Agricultural Extension to Empower Women: Access to Information and Role Models

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Abstract

Programs designed to increase well-being among low-income households generally include an information provision component. Often, these components ignore complex dynamics that govern intra-household decision-making. In the context of digital agricultural extension provision in Uganda—where male targeting bias is common and female extension agents, experts, and model farmers are rare—we conduct a field experiment with 3,330 Ugandan maize farmers to examine how gendered information campaigns affect women's agency and achievements. In one treatment, we investigate the effect of targeting women within households, either alone

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or as part of the couple. In a second treatment, we explore exposure to female role models. We find that targeting women with relevant information in ways that are appealing increases their agency, access to resources, and achievements in farming. Featuring women as role models in information campaigns may be useful in reducing men's dominance in the domain of agriculture, and therefore can create opportunities for greater involvement of women.

Women have limited ability to make strategic choices that are important to live the life they value, and to transform these choices into desired action and outcomes (Kabeer, 1999). This lack of agency manifests itself in a variety of contexts but is particularly in many developing countries. For instance, while women bare the brunt of child care, their voice in deciding how many children to bear is often limited (Ashraf et al., 2014). In a number of low income countries, nearly fifty percent of adult women are restricted in their movement, lack control over resources, are married as a child, condone or have suffered intimate partner violence, and cannot ask for the use of a condom (Hanmer and Klugman, 2016). Partly as a result of this lack of decision-making power, women are also often constrained in their achievements. In low- and middle income countries in particular, women's labor force participation is generally lower then men's and women receive significantly lower wages for similar work (Jayachandran, 2015). In societies with son-biased fertility preferences, mothers breastfeed girls less than boys and provide greater care for boys, with consequences for daugthers' survival rates, their long-run health effect, and broader demographic inequalities (Jayachandran and Kuziemko, 2011; Anderson and Ray, 2010).

There are various factors that limit women's agency and achievements. Some are linked to gendered economic inequalities in access to resources, for example, ownership and use-rights over land or capital owned by a household (Deininger et al., 2013). These inequalities may be further exacerbated by asymmetric access to information between spouses in a household, as women who are informationally disadvantaged have been empirically shown to affect intra-household allocations of assets, income, and consumption goods, or access to health and education services, and other resources (Ambler, 2015; Castilla and Walker, 2013; Ashraf, 2009; Chen, 2006). Strong gendered norms and institutions often perpetuate these inequalities, even in the presence of equitable access to resources and information, to women's agency over both (Agarwal, 1997).

Research suggests that programs that target women with information may be an important route to increasing women's empowerment. For example, Bandiera et al. (2020) find that the share of girls reporting sex against their will dropped by close to a third as a result of providing them with, inter alia, information on sex, reproduction, and marriage. Dupas (2011) finds that providing new information to adolescent girls—that older men are more likely to be infected with HIV—reduced sex with older men. But while emphasis is often placed on selecting who to target information to, less emphasis is typically placed on selecting who should provide the information. Yet studies show that information may be more credible if it comes from an official source (eg. Cole et al., 2013), or if the recipient of the information can identify with the person or persons who provide the information (McPherson et al., 2001). The combination of peer effects and gender homophily effects, where individuals learn from similar individuals of the same gender, may be particularly important in the context of information campaigns to promote women's empowerment. This is highlighted in several recent studies on the influence of role models, which suggest important non-cognitive impact pathways that can be instrumental to information campaigns. For instance, Porter and Serra (2019) show that successful role models can increase entry into traditionally male-dominated sectors. Beaman et al. (2009) show that role models not only affect the behavior of those that identify with the model, but also influence the behavior of others in situations where women are constrained by relationships and social norms. Furthermore, role models may facilitate shifts in social norms: La Ferrara et al. (2012) shows how reductions in fertility result from television soap operas portraying small families.

Gendered dimensions of information campaigns such as targeting information to women or presenting women as role models are particularly relevant in developing-country agriculture, where smallholder production systems are typically characterized by strong social norms that marginalize women in productive decision-making processes (Croppenstedt et al., 2013). In these systems, women typically work long days in the field, yet have little voice in deciding what crops to grow, which technologies and inputs to use, and how much of the output to allocate to home consumption or sale in markets (Magnan et al., 2015; Fisher and Carr, 2015). Yet, in addition to its intrinsic value, there are many well-established benefits to empowering women farmers in developing countries. A more prominent role for women in the farm household has been shown to result in more efficient intra-household allocations of scarce resources, more equitable distribution of the risks and returns to investments in household production, and general improvements in welfare and poverty (Fiala and He, 2016; Croppenstedt et al., 2013; de Brauw et al., 2014). Involving women in the choice of which crops to cultivate may also lead to better dietary and nutritional outcomes at the household level (Heckert et al., 2019; Duflo and Udry, 2004; Quisumbing and Maluccio, 2003; Esha et al., 2014).

One constraint to realizing such outcomes is the presence of asymmetric information between spouses, with women having less information on a range of productivity-enhancing technologies, inputs, and practices. The fact that women possess less knowledge than their male spouses necessarily limits their participation in decision-making on agricultural production (Fisher and Carr, 2015). In many contexts, men rarely discuss agronomic practices or crop management choices with their wives or female partners (Magnan et al., 2015; Fisher and Carr, 2015), and agricultural extension services rarely recognize women in their role as agricultural producers (Doss and Morris, 2000; Doss, 2001).

Reducing womens' information disadvantage by targeting women with information may thus be empowering, particularly if the information is presented in an appealing manner. For instance, BenYishay et al. (2020) show that male and female farmers in Malawi learn and retain information about the new technology equally well, with women applying it on their own farm more often than their male counterparts. In Uganda, Kabunga et al. (2014) find that women in female-headed households would be as likely to adopt innovations in banana cultivation as men in male-headed households if they were as knowledgeable about the technology.

There are also reasons to believe that the source of information may be important for women's empowerment in agriculture. Peer effects have been found important in learning about new technologies or practices (Beaman and Dillon, 2018; Conley and Udry, 2010; Bandiera and Rasul, 2006; Foster and Rosenzweig, 1995). BenYishay and Mobarak (2019) find that social identity of the person that provides extension information influences others' learning and adoption, as farmers appear most convinced by communicators who share a group identity with them, or who face agricultural conditions most comparable to themselves. In Mozambique, Kondylis et al. (2016) find that women's awareness of pit planting farming techniques increased by 9 percentage points and adoption of the technology by 5 percentage points in communities where they trained female messengers on sustainable land management techniques.

In smallholder agriculture systems in developing countries, information related to productivity-enhancing technologies, inputs, and practices is generally disseminated though public extension services. However, agricultural extension services are typically biased toward men, with information targeted mainly to male members of a farm-household and in formats that are rarely tailored to women. In Malawi, (BenYishay et al., 2020) find that women who provided information about a new maize farming technology were perceived to be less knowledgeable both by male and female maize farmers, while, objectively, they were not. These perceptions are both pervasive and influential, deepening the male bias in extension systems. In Uganda, a recent survey on public service delivery found that only 16 percent of extension agents are women (Kabunga et al., 2016). This suggests that extension systems do not sufficiently recognize the gendered power dynamics governing intra-household information exchanges, thus reinforcing the dis-empowerment of women in agricultural decision-making processes (Doss, 2001; Quisumbing and Pandolfelli, 2010).

In this paper, we examine ways in which information and communication technology (ICT) applications used in agricultural extension services can be designed to increase women's access to informational resources, their agency, and their achievements in farming, all of which directly relate to women's empowerment in agriculture. We conduct a field experiment among 3,330 maize-farming households in eastern Uganda to test the effectiveness of including women as recipients of information, and of exposure to female role models. To test the effectiveness of targeting women with information, we compare outcomes of households where the female co-head was included in the target audience to outcomes of households where information was targeted to the male co-head alone. To test if exposure to female role models is effective, we compare outcomes of households where a women was included in the dissemination of the information to outcomes of households where the information is provided exclusively by a man. Our study design, which takes the form of a factorial experiment with 3 levels in each of the two factors, allows us to further explore some of the mechanisms, such as the role of private access to information, the effect of reductions in information asymmetry within the household, of importance of peer effects and gender homophily effects, and the impact of challenging gendered norms and stereotypes among both women and men.

The information intervention is implemented as a set of short videos that provides viewers with information and recommendations on appropriate input use, management practices, and investment strategies that can be followed to obtain higher maize yields. To test the impact of information effects on women's empowerment, we vary who is targeted within the household by randomly assigning household members—the male co-head alone, the female co-head alone, or both co-heads together—to the video screenings. To test the impact of role model, peer, and gender homophily effects on women's empowerment, we randomly assigned farmers to screenings of three different versions of the video: one featuring a male actor, another featuring a female actor, and a third featuring both actors together, holding constant all other information contained in the video. The videos were screened with study participants at their homes using tablet computers, and were screened twice during the course of the field experiment: once before the start of the agricultural season and once at the time of planting.

The empowerment impacts of information provision are fairly straightforward in our experiment. We find that targeting women within the household (as opposed to only targeting the male co-head) with information had a positive effect on different domains of empowerment, including women's knowledge of agronomic practices, their participation in agricultural decision-making, and their adoption of recommended practices and inputs. Most of the effects were driven by the subsample of women who received the information alone, suggesting that both male and female co-heads tend to monopolize information or engage in only very limited intra-household information sharing. While there is some evidence that the subsample of women who received information jointly with their husbands increased joint decision-making, these effects are much weaker.

The empowerment impacts of involving women as messengers are more complicated. While we find no effect on women's knowledge, decision-making, or adoption of recommended agronomic practices, we do find that involving women as messengers may lead to an increase in the use of organic fertilizer by women. Looking only at households where women co-heads were targeted, we find that if these women were shown a video featuring a woman, they were more likely to make decisions than if they were shown a video in which a man provided the information. This suggests the presence of peer or gender homophily effects. Furthermore, if we consider only households where male co-heads were targeted, we find that if these men were shown a video featuring a woman, they were less likely to make decisions unilaterally, suggesting that presence of role incongruity effects that result from challenging widely held beliefs and stereotypes about women being less able to make decisions related to agriculture.

The paper is structured as follows. In Section 1 we review the literature on women's information deficiencies and how this is linked to women empowerment.

We then give an overview of the emerging literature on how exposure to role models may affect women's decision making power. In Section 2 the research hypotheses are presented. Section 3 describes the context of female and male smallholder farmers in eastern Uganda. In Section 4 we explain the methods and elaborate on the experimental design, present the specifications we will estimate, look at baseline data, and define indicators that will be used to assess impact of the different interventions. The design of our experiment in combination with the richness of the data we collected means we have a lot of results to present; Section 5 does this in a systematic way. The results are then interpreted and discussed in a separate section (Section 6). A final section concludes.

1 Prior Literature

This section offers a review of related literature on gender and agriculture with specific emphasis on the gendered dimensions of access to information within the household and role models, drawing on examples that highlight their influence on extension service provision and technology adoption. Throughout the study, we define empowerment as a process where those (women) who were previously denied the ability to make and act upon important choices in their lives gain such ability (Kabeer, 1999). This ability to make choices is based on three main components: access to resources (including material assets, informational resources, and social capital); agency (a person's ability to act on their decisions); and achievement (the social and economic outcomes such as income and well-being). Women's empowerment can imply that women have greater ability to make and act upon choices both individually, or jointly with their male co-head (Johnson et al., 2016).

1.1 Information Constraints

There is ample evidence that women face information deficiencies and asymmetries relative to men in a range of circumstances, and thus may hold weaker bargaining positions. In agriculture, women farmers have been shown to be more deprived of information regarding good agronomic practices (Doss and Morris, 2000; Doss, 2001; Lambrecht et al., 2016). In certain situations, this may be directly linked to unequal access to agricultural extension and advisory services between men and women farmers (Ndiritu et al., 2014). This unequal access may contribute to lower adoption rates of improved agricultural practices and technologies among women. For example, studies show that with equal access to extension services, land, and labor, men and women farmers in male-headed households in Ghana would be as likely to adopt modern agronomic practices (Doss and Morris, 2000).

Women's access to information—specifically, to information provided by agricultural extension services—may be subject to both extra-household and intra-household constraints. The extra-household constraints can be infrastructural and logistic, such as for instance women not being targeted, women lacking the money to travel to extension training locations, or women lacking the time to attend because of household management, domestic and reproductive responsibilities (Fletschner and Mesbah, 2011; Wodon and Blackden, 2006). Extra-household constraints may also exist in terms of information content or delivery: it may not be adapted to women's interests or needs, or may not recognize women's role as agricultural producers, and therefore may not appeal to women. Human capital constraints may also play a role given women's generally lower levels of education in many rural contexts in developing countries. Norms limiting women's mobility and women's interaction with men may impose additional constraints (Fletschner and Mesbah, 2011). These extra-household constraints to women's access to information mean that, in many situations, women may rely more on informal networks for gathering information. When these networks are gender-specific and gender-segregated, problems associated with asymmetric information persist (Zeltzer, 2020; Beaman and Dillon, 2018).

A (married) woman's interaction with her husband may often be her main (intra-household) source of information on agriculture. This assumption is implicit in most extension strategies that target the male household head (Fletschner and Mesbah, 2011). Yet the assumption requires that preferences of male and female co-heads within a household align; that household resources, including information, are shared; and that households cooperate to reach Pareto-optimal outcomes. However, the conceptualization of the agricultural household as a unit with such properties has been challenged in theoretical work (Lundberg and Pollak, 1994; Pollak, 1994; Alderman et al., 1995) and rejected in empirical work (Udry, 1996; Duflo and Udry, 2004; Ashraf, 2009; Iversen et al., 2011).

Several studies explore intra-household information asymmetries in the context of developing-country agriculture and the provision of agricultural extension services using non-cooperative models of the household. Kondylis et al. (2016) start from the observation that information about sustainable land management practices in Mozambique does not reach female farmers as effectively as male farmers, and is not perfectly shared between male and female co-heads within these households. They find a positive effect on awareness and adoption among female farmers when they introduce additional female extension agents who reach out to female farmers. Pan et al. (2018) explore similar issues in Uganda with women model farmers who facilitate training and access to hybrid maize seed, particularly for fellow women smallholder farmers. They find significant positive effects on the adoption of low-cost recommended agronomic practices and inputs by households, and on household food security. Lambrecht et al. (2016) investigate whether extension services are more effective if information is provided to both male and female co-heads together, the male co-head alone, or the female co-head alone in the household. Focusing on integrated soil fertility management practices in eastern DR Congo, they find that joint participation of male and female co-heads in extension information events increases adoption most. Fisher and Carr (2015) use observational data to explore explanations for the relatively low adoption rates for drought-tolerant maize varieties among women farmers (in male-headed households) in eastern Uganda. They do not find support for the idea that this is caused by differences in technology preferences, but that differences in adoption are related to awareness, and particularly whether the woman farmer received information about the varieties.

1.2 Role Models and Aspirations

There is also a growing literature that explores the psychosocial dimensions of gender inequality. For instance, an emerging literature investigates the importance of role models in challenging gender stereotypes and empowering women in domains where they are active but lack voice and agency. Role models are defined as individuals who inspire people to make similar choices, to adopt a similar set of values, or to achieve comparable results (Porter and Serra, 2019).

Role models are seen as important in stimulating aspirations and the development of an internal locus of control. They can update beliefs in one's own ability (self-efficacy) or beliefs about the returns to investments, especially for disadvantaged social groups that have few examples of success (Beaman et al., 2012; Riley, 2017). Updated beliefs in self-efficacy and returns to investments can, in turn, raise aspirations and increase people's ambitions, which create the motivation to work hard and attain the success projected by the role model (Riley, 2017). Inspiring films about successful farmers' life choices promoted welfare-improving aspirations among Ethiopian farmers (Bernard et al., 2015). Women chief village councilors in rural India raised parents' and girls' aspirations with regard to education and adult life opportunities (Beaman et al., 2012). Kandpal and Baylis (2019) demonstrate that women in social networks of women who became empowered through a women's education program gained empowerment in terms of mobility and investment in girl children, but not in other domains where sticky norms seem to prevent change. In Nicaragua, proximity of women promoters of a conditional cash transfer program made women more optimistic about the future, happier in life, and less fatalistic (Macours and Vakis, 2014). In Egypt, the prominent and visible role that women played in the Arab Spring protests, has inspired women to more autonomy in decisions about health, socialization and household decisions and less accepting attitudes towards domestic violence and girls excision (Bargain et al., 2019).

Evidence shows that role models not only increase aspirations, but also lead to changes in choices made. In Ethiopia, while the inspiring films did not specifically mention what choices made the role models successful, viewers were more likely to save. The number of children enrolled in school and school-related expenditures went up as well (Bernard et al., 2015). Porter and Serra (2019) observed an increase in female student enrollment in an intermediate economics class after women alumni's testimonies. The proximity of women promoters in Nicaragua positively affected investments in education and nutrition (Macours and Vakis, 2014). State-level implementation of political reservations for women in India increased the number of women-owned establishments in the informal sector, particularly household based enterprises in sectors where women traditionally owned businesses. This may have followed from greater aspirations of women to start their own businesses or from improved infrastructure favored by women (Ghani et al., 2014). Some studies also show that role models can help people becoming more successful. Nguyen (2008) finds that in Madagascar, role models increase children's test scores. Riley (2017) finds a direct positive effect of a movie about a poor Ugandan girl championing in chess on the educational achievements of lower and higher secondary school students. Beaman et al. (2012) show that women leaders in Indian village councils not only raised aspirations, but also boosted girls' educational attainment and reduced girls' time spent on domestic chores.

The power of role models can also be linked to the fact that people's tendency to conform (i.e., not wanting to deviate from the group) can be challenged by an influential person whose behavior is non-conformist (Thaler and Sunstein, 2008). Role models thus have been found important in challenging role incongruity, which can be defined as prejudiced views and cognitive biases about the capabilities of specific social groups in specific social roles that arise from a combination of perceptions about the characteristics of members of that social group and perceptions about the capabilities and characteristics that specific social roles require (Eagly and Karau, 2002). Role models can affect women's empowerment directly: as women start questioning cultural norms and gender stereotypes, their locus of control may shift, resulting in increased entry into traditionally male-dominated domains. Indirectly, role models can challenge beliefs and stereotypes about lesser abilities of another group held by the group whose abilities are not underestimated. For example, Beaman et al. (2009) show that the appointment of women leaders to Indian village councils improved men's perceptions of women's leadership abilities.

Other mechanisms, including peer effects (which are linked to recognition and conformity) and gender homophily may also be at play in the case of role models of the same sex. Gender homophily is defined as the preference for interaction with individuals of the same sex, and is linked to having more trust in individuals of the same social group (McPherson et al., 2001; Zeltzer, 2020). Such mechanisms imply that the information contained in a message brought by role models of the same sex is better understood and more trusted, thereby contributing to changes in an individual's choices and improving chances of success.

2 Testable Hypotheses

We explore cognitive and socio-psychological dimensions of extension information campaigns on various dimensions of women's empowerment. We consider women's empowerment along the lines of Johnson et al. (2016), where empowerment encompasses both an increase in women's individual and joint decision-making within the household with respect to a set of key livelihood-related variables. We thus assess empowerment as a positive change both for the female co-head individually and for the female and male co-heads jointly in each to the following spheres: their knowledge about recommended agronomic practices and inputs; their participation in intra-household decision-making on farm production; the choices they make about the adoption of recommended practices and the use of inputs; the output and yield from plots; and their participation in selling farm output. A reduction in male domination over these different dimensions is considered empowering as well. In the context of our study, these variables are specific to the types of smallholders defined by our population of interest (and described in detail below), but are likely to be relevant for other smallholder agricultural contexts.

In a first hypothesis, we test if involving women in receiving extension information strengthens women's knowledge about recommended practices and inputs, and possibly makes common knowledge about other agronomic practices more salient. There are different ways in which (also) targeting women with information may lead to these outcomes. The first assumes that information that would otherwise be, to some extent, monopolized by the male co-head, now also reaches women. If the female co-head receives the information alone and does not monopolize that information or if both the female and male co-head of a household receive the information as a couple, we would expect an increase in both women's individual knowledge and the couple's overall (joint) knowledge where intra-household communication, consultation, and learning occur, which can lead to an increase in women's individual and joint decision-making and outcomes. If the female co-head receives the information alone, she might also monopolize that information, in which case changes in women's individual knowledge, decision-making and outcomes may be expected. The second channel is through a change in a woman's bargaining position that results from possession of an informational asset, which may prevent a male co-head from advancing his preferences at the expense of hers.

In a second hypothesis, we test whether directly involving women in conveying information, thereby portraying them as (equally) qualified experts, may also affect women's empowerment. Giving women key roles in conveying information may affect recipients of the information via role model effects. Role model effects work via learning externalities through peers and gender homophily effects. In addition, role models may also challenge role incongruity. Peer effects occur where information recipients can relate to the information messenger as a peer—as an individual with a similar identity or experience, or as an individual possessing credible knowledge and information. Gender homophily effects, a specific type of peer effects, occur where these peer effects are specifically based on a match in the sex of the messenger and recipient. Role incongruity effects occur where women update their beliefs about roles and responsibilities in the household as a result of receiving information from a messenger that is somehow inconsistent with their beliefs. We expect such effects to increase women's aspirations about their households and livelihoods, thereby causing them to make more ambitious choices, in turn contributing to improved outcomes.

Role incongruity effects may also work indirectly. The involvement of women in conveying information may cause men to revise their beliefs about women's agency and capacity to make sound investment decisions on the farm. As a result, men may leave more space for decision-making by their wife and relax any inhibition to their wife's access to complementary inputs, their decision-making on the adoption of recommended practices, or the improvement of crop production.

3 Study Context

To explore these effects, we conducted a field experiment in 2017 among smallholder maize-farming households in eastern Uganda. Participants in the field experiment were drawn from monogamous maize-cultivating households residing in five districts where maize is particularly important, both as a staple and as a marketable crop. The experiment was conducted during the second maize-growing season, which runs from approximately August to January of the following year, and is characterized by a shorter period of rainfall than the first maize-growing season. During this second season, the complete cycle from planting to harvest requires three to three and a half months, and farmers tend to cultivate early-maturing but lower yielding maize varieties. Fields are prepared in August, planted in September, and harvested from December onward.

Maize yields in the study area, and in Uganda more generally, are well below their potential. Research station trials in Uganda have demonstrated that yields range between 730 kg per acre and 1,820 kg per acre (Fermont and Benson, 2011). Yet, on-farm estimates are generally lower. A recent study of on-farm yield reports figures between 270 kg per acre and 995 kg per acre (Gourlay et al., 2019). There is also evidence that maize plots under female management are less productive than maize plots under male management. Ali et al. (2016) observe that, generally, male-managed plots are on average 17.5 percent more productive than female-managed plots in Uganda. They link the productivity gap between male- and female-managed plots (controlled for plot size but without distinguishing between type of crops) to an unequal distribution between men and women of responsibilities and resources, including modern inputs such as improved varieties, fertilizer, and agrochemicals.

Decision-making power over agricultural production is related to the actual or perceived ownership of the land. In Uganda, ownership of land for married women is constrained by patrilineal land inheritance customs and by customs and traditional rules prescribing that, through marriage, women gain access to land owned by their husband (Jacobs and Kes, 2015). Fisher and Carr (2015) show that in eastern Uganda, married women farmers are the primary owners of only 2.7 percent of all maize plots in the study's sample, and are the main decision-maker for the choice of maize variety on only 15.4 percent of the plots. They did not find evidence that land quality (in terms of soil fertility and slope) or type of tenure differ between female- and male-managed maize plots. Decision-making power is also related to customary gender roles and responsibilities which, in turn, affect intra-household labor allocations. Based on data from the 2011/12 Uganda Living Standards Measurement Study (LSMS), Fisher and Carr (2015) further found that, in total, more household labor was used on male-managed maize plots than on female-managed maize plots in male-headed households. On those female-managed plots, more female and child labor (and less male labor) was allocated to maize cultivation.

		Messenger		
		Man	Woman	Couple
Recipient	Man	385	385	369
	Woman	385	385	369
	Couple	342	342	369

Figure 1: Layout of experimental design

4 Methods

4.1 The Experiment: A Video Extension Information Intervention in a Factorial Design

We test hypotheses about the effectiveness of involving women in receiving and conveying extension information via ICT-enabled videos. To do so, we developed a 3x3 factorial design, in which one factor corresponds to the gender of the person (or persons) who receives the information (henceforth referred to as the *recipient* factor) and the other factor corresponds to the gender of the person (or persons) who delivers the information (henceforth referred to as the *messenger* factor).[1] Each factor contained three levels: man alone, woman alone, or man and woman together (as a couple). The design is represented in Figure 1 below, with sample sizes shown in each of the nine treatment combinations to indicate the number of households randomly allocated to one of these nine treatment cells.[2]

To operationalize this design, we developed a series of videos that was shown to participating farmers according to this design. Corresponding to the recipient factor, the video was shown to one of the three recipients: the male co-head of the household; the female co-head; or the male and female co-heads together as a couple. Corresponding to the messenger factor, we produced three versions of essentially the same video, with the only difference being the actor(s) featured in the video. In a first version of the video, a male actor-farmer is featured in

[1]In the context of this study, we refer to these factors in terms of "gender" and not "sex" because the implicit differences in the person(s) receiving or delivering the information are social and cultural in nature, and not simply biological.

[2]Power calculations were based on a set of comparisons using different outcomes to power the complete 3x3 factorial design. We used simulation techniques that allowed us to sample from actual data on outcome variables (maize yields obtained from Uganda National Household Survey of 2005/06) instead of a theoretical distribution with an assumed mean and standard deviation. Detailed information on the power calculations can be found in the pre-analysis in Lecoutere et al. (2017).

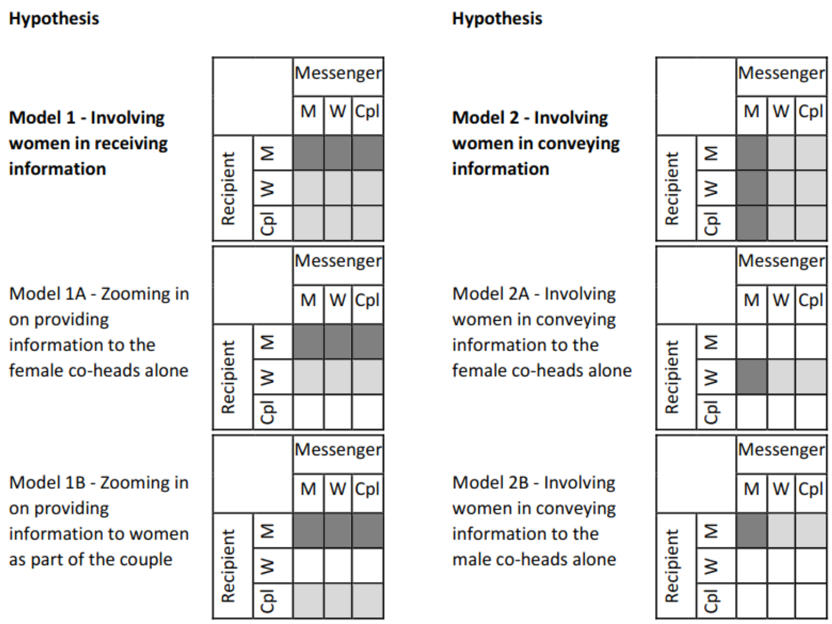
the video. The second version of the video features a female actor-farmer. In a third version of the video, both the male and female actor-farmers are featured. The videos can be found here.

During implementation of the experiment, one of these three versions of the video was screened to the participating individual(s) according to the treatment arm that the household was randomly assigned to. The videos were shown on 10-inch Android tablet computers by trained field enumerators during a private meeting with the participant (or participants if the recipient was the couple). Information on the sampled households and their treatment assignment was preloaded onto the tablet computers, such that the correct video was automatically queued and enumerators were only able to screen the appropriate version of the video. The video was shown twice to our study participants, once before the maize planting time (July 2017) and once around the actual time of planting (August 2017).

The video itself consists of a 10-minute inspirational story in which a farmer (man, woman, or a man and woman acting together as a couple) recounts how s/he used to struggle with low maize yields. The actor-farmer then shows what inputs s/he used and what recommended practices s/he followed to successfully increase his/her yields. The choice of what inputs and practices to promote in this video was based on key informant interviews conducted in May 2017 with agronomists, maize breeders, district agricultural officers and other government staff, extension workers, and maize farmers. The information provided in the video is also generally consistent with the package of recommendations promoted by the Ugandan Ministry of Agriculture, Animal Industry and Fisheries.

The video includes information about a range of productivity-enhancing strategies including: management of pests and disease, including striga (*Striga hermonihica*) a parasitic plant affecting maize growth; improvement of soil fertility through the timely application of organic and inorganic fertilizers; use of fresh seed of improved maize varieties and hybrids; and crop management practices such as timely planting, optimal plant spacing, and timely weeding. The video also contained content on the costs and benefits of the different practices and inputs being promoted, and recommended that viewers take a long-term perspective on improving their maize cultivation by starting small and reinvesting profits on increasingly larger areas of land.

The factorial design laid out in Figure 1 allows us to test the different hypotheses described earlier by comparing outcomes across different treatment groups. This is visualized in Figure 2. To examine the impact of providing women with direct access to extension information on different measures of women's empowerment, we compare outcomes of the 2,192 households where the female co-head was involved in watching the video (either alone or as part of a couple) to outcomes of the 1,139 households where only the male co-head watched the video (Model 1). There are likely to be different effects from showing the video to the female co-head alone as compared to showing it to the female co-head as part of the couple, for instance related to the possibility of monopolizing information or gaining bargaining power on the basis of uniquely held information. That is why we additionally zoom in on the effect of showing



Note: M=man; W= woman; Cpl= couple. Dark grey cells represent the control group and light gray cells represent the treatment group used to test the specific hypothesis.

Figure 2: Hypotheses tests

the video to the female co-head alone versus showing it to the male co-head (Model 1A) and the effect of showing it to the female and male co-head as a couple versus only to the male co-head (Model 1B).

Next, to examine the impact of providing women and men with information that includes women as messengers, we compare outcomes of the 2,219 households where a female actor featured in the video (either alone or as part of a couple) to outcomes of the 1,112 households where only a male actor featured in the video (Model 2). To specifically assess the impact of women receiving information conveyed by women—a specific test of our hypothesis of peer or gender homophily effects and/or challenges to role incongruity among women—we compare outcomes of the 754 households where the video in which a female actor was featured (either alone or as part of a couple) was shown to the female co-head within the household to outcomes of the 385 households where the video in which a male actor featured was shown to the female co-head (Model 2A). We additionally zoom in on effects following from men updating role incongruent beliefs when a woman is providing information and portrayed as a successful farmer by comparing outcomes of the 754 households where the video in which a female actor was featured (either alone or as part of a couple) was shown to the male co-head to outcomes of the 385 households where the video in which a male actor featured was shown to the male co-head (Model 2B)[3].

4.2 Estimation

We estimate average treatment effects using the following Ordinary Least Squares specification for the impact of the different treatments on outcome y in household i,

$$y_i = \alpha + \beta.T_i + \gamma X_i + \delta.O_i + \varepsilon_i \tag{1}$$

In the equation, T_i is an indicator that takes the value one if a household received the treatment for the particular hypothesis that is tested, and zero otherwise. O_i is a vector of indicators for the orthogonal factor for household i. X_i is a vector of baseline control variables that are included to adjust for any imbalance that is found between treatment and control at baseline (See Section 4.3), and ε_i is the error term. For example, to test the first hypothesis whether involving women as recipients of information is effective, T_i equals one if the video was shown to the couple or to the female co-head alone, and zero if the video was shown to the male co-head alone within the household. O_i is a vector of two dummy variables, corresponding to what version of the video was shown.[4]

The parameter of interest in equation 1 is the treatment effect (β). It is important to note that this is a composite parameter, denoting the effect of the treatment when approximately equal shares of households receive the orthogonal treatments. In factorial designs where each factor has a treatment and a control condition, one can run a fully interacted model. The main effects can then be interpreted as the effect of the treatment alone. However, in our design, we do not have strict control categories in the factors (at least someone needs to provide information in the video and at least one person in the household was shown a video). It is therefore more informative to estimate treatment effects that are weighted-averages of the interactions with other treatments. To continue with the example of the first hypothesis, β thus denotes the effect of involving women in receiving information when one third of the sample receives this information in the form of a video where only a man provides the information, one third where only a women provides this information, and one third where the information is given by a couple.

In addition to controlling for the orthogonal factor O_i in equation 1, we need to take into account the fact that also within a factor, treatment cells may have a different number of observations. This becomes an issue when two cells are pooled. For example, in testing the first hypothesis, we see from figure 1

[3]Note that this comparison conflates role incongruency effects with gender homophily or peer effects from the husband.

[4]The first dummy takes the value of one if the version of the video was shown where the information was provided by a woman alone (and zero otherwise). The second dummy takes the value of one if the version of the video was shown where the information was provided by a couple (and zero other wise). The reference category is thus the video where a man alone provides the information.

that there are 1,139 households where the female co-head alone is to receive the information treatment, but only 1,053 households are allocated to receive the information treatment as a couple. When pooling these two groups into a single group to assess women involvement in receiving information, the women alone group gets a higher weight. We thus reweigh observations to make sure each group gets an appropriate weight when pooling groups.

We use randomization inference to calculate associated p-values for the two-sided hypothesis of no effect. We aggregate families of outcomes into indices, which are constructed as the weighted mean of the individual standardized outcomes, using as weights the inverse of the co-variance matrix of the transformed outcomes (Anderson, 2008). Combining outcomes in indices is a common strategy to guard against over-rejection of the null hypothesis due to multiple inference. However, it may also be interesting to see the effect of the intervention on individual outcomes. An alternative strategy to deal with the multiple comparisons problem is to adjustment the significance levels to control the Family Wise Error Rates (FWER). We used re-randomization to construct the joint null distribution for the family of outcomes we are testing. From this family-wise sharp null, we obtained the corresponding FWER-consistent significance thresholds by determining which cutoffs yield 10 percent, five percent and one percent significant hypothesis tests across all tests and simulations (Ottoboni et al., 2021; Caughey et al., 2017).

4.3 Data

Data were collected from households in five districts in eastern Uganda: Bugiri, Mayuge, Iganga, Namayingo, and Namutumba. From among these districts, we first removed town councils and two sub-counties that consisted of islands in Lake Victoria. We then used a two-stage cluster sampling approach to obtain a representative sample of this population. Specifically, we first selected parishes randomly and in proportion to the number of villages within each parish. In the selected parishes, all villages were included in the study. Within each village, we then listed all households, from which we randomly selected households to be included in the study.

Table 1 summarizes pre-treatment characteristics of the households that were enrolled in the study. The first column provides averages for the entire sample, with corresponding standard deviations in parentheses below. The 5 percent trimmed log maize yield (defined as kilograms produced per acre) was 5.3 on average. The average household head is about 40 years old, and in only 37 percent of households did the head finish primary school. Households are large, consisting of more than 7.6 members. Only 11 percent of sampled households reported having access to extension in the previous year. Few farmers use inorganic fertilizer at baseline; the use of fresh improved seed is higher. About 78 percent of households report to be owning a mobile phone.

The table also serves as a balance test for the two main comparisons we will make (Balance tests for the other hypothesis tests can be found in Appendix Tables A.1 and A.2). We find baseline imbalance in observable characteristics that

Table 1: Balance tests

	Model 1: Involving women in receiving information					
	Avg	S.D.	ATE	S.E.	p-value	N
Yield (log)	5.310	0.823	-0.068	0.031	0.013	3,153
Age of male co-head	39.891	13.834	-4.788	0.499	0.000	3,294
Male co-head finished primary school	0.371	0.483	-0.076	0.018	0.000	3,322
Household size	7.623	3.309	0.211	0.120	0.069	3,322
Nbr of bedrooms	2.236	1.144	-0.033	0.042	0.401	3,322
Access to extension	0.110	0.313	-0.003	0.011	0.748	3,322
Used fertilizer	0.207	0.405	-0.049	0.015	0.001	3,322
Used improved seed	0.384	0.486	-0.068	0.018	0.000	3,322
Distance to input provider	5.554	5.544	-0.027	0.202	0.876	3,322
Household owns mobile	0.779	0.415	-0.081	0.015	0.000	3,322
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
Yield (log)	5.310	0.823	-0.014	0.031	0.619	3,153
Age of male co-head	39.756	13.798	0.236	0.490	0.644	3,294
Male co-head finished primary school	0.368	0.482	0.015	0.018	0.403	3,322
Household size	7.621	3.307	-0.024	0.121	0.844	3,322
Nbr of bedrooms	2.234	1.143	0.003	0.042	0.945	3,322
Access to extension	0.110	0.313	0.013	0.012	0.236	3,322
Used fertilizer	0.206	0.405	-0.009	0.015	0.516	3,322
Used improved seed	0.383	0.486	0.022	0.018	0.213	3,322
Distance to input provider	5.551	5.537	-0.132	0.204	0.450	3,322
Household owns mobile	0.776	0.417	0.005	0.015	0.735	3,322

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1 for top panel and Model 2 for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference.

are statistically significant, especially for the hypothesis related to empowering women with information (Model 1 in the upper panel of Table 1). For example we find that, at baseline, male co-heads were significantly younger in households where women were involved in receiving information, and that male co-heads were less likely to have finished primary education. We also find that they were less likely to use improved seed, use fertilizer, or own a mobile phone and that they reported lower maize yields. Households also were larger. A test for joint significance of the differences confirms this imbalance for the comparison in Model 1 (F-statistic = 20.253; p-value < 0.001). For the comparison to test the impact of role model effects, we do not find imbalance between the groups (lower panel in Table 1) (F-statistic = 0.682; p-value = 0.742). We will control for baseline characteristics that show up as significant in the balance tables when treatment and control outcomes are compared throughout the paper.

Endline data was collected between February and April 2018. Households were revisited and male and female co-heads where interviewed separately.

4.4 Indicator Definition

This study aims to estimate effects on women's empowerment. We consider a woman as 'empowered' not only if she decides or achieves things on her own, but also if she does so in partnership with the male co-head in the household. Thus, we examine effects on both women's outcomes and outcomes that are shared (joint) between the female and male co-heads of household. Those outcomes are cast as increases in (a) the female co-head's knowledge (individually and/or jointly with her male co-head) about the information promoted in the video or re-activated by it; (b) the extent to which maize production decisions in the household are taken by the female co-head alone and/or jointly with her male co-head; (c) the adoption of the recommended practices and inputs decided upon by the female co-head individually and/or jointly with her male co-head; (d) output and yield on maize plots that were female-managed and/or jointly managed; and (e) maize sales decided upon by the female co-head individually or jointly with her male co-head. Additionally, we will examine effects on men's outcomes assuming that a reduction of men's individual decision-making and adoption can be empowering for women as well.

Knowledge about four different practices recommended in the video is measured by the extent to which respondents answered correctly to multiple choice questions about the practices.[5] A woman's (man's) knowledge score is based

[5]First, respondents are considered knowledgeable about plant spacing if they correctly answered that the best spacing is two and a half feet between rows and one foot between plants, with one seed per hill. Second, respondents are considered knowledgeable about combining practices if they correctly answered they would allocate 40,000 Ugandan shillings to buy improved seed and fertilizer, as combining inputs is a better strategy than putting all the eggs in one basket. Third, respondents are considered knowledgeable about optimal weeding if they correctly answered weeding is most important during the first four weeks after planting. Fourth, respondents are considered knowledgeable about fall armyworm control if they correctly answered that spraying in the evening is most effective since fall armyworm eats during night. The information needed to correctly answer the first three questions was provided in

on responses from the female (male) co-head; the joint knowledge score is based on responses from both the female and male co-heads, where it was considered a correct joint answer if both of them got the answer correct, otherwise, not. We combine the outcomes of the four knowledge questions into a Women's Knowledge Index, a Joint Knowledge Index and a Men's Knowledge Index as mentioned in Section 4.2.

Agricultural decision-making is based on the woman's answers about whether she made a series of decisions related to household maize production. We differentiate between decisions made individually by the female co-head and decisions made jointly with her spouse. As women's empowerment may also lead to a reduction in unilateral decision making by the male co-head, we also consider decisions that, according to the female co-head, were decided by the man without consulting her. For each maize plot within the household, we thus recorded if the following decisions were made by the female co-head, jointly or by the male co-head: whether to plant maize on the plot; when to start planting the maize on the plot; what spacing of maize plants to use and how many maize seeds per hill to plant on the plot; what strategies to use to control striga on the plot; and when to start weeding on the plot. To aggregate this at the household level, we consider the proportion of maize plots within the household on which the female co-head reported that she made the decision alone, that the decision was taken jointly with her husband, or that her husband took the decision alone. Following a similar procedure as discussed above, we constructed a Women's Decision-making Index, based on the proportion of the household's maize plots for which the female co-head made the decisions described above alone. We also make indices for joint decision making and for male unilateral decision making.

Decision making is central to women's empowerment. However, we may also want to check if the practices and inputs that were recommended in the video were also implemented on the plots. For instance, it may be that, due to the video, women gain voice in the decision making process, but if additional investments are needed (for instance in terms of labour time or inputs), they may still be constrained and decide to use a second best technology. We thus also consider the proportion of the household's maize plots for which the female co-head decided about a particular practice alone and adopted the practice that was recommended in the video. Similarly, we consider the proportion of the household's maize plots for which the female and male co-head decided and adopted a recommended practice jointly, as well as the proportion of household's maize plots for which the male co-head decided unilaterally and adopted the practice that was promoted in the video.[6] We measure adoption of the following

the videos. The videos did not provide information on fall armyworm control, hence no effect was expected for this question.

[6]It is important to note that our intervention may change both the likelihood that a spouse makes a decision as well as the likelihood that the decision maker then adopts what was recommended in the video. As both events are not independent, this means that the joint likelihood we estimate corresponds to the conditional probability that a recommended practice is adopted by the woman multiplied by the probability that that the woman makes a decision on the practice. This should be kept in mind when comparing effects of adoption to effects of decision making.

practices as recommended in the video: planting within one day after the start of the rain, using the recommended spacing and number of seeds per hill, removing striga before it flowers, and doing the first weeding in the third week after planting. As before, we use the same method to construct a Women's Adoption Index, a Joint Adoption Index and a Men's Adoption index.

We measure use of inputs such as DAP (*Diammonium phosphate*), urea, organic fertilizer, maize hybrids, and open pollinated varieties (OPVs). Similar to adoption of recommended practices, we consider the proportion of the household's maize plots for which a particular input was used and this was decided individually by the female co-head. Similar outcomes for input adoption were constructed for joint input adoption and for unilateral adoption by the male co-head. Also here, adoption of different inputs is aggregated in a Women's Input Use Index, a Joint Input Use Index, and a Men's Input Use Index respectively.

Next, we measured outcomes related to production, area of production, and productivity on maize plots under female and joint management. Female (jointly) managed plots are defined as plots on which, according to female co-head respondents, female co-heads alone (jointly) took at least three out of five decisions. We use the total amount of maize produced on female-managed maize plots within the household as our measure of production. The area of production is the total area (in acres) of female-managed maize plots in the household. Yield (in kg per acre) is the total amount of maize produced on female-managed plots divided by the total area of the female-managed maize plots in the household. A secondary, more subjective indicator for yield effects is an indicator variable that takes the value of one if the female co-head indicates if the yield on at least one of the maize plots under her management was greater than in a normal year. To capture the change in women's control over total household maize production, we measure both the share of household maize production that was produced on female-managed maize plots and the share of household acreage under maize cultivation that is female-managed. We also defined similar indicators for jointly managed plots.

Finally, we look at maize sales as an outcome. A first indicator takes the value of one if any amount of the maize produced in the household was reported by the female co-head respondent to have been sold independently by the female co-head (respectively, jointly and independently by the male co-head). Selling independently by the female (male) co-head means all decisions regarding quantity, price and to whom the maize was sold were taken by the female (male) co-head according to the female co-head respondent. Jointly means all those decisions were taken together by the female and male co-head together. A second indicator is the amount of maize (in bags of about 100 kg) that the female co-head respondent reported to have sold independently (jointly/independently by the male co-head). For the first indicator of the likelihood of selling independently we assumed women did not sell any maize independently if they did not know the amount sold independently. For the second indicator (amount of maize sold independently), we only considered non-zero positive amounts of maize sold independently.

5 Results

We present results for the six comparisons laid out in Figure 2. As mentioned above, we consider results for female co-head alone, for male and female co-head jointly as a couple, and for male co-heads alone. We look at the changes in knowledge, decision making, adoption of recommended practices and input use, production, and sales. Together, this means a large number of results have to be presented, so a fairly rigid structure is adopted. In the next section (Section 6) we summarize and interpret the most important findings.

5.1 Knowledge of Recommended Practices

We begin our discussion of results by examining women's knowledge outcomes, focusing on the knowledge index described earlier as well as the individual recommended practices that respondents answered questions about.

First, we examine whether involving women as recipients of information leads to an increase in their knowledge (Model 1 in Figure 2). We do this by comparing knowledge of women in households in which female co-heads received the information, either alone or with their male spouse, to knowledge of women in households in which only the male co-head received the information. Results are reported in the upper panel of Table 2. Results show involving women as recipients of information leads to an overall positive and statistically significant increase women's knowledge as judged by the index. This is driven by a positive and significant treatment effect of involving women as recipients of information on women's knowledge about adequate spacing and the number of maize seeds per hill, and about the importance of combining inputs. Knowledge about the former increased by 7 percentage points (pp), essentially doubling women's knowledge on this topic. We observe a 5 pp increase in women's knowledge about combining inputs.

In the Appendix, we also report results for comparisons between households in which the female co-head received the information alone and households in which the male co-head received the information alone (model 1A in in Figure 2). Results for this comparison, reported in the top panel in Appendix Table A.3, show similar increase in knowledge. Also in the Appendix, we report results for comparisons between households in which the female and male co-heads together as a couple received the information and households in which the male co-head received the information alone (model 1B in in Figure 2). Results for this comparison, reported in the lower panel in Appendix Table A.3. Also for this comparison, the increase in knowledge is similar to the one reported in the top panel of Table 2.

Second, we examine the knowledge outcomes that result from variation in the provider of information, as in model 2 in Figure 2. We examine results for role-model effects by comparing women's knowledge outcomes in households that were shown the video in which a female actor in the video provides information (whether alone or with a male co-actor), to women's knowledge outcomes in households that were shown the video in which only a male actor provides

Table 2: Women's knowledge of recommended practices

	Model 1: Involving women in receiving information					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.127	0.334	0.066**	0.016	0.000	2,758
Combining practices	0.817	0.387	0.051**	0.015	0.000	2,758
Optimal weeding	0.880	0.325	0.005	0.013	0.699	2,758
Fall armyworm control	0.207	0.406	-0.011	0.016	0.459	2,758
Women's knowledge index	-0.018	0.605	0.114**	0.024	0.000	2,758
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.169	0.375	0.007	0.015	0.651	2,753
Combining practices	0.848	0.359	0.005	0.014	0.719	2,753
Optimal weeding	0.888	0.316	-0.003	0.013	0.842	2,753
Fall armyworm control	0.203	0.403	-0.014	0.016	0.375	2,753
Women's knowledge index	0.021	0.607	0.008	0.024	0.756	2,753

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1 for top panel and Model 2 for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test. Note that no information on the recommended way to fight fall armyworm was given in the video, so no effects were expected.

information. Results, reported in the lower panel of Table 2, show no evidence of a generalized role-model effect: we observe no change in women's knowledge outcomes as a result of involving female actors in the provision of information. Restricting the sample to households where only women were shown the video (as in model 2A in 2) does not change this conclusion. Results for this are reported in the top panel in of Appendix Table A.4. Restricting the sample to households where only men were shown the video (as in model 2B in 2) also does not change this conclusion (bottom panel in Appendix Table A.4).

Third, we examine joint knowledge outcomes, and present results in terms of a comparison between the same sets of groups. Results are reported in Table 3 for model 1 (top panel) and model 2 (bottom panel). Neither reducing female knowledge deficiencies nor female role models seem to affect joint knowledge outcomes. There is some indication that new information (about spacing) received by female co-heads alone (as in model 1A in 2) is somewhat less likely to be passed on to their spouses than when male co-heads received the information, which is evident from the negative treatment effect of –2.6 pp on joint knowledge (reported in top panel in Appendix Table A.5). However, the difference becomes insignificant after controlling FWER. Appendix Table A.6 also reports results for Models 2A and 2B for joint knowledge.

In Appendix Tables A.7 to A.9, we also repeat the analysis for men's knowledge. Men's knowledge index, and particularly his knowledge of new information (about spacing and starting small with a combination of practices), is negatively affected by involving women in receiving information (top panel in Appendix Table A.7). Appendix Table A.8 shows this is especially the case if women

Table 3: Joint knowledge of recommended practices

	Model 1: Involving women in receiving information					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.073	0.260	0.003	0.012	0.780	2,361
Combining practices and starting small	0.737	0.440	0.015	0.019	0.449	2,361
Optimal weeding	0.805	0.396	-0.003	0.018	0.855	2,361
Fall armyworm control	0.075	0.264	0.019	0.012	0.096	2,361
Joint knowledge index	-0.003	0.602	0.010	0.026	0.636	2,361
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.073	0.261	-0.003	0.011	0.783	2,358
Combining practices and starting small	0.739	0.439	0.008	0.019	0.683	2,358
Optimal weeding	0.817	0.387	-0.018	0.017	0.295	2,358
Fall armyworm control	0.091	0.288	-0.012	0.012	0.310	2,358
Joint knowledge index	0.001	0.595	-0.014	0.026	0.581	2,358

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1 for top panel and Model 2 for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test. Note that no information on the recommended way to fight fall armyworm was given in the video, so no effects were expected.

co-heads receive information alone.

5.2 Decision-making about Maize Production

Next, we explore the effect of the treatments on decision-making related to maize production within the household. We do this by first examining whether involving women as information recipients (alone or as part of a couple) results in an increase in their participation in decisions about maize production on an average plot managed by the household (Figure 2, Model 1).

Results (Table 4, top panel) show a positive and statistically significant treatment effect of 0.13 on the women's decision-making index. The results are also evident across all of the decisions, where low mean values in the control group suggest high percent increases in women's decision-making. Comparing the group in which the female co-head received the information alone versus the male co-head alone (as in Figure 2, Model 1A) shows a larger positive effect on the women's decision-making index of 0.22 (Appendix Table A.10, top panel). No such increase is found when the treatment group is restricted to the group in which female co-heads received the information together with their male spouse (as in Figure 2, Model 1B; results in Appendix Table A.10, bottom panel). The gains in women's individual decision-making are thus largely driven by exclusively targeting female co-heads with information.

In the lower panel of Figure 4, we explore decision-making outcomes that result from variations in the information provider (illustrated in Model 2 of Figure 2). Results show no evidence of a generalized role-model effect on women's decision-making. However, when we restrict this comparison to groups in which

Table 4: Women decision making

	Model 1: Involving women in receiving information					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.158	0.338	0.046**	0.015	0.002	2,661
Timing of planting maize	0.163	0.340	0.053**	0.016	0.001	2,661
Spacing and number of seeds	0.150	0.333	0.049**	0.015	0.001	2,661
Striga control measures	0.113	0.295	0.055**	0.014	0.000	2,596
Timing of the first weeding	0.178	0.357	0.049**	0.016	0.002	2,661
Women′s decision-making index	-0.032	0.783	0.132**	0.034	0.000	2,596
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.184	0.359	0.004	0.015	0.762	2,714
Timing of planting maize	0.197	0.367	0.000	0.015	0.989	2,714
Spacing and number of seeds	0.180	0.356	0.004	0.015	0.782	2,714
Striga control measures	0.152	0.339	-0.001	0.014	0.971	2,645
Timing of the first weeding	0.227	0.393	-0.019	0.016	0.227	2,714
Women′s decision-making index	-0.066	0.761	-0.014	0.033	0.672	2,645

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1 for top panel and Model 2 for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

a female actor in the video provides information (whether alone or with a male co-actor) to female co-heads against groups in which a male actor provides information to female co-heads (2, Model 2A), we do observe positive and statistically significant effects (top panel of Appendix Table A.11). Specifically, we observe an increase of 0.16 in the women's decision-making index and an increase in women's decision-making about the timing for planting maize, about spacing, about striga control measures, and the timing of weeding that amount to 7, 9 and 7 pp respectively, which translates into increases of 26, 34 and 39 percent, respectively, over the mean of the control group. Challenging role incongruity among male co-heads by showing them the video that involves a female actor (whether alone or with a male co-actor) instead of a male actor (as in 2, Model 2B) does not make a difference for women's decision-making (bottom panel of Appendix Table A.11).

We find no change in joint decision-making outcomes as a result of involving women as information recipients (alone or as part of a couple, see top panel in Table 5). But, when the treatment group is restricted to the group in which female co-heads received the information together with their male spouse (as in Model 1B in Figure 2), there is a significant and positive effect on joint decision-making about seed spacing and seed rate (bottom panel of Appendix Table A.12).

We do find significant negative effects of involving women in receiving information on men's individual decision-making. The men's decision-making index decreases by 0.18 and men are less likely to make each of the decisions alone (top panel Appendix Table A.14). These negative effects on men's individual

Table 5: Joint decision making

	Model 1: Involving women in receiving information					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.520	0.472	0.015	0.020	0.443	2,661
Timing of planting maize	0.477	0.470	0.011	0.020	0.553	2,661
Spacing and number of seeds	0.475	0.473	0.029	0.020	0.135	2,661
Striga control measures	0.420	0.464	0.024	0.020	0.193	2,596
Timing of the first weeding	0.535	0.469	-0.007	0.020	0.702	2,661
Joint decision-making index	0.021	0.787	0.008	0.033	0.294	2,596
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.524	0.469	-0.007	0.019	0.702	2,714
Timing of planting maize	0.471	0.465	0.006	0.019	0.733	2,714
Spacing and number of seeds	0.481	0.471	0.003	0.019	0.870	2,714
Striga control measures	0.423	0.464	0.010	0.019	0.580	2,645
Timing of the first weeding	0.512	0.470	0.008	0.019	0.679	2,714
Joint decision-making index	0.000	0.788	0.006	0.033	0.838	2,645

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1 for top panel and Model 2 for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

decision-making do not only follow from giving the female co-head the information alone (in which case the female co-head can monopolize the information) (top panel Appendix Table A.15), but also from giving the female and male co-head the information together (bottom panel Appendix Table A.15).

While joint decision-making does not change as a result of variations in the information provider (bottom panel of Table 5), men's decision-making does. Men's unilateral decision-making about whether to plant maize on the plot is reduced by 4 pp (an 11 percent reduction over the mean of the control) when a female actor is involved in providing the information (alone or together with a male actor) as compared to only a male actor, regardless of whom the video was shown to (Appendix Table A.14, Model 2). The fact that this reduction in men's decision-making about whether to plant maize is mirrored when male co-heads viewed the video that involved a female actor instead of the video with only a male actor (Model 2B) may mean that role incongruity challenges may be at work among male co-heads or that men are susceptible to gender homophily effects (bottom panel in Appendix Table A.16).

5.3 Adoption of Recommended Practices

We apply the same approach to our presentation of changes in the likelihood that spouses both decide on a particular practice and subsequently adopt the practice that was recommended in the video. We start by making the comparison illustrated in Model 1 of Figure 2. Results (top panel of Table 6) show a positive and statistically significant treatment effect of involving women in receiving information, denoted by an increase of 0.12 in the women's adoption

Table 6: Women adoption of recommended practices

	Model 1: Involving women in receiving information					
	Avg	S.D.	ATE	S.E.	p-value	N
Timing of planting maize	0.043	0.179	0.021^{**}	0.009	0.014	2,493
Spacing and number of seeds	0.001	0.034	0.007^{**}	0.003	0.015	2,660
Striga control measures	0.080	0.253	0.052^{**}	0.013	0.000	2,595
Timing of the first weeding	0.157	0.338	0.048^{**}	0.016	0.001	2,660
Women′s adoption index	0.001	0.599	0.117^{**}	0.026	0.000	2,433
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
Timing of planting maize	0.050	0.194	0.007	0.009	0.419	2,542
Spacing and number of seeds	0.005	0.069	0.001	0.003	0.703	2,713
Striga control measures	0.116	0.302	0.002	0.012	0.871	2,644
Timing of the first weeding	0.205	0.379	-0.021	0.015	0.156	2,713
Women′s adoption index	-0.034	0.546	0.004	0.026	0.872	2,478

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1 for top panel and Model 2 for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

index. The likelihood of a woman both deciding and adopting a particular recommended practice increases by between 1 and 5 pp. Given that women alone both decided and adopt a particular practice is generally low in the control group, these changes translate into sizable percent increases. Effects remain generally consistent when the treatment group is restricted to the group in which the female co-head received the information alone (Model 1A in Figure 2), in which case the women's adoption index increases by 0.15 (top panel in Appendix Table A.17). When the treatment group is restricted to the group in which the female co-head receives the information together with her male spouse (Model 1B in Figure 2), the women's adoption index increases by 0.09 and only the likelihood of the female co-head unilateral deciding about striga control and adoption the recommended striga control strategy is positively affected (bottom panel in Appendix Table A.17).

We proceed by assessing the effects of variation in the information provider in the same manner as before (Model 2 of Figure 2). Results (bottom panel of Table 6) do not indicate any difference in women's adoption outcomes as a result of involving women in conveying information. But when we compare groups in which the female co-heads were shown the video with a female actor (alone or with a male co-actor) instead of the video with only a male actor (Model 2A of Figure 2), there are indications of positive role-model effects on the likelihood that female co-heads both decide about when to plant and adopt the recommended timing of planting maize (top panel in Appendix Table A.18): an increase of 2.6 pp, which translates into a 62 percent increase over the mean of the control.

Next, we examine joint adoption outcomes, and present results in terms of a comparison depicted in Model 1 of Figure 2 in Table 7. Involving women

Table 7: Joint adoption of recommended practices

	Avg	S.D.	ATE	S.E.	p-value	N
	Model 1: Involving women in receiving information					
Timing of planting maize	0.110	0.294	0.006	0.013	0.624	2,493
Spacing and number of seeds	0.014	0.112	0.015**	0.006	0.011	2,660
Striga control measures	0.321	0.437	0.025	0.019	0.154	2,595
Timing of the first weeding	0.478	0.470	0.006	0.020	0.751	2,660
Joint adoption index	-0.010	0.577	0.043*	0.026	0.044	2,433
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
Timing of planting maize	0.125	0.307	-0.015	0.013	0.226	2,542
Spacing and number of seeds	0.024	0.147	-0.001	0.006	0.925	2,713
Striga control measures	0.328	0.439	0.006	0.018	0.744	2,644
Timing of the first weeding	0.478	0.468	-0.012	0.019	0.541	2,713
Joint adoption index	-0.004	0.585	-0.003	0.026	0.898	2,478

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1 for top panel and Model 2 for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

in receiving information has a positive and significant effect of 1.5 pp on the likelihood of jointly deciding upon spacing and subsequent adoption of the recommended practice of spacing and number of seeds per hill (top panel of Table 7). Joint adoption outcomes follow from providing the information to the female and male co-head together in contrast to only providing the male co-head with information (Model 1B of Figure 2): Results (bottom panel in Appendix Table A.19) show an increase in the joint adoption index of 0.08, a 2 pp increase in the jointly decided-upon adoption of proper spacing, and a 5 pp increase in the jointly decided-upon adoption of striga control measures.

In the appendix, we examine the effect of involving women as recipients and messengers on men's adoption as well. Involving women in receiving information, alone or as part of the couple, as compared to giving the information only to the male co-head (Model 1 of Figure 2), reduces the likelihood that men unilaterally decide on and subsequently adopt striga control measures by 3 pp (top panel in Appendix Table A.21). Providing only the female co-head with information as compared to only the male co-head (Model 1A of Figure 2) reduces this likelihood by 4 pp. We further find that it also reduces the likelihood that men alone decide about when to weed and also follow recommendations by 6 pp, which is equivalent to a 30 percent reduction (top panel in Appendix Table A.22).

Involving women in conveying information does not make any difference in joint adoption outcomes (bottom panel of Table 7). There are indications, however, that men's adoption outcomes are negatively affected by showing male co-heads the video with a female actor (whether alone or with a male co-actor) rather than with only a male actor (Model 2B). Results (bottom panel in Appendix Table A.23) show a decrease of 2.9 pp (a 38 percent decrease relative to the mean of the control) in men's individually decided-upon adoption of the appropriate timing for planting maize.

5.4 The Use of Fertilizer and Improved Seeds

In this section, we explore the impact of the different treatments on the use of specific types of fertilizer (DAP, urea, and organic fertilizer) and improved seeds (hybrids or OPVs) by women who decided individually upon using the specified inputs, by female and male co-heads who jointly decided upon using those inputs, and by men who individually decided upon using those inputs.

First, we examine the effect of involving women in receiving information, alone or as part of the couple (Model 1 of Figure 2). Results (top panel Table 8) show a positive and significant increase of women's input use index by 0.08. The effect of providing only female co-heads with information as opposed to only male co-heads (as in Figure 2, Model 1A) is an increase of the women's input use index by 0.13. We register an increase of the use of all inputs (top panel of Appendix Table A.24). Providing the female co-heads together with their male co-heads with information as opposed to only the male co-heads (as in 2, Model 1B) has only a weak effect on women's input use index (bottom panel of Appendix Table A.24).

We continue by examining role-model effects with the comparison illustrated in 2, Model 2. Involving women in conveying extension information has a positive and significant effect of 2 pp on the use of organic fertilizer by women who individually made the decision about its use (bottom panel of Table 8). There are also indications of positive effects on women's decided-upon use of OPVs and the women's input use index. The estimated effects have p-values lower than 0.10 but are not significant according to FWER consistent significance thresholds.

Next, we examine the effects of involving women in receiving information, alone or as part of the couple, on joint input-use outcomes. Results (top panel Table 9) show a positive and significant effect on the joint input use index, which is increased by 0.06. Providing only female co-heads with information as opposed to only male co-heads (Model 1A of Figure 2) increases the joint input use index by 0.04 (top panel Appendix Table A.26). Providing female co-heads and their male co-heads with information as opposed to only the male co-heads (Model 1B of Figure 2) increases the joint input use index by 0.09 (bottom panel Appendix Table A.26).

The effect of involving women in receiving information, alone or as part of the couple, on input use decided upon by men is mixed: it is negative for the use of the fertilizer DAP and positive for organic fertilizer (Model 1 of Figure 2; top panel Appendix Table A.28). The negative effect on men's decided-upon use of DAP is driven by the female co-heads receiving the information alone (Model 1A of Figure 2; top panel Appendix Table A.29), which may be linked to men lacking information about the use of DAP.

Involving women in conveying the information has no significant effects on joint input use (bottom panel of Table 9). Yet there are indications that jointly

Table 8: Women input use

	Avg	S.D.	ATE	S.E.	p-value	N
	Model 1: Involving women in receiving information					
DAP	0.016	0.121	0.017^{**}	0.006	0.002	2,661
Urea	0.002	0.038	0.010^{**}	0.003	0.001	2,661
Organic fertilizer	0.017	0.126	0.011	0.006	0.057	2,661
Hybrid seeds	0.013	0.111	0.009	0.005	0.078	2,661
OPV	0.018	0.126	0.011	0.006	0.059	2,661
Women′s input use index	0.009	0.547	0.083^{**}	0.021	0.000	2,661
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
DAP	0.020	0.133	0.004	0.006	0.524	2,714
Urea	0.011	0.099	-0.004	0.003	0.279	2,714
Organic fertilizer	0.016	0.111	0.015^{+}	0.006	0.013	2,714
Hybrid seeds	0.017	0.116	0.003	0.005	0.549	2,714
OPV	0.019	0.129	0.010	0.006	0.084	2,714
Women′s input use index	-0.028	0.487	0.038^{+}	0.021	0.070	2,714

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1 for top panel and Model 2 for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table 9: Joint input use

	Avg	S.D.	ATE	S.E.	p-value	N
	Model 1: Involving women in receiving information					
DAP	0.050	0.207	0.022^{*}	0.009	0.014	2,661
Urea	0.014	0.116	0.003	0.005	0.528	2,661
Organic fertilizer	0.051	0.209	0.027^{*}	0.010	0.005	2,661
Hybrid seeds	0.027	0.150	0.021^{*}	0.008	0.004	2,661
OPV	0.021	0.084	0.005	0.004	0.157	2,700
Joint input use index	0.002	0.484	0.063^{**}	0.020	0.000	2,661
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
DAP	0.048	0.201	0.017	0.009	0.049	2,714
Urea	0.011	0.095	0.009	0.005	0.074	2,714
Organic fertilizer	0.065	0.235	0.003	0.010	0.716	2,714
Hybrid seeds	0.036	0.176	0.002	0.007	0.787	2,714
OPV	0.024	0.091	-0.002	0.004	0.593	2,754
Joint input use index	-0.007	0.484	0.031	0.020	0.119	2,714

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1 for top panel and Model 2 for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

decided-upon use of urea increased by 2 pp as a result of female co-heads having seen the video with a female actor (alone or with a male co-actor) instead of the video with only a male actor (Model 2A of Figure 2; top panel Appendix Table A.27). The use of DAP individually decided upon by men, however, seems negatively affected by that treatment (bottom panel of Appendix Table A.28). There are indications that the use of both urea and hybrid seed individually decided upon by men are positively affected as a result of showing male co-heads the video with a female actor (alone or with a male co-actor) instead of the video with only a male actor (bottom panel of Appendix Table A.30).

5.5 Production and Productivity

Next, we assess effects on production and productivity of female-managed maize plots as a result of involving women in receiving information versus only targeting the man (as illustrated in 2, Model 1). The results (top panel of Table 10) show a significant and positive increase of the total area of female-managed maize plots in the household, an increase of the total amount of household maize produced on female-managed plots, and an increase of the yield on female-managed maize plots. There is also a 2 pp increase in the likelihood of reporting better-than-normal yield. Both the share of household maize production and maize area under female management increased by 6 pp. The positive effects on production and productivity outcomes on female-managed plots that result from providing only the female co-head with information instead of the male co-head (Model 1A of Figure 2) are even larger in magnitude (top panel in Table A.31). In contrast, involving the female co-head as part of a couple receiving the information instead of only the male co-head (Model 1B of Figure 2) shows no effect on production and productivity outcomes on female-managed plots (bottom panel in Table A.31).

We also again examine the effect of involving women in conveying the information rather than only a man (Model 2 of 2) on production and productivity outcomes of female-managed plots. Results (bottom panel of Table 10) point to a significant and negative effect on the yield on female-managed plots. Suggestive indications of the negative effects on yield on female-managed plots emerge both when female co-heads and when male co-heads have seen the video featuring a female actor (alone or with a male co-actor) instead of the video featuring only a male actor (respectively Model 2A and Model 2B in Figure 2). In the latter case, there are also indications of a negative effect on production on female-managed plots (Appendix Table A.32).

Involving women in receiving information, however, does not have any effect on production and productivity outcomes on jointly managed plots (top panel of Table 11). Even when the female and male co-heads received the information together (Model 1B of Figure 2), there is no impact on production and productivity outcomes on jointly managed plots (bottom panel of Appendix, Table A.33).

There is no evidence that production and productivity outcomes of jointly managed plots changed as a result of involving women in conveying the infor-

Table 10: Women production outcomes

	Model 1: Involving women in receiving information					
	Avg	S.D.	ATE	S.E.	p-value	N
Production	39.094	155.909	35.849**	8.687	0.000	2,700
Area	0.105	0.332	0.074**	0.019	0.000	2,700
Yield better than normal	0.024	0.142	0.026**	0.008	0.001	2,595
Yield	57.675	237.920	50.389**	12.853	0.000	2,700
Share of household maize production	0.122	0.315	0.060**	0.015	0.000	2,534
Share of area under maize cultivation	0.122	0.315	0.063**	0.016	0.000	2,507
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
Production	64.273	227.836	-7.349	8.347	0.381	2,754
Area	0.152	0.431	-0.001	0.018	0.955	2,754
Yield better than normal	0.041	0.177	0.001	0.007	0.916	2,644
Yield	112.428	410.309	-35.867**	12.415	0.003	2,754
Share of household maize production	0.171	0.358	-0.012	0.015	0.395	2,584
Share of area under maize cultivation	0.173	0.362	-0.012	0.015	0.416	2,556

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1 for top panel and Model 2 for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table 11: Joint production outcomes

	Model 1: Involving women in receiving information					
	Avg	S.D.	ATE	S.E.	p-value	N
Production	239.898	478.920	-14.825	17.251	0.359	2,700
Area	0.591	0.908	-0.019	0.036	0.576	2,700
Yield better than normal	0.132	0.326	0.003	0.014	0.799	2,595
Yield	222.381	383.192	-3.393	15.549	0.823	2,700
Share of household maize production	0.501	0.486	0.011	0.021	0.592	2,534
Share of area under maize cultivation	0.502	0.485	0.007	0.021	0.709	2,507
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
Production	222.311	417.654	-0.363	16.763	0.983	2,754
Area	0.586	0.874	-0.033	0.034	0.337	2,754
Yield better than normal	0.119	0.306	0.017	0.013	0.187	2,644
Yield	207.692	340.322	13.985	15.192	0.349	2,754
Share of household maize production	0.500	0.484	0.000	0.020	0.997	2,584
Share of area under maize cultivation	0.502	0.484	-0.003	0.021	0.870	2,556

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1 for top panel and Model 2 for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table 12: Women sales outcomes

	Model 1: Involving women in receiving information					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.088	0.284	0.018	0.013	0.159	2,700
Amount sold (in 100 kg bags)	0.184	0.977	0.030	0.037	0.399	2,700
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.103	0.305	-0.009	0.012	0.490	2,754
Amount sold (in 100 kg bags)	0.238	1.204	-0.084*	0.036	0.018	2,754

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1 for top panel and Model 2 for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

mation (alone or with a male co-actor) rather than only a man (bottom part of Table 11). However, both as a result of showing female co-heads and as result of showing male co-heads the video featuring a female actor (alone or with a male co-actor) instead of the video with only a male actor (Model 2A and Model 2B of Figure 2), the likelihood that the yield on jointly managed plots is better than normal increased by about 4 pp. This translates into about a 40 percent increase over the mean of the control (Appendix Table A.34).

5.6 Sales

Maize produced in the household independently sold by the female co-head is not affected by involving women in receiving information, alone or as part of the couple (top panel of Table 12). Yet providing the information to only the female co-head as opposed to providing it to only the male co-head (Model 1A of Figure 2) increases the likelihood that she independently sells maize by 4 pp (top panel in Appendix Table A.35). As few women in the control group actually sell maize independently, this translates into a substantial percentage increase of 46 percent over the mean of the control. There are indications of a positive effect on the amount of maize sold independently by women as well. Sales of maize by the female and male co-head jointly does not change by involving women in receiving information, alone or as part of the couple (top panel in Table 13). Neither does sales of maize individually by the male co-head (top panel Appendix Table A.39).

Next, we look into the effect of involving women in conveying information (Model 2 of Figure 2). Results (bottom panel of Table 12) show a significant and negative effect on the amount of maize that women independently sell. There are indications of negative effects on the likelihood and the amount sold independently by women when male co-heads view the video featuring a female actor (alone or with a male co-actor) delivering the information instead of only a male actor (bottom panel of Appendix Table A.36).

Table 13: Joint sales

	Model 1: Involving women in receiving information					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.319	0.466	-0.003	0.020	0.881	2,700
Amount sold (in 100 kg bags)	1.179	3.173	-0.022	0.131	0.867	2,700
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.296	0.457	0.035	0.019	0.060	2,754
Amount sold (in 100 kg bags)	1.236	3.948	-0.105	0.132	0.420	2,754

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1 for top panel and Model 2 for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Involving women in conveying information has a positive effect of 4 pp (though just under the FWER-consistent significance threshold) on the likelihood that maize produced in the household is jointly sold. This translates into a 12 percent increase over the mean of the control (bottom panel in Table 13). An indication of a similar positive role model effect on joint sales emerges when women are involved in conveying information given to the female co-heads alone (top panel in Appendix Table A.38).

The amount of maize independently sold by men, however, is significantly and negatively affected by involving women in conveying information (bottom panel Appendix Table A.39). This seems particularly the case when female co-heads alone viewed the video in which women are involved in conveying information (top panel of Appendix Table A.41), and seems unrelated to challenging role incongruity among men since significant effects are absent in that case (bottom panel of Appendix Table A.41).

6 Discussion

In this section we interpret the results provided in the previous section.

6.1 Women's Access to Information

Results suggest that, to some extent, spouses monopolize agricultural extension information. Involving women in receiving extension information (as opposed to exclusively targeting the male co-head) has positive effects on women's individual knowledge. This finding suggests that male co-heads do not necessarily pass the information to their spouse. The fact that men's knowledge, particularly knowledge about new information, is reduced when the information if targeted exclusively to the female co-head (as opposed to exclusively to the male co-head), suggests that female co-heads also do not necessarily share information with their spouse.

Results further show that women's knowledge gains are similar regardless of whether a woman saw the extension video alone or together with her male co-head; the presence of the male spouse in the exposure process does not influence her knowledge[7]. This suggest limited discussion of the content of the video between spouses even when the video was shown to both of them as a couple. Hence, from a knowledge transfer point of view, if the aim is to increase women knowledge, it seems most effective to exclusively target the female co-head.

Women gain individual agricultural decision-making power when they are involved in receiving extension information, particularly if this information is exclusively provided to them. Joint decision-making remains unchanged. While reducing information asymmetries by targeting couples increases empowerment, most gains are made by providing women with an informational advantage.

Men's unilateral decision-making is reduced as a result of involving women in receiving information, no matter if this happens by targeting the female co-head alone or together with the male co-head. If this reduction only occurred in the former case, men's reduced decision-making could have been related to a lack of information. The fact that the reduction occurs in both cases suggests that men's individual decision-making does not only decrease due to a lack of direct access to information. Apparently, the fact that women can also access information leads them to refrain from unilateral decision making[8].

Going beyond women's decision-making, the adoption of recommended practices and use of inputs individually decided upon by women is also positively affected by providing women with information. Hence, women seem to use their increased agency as a result of increased information access to become more involved in farm-related activities. Additionally, the adoption of recommended practices and use of inputs jointly decided upon by the female and male co-head also increases as a result of involving women in receiving information: Informed women can also participate more in joint action. The positive effect on jointly decided adoption of recommended practices and inputs when the female and male co-heads receive the information together is consistent with Lambrecht et al. (2016) who found a positive impact of joint participation in an extension program on fertilizer adoption on jointly (and male-) managed plots. The adoption of recommended practices and use of inputs individually decided upon by men is negatively affected by involving women as recipients of information, but the effect is less convincing than for male unilateral decision-making.

As a result of providing only women with information, the total area of maize plots in the household managed by women increases and maize production on female-managed plots more than doubles. Apparently, the increase in decision making and adoption of recommended practices and inputs by women as a result of solely involving women as information recipients paid off in higher production,

[7]Interestingly, unlike for the female co-head, the presence of the female spouse in the exposure process does influence the knowledge of the male co-head, who appears to learn less when information is provided to the couple than when this information is targeted to him alone.

[8]At the same time, it should be noted that men also seem to learn less in the presence of women.

increased area, and higher productivity on female-managed maize plots.

In contrast, providing the information to the female and male co-head together did not make a change for area, production and productivity of female-managed maize plots. This is probably due to the fact that providing the information to the female and male co-head together does not have the same strong positive effects on women's individual agency as providing the information to only the woman. Her lack of an exclusive informational asset seems to be in the way of capitalizing on her gain of information. There is no evidence of an increase of maize production, productivity, nor area under cultivation under joint management as result of involving women in receiving information either. In sum, increased joint decision-making and adoption as a result of the female and male co-head receiving the information together did not pay off in higher production and productivity on jointly managed maize plots.

Women are also more likely to sell (more) maize independently if they alone received the extension information instead of the male co-head. At the same time, sales of maize individually by men is less likely, which indicates that women's increased agency as a result of unique access to information reduces men's dominance over maize sales. Giving the information to the female and male co-head together does not affect women's (nor men's) individual sales of maize. Joint sales of maize remains unaffected by involving women in receiving information.

Women seem to gain in production and sales if they receive agricultural extension information alone. However, these effects are not there if the information is given to the couple. This suggests that a woman's monopoly over information is essential for her individual achievements. The fact that giving the information to the couple instead of only the male co-head increased women's agency in terms of joint decision-making and adoption but not joint achievement implies that, despite women's greater (joint) agency, these joint achievement are not different from what men individually achieve.

A question that remains is the extent to which the increased efforts by women that result from exclusively giving them extension information, in terms of applying the recommended practices and inputs and larger areas of maize cultivation under their management, augment their work burden. Indeed, we observe that the time women spent on preparing fields and weeding went up by 1.4 and 3.3 person-days/maize season, respectively, as a result of providing only the female co-head, instead of only the male co-head, with information. Women generally apply labor-based intensification practices, which are likely more accessible to women than capital intensive practices such as the use of improved seeds or fertilizer. This suggests the need for further research on the labor and drudgery implications of these outcomes and the need to reflect upon making less labor-intensive intensification practices accessible to women.

6.2 Role Model Effects

We expected that including women in the extension information videos portrayed as farmers, whom viewers can relate to and who become successful by applying the practices shown in the video, would have had role model effects and improve women's outcomes. The evidence, however, is mixed. There is no impact on women's knowledge of agronomic practices, nor on women's individual decision-making and adoption of recommended practices, and indications of a negative effect on the yield on female-managed plots and sales of maize by women. There is some indication of a positive role model effect on the use of organic fertilizer decided upon by women, a productivity-enhancing input that may be directly available to a woman without a need for bargaining.

There are no effects of involving women in conveying information on joint outcomes either, except for an indication that jointly selling maize has become more likely. The lack of effects on joint decision-making and adoption means that couples nor men were inspired to accept a greater participation of women in those decisions. There are, however, negative effects on men's unilateral decision-making, as well as on the amount of maize independently sold by men, which may make way for more involvement of women in decision-making and action.

Zooming in on role model effects among female co-heads who viewed the extension information videos with women involved as messengers alone paints a slightly different picture. In this sub-sample, women's individual decision-making increased as well as women's individually decided-upon adoption of the appropriate timing for planting maize and use of organic fertilizer—again practices that are available to a woman at limited cost. Yet, the indication of a negative effect on yield on female-managed plots emerges in this case as well.

There are some indications of positive effects on joint outcomes as well, such as use of fertilizer, improved yields on jointly managed plots and a higher likelihood of jointly selling maize. The amount of maize sold independently by men seems to decrease as a result. The effects on joint and men's outcomes of including women in the extension information videos shown to female co-heads alone seems to suggest that women who are inspired by the female role models not only gained individual agency but managed to make some changes at the couple level.

The effects of involving women in conveying information in the extension videos shown to male co-heads alone seem to have reduced men's individual decision-making, particularly about whether to plant maize on a plot, men's individually decided-upon adoption, and improve yield of jointly managed plots. These results may indicate that role model effects and particularly challenging role incongruity among male co-heads may have encouraged them to dominate agricultural decision-making less. At the same, to some extent, these results may be due to gender homophily effects on the part of the husband, as half of the treatment group were exposed to a video featuring only a woman.

In sum, we find only weak evidence that role models work, both directly by increasing aspirations of women and indirectly by challenging role incongruity of men. The fact that effects we find are less convincing than what other studies such as Riley (2017) or Beaman et al. (2009) find may be due to the fact that our intervention was relatively light. A 10 minute video, even though screened twice, is still quite different from a two hour feel good movie or first hand experience with women leaders over the course of multiple years of quota policy. Norms defining women's and men's role in agriculture may also be harder to change than in other contexts (Kandpal and Baylis, 2019).

While evidence of effects of role models on success is scarce in the literature, we find indications of negative effects of female role models on yield and sales by women. One possible explanation may be that women opt to concentrate their efforts on other crops when men become less likely to decide on planting maize.

We do not find that women move away from maize as a result of being exposed to role models. In Table 10, we do not find that area cultivated by maize is affected by women role models. The reduction in yields is entirely driven by a reduction in production on the same area planted. We do, however, find an, albeit weak, negative effect on time spent in agriculture, particular on preparing fields. Role model effects may this encourage women to spend more time on other crops (or activities), explaining the reduced productivity.

7 Conclusions

In smallholder agriculture, women perform a lot of the work, yet have little say in which crops to plant, what technologies and inputs to use, and how much of the crop to sell on the market. Targeting women with relevant information in formats that are appealing and accessible to them have been found to increase empowerment in a variety of settings, and so providing extension information tailored to women may be an effective way to increase their voice in agricultural production. However, public agricultural advisory services, the main source of agricultural information in many developing countries, remains severely male biased, with predominantly male experts targeting the main decision maker within the household, which is assumed to be the male co-head.

In this paper, we test how gender related attributes of digital agricultural extension information campaigns affect women's access to informational resources, their agency, and their achievements in farming may increase, all of which directly relate to women's empowerment in agriculture. We do this through a field experiment in the form of a factorial design that was run in eastern Uganda. Working with monogamous maize farming households, in one treatment arm, we assess the importance of the gender of the person within the household who is targeted with information for women's, joint and men's knowledge, decision making, adoption of recommended agronomic practices and technology, and outcomes. In a cross treatment, we test if the gender of the person who provides this information makes a difference.

The information intervention is implemented using short videos shown twice to farmers. In these videos, farmer-actors explain and demonstrate various strategies and practices to intensify the production of maize. Three versions were randomized across farming households: one version portrays a male farmer, another a female farmer, the third a couple formed by male and female farmers. Three constellations of recipients of information in the household were randomized as well: the male co-head alone, the female co-head alone, the male and female co-heads together as a couple.

The results of this study clearly show that significant advances in women's empowerment in agriculture are made by giving women direct and exclusive access to extension information. Furthermore, while the evidence is somewhat mixed, the results of this study suggest that women as role models, through peer effects, gender homophily effects, and/or through challenging role incongruity, influence women and men in different ways. In particular, women are inspired to aspire when they receive information delivered by women but cannot turn that into individual success, in terms of yield and maize sales. Men's individual decision-making and agency, however, seems to reduce when men receive information delivered by women, which may create space for women's participation in decision-making and action.

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A Appendix

Table A.1: Balance tests for Models 1A and 1B

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Yield (log)	5.339	0.801	-0.029	0.035	0.370	2,154
Age of male co-head	38.702	13.511	-8.630	0.541	0.000	2,242
Male co-head finished primary school	0.338	0.473	-0.162	0.020	0.000	2,269
Household size	7.521	3.233	0.071	0.136	0.599	2,269
Nbr of bedrooms	2.218	1.126	-0.079	0.047	0.073	2,269
Access to extension	0.112	0.316	0.001	0.013	0.967	2,269
Used fertilizer	0.221	0.415	-0.036	0.017	0.023	2,269
Used improved seed	0.387	0.487	-0.081	0.020	0.000	2,269
Distance to input provider	5.516	5.598	-0.113	0.235	0.577	2,269
Household owns mobile	0.742	0.438	-0.180	0.018	0.000	2,269
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
Yield (log)	5.313	0.823	-0.092	0.036	0.004	2,077
Age of male co-head	42.521	14.254	-0.988	0.612	0.098	2,176
Male co-head finished primary school	0.425	0.494	0.011	0.021	0.596	2,187
Household size	7.655	3.355	0.352	0.143	0.011	2,187
Nbr of bedrooms	2.263	1.180	0.014	0.051	0.779	2,187
Access to extension	0.108	0.311	-0.008	0.013	0.543	2,187
Used fertilizer	0.209	0.406	-0.063	0.017	0.000	2,187
Used improved seed	0.401	0.490	-0.055	0.021	0.009	2,187
Distance to input provider	5.599	5.671	0.062	0.243	0.764	2,187
Household owns mobile	0.840	0.366	0.019	0.016	0.226	2,187

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1A for top panel and Model 1B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference. A joint test for balance is rejected for the first model (F-statistic 49.319, p-value < 0.001) and also for the second model (F-statistic 4.168, p-value < 0.001).

Table A.2: Balance tests for Models 2A and 2B

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Yield (log)	5.303	0.824	-0.067	0.053	0.165	1,075
Age of male co-head	34.370	11.043	0.851	0.696	0.220	1,118
Male co-head finished primary school	0.257	0.437	0.002	0.027	0.928	1,135
Household size	7.554	3.212	0.108	0.201	0.582	1,135
Nbr of bedrooms	2.177	1.064	0.095	0.066	0.139	1,135
Access to extension	0.113	0.316	-0.011	0.020	0.569	1,135
Used fertilizer	0.203	0.402	-0.049	0.025	0.047	1,135
Used improved seed	0.346	0.476	-0.037	0.030	0.186	1,135
Distance to input provider	5.459	5.273	0.075	0.330	0.777	1,135
Household owns mobile	0.652	0.477	0.007	0.030	0.803	1,135
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Yield (log)	5.372	0.778	-0.022	0.050	0.629	1,075
Age of male co-head	43.002	14.349	0.151	0.904	0.863	1,124
Male co-head finished primary school	0.420	0.494	0.015	0.031	0.616	1,134
Household size	7.487	3.257	-0.243	0.204	0.249	1,134
Nbr of bedrooms	2.258	1.183	-0.100	0.074	0.154	1,134
Access to extension	0.112	0.315	0.035	0.020	0.079	1,134
Used fertilizer	0.239	0.427	-0.002	0.027	0.935	1,134
Used improved seed	0.427	0.495	0.062	0.031	0.043	1,134
Distance to input provider	5.573	5.898	-0.723	0.369	0.022	1,134
Household owns mobile	0.832	0.374	-0.018	0.023	0.424	1,134

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 2A for top panel and Model 2B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference. A joint test for balance can not be rejected for the first model (F-statistic 0.974, p-value = 0.465) and also not for the second model (F-statistic 1.579, p-value = 0.108).

Table A.3: Women's knowledge of recommended practices (models 1A and 1B)

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.127	0.334	0.058**	0.019	0.000	1,875
Combining practices and starting small	0.817	0.387	0.060**	0.018	0.001	1,875
Optimal weeding	0.880	0.325	0.026	0.016	0.078	1,875
Fall armyworm control	0.207	0.406	-0.014	0.020	0.416	1,875
Women′s knowledge index	0.003	0.612	0.128**	0.028	0.000	1,875
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.127	0.334	0.071**	0.018	0.000	1,770
Combining practices and starting small	0.817	0.387	0.051**	0.018	0.003	1,770
Optimal weeding	0.880	0.325	-0.005	0.016	0.761	1,770
Fall armyworm control	0.207	0.406	-0.008	0.019	0.652	1,770
Women′s knowledge index	-0.028	0.622	0.102**	0.029	0.000	1,770

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1A for top panel and Model 1B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test. Note that no information on the recommended way to fight fall armyworm was given in the video, so no effects were expected.

Table A.4: Women's knowledge of recommended practices (models 2A and 2B)

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.196	0.398	0.000	0.027	0.991	981
Combining practices and starting small	0.868	0.339	0.003	0.023	0.907	981
Optimal weeding	0.896	0.306	0.005	0.020	0.805	981
Fall armyworm control	0.175	0.380	0.005	0.026	0.850	981
Women′s knowledge index	0.007	0.578	0.008	0.040	0.835	981
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.131	0.338	-0.006	0.024	0.800	887
Combining practices and starting small	0.815	0.389	-0.004	0.028	0.884	887
Optimal weeding	0.875	0.331	0.008	0.023	0.731	887
Fall armyworm control	0.212	0.410	-0.010	0.029	0.706	887
Women′s knowledge index	0.000	0.548	0.005	0.043	0.987	887

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Table A.5: Joint knowledge of recommended practices (models 1A and 1B)

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.073	0.260	-0.026	0.013	0.032	1,626
Combining practices and starting small	0.737	0.440	-0.011	0.024	0.638	1,626
Optimal weeding	0.805	0.396	0.033	0.021	0.089	1,626
Fall armyworm control	0.075	0.264	0.017	0.015	0.191	1,626
Joint knowledge index	-0.022	0.642	-0.021	0.030	0.596	1,626
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.073	0.260	0.026	0.014	0.067	1,546
Combining practices and starting small	0.737	0.440	0.043	0.022	0.052	1,546
Optimal weeding	0.805	0.396	-0.028	0.021	0.162	1,546
Fall armyworm control	0.075	0.264	0.019	0.014	0.156	1,546
Joint knowledge index	0.004	0.615	0.037	0.031	0.226	1,546

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Table A.6: Joint knowledge of recommended practices (models 2A and 2B)

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.053	0.224	-0.005	0.016	0.765	810
Combining practices and starting small	0.732	0.444	-0.013	0.034	0.704	810
Optimal weeding	0.853	0.355	-0.035	0.028	0.236	810
Fall armyworm control	0.075	0.265	0.011	0.021	0.548	810
Joint knowledge index	0.010	0.611	-0.049	0.045	0.273	810
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.076	0.266	-0.006	0.019	0.778	811
Combining practices and starting small	0.746	0.436	-0.022	0.033	0.564	811
Optimal weeding	0.812	0.392	-0.008	0.029	0.772	811
Fall armyworm control	0.083	0.277	-0.015	0.020	0.435	811
Joint knowledge index	-0.003	0.584	-0.027	0.045	0.552	811

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 2A for top panel and Model 2B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test. Note that no information on the recommended way to fight fall armyworm was given in the video, so no effects were expected.

Table A.7: Men's knowledge of recommended practices

	Model 1: Involving women in receiving information					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.266	0.442	-0.083**	0.017	0.000	2650
Combining practices and starting small	0.893	0.310	-0.043**	0.014	0.003	2650
Optimal weeding	0.884	0.320	-0.011	0.014	0.411	2650
Fall armyworm control	0.237	0.426	0.002	0.018	0.893	2650
Men′s knowledge index	0.004	0.614	-0.129**	0.024	0.000	2650
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.187	0.390	0.022	0.016	0.157	2647
Combining practices and starting small	0.849	0.358	0.021	0.014	0.141	2647
Optimal weeding	0.888	0.316	-0.013	0.013	0.343	2647
Fall armyworm control	0.229	0.421	0.005	0.017	0.753	2647
Men′s knowledge index	0.024	0.593	0.024	0.025	0.329	2647

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Table A.8: Men's knowledge of recommended practices (models 1A and 1B)

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.266	0.442	-0.151**	0.020	0.000	1833
Combining practices and starting small	0.893	0.310	-0.091**	0.019	0.000	1833
Optimal weeding	0.884	0.320	0.010	0.016	0.491	1833
Fall armyworm control	0.237	0.426	-0.004	0.022	0.849	1833
Men′s knowledge index	0.049	0.619	-0.185**	0.028	0.000	1833
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.266	0.442	-0.044+	0.021	0.029	1778
Combining practices and starting small	0.893	0.310	-0.007	0.015	0.690	1778
Optimal weeding	0.884	0.320	-0.030	0.016	0.067	1778
Fall armyworm control	0.237	0.426	-0.004	0.020	0.832	1778
Men′s knowledge index	-0.010	0.606	-0.071*	0.029	0.042	1778

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1A for top panel and Model 1B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test. Note that no information on the recommended way to fight fall armyworm was given in the video, so no effects were expected.

Table A.9: Men's knowledge of recommended practices (models 2A and 2B)

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.115	0.320	0.005	0.023	0.831	867
Combining practices and starting small	0.801	0.400	0.013	0.028	0.638	867
Optimal weeding	0.913	0.283	-0.025	0.022	0.286	867
Fall armyworm control	0.206	0.405	0.042	0.031	0.168	867
Men′s knowledge index	-0.007	0.603	-0.011	0.044	0.782	867
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Proper spacing and seeds per hill	0.237	0.426	0.049	0.030	0.124	961
Combining practices and starting small	0.891	0.313	0.002	0.021	0.942	961
Optimal weeding	0.891	0.313	-0.007	0.022	0.744	961
Fall armyworm control	0.243	0.430	-0.007	0.029	0.789	961
Men′s knowledge index	-0.013	0.604	0.026	0.041	0.462	961

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 2A for top panel and Model 2B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test. Note that no information on the recommended way to fight fall armyworm was given in the video, so no effects were expected.

Table A.10: Women's decision making (models 1A and 1B)

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.158	0.338	0.094^{**}	0.019	0.000	1,809
Timing of planting maize	0.163	0.340	0.099^{**}	0.020	0.000	1,809
Spacing and number of seeds	0.150	0.333	0.094^{**}	0.019	0.000	1,809
Striga control measures	0.113	0.295	0.086^{**}	0.018	0.000	1,764
Timing of the first weeding	0.178	0.357	0.090^{**}	0.020	0.000	1,809
Women′s decision-making index	-0.015	0.825	0.220^{**}	0.039	0.000	1,764
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.158	0.338	0.004	0.016	0.783	1,710
Timing of planting maize	0.163	0.340	0.013	0.017	0.450	1,710
Spacing and number of seeds	0.150	0.333	0.008	0.016	0.594	1,710
Striga control measures	0.113	0.295	0.025	0.015	0.076	1,665
Timing of the first weeding	0.178	0.357	0.011	0.018	0.507	1,710
Women′s decision-making index	-0.015	0.784	0.037	0.039	0.345	1,665

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1A for top panel and Model 1B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.11: Women's decision making (models 2A and 2B)

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.287	0.418	0.017	0.031	0.562	854
Timing of planting maize	0.258	0.409	0.068^{+}	0.032	0.031	854
Spacing and number of seeds	0.264	0.415	0.090^{*}	0.032	0.008	854
Striga control measures	0.175	0.364	0.068^{+}	0.029	0.018	835
Timing of the first weeding	0.236	0.398	0.080^{*}	0.031	0.011	854
Women′s decision-making index	0.066	0.856	0.155^{*}	0.060	0.006	835
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.174	0.351	-0.023	0.025	0.337	858
Timing of planting maize	0.174	0.345	-0.012	0.025	0.603	858
Spacing and number of seeds	0.153	0.328	0.000	0.024	0.997	858
Striga control measures	0.109	0.291	0.008	0.022	0.711	833
Timing of the first weeding	0.192	0.365	-0.014	0.026	0.579	858
Women′s decision-making index	-0.029	0.765	-0.038	0.059	0.659	833

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 2A for top panel and Model 2B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.12: Joint decision making (models 1A and 1B)

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.520	0.472	-0.012	0.025	0.576	1,809
Timing of planting maize	0.477	0.470	-0.005	0.024	0.814	1,809
Spacing and number of seeds	0.475	0.473	0.006	0.025	0.790	1,809
Striga control measures	0.420	0.464	-0.010	0.025	0.652	1,764
Timing of the first weeding	0.535	0.469	-0.019	0.025	0.398	1,809
Joint decision-making index	0.018	0.790	-0.055	0.038	0.671	1,764
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.520	0.472	0.038	0.023	0.106	1,710
Timing of planting maize	0.477	0.470	0.022	0.023	0.322	1,710
Spacing and number of seeds	0.475	0.473	0.053^{+}	0.023	0.019	1,710
Striga control measures	0.420	0.464	0.050	0.023	0.029	1,665
Timing of the first weeding	0.535	0.469	0.009	0.023	0.680	1,710
Joint decision-making index	0.010	0.781	0.074^{*}	0.039	0.034	1,665

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1A for top panel and Model 1B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.13: Joint decision making (models 2A and 2B)

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.502	0.474	-0.018	0.032	0.565	967
Timing of planting maize	0.461	0.464	-0.009	0.032	0.783	967
Spacing and number of seeds	0.438	0.468	0.026	0.032	0.412	967
Striga control measures	0.399	0.465	0.011	0.032	0.732	946
Timing of the first weeding	0.490	0.477	-0.013	0.033	0.669	967
Joint decision-making index	-0.045	0.805	-0.001	0.056	0.982	946
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.512	0.471	0.006	0.034	0.857	858
Timing of planting maize	0.475	0.465	-0.003	0.034	0.941	858
Spacing and number of seeds	0.480	0.469	-0.016	0.034	0.638	858
Striga control measures	0.423	0.460	-0.017	0.034	0.612	833
Timing of the first weeding	0.540	0.462	-0.017	0.034	0.610	858
Joint decision-making index	0.035	0.781	0.000	0.058	0.753	833

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 2A for top panel and Model 2B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.14: Men's decision making

	Model 1: Involving women in receiving information					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.369	0.454	-0.077**	0.019	0.000	2,563
Timing of planting maize	0.395	0.461	-0.085**	0.019	0.000	2,563
Spacing and number of seeds	0.431	0.468	-0.107**	0.019	0.000	2,563
Striga control measures	0.323	0.442	-0.093**	0.018	0.000	2,497
Timing of the first weeding	0.394	0.460	-0.109**	0.019	0.000	2,563
Men′s decision-making index	0.033	0.823	-0.184**	0.034	0.000	2,497
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.354	0.444	-0.039+	0.018	0.030	2,612
Timing of planting maize	0.348	0.446	-0.004	0.019	0.848	2,612
Spacing and number of seeds	0.363	0.453	0.007	0.019	0.711	2,612
Striga control measures	0.273	0.418	-0.008	0.018	0.663	2,542
Timing of the first weeding	0.331	0.440	0.001	0.018	0.943	2,612
Men′s decision-making index	0.047	0.829	-0.023	0.034	0.491	2,542

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1 for top panel and Model 2 for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.15: Men's decision making (models 1A and 1B)

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.369	0.454	-0.092**	0.024	0.000	1,772
Timing of planting maize	0.395	0.461	-0.114**	0.024	0.000	1,772
Spacing and number of seeds	0.431	0.468	-0.136**	0.024	0.000	1,772
Striga control measures	0.323	0.442	-0.121**	0.023	0.000	1,728
Timing of the first weeding	0.394	0.460	-0.121**	0.024	0.000	1,772
Men′s decision-making index	-0.007	0.811	-0.210**	0.039	0.000	1,728
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.369	0.454	-0.062*	0.022	0.005	1,721
Timing of planting maize	0.395	0.461	-0.060*	0.022	0.006	1,721
Spacing and number of seeds	0.431	0.468	-0.084**	0.022	0.000	1,721
Striga control measures	0.323	0.442	-0.066**	0.021	0.001	1,673
Timing of the first weeding	0.394	0.460	-0.087**	0.022	0.000	1,721
Men′s decision-making index	-0.026	0.816	-0.152**	0.040	0.001	1,673

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1A for top panel and Model 1B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.16: Men's decision making (models 2A and 2B)

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.228	0.398	0.012	0.027	0.652	967
Timing of planting maize	0.232	0.395	0.024	0.028	0.399	967
Spacing and number of seeds	0.237	0.404	-0.006	0.027	0.836	967
Striga control measures	0.197	0.383	0.000	0.026	0.990	946
Timing of the first weeding	0.274	0.431	-0.006	0.029	0.838	967
Men′s decision-making index	0.036	0.847	-0.001	0.057	0.985	946
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Planting maize on the plot	0.421	0.462	-0.075	0.031	0.044	930
Timing of planting maize	0.420	0.463	-0.035	0.032	0.288	930
Spacing and number of seeds	0.445	0.466	-0.014	0.032	0.661	930
Striga control measures	0.353	0.447	-0.040	0.031	0.187	904
Timing of the first weeding	0.404	0.457	-0.014	0.032	0.656	930
Men′s decision-making index	0.069	0.825	-0.098	0.058	0.123	904

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 2A for top panel and Model 2B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.17: Women's adoption of recommended practices (models 1A and 1B)

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Timing of planting maize	0.043	0.179	0.028^{**}	0.011	0.003	1,686
Spacing and number of seeds	0.001	0.034	0.008^{*}	0.003	0.005	1,808
Striga control measures	0.080	0.253	0.076^{**}	0.016	0.000	1,763
Timing of the first weeding	0.157	0.338	0.086^{**}	0.020	0.000	1,808
Women Joint adoption index	-0.002	0.589	0.147^{**}	0.030	0.000	1,646
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
Timing of planting maize	0.043	0.179	0.019	0.010	0.057	1,599
Spacing and number of seeds	0.001	0.034	0.007	0.003	0.035	1,709
Striga control measures	0.080	0.253	0.031^{+}	0.013	0.020	1,664
Timing of the first weeding	0.157	0.338	0.011	0.017	0.503	1,709
Women Joint adoption index	-0.011	0.601	0.092^{**}	0.031	0.003	1,558

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1A for top panel and Model 1B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.18: Women's adoption of recommended practices (models 2A and 2B)

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Timing of planting maize	0.042	0.178	0.026	0.015	0.080	909
Spacing and number of seeds	0.005	0.062	0.005	0.005	0.382	967
Striga control measures	0.154	0.347	0.003	0.024	0.904	946
Timing of the first weeding	0.248	0.419	-0.006	0.028	0.834	967
Women adoption index	0.021	0.682	0.050	0.043	0.231	889
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Timing of planting maize	0.053	0.196	-0.013	0.014	0.322	792
Spacing and number of seeds	0.004	0.059	-0.003	0.002	0.327	857
Striga control measures	0.077	0.244	0.008	0.019	0.652	832
Timing of the first weeding	0.178	0.353	-0.025	0.024	0.311	857
Women adoption index	-0.016	0.799	-0.074	0.050	0.242	771

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 2A for top panel and Model 2B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.19: Joint adoption of recommended practices (models 1A and 1B)

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Timing of planting maize	0.110	0.294	0.009	0.016	0.538	1,686
Spacing and number of seeds	0.014	0.112	0.011	0.007	0.081	1,808
Striga control measures	0.321	0.437	-0.005	0.023	0.828	1,763
Timing of the first weeding	0.478	0.470	-0.012	0.025	0.598	1,808
Joint adoption index	0.000	0.600	0.015	0.030	0.285	1,646
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
Timing of planting maize	0.110	0.294	0.007	0.015	0.651	1,599
Spacing and number of seeds	0.014	0.112	0.018^{*}	0.007	0.007	1,709
Striga control measures	0.321	0.437	0.051^{+}	0.022	0.018	1,664
Timing of the first weeding	0.478	0.470	0.029	0.023	0.206	1,709
Joint adoption index	0.004	0.619	0.076^{**}	0.030	0.005	1,558

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1A for top panel and Model 1B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.20: Joint adoption of recommended practices (models 2A and 2B)

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Timing of planting maize	0.112	0.286	0.002	0.021	0.935	909
Spacing and number of seeds	0.027	0.149	-0.001	0.011	0.946	967
Striga control measures	0.317	0.441	-0.013	0.030	0.636	946
Timing of the first weeding	0.462	0.471	-0.037	0.032	0.228	967
Joint adoption index	-0.044	0.533	0.010	0.042	0.796	889
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Timing of planting maize	0.119	0.298	-0.010	0.022	0.640	792
Spacing and number of seeds	0.009	0.089	0.006	0.008	0.456	857
Striga control measures	0.317	0.428	-0.004	0.032	0.888	832
Timing of the first weeding	0.491	0.466	-0.030	0.034	0.384	857
Joint adoption index	0.058	0.631	0.008	0.046	0.999	771

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 2A for top panel and Model 2B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.21: Men's adoption of recommended practices

	Model 1: Involving women in receiving information					
	Avg	S.D.	ATE	S.E.	p-value	N
Timing of planting maize	0.057	0.208	-0.009	0.009	0.308	2,493
Spacing and number of seeds	0.008	0.082	0.003	0.004	0.447	2,660
Striga control measures	0.143	0.325	-0.027^{+}	0.014	0.029	2,595
Timing of the first weeding	0.202	0.375	-0.019	0.016	0.226	2,660
Men adoption index	0.025	0.610	-0.002	0.026	0.386	2,433
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
timing of planting maize	0.057	0.213	-0.002	0.009	0.793	2,542
spacing and number of seeds	0.012	0.105	-0.001	0.004	0.754	2,713
striga control measures	0.126	0.306	0.004	0.013	0.752	2,644
timing of the first weeding	0.189	0.363	0.014	0.015	0.355	2,713
Men adoption index	0.037	0.657	0.009	0.026	0.731	2,478

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1 for top panel and Model 2 for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.22: Men's adoption of recommended practices (models 1A and 1B)

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
timing of planting maize	0.057	0.208	-0.004	0.012	0.672	1,686
spacing and number of seeds	0.008	0.082	0.003	0.005	0.487	1,808
striga control measures	0.143	0.325	-0.039*	0.016	0.006	1,763
timing of the first weeding	0.202	0.375	-0.056**	0.019	0.001	1,808
men's adoption index	0.005	0.610	-0.014	0.030	0.179	1,646
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
timing of planting maize	0.057	0.208	-0.012	0.010	0.242	1,599
spacing and number of seeds	0.008	0.082	0.004	0.005	0.361	1,709
striga control measures	0.143	0.325	-0.013	0.016	0.398	1,664
timing of the first weeding	0.202	0.375	0.009	0.019	0.623	1,709
men's adoption index	-0.022	0.576	0.011	0.030	0.965	1,558

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1A for top panel and Model 1B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.23: Men's adoption of recommended practices (models 2A and 2B)

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
timing of planting maize	0.050	0.201	0.014	0.016	0.365	909
spacing and number of seeds	0.011	0.100	0.002	0.007	0.774	967
striga control measures	0.095	0.265	0.019	0.020	0.313	946
timing of the first weeding	0.162	0.348	0.025	0.024	0.285	967
men's adoption index	-0.008	0.599	0.047	0.044	0.259	889
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
timing of planting maize	0.076	0.239	-0.029	0.016	0.065	792
spacing and number of seeds	0.011	0.102	-0.003	0.006	0.570	857
striga control measures	0.140	0.318	0.009	0.024	0.678	832
timing of the first weeding	0.185	0.358	0.027	0.027	0.319	857
men's adoption index	0.028	0.602	-0.021	0.046	0.684	771

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 2A for top panel and Model 2B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.24: Women's input use (models 1A and 1B)

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
DAP	0.016	0.121	0.027^{**}	0.007	0.000	1,809
Urea	0.002	0.038	0.014^{**}	0.004	0.000	1,809
Organic fertilizer	0.017	0.126	0.021^{*}	0.008	0.004	1,809
Hybrid seeds	0.013	0.111	0.024^{**}	0.007	0.000	1,809
OPV	0.018	0.126	0.017^{+}	0.008	0.020	1,809
Women input use index	-0.027	0.461	0.129^{**}	0.025	0.000	1,809
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
DAP	0.016	0.121	0.007	0.006	0.255	1,710
Urea	0.002	0.038	0.006	0.003	0.028	1,710
Organic fertilizer	0.017	0.126	0.006	0.006	0.332	1,710
Hybrid seeds	0.013	0.111	-0.001	0.005	0.874	1,710
OPV	0.018	0.126	0.002	0.006	0.764	1,710
Women input use index	-0.012	0.484	0.033^{+}	0.024	0.063	1,710

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1A for top panel and Model 1B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.25: Women's input use (models 2A and 2B)

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
DAP	0.029	0.156	0.005	0.011	0.650	967
Urea	0.017	0.127	-0.004	0.007	0.586	967
Organic fertilizer	0.021	0.128	0.021	0.012	0.077	967
Hybrid seeds	0.029	0.152	0.004	0.011	0.727	967
OPV	0.031	0.169	0.007	0.012	0.545	967
Women input use index	-0.037	0.470	0.041	0.037	0.272	967
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
DAP	0.015	0.120	0.002	0.009	0.780	858
Urea	0.000	0.000	0.003	0.003	0.129	858
Organic fertilizer	0.014	0.110	0.005	0.009	0.613	858
Hybrid seeds	0.011	0.097	0.003	0.008	0.747	858
OPV	0.015	0.120	0.006	0.009	0.553	858
Women input use index	-0.028	0.385	0.038	0.035	0.238	858

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 2A for top panel and Model 2B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.26: Joint input use (models 1A and 1B)

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
DAP	0.050	0.207	0.020	0.011	0.042	1,809
Urea	0.014	0.116	0.001	0.006	0.886	1,809
Organic fertilizer	0.051	0.209	0.008	0.011	0.385	1,809
Hybrid seeds	0.027	0.150	0.013	0.009	0.110	1,809
OPV	0.021	0.084	0.008	0.005	0.052	1,836
Joint input use index	0.001	0.489	0.039**	0.023	0.010	1,809
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
DAP	0.050	0.207	0.022	0.011	0.035	1,710
Urea	0.014	0.116	0.004	0.006	0.506	1,710
Organic fertilizer	0.051	0.209	0.043**	0.012	0.000	1,710
Hybrid seeds	0.027	0.150	0.027**	0.009	0.002	1,710
OPV	0.021	0.084	0.002	0.004	0.629	1,735
Joint input use index	0.001	0.509	0.089**	0.024	0.000	1,710

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1A for top panel and Model 1B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.27: Joint input use (models 2A and 2B)

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
DAP	0.056	0.215	0.009	0.015	0.554	967
Urea	0.006	0.079	0.019	0.009	0.056	967
Organic fertilizer	0.058	0.220	0.000	0.015	0.991	967
Hybrid seeds	0.034	0.173	0.001	0.012	0.959	967
OPV	0.022	0.088	0.002	0.006	0.755	981
Joint input use index	0.007	0.489	0.043	0.033	0.199	967
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
DAP	0.041	0.192	0.010	0.015	0.498	858
Urea	0.008	0.086	0.010	0.008	0.268	858
Organic fertilizer	0.040	0.186	0.019	0.015	0.188	858
Hybrid seeds	0.026	0.152	0.000	0.011	0.999	858
OPV	0.022	0.089	-0.001	0.006	0.850	871
Joint input use index	-0.003	0.505	0.044	0.035	0.200	858

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 2A for top panel and Model 2B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.28: Men's use of inputs

	Model 1: Involving women in receiving information					
	Avg	S.D.	ATE	S.E.	p-value	N
DAP	0.067	0.239	-0.026**	0.009	0.002	2,661
Urea	0.018	0.122	0.002	0.005	0.766	2,661
Organic fertilizer	0.051	0.209	0.027*	0.010	0.006	2,661
Hybrid seeds	0.055	0.215	-0.006	0.009	0.495	2,661
OPV	0.019	0.077	0.005	0.004	0.191	2,700
Men input use index	-0.008	0.480	-0.012	0.021	0.381	2,661
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
DAP	0.055	0.217	-0.005	0.009	0.550	2,714
Urea	0.015	0.114	0.005	0.005	0.309	2,714
Organic fertilizer	0.065	0.235	0.003	0.010	0.717	2,714
Hybrid seeds	0.048	0.204	0.002	0.008	0.854	2,714
OPV	0.022	0.087	0.002	0.004	0.678	2,754
Men input use index	0.010	0.516	-0.007	0.020	0.741	2,714
	2,713					
Men adoption index	0.037	0.657	0.009	0.026	0.731	2,478

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1 for top panel and Model 2 for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.29: Men's use of inputs (models 1A and 1B)

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
DAP	0.067	0.239	-0.032**	0.011	0.000	1,809
Urea	0.018	0.122	-0.005	0.006	0.359	1,809
Organic fertilizer	0.051	0.209	0.008	0.011	0.391	1,809
Hybrid seeds	0.055	0.215	-0.011	0.011	0.271	1,809
OPV	0.019	0.077	0.003	0.004	0.448	1,836
Men input use index	0.018	0.514	-0.023+	0.023	0.058	1,809
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
DAP	0.067	0.239	-0.021	0.011	0.036	1,710
Urea	0.018	0.122	0.007	0.007	0.269	1,710
Organic fertilizer	0.051	0.209	0.043**	0.012	0.000	1,710
Hybrid seeds	0.055	0.215	-0.003	0.010	0.804	1,710
OPV	0.019	0.077	0.006	0.004	0.166	1,735
Men input use index	-0.006	0.499	0.001	0.024	0.783	1,710

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1A for top panel and Model 1B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.30: Men's use of inputs (models 2A and 2B)

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
DAP	0.054	0.218	-0.020	0.013	0.093	967
Urea	0.017	0.127	-0.003	0.008	0.664	967
Organic fertilizer	0.058	0.220	0.000	0.015	0.993	967
Hybrid seeds	0.047	0.205	-0.006	0.013	0.650	967
OPV	0.022	0.089	0.004	0.006	0.564	981
Men input use index	-0.010	0.484	-0.045	0.034	0.168	967
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
DAP	0.054	0.213	0.017	0.017	0.324	858
Urea	0.009	0.078	0.014	0.009	0.090	858
Organic fertilizer	0.040	0.186	0.019	0.015	0.183	858
Hybrid seeds	0.036	0.172	0.026	0.016	0.083	858
OPV	0.019	0.075	-0.001	0.006	0.819	871
Men input use index	-0.010	0.500	0.037	0.035	0.378	858

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 2A for top panel and Model 2B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.31: Women's production outcomes (models 1A and 1B)

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Production	39.094	155.909	51.576**	10.641	0.000	1,836
Area	0.105	0.332	0.103**	0.022	0.000	1,836
Yield better than normal	0.024	0.142	0.043**	0.010	0.000	1,763
Yield	57.675	237.920	75.144**	16.607	0.000	1,836
Share of household maize production	0.122	0.315	0.106**	0.019	0.000	1,729
Share of area under maize cultivation	0.122	0.315	0.107**	0.020	0.000	1,697
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
Production	39.094	155.909	18.834	8.911	0.033	1,735
Area	0.105	0.332	0.045	0.021	0.029	1,735
Yield better than normal	0.024	0.142	0.011	0.008	0.131	1,664
Yield	57.675	237.920	27.178	12.515	0.027	1,735
Share of household maize production	0.122	0.315	0.019	0.016	0.208	1,618
Share of area under maize cultivation	0.122	0.315	0.021	0.016	0.200	1,604

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1A for top panel and Model 1B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.32: Women's production outcomes (models 2A and 2B)

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Production	74.487	183.926	11.897	16.217	0.458	981
Area	0.193	0.451	0.005	0.033	0.873	981
Yield better than normal	0.055	0.207	0.011	0.015	0.458	946
Yield	154.249	512.437	-49.172	25.418	0.053	981
Share of household maize production	0.235	0.413	-0.024	0.028	0.381	930
Share of area under maize cultivation	0.239	0.415	-0.027	0.028	0.329	918
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Production	52.850	215.563	-19.752	11.276	0.070	871
Area	0.117	0.384	-0.017	0.024	0.477	871
Yield better than normal	0.029	0.156	-0.005	0.010	0.606	832
Yield	79.907	345.055	-32.709	17.220	0.061	871
Share of household maize production	0.131	0.320	-0.010	0.024	0.653	813
Share of area under maize cultivation	0.121	0.311	0.006	0.024	0.800	794

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 2A for top panel and Model 2B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.33: Joint production outcomes (models 1A and 1B)

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Production	239.898	478.920	-35.666	21.564	0.057	1,836
Area	0.591	0.908	-0.036	0.044	0.343	1,836
Yield better than normal	0.132	0.326	-0.009	0.017	0.521	1,763
Yield	222.381	383.192	-16.996	19.671	0.338	1,836
Share of household maize production	0.501	0.486	-0.013	0.026	0.573	1,729
Share of area under maize cultivation	0.502	0.485	-0.012	0.026	0.633	1,697
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
Production	239.898	478.920	-1.069	21.157	0.960	1,735
Area	0.591	0.908	0.004	0.042	0.915	1,735
Yield better than normal	0.132	0.326	0.016	0.016	0.303	1,664
Yield	222.381	383.192	7.339	17.845	0.671	1,735
Share of household maize production	0.501	0.486	0.031	0.024	0.197	1,618
Share of area under maize cultivation	0.502	0.485	0.029	0.025	0.224	1,604

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1A for top panel and Model 1B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.34: Joint production outcomes (models 2A and 2B)

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Production	183.716	309.267	26.039	24.464	0.269	981
Area	0.555	0.878	-0.050	0.055	0.344	981
Yield better than normal	0.090	0.267	0.038	0.021	0.066	946
Yield	184.792	332.737	25.809	25.834	0.311	981
Share of household maize production	0.467	0.486	0.014	0.034	0.668	930
Share of area under maize cultivation	0.469	0.486	0.004	0.034	0.904	918
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Production	250.434	526.708	-20.439	34.440	0.552	871
Area	0.621	0.915	-0.064	0.065	0.320	871
Yield better than normal	0.103	0.295	0.041	0.024	0.079	832
Yield	210.600	336.621	18.882	27.606	0.483	871
Share of household maize production	0.508	0.486	-0.019	0.036	0.610	813
Share of area under maize cultivation	0.518	0.484	-0.035	0.037	0.348	794

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 2A for top panel and Model 2B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.35: Women's sales (models 1A and 1B)

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.088	0.284	0.041**	0.016	0.005	1,836
Amount sold (in 100 kg bags)	0.184	0.977	0.071	0.047	0.098	1,836
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.088	0.284	-0.005	0.013	0.691	1,735
Amount sold (in 100 kg bags)	0.184	0.977	-0.025	0.044	0.574	1,735

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1A for top panel and Model 1B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.36: Women's sales (models 2A and 2B)

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.113	0.318	0.016	0.022	0.476	981
Amount sold (in 100 kg bags)	0.238	1.055	-0.023	0.057	0.684	981
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.109	0.312	-0.030	0.020	0.130	891
Amount sold (in 100 kg bags)	0.255	1.231	-0.106	0.069	0.122	891

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 2A for top panel and Model 2B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.37: Joint sales (models 1A and 1B)

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.319	0.466	-0.029	0.024	0.178	1,836
Amount sold (in 100 kg bags)	1.179	3.173	-0.157	0.151	0.241	1,836
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.319	0.466	0.009	0.023	0.673	1,735
Amount sold (in 100 kg bags)	1.179	3.173	0.053	0.162	0.740	1,735

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1A for top panel and Model 1B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.38: Joint sales (models 2A and 2B)

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.273	0.446	0.052	0.031	0.106	981
Amount sold (in 100 kg bags)	0.959	2.210	0.171	0.189	0.372	981
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.296	0.457	0.038	0.033	0.245	891
Amount sold (in 100 kg bags)	1.333	4.326	-0.155	0.244	0.516	891

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 2A for top panel and Model 2B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.39: Men's sales

	Model 1: Involving women in receiving information					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.116	0.320	-0.006	0.013	0.669	2,700
Amount sold (in 100 kg bags)	0.409	2.544	-0.055	0.089	0.547	2,700
	Model 2: Involving women in conveying information					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.124	0.330	-0.015	0.013	0.234	2,754
Amount sold (in 100 kg bags)	0.525	2.840	-0.228**	0.084	0.004	2,754

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1 for top panel and Model 2 for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.40: Men's sales (models 1A and 1B)

	Model 1A: Zooming in on providing information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.116	0.320	-0.028+	0.016	0.053	1,836
Amount sold (in 100 kg bags)	0.409	2.544	-0.111	0.109	0.273	1,836
	Model 1B: Zooming in on providing information to women as part of the couple					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.116	0.320	0.008	0.016	0.596	1,735
Amount sold (in 100 kg bags)	0.409	2.544	-0.021	0.114	0.855	1,735

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 1A for top panel and Model 1B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.

Table A.41: Men's sales (models 2A and 2B)

	Model 2A: Involving women in conveying information to the female co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.110	0.314	-0.007	0.021	0.741	981
Amount sold (in 100 kg bags)	0.456	1.944	-0.181	0.103	0.077	981
	Model 2B: Involving women in conveying information to the male co-heads alone					
	Avg	S.D.	ATE	S.E.	p-value	N
Sold any	0.112	0.316	0.005	0.023	0.822	891
Amount sold (in 100 kg bags)	0.487	3.175	-0.127	0.178	0.540	891

First column reports sample means; standard deviations are in the second column; column 3 reports differences between treatment and control as defined in Figure 2 (Model 2A for top panel and Model 2B for bottom panel); associated standard errors are in column 4; column 5 reports p-values based on randomization inference; the last column is sample size; **, * and + indicate that the difference is signficantly different from zero at the 1, 5 and 10 percent level after controlling FWER using an omnibus test.