of targeting both spouses in agricultural extension might have relatively low budget and resources implications and could increase the cost-effectiveness of the program.

A second important finding is that targeting female farmers in male-headed or bi-parental households has different implications than targeting female farmers in single female-headed households. Targeting single female-headed households seems to be a valid gender strategy as it has a higher impact on technology adoption than targeting female farmers in male-headed households (if only females are targeted in the household). This is an important distinction as very often the gender outcome of a program is evaluated by comparing male- and female-headed households while our results show that a positive impact for female-headed households does not necessarily mean an equally positive impact for females in male-headed households.

A third important finding is that female targeting is more effective for certain types of technologies than for others. We find that female program participation is not conducive for the adoption of capital-intensive technologies, such as mineral fertilizer, while it is for technologies that increase the labor-intensity of specific female activities, such as row planting, or specific female crops, such as legume varieties. Therefore, joint targeting of male and female farmers within a single household is especially important for capital-intensive technologies. Alternatively, complementary measures are needed to specifically reduce the capital constraints of female farmers. We need to stress that our findings are case-study findings and hence context-specific. The impact of female participation in agricultural extension programs on technology adoption likely differs depending on the local context. Farmers in our research area face some very specific and severe constraints in terms of food security problems, high incidence and severe poverty, lack of infrastructure, bad governance and high risk due to violent conflict. These factors are known to hinder technology adoption, and findings might be different in areas where these constraints are less severe. In our research area, there is no complete gender separation of plots and the majority of plots are jointly cultivated. In addition, in our research area. there are some agricultural activities and crops that are more female-specific and others that are more male-specific, but again there is no complete gender separation of activities or crops either. In other areas, with a more pronounced gender division of labor in agriculture, findings about the impact of female targeting in agricultural extension programs can be very different. Therefore, more research on this issue is needed to come to more generally valid findings on gender targeting in agricultural extension programs.

7. References

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8. Figures

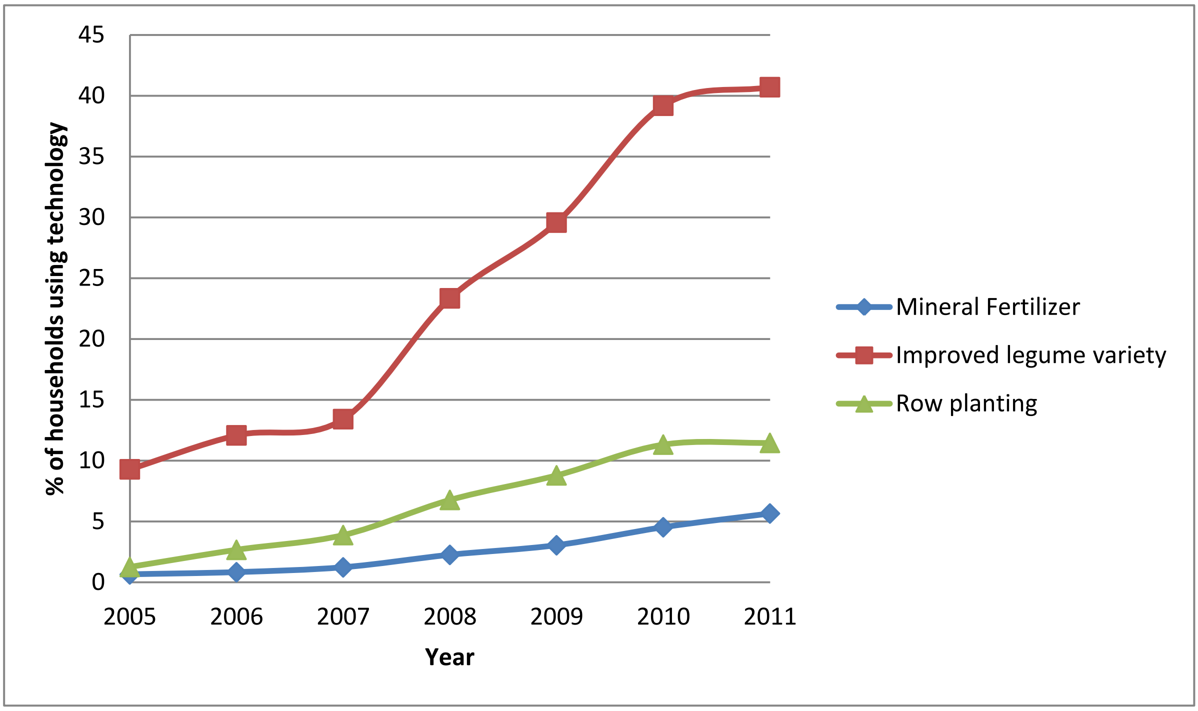

Fig. 1: Share of households using mineral fertilizer, improved legume varieties and row planting, 2005-2011

9. Tables

Table 1: Comparison of selected individual characteristics according to gender of the respondent and program participation

	Full sample		Non-program participants		Program participants	
	Male	Female	Male	Female	Male	Female
Program participant	0.04	0.04	0.00	0.00	1.00	1.00
Years program participant	0.19	0.13	0.00	0.00	4.50	3.15
	(0.06)	(0.04)	(0.00)	(0.00)	(0.86)	(0.56)
Agricultural assoc member	0.24	0.20	0.21	0.16	1.00	1.00
Age	45.36	40.27***	45.18	40.15***	49.64	42.99**
	(1.51)	(1.15)	(1.58)	(1.18)	(1.72)	(1.59)
Years education	3.96	1.49***	3.90	1.47***	5.36	1.91***
	(041)	(0.33)	(0.42)	(0.33)	(0.44)	(0.52)
Off Farm income (1000 USD)	0.22	0.05***	0.22	0.06***	0.07	0.05
	(0.03)	(0.01)	(0.03)	(0.01)	(0.03)	(0.01)
Number of observations	*371*	*409*	*303*	*352*	*68*	*57*

Note: Male and female farmers significantly different at * p<0.10; ** p<0.05; *** p<0.01

Table 2: Characteristics of households in the full sample and program sub-samples

	Full Sample	Non-program households	Program households		
			Male participant households	Joint participant households	Female participant households
Farm and household characteristics					
Female-headed hh	0.10	0.11***	0.00	0.00	0.05
Polygamous hh	0.10	0.10	0.08	0.18	0.21*
Adult Men	1.86	1.82*	2.85	2.85	1.61**
	(0.09)	(0.09)	(0.35)	(0.35)	(0.23)
Adult Women	2.01	1.99**	2.35	2.04	2.89
	(0.06)	(0.07)	(0.18)	(0.24)	(0.35)
Children	2.81	2.76*	3.31	3.72	3.73
	(0.13)	(0.12)	(0.42)	(0.33)	(0.91)
Age of household head	46.21	46.00	48.61	51.16	49.14
	(1.33)	(1.39)	(2.23)	(1.92)	(4.74)
Asset index [a]	2.52	2.43***	4.43	4.14	2.65*
	(0.12)	(0.11)	(0.68)	(0.31)	(0.56)
TLU [b]	0.71	0.63*	3.06	1.97	0.41**
	(0.12)	(0.10)	(1.18)	(0.63)	(0.13)
Number of plots cultivated	3.46	3.36***	5.74	5.39	4.18**
	(0.19)	(0.19)	(0.43)	(0.62)	(0.56)
Distance to market (minutes) [c]	48.25	48.48	39.36	49.45	49.26
	(8.81)	(9.33)	(9.71)	(13.53)	(11.32)
Village characteristics					
Program village	0.22	0.21***	0.66	0.76	0.52
Next to program village	0.31	0.20	0.34	0.24	0.27
Not near program village	0.47	0.59***	0.00	0.00	0.21
Distance to main center (km) [d]	16.47	16.54	15.13	10.37	16.86
	(1.50)	(1.55)	(5.50)	(1.52)	(2.05)
Close INERA [e]	0.02	0.02	0.11	0.04	0.00
North Territory (Kabare)	0.72	0.71	0.69	0.51	0.89
Number of observations	*412*	*324*	*36*	*32*	*20*

a. The asset index is the first term of a principal component analysis on ownership of household durables (excluding productive assets) (Filmer and Pritchett, 2001) (table A1)
b. Tropical livestock units, calculated as relative weight to one cow: one cow equals one livestock unit, pig is 0.40, goat/sheep 0.20, chicken/rabbit 0.05, guinea pig 0.005.
c. Time (in minutes) walking from the homestead to the nearest market without heavy weight and for a normal healthy person
d. Distance (in km) from the village center to the nearest main center (of a larger village)
e. Dummy variable indicating whether the village center is less than 16km away from the INERA research center

Non-program households compared to program households using ttest; significant differences reported with * p<0.10; ** p<0.05; *** p<0.01

Joint participant households and female participant households compared to male participant households; significant differences reported with * p<0.10; ** p<0.05; *** p<0.01

Table 3: Plot level characteristics in the full sample and program sub-samples

	Full sample	Non-program households	Program households		
			Male participant households	Joint participant households	Female participant households
Male owner /tenant	0.57	0.58	0.44	0.66	0.26
Joint owner/ tenant	0.33	0.32**	0.54	0.31	0.66
Female owner/ tenant	0.09	0.10***	0.01	0.03	0.06*
Male managed	0.16	0.15	0.27	0.16	0.04*
Jointly managed	0.64	0.63**	0.70	0.78	0.88
Female managed	0.20	0.22***	0.03	0.06	0.08
Hired	0.19	0.19	0.06	0.17	0.30***
Good soil [a]	0.45	0.44	0.46	0.45	0.47
Sloped plot	0.41	0.40	0.42	0.49	0.50
Distance to the house (minutes) [b]	17.27 (2.52)	17.77 (2.83)	12.89 (1.67)	13.77 (1.92)	12.58 (1.12)
Number of observations	*1595*	*1124*	*203*	*178*	*83*

a. Local farmers' classification of soil quality (CIALCA, 2009)
b. Time (in minutes) walking from the field to the homestead without heavy weight and for a normal healthy person

Non-program households compared to program households using ttest; significant differences reported with * p<0.10; ** p<0.05; *** p<0.01

Joint participant households and female participant households compared to male participant households; significant differences reported with * p<0.10; ** p<0.05; *** p<0.01

Table 4: Adoption of ISFM technologies

	Full Sample	Non-program households	Program households		
			Male Participant households	Joint participant households	Female participant households
Technology adoption at household level					
Mineral fertilizer	0.06	0.05***	0.21	0.66***	0.05*
Improved legume var	0.38	0.36***	0.73	0.87	0.49
Row planting	0.12	0.10***	0.29	0.62*	0.44
Number of observations	*412*	*323*	*36*	*32*	*20*
Technology adoption at plot level					
Mineral fertilizer	0.03	0.03	0.05	0.19**	0.01*
Improved legume var	0.18	0.17**	0.24	0.31	0.24
Row planting	0.07	0.06*	0.07	0.30***	0.10
Number of observations	*1595*	*1124*	*203*	*178*	*83*

Non-program households compared to program households using ttest; significant differences reported with * p<0.10; ** p<0.05; *** p<0.01

Joint participant households and female participant households compared to male participant households; significant differences reported with * p<0.10; ** p<0.05; *** p<0.01

Table 5: Awareness of ISFM technologies

	Full sample		Non-program participant		Program participant	
	Male	Female	Male	Female	Male	Female
Technology awareness at respondent level						
Mineral fertilizer	0.54	0.39***	0.52	0.37***	0.94	0.79**
Improved legume var	0.80	0.78	0.79	0.77	1.00	1.00
Row planting	0.71	0.60*	0.69	0.58*	1.00	1.00
Number of observations	*371*	*404*	*303*	*347*	*68*	*57*

Awareness of female compared to male respondents significant at * p<0.10; ** p<0.05; *** p<0.01

Table 6: Comparison of technology adoption on male managed plots and jointly managed plots by gender of the program participant in the household

	Male main plot manager			Joint plot management			Female plot manager		
Program household	Male	Both	Female	Male	Both	Female	Male	Both	Female
Mineral fertilizer	0.10	0.30	0.00	0.03	0.18	0.01	0.00	0.04	0.04
Improved legume v	0.09	0.30	0.00	0.32	0.33	0.25	0.00	0.14	0.18
Row planting	0.12	0.34	0.00	0.05	0.31	0.11	0.00	0.08	0.10
Number of obs	*82*	*35*	*11*	*113*	*129*	*52*	*7*	*16*	*21*

Table 7: Probit regression results (average marginal effects) on the impact of program participation, by gender, on the probability of technology adoption.

	Mineral fertilizer		**Impr Legume Varieties**		**Row planting**	
Sample	Full	Program	Full	Program	Full	Program
Male member only	0.036		0.028		0.002	
Female member only	-0.016	-0.114*	-0.013	-0.001	0.059*	0.029
Joint membership	0.124***	0.097***	0.093	0.191***	0.134***	0.114***
Female-headed hh	0.017	0.285**	0.287	0.419*	0.058	0.136
Polygamous hh	0.012	-0.010	-0.015	0.129	-0.007	0.034*
Asset index	0.004	0.019**	0.022	-0.039	-0.003	-0.008
TLU	-0.003	-0.003	0.038	0.054**	0.007	0.010*
Total plots	0.004	-0.009	-0.014	-0.018*	-0.006**	-0.001
Age hh head	-0.001	0.008***	0.003	0.002	-0.002*	0.003
Adult Men	-0.016***	-0.036**	-0.004	0.049	0.007	-0.022*
Adult Women	0.013**	0.005	0.032	0.027	0.000	0.001
Children	0.003	0.017**	-0.012	-0.003	0.004	-0.002
Distance to market	0.000	0.000	-0.002***	0.000	-0.001**	0.000
Years education male	0.000	0.003	0.010	-0.016	0.005	0.004
Years education female	0.001	0.000	-0.006	0.026	0.000	0.003
Male other agr assoc	-0.016		-0.161*		0.034	
Female other agr assoc	0.057***	0.039	-0.012	0.101	0.029*	-0.024
Male off-farm income	0.034*	-0.061	-0.034	0.014	0.022	-0.023
Female off-farm income	-0.095*	0.102	-0.279	0.183	-0.015	0.057
Male agricultural decision	-0.002	0.150*	0.037	0.311*	0.047	0.175**
Joint agricultural decisions	0.026	0.102	0.112	0.388**	0.045	0.143**
Male owner/ tenant	0.045*	0.018	0.103	-0.069	0.063**	-0.052
Joint owner/ tenant	0.041	0.002	0.175*	0.004	0.038	-0.040
Hired	0.003		0.093**	-0.137	0.010	-0.069*
Distance to the house	0.000	0.000	-0.001	0.002*	0.000	0.000
Good soil	-0.012	-0.046**	0.050	-0.052	-0.032**	-0.033
Sloped plot	-0.003	0.021	0.042	0.067	-0.020*	0.005
Village Type	-0.004	0.050	0.023	-0.288***	-0.039***	-0.012
Distance to main center	0.001	-0.001	0.001	0.012*	0.002*	-0.002
North Territory	0.016	-0.050	-0.243**	-0.002	-0.034	-0.038
Close to INERA			0.197**	0.164*		
Observations with technology	6.4%	13.2%	30.1%	42.2%	11.2%	19.2%
Observations correctly predicted	92.2%	81.6%	69.8%	69.4%	87.4%	77.2%
Chi2	229.45	947.93	381.66	767.81	975.05	387.07
N	1260	411	847	230	1492	413

Average marginal effects significant at * p<0.10; **p<0.05; ***p<0.01

10. Appendix

Table A.1: First coefficients of polychoric PCA analysis created for asset index

Variable	**#**	**Coeff.**	**Variable**	**#**	**Coeff.**	**Qualitative variables**		**Coeff.**
Table	0	-0.435	Iron	0	-0.104	Wall material		
	1	-0.021		1	0.376		adobe	-0.615
	2	0.308		2	0.635		leaves	-0.069
	3	0.534		3	0.740		wood	0.241
	4	0.685	Radio	0	-0.260		concrete	0.408
	5	0.832		1	0.169	Floor material		
Chairs	0	-0.137		2	0.464		dust	-0.543
	1	0.090		3	0.608		straw	0.257
	2	0.159		4	0.676		concrete	0.359
	3	0.222		5	0.803			
	4	0.286	Mobile phone	0	-0.148	Roof type		
	5	0.357		1	0.248		leaves	-0.232
	6	0.410		2	0.457		wood	0.022
	7	0.449		3	0.579		iron	0.260
	12	0.545		4	0.625	toilet type		
Armoir	0	-0.111		5	0.728		none	-0.309
	1	0.404	Sewing machine	0	-0.023		hole	-0.002
	2	0.642		1	0.466		pit latrine	0.281
	3	0.719		2	0.523			
	.	0.846		3	0.621	source of light		
Mattress	0	-0.192	Rooms	0	-0.418		none	-0.297
	1	0.241		1	-0.033		wood	-0.193
	2	0.497		2	0.228		charcoal	-0.146
	3	0.627		3	0.310		petrol	-0.052
	4	0.683		4	0.372		candle	0.022
	6	0.807	Bed (continuous)		0.244		torch	0.089
			Chairs (continuous)		0.146		electricity	0.232

Component 1: 35% explained

Table A.2 Coefficients of regression results on the full and program sample of trivariate models controlling for selection bias of program participation.

	Mineral Fertilizer		Improved legume varieties		Row planting	
Sample (model)	*Full*	*Program*	*Full*	*Program*	*Full*	*Program*
Male member only	0.246		0.365		-0.205	
Female member only	0.004	-1.949***	1.086	-0.272	0.981	-0.592
Joint membership	1.459**	1.857***	0.023	0.964**	0.803	2.132***
Female-headed hh	0.183	1.382*	0.954*	1.638	0.599	0.114
Polygamous hh	0.172	-0.044	-0.050	0.079	-0.061	0.446
Asset index	0.070	-0.157	0.074	-0.171	-0.027	-0.311***
TLU	-0.023	-0.087	0.094	0.228*	0.098	0.027
Total plots	0.053	-0.052	-0.061	-0.013	-0.071*	0.033
Age hh head	-0.016	0.046**	0.010	0.001	-0.018**	
Adult Men	-0.218**		-0.009		0.080	
AdultWomen	0.177*		0.102		-0.002	
Children	0.037	0.103	-0.042	-0.068	0.042	-0.088
Distance to market	-0.006	-0.003	-0.008***	-0.002	-0.006**	-0.006
Years education male	0.007	0.059	0.035	-0.009	0.050*	0.062*
Years education female	0.009		-0.015		0.001	
Male other agr assoc	-0.236		-0.554**		0.368*	
Female other agr assoc	0.798***	0.015	-0.054	0.097	0.336	-0.228
Male off-farm income	0.455**	0.028	-0.099	0.085	0.234**	0.593
Female off-farm income	-1.486*	1.050	-1.025	0.487	-0.261	0.542
Male Agricultural decision	-0.039		0.151	0.667	0.515	
Joint agricultural decisions	0.354		0.404	1.292	0.489	
Male owner/ tenant	0.613	-0.098	0.341	-0.262	0.676*	-0.306*
Joint owner/ tenant	0.563		0.573		0.392	
Hired	0.047		0.278		0.109	
Distance to the house	0.000	-0.001	-0.002	0.002	0.001	-0.006
Good soil	-0.160	-0.235	0.144	-0.292	-0.356**	-0.234
Sloped plot	-0.032	0.089	0.138	0.241	-0.219	0.081
Village Type	-0.056	0.578	0.121	-0.498	-0.423***	0.147
Distance to main center	0.008	0.010	0.006	0.028	0.021	-0.005
North Territory	0.235	-0.754**	-0.756***	-0.268	-0.348	-0.556
Close to INERA			0.292	0.292		
Constant	-2.806**	-3.810**	-1.846**	-0.617	-1.391**	-0.019
Atanhrho: Techn – Female participant	-0.065	1.214**	-0.704	0.117	-0.112	0.863**
Atanhrho: Techn – Male/joint participant	0.111	-1.364	-0.374	-0.378	0.084	-1.362**
Atanhrho: Female – Male/joint participant	1.124***	-1.719	1.130***	-1.517**	1.127***	-1.565**
chi2	1019.95	346.86	396.10	560.95	750.93	696.43
Number of observations	1274	426	851	232	1511	426

Coefficients significant at * p<0.10; **p<0.05; ***p<0.01

Table A.3: Estimations of the first stage results for the trivariate probit models on the full and program sample.

	Full sample		**Program sample**	
Program member	*Male*	*Female*	*Joint*	*Female only*
5y ago agr assoc male/both	0.902***		0.828*	
5 y ago agr assoc female		0.589**		1.545***
Off-farm income male	-0.869*		-0.494	3.473***
Off-farm income female		0.676		
Age male	-0.013			
Years education male	-0.004		-0.083	
Years education female		-0.040		0.016
Asset index	0.130	-0.008	0.203	-1.003***
TLU	0.283***	0.044	0.028	-0.613***
Total plots	0.039	0.037	-0.079	-0.045
Distance to market	0.007*	0.010***	0.005	-0.002
Adult Men	0.043	-0.060		
Adult Women	0.090	0.156		
Children	0.037	0.071	0.112	-0.084
North Territory	0.280	-0.048	0.188	-1.323**
Village type	-0.579**	-0.307	-0.268	1.566**
Distance to main center	-0.015	0.009	-0.024	0.021
Constant	-1.565*	-2.175**	-0.666	1.045
Atanhrho: Female – Male/joint participant	1.124***		-1.719	
chi2	1019.95		346.86	
Number of observations	1274		426	

Coefficients significant at * p<0.10; **p<0.05; ***p<0.01