Empowering women through targeting information or role models: Evidence from an experiment in agricultural extension in Uganda

September 5, 2022

Abstract

Agricultural advisory services are generally biased towards men, with information targeted mainly to male members within the household, and in formats that often reinforce male dominance in agricultural decision-making. Such biases affect women's ability to make informed decisions and limit their intra-household bargaining power. Because women's empowerment in agriculture has many well-established benefits, designing inclusive agricultural extension and advisory services is important. In this study, we challenge the assumption that information is fully shared between co-heads of a household. We also test if portraying women as equally able farmers challenges gender norms and stereotypes in agriculture. We do this through a field experiment in eastern Uganda in which videos that provide information on recommended maize-farming practices are shown to monogamous maize-farming households. In the experiment, we manipulate who within the household is exposed to the information contained in the video. Furthermore, we vary the gender of the person delivering the information in the video. We find that targeting the female co-head

alone with information increases her knowledge about recommended practices, her role in agricultural decision-making, her subsequent adoption of recommended practices and inputs, and yields on fields she manages, while the male co-head's knowledge about the practices and his unilateral decision-making is reduced. When both co-heads are targeted, joint adoption of recommended practices and inputs increases, while the male co-head's unilateral decision-making is reduced. We find some support that featuring female role models in the videos challenges men's beliefs and stereotypes about women's roles in agriculture, and encourages adoption of recommended practices by women. We conclude that if the aim is to empower women, most gains can be made by re-designing advisory services to target information exclusively to the female co-head within the household. Challenging gender stereotypes may create room for increasing women's involvement in agriculture.

1 Introduction

A lack of information about the existence, use, and profitability of modern inputs, improved technologies, and recommended management practices is a major constraint to agricultural productivity growth, sustainable intensification, and food security in many developing countries (Magruder, 2018). Therefore, agricultural extension programs and advisory services are often important components of agricultural development strategies designed to remove these constraints. However, extension services are typically biased toward men, with information targeted mainly to male members of the farm household (generally the male household head) and delivered by male extension agents in ways that do not always recognize the role of women in agriculture. Such biases affect women's ability to make informed decisions and limit their intra-household bargaining power.

In this paper, we examine how the design of information and communication technology (ICT) applications used in video based agricultural extension information campaigns affects household member's access—the female co-head within the household, in particular—to informational resources, their agency, and their achievements in smallholder semi-subsistence farming. We conduct a Randomized Control Trial (RCT) among 3,330 maize-farming households in eastern Uganda and zoom in on two design features. In a first treatment, we focus on targeting the information, and compare outcomes for households where the informational video was shown to the male co-head only (corresponding to the status quo in generic extension models) to outcomes for households where the female co-head was also exposed to the video—either alone or as part of the couple of co-heads. In a second treatment, we investigate the potential of role models to increase participation in maize farming, a traditionally male dominated activity (Porter and Serra, 2019). Here, we vary exposure to the gender of the actors in the videos, and compare outcomes within households that were shown a video with a male actor (again corresponding to the status quo of male extension providers in generic extension models) to outcomes within households that were shown a video that features a female actress—either alone or together with a male actor. The outcomes we use to assess impact of the treatments are individual and joint outcomes (the female and male co-heads' knowledge, decision-making, adoption and production, and joint knowledge, decision-making, adoption and production) as reported by the female co-head.

We find that targeting the female co-head alone within the household (as opposed to targeting the male co-head alone) increased the female co-head's outcomes and reduced the male co-head's outcomes, mainly men's knowledge and men's unilateral decision making. We further find that targeting both the female co-head and male co-head within the household jointly with information

(as opposed to targeting the male co-head alone) increased joint outcomes. The effectiveness of the use of female role models is less straightforward. We only find that in the subgroup where a video was shown in which a couple of male and female actors provided information (as opposed to the status quo where a male actor provides all the advice), men were less likely to take decisions without involving their wives.

Our study contributes to the literature on the provision of agricultural extension and advisory services to address intra-household information asymmetries in the context of agriculture in low- and middle-income countries. Several recent studies explicitly target women within the household, thereby challenging the assumption that information provided to the (male) co-head trickles down to other household members (eg. Kondylis et al., 2016; Pan et al., 2018; Lambrecht et al., 2016). We also contribute to the emerging literature that investigates the importance of female role models in challenging gender stereotypes and empowering women in domains where they are active but lack voice and agency. Here, we complement studies that focus on aspirational channels, where women update their beliefs in one's own ability after being exposed to role models (eg. Beaman et al., 2012; Riley, 2022; Macours and Vakis, 2014). We also contribute to a growing body of literature that shows how role models can challenge prejudiced views and cognitive biases about the capabilities of specific social groups in specific social roles (eg. BenYishay and Mobarak, 2019; Beaman et al., 2009).

The remainder of the paper is structured as follows. The next section situates our study in the literature and highlights its contribution. In Section 3, we present the study context. In Section 4 we explain the methods, with subsections on the experimental design, sampling, the specification we will estimate, and the indicators that will be used to assess impact of the different interventions. We then turn to the results in Section 5, where we first discuss the impact of

targeting the information to the female co-head, alone or as part of the couple. We then look at role model effects. We also have a subsection that reports on interactions between the two treatments. A final section concludes.

2 Related Literature and Contribution

There are many well-established benefits to empowering women in agriculture. A more prominent role for women in the farm household has been shown to result in a more efficient allocation of scarce resources within the household, a more equitable distribution of the returns to investments in household production, and general improvements in welfare and reductions in poverty (eg. de Brauw et al., 2014; Fiala and He, 2016; Croppenstedt et al., 2013). Involving women in the choice of crops may also lead to more nutritious dietary outcomes at the household level (Gilligan et al., 2020; Duflo and Udry, 2004). More generally and from a human rights perspective, there is intrinsic value in empowering women (Kabeer, 1999).

Women are likely to benefit from more inclusive agricultural extension models, as they face information deficiencies and asymmetries relative to men in a range of circumstances. In agriculture, women have been shown to be more deprived of information regarding good agronomic practices (Doss and Morris, 2000; Doss, 2001; Lambrecht et al., 2016). 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 equally likely to adopt modern agronomic practices (Doss and Morris, 2000). Kabunga et al. (2014) find that female farmers are less likely to adopt tissue banana culture technology in Kenya, but would have an equal chance of adopting the innovation if they acquired sufficient information about

the innovation.

Women's access to information—particularly to information provided by extension services—may be subject to both extra-household and intra-household constraints. The extra-household constraints can be infrastructural and logistical, for instance, women not being targeted, lacking the money to travel to extension training locations, or lacking the time to attend training 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 that is not adapted to women's interests or needs, or does 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, while norms limiting women's mobility and women's interaction with men may impose additional constraints. 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).

Intra-household constraints are often closely tied to spousal relationships. For example, a married woman's interaction with her husband may be her main source of information on agriculture. The assumption that information flows freely and without friction within the household 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. The con-

ceptualization 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).

In this research, we assess the impact of including the female co-head as a recipient of agricultural extension information within the household. Various recent studies have found that targeting is important in making information effective for particular groups or individuals. For example, Kondylis et al. (2016) observe that extension 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 farm 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.

We also assess the impact of the gender of the person who provides the information. Here, recent research suggests that role models are 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, 2022). 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, 2022). Inspiring films about successful farmers' life choices promoted welfare-improving aspirations among Ethiopian farmers (Bernard et al., 2015), while 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 to 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 inspired women to demand more autonomy in decisions about health, socialization and household decisions and less accepting attitudes towards domestic violence and girls circumcision (Bargain et al., 2019). Evans (2014) argues that in mixed-sex schools in Zambia, seeing girls demonstrate equal competence can undermine gender stereotypes, on the part of girls and boys alike. Most of these studies show that role models not only increased aspirations, but also led to changes in choices made, such as women employment (Ghani et al., 2014) and investment in child education (Bernard et al., 2015; Macours and Vakis, 2014), particularly of girls (Beaman et al., 2012).

Role models have also been found important in challenging role incongruity,

that is, 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). Peer effects (which are linked to recognition and conformity) and gender homophily effects may imply that information contained in a message brought by role models of the same sex is better understood and more trusted than when delivered by a messenger of the other sex, thereby contributing to changes in an individual's choices and chances of success.[1] BenYishay and Mobarak (2019) showed that the social identity of the person who provides extension information influences learning and adoption. Farmers appeared most convinced by communicators who shared a group identity with them, or who faced similar agricultural conditions.While female role models can affect women's empowerment directly as women start questioning cultural norms and gender stereotypes, the indirect effect of role models may be even more important, particularly in the longer run, as role models challenge beliefs and stereotypes about lesser abilities of that group held by other groups 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.

3 Study Context

The field experiment was conducted in five districts in eastern Uganda (Bugiri, Mayuge, Iganga, Namayingo, and Namutumba) where maize is particularly important, both as a staple and as a marketable crop. Figure 1 provides a map

[1] 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).

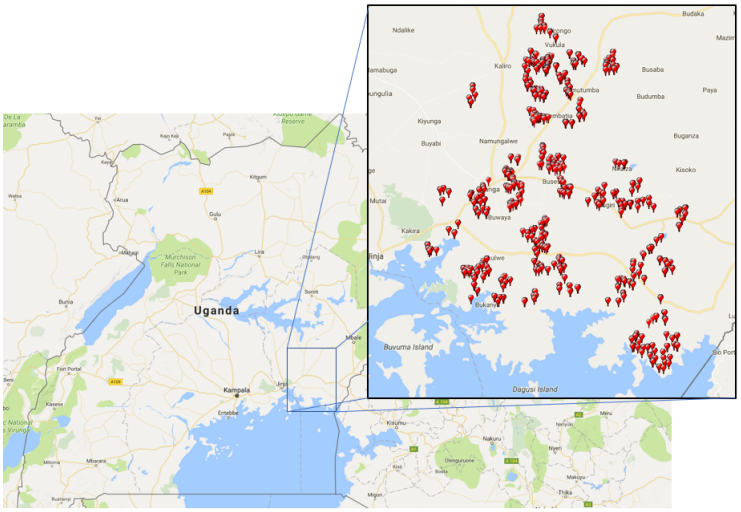

Figure 1: Map of the study area

of the study area. The experiment was conducted during the second maize growing season, which runs from approximately August to January, 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 yields 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 yields reports figures between 270 kg per acre and 995 kg per acre (Gourlay et al., 2019).

The public agricultural extension system in Uganda has a turbulent history. The National Agricultural Advisory Services (NAADS), which was set up as a public-private partnership in 2000, was hailed by experts and donors as an exam-

ple of how to increase market-oriented agricultural production by empowering farmers to demand and control extension services. NAADS did consider gender in its programming—for instance by distributing dairy cattle to women to improve food security. A large-scale impact evaluation, however, found that the program was relatively more effective among male-headed than female-headed households (Benin et al., 2011). Another study provides initial descriptive evidence suggesting NAADS did better in reaching women and vulnerable groups than privatized extension services (eg. Turyahikayo and Kamagara, 2016).

NAADS ultimately became a victim of political capture and governance problems, and was eventually replaced by Operation Wealth Creation (OWC) in 2014 (Kjær and Joughin, 2019). The latter is organized by the army and approaches problems in the sector from a logistical angle, with a strong focus on (subsidized) input distribution. While the OWC program guidelines emphasize gender equity and non-discrimination, it does not have any arrangements to ensure gender equity in receiving inputs (Acosta et al., 2019). Hence it is likely to further reduce the gender responsiveness of the public extension system in Uganda. Data obtained from the Uganda National Panel Survey (wave 2013/2014) suggest that only 20 percent of households received extension in the past 12 months. While there is no reliable data on who was targeted within these households, a recent survey on public service delivery found that only 16 percent of extension agents in Uganda are women (Kabunga et al., 2016).

There is evidence that maize plots under female management are less productive than maize plots under male management. Ali et al. (2016) observe that 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 (controlling 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. While there is no evidence of differences in land tenure and quality between maize plots managed by (married) men and women in male-headed households in eastern Uganda, significantly more labor and more male labor was found to be allocated to male managed maize plots. Lower access to credit by married women farmers than men farmers was identified as one of the reasons for more limited adoption of improved maize varieties (Fisher and Carr, 2015)

While there are some contextual nuances, generally, women farmers in Uganda face inequalities in access and control over resources and decision-making power within their households, as well as structural constraints to equality and their empowerment in agriculture relating to gender norms and roles. According to a 2011 study calculating the women's empowerment in agriculture index, 56.7 percent of (married) women in rural dual households in Uganda (including in districts in eastern Uganda) are disempowered, and over 60 percent of these women live in a household where the man is empowered. Women's work and lack of control over resources were found to contribute most to women's disempowerment (Alkire et al., 2013). Women's work burden derives from gender roles assigning most care and domestic work to women in addition to farm work (Lodin et al., 2012). In terms of access to resources, there are strong social norms dictating against women owning land. While there are provisions in formal law to protect women's access to land, the absence of a legal provision for co-ownerhip, the preference for customary marriage with weaker protection for women's property rights and the ambiguity around inheritance by widows disfavour women (Andersson Djurfeldt, 2020). In most cases, women marry into the community where the husband often already (informally) owns land or has use rights to land. Therefore, most agricultural land is owned by men. Land ac-

quired during the course of (legal or customary) marriage tends to be considered co-owned by spouses and some married women acquire plots in their own name (Lecoutere and Wuyts, 2021). A study in eastern Uganda shows there are few married women who own maize plots but that 13 percent of maize plots have a married woman as the main decision-maker, who often manages multiple maize plots (Fisher and Carr, 2015). Generally, men have greater voice in intrahousehold agricultural decision-making, especially when a crop is (also) marketed, which partly relates to gender norms assigning the roles of breadwinner and head of household to men (Lodin et al., 2012; Lecoutere and Jassogne, 2019).

4 Methods

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

We test the effectiveness of involving women in receiving and conveying agricultural extension information via ICT-enabled videos. To do so, we use a 3^2 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).[2] Each factor contained three levels: male alone, female alone, or male and female together (as a couple). The design is represented in Figure 2 below, with numbers shown in each of the nine treatment cells to indicate the number of households randomly allocated to one of these nine treatment combinations.[3]

[2] 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.

[3] Power calculations were based on a set of comparisons using different outcomes to power the complete 3^2 factorial design. We used simulation techniques that allowed us to sample from actual data on outcome variables (maize yields obtained from Uganda National Household

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

Figure 2: Layout of experimental design

The design was operationalized using short videos. Corresponding to the recipient factor, the video was shown to one of the three recipients: the male co-head within 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. The second version features a female actor-farmer, and the third version features both the male and female actor-farmers. The videos can be found here. The videos were shown on 10-inch Android tablet computers by trained field enumerators during a private meeting with the participant(s). 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 consisted of a 10-minute aspirational story in which a farmer (a 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

Survey of 2005/06) instead of a theoretical distribution with an assumed mean and standard deviation.

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.

4.2 Sampling and treatment assignment

We conducted the field experiment and collected data during the second maize-growing season, more specifically between August to October 2017. Participants in the experiment were drawn from monogamous smallholder maize-cultivating households residing in five districts in eastern Uganda, listed above. 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 selected a random sub-set of monogamous households to be included in the study.[4]

We randomized treatment at the household level. Assignment of the households to a particular treatment combination was randomized using a random number generator. We pre-loaded information on the sampled households, including names, contact details, and their treatment assignment, onto the tablets so that the correct video was automatically queued for screening. The integration of treatment assignment into our Computer Assisted Personal Interview (CAPI) system allowed us to monitor implementation fidelity in real time. We collected endline data after harvest between February and April 2018. We revisited the households and interviewed both male and female co-heads separately.

4.3 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:

$$y_i = \alpha + \sum^{T_R=W,J} \beta^{T_R}.R_i^{T_R} + \sum^{T_M=W,J} \gamma^{T_M}.M_i^{T_M} +$$

$$\sum^{T_R=W,J} \sum^{T_M=W,J} \delta^{T_R T_M} R_i^{T_R} M_i^{T_M} + \varepsilon_i \quad (1)$$

In this equation, R_i are indicator dummy variables that denote who within the household was shown the video (the recipient factor). If the video was

[4] We focus on addressing intra-household challenges to extension information in households with monogamous marital/cohabiting relationships and excluded polygynous households from this study. Not only are intra-household dynamics in polygynous households (which themselves vary in the way they are organized) different from those in monogamous households, testing our hypotheses may have required additional treatment arms in the experiment and/or interaction terms controlling for type of relationship. Besides, according to the Ugandan National Population and Housing Census of 2016/17, only about ten percent of the adult population is in a polygamous marital/cohabiting relationship.

shown to the female co-head alone in household i, $R_i^W = 1$ and $R_i^J = 0$. If the video was shown to the couple of female and male co-heads in household i, the $R_i^W = 0$ and $R_i^J = 1$. The comparison category thus consist of households where the video was shown to the male co-head only in household i, in which case both $R_i^W = 0$ and $R_i^J = 0$. Similarly, M_i are indicator dummy variables that correspond to the messenger factor. If the video that was shown in household i was the version with the female actress alone, $M_i^W = 1$ and $M_i^J = 0$. If the video where the couple was acting was shown, then $M_i^W = 0$ and $M_i^J = 1$. Also here, the comparison category consist of households where the video was shown with only a male actor, in which case $M_i^W = 0$ and $M_i^J = 0$.

We obtain four parameters of interest. First, β^W corresponds to the impact of showing a video to the female co-head only (as compared to a situation where the video is shown to the male co-head alone and keeping the version of the video fixed). Second, β^J corresponds to the impact of showing a video to the male and female co-heads jointly (as compared to a situation where the video is shown to the male co-head alone and keeping the version of the video fixed). Third, γ^W provides and estimate of the effect of showing a video featuring a female role model (as compared to a situation where the video features a male actor only and controlling for who the video is shown to within the household). Fourth, γ^J provides and estimate of the effect of showing a video where a couple of male and female actors provides all the information (as compared to a situation where the video features only a male actor and keeping recipient fixed). We also test if $\beta^W = \beta^J$ and $\gamma^W = \gamma^J$.

Equation 1 also includes a full set of interactions and associated parameters (δ) allowing us to identify effects corresponding to each treatment cell in Figure 2. While our primary interest lies in the main effects and estimates of interactions are not reported in figures and tables to conserve space, some of

these interactions may be informative for particular outcomes. For instance, positive significant coefficient estimates of δ^{WW} for knowledge outcomes may indicate that gender related homophily effects—the tendency of individuals to associate more to individuals of the same gender—are important for learning. In our discussion of results in the next section, we highlight key findings from these interactions.

4.4 Outcomes

Impact is assessed as changes in key outcomes along the impact pathway. We examine effects on women's outcomes, men's outcomes, and outcomes that are shared (joint) between the female and male co-heads of households. Those outcomes are cast as changes in (a) the knowledge of the female co-head, knowledge of the male co-head, or joint knowledge, about the information promoted in the video; (b) the extent to which maize production-related decisions in the household are taken by the female co-head alone, by the male co-head alone, or jointly; (c) the adoption of the recommended practices and inputs decided upon unilaterally by the female co-head, unilaterally by the male co-head, or jointly; and (d) production-related outcomes on plots that were female-managed, male-managed, or jointly managed. We aggregate outcomes within each of these four families of outcomes into four indices, which are constructed as the weighted mean of the individual standardized outcomes, weighted by the inverse of the co-variance matrix of the transformed outcomes (Anderson, 2008). We further combine the four indices into an overall index that allows us to assess broader impact at a glance. Combining outcomes in indices is a common strategy to guard against over-rejection of the null hypothesis due to multiple inference.

Knowledge about the different practices recommended in the video is measured by the extent to which respondents correctly answered multiple choice

questions about the practices.[5] A woman's (man's) knowledge score is based 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 a correct answer to a multiple choice question was based on both co-head answering correctly. We combine the outcomes of the four knowledge questions into a knowledge index, resulting in female co-head, male co-head, and joint knowledge indices.

Agricultural decision-making is based on the female co-head's answers about who made a series of five decisions related to household maize production. We differentiate between decisions that the female co-head reports were made individually by herself, decisions that the female co-head reports were made unilaterally by the male co-head, and decisions that the female co-head reports were made jointly with her spouse. For each maize plot within the household, we recorded if the following decisions were made by the female co-head, by the male co-head, or jointly: whether to plant maize on the plot; when to start planting maize on the plot; what plant spacing to use and how many seeds per hill to plant on the plot; what strategies to deploy for striga control on the plot; and when to start weeding the plot. To aggregate this at the household level, we consider, for each of these five decisions, the proportion of maize plots within the household on which the female co-head reported that she took the decision alone, took the decision jointly with her spouse, or was taken by her spouse alone. To summarize individual co-heads and joint decision-making, we

[5]First, respondents are considered knowledgeable about recommended plant spacing and seed rate 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 that 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 that weeding is most important during the first four weeks after planting. Fourth, respondents are considered knowledgeable about fall armyworm (*Spodoptera frugiperda*) control if they correctly answered that spraying in the evening is most effective since fall armyworm feeds during night. The information needed to correctly answer the first three questions was provided in the videos. The videos did not provide information on fall armyworm control, hence no effect was expected for this question.

construct women's, men's and joint decision-making indices based on the five decision-making outcomes aggregated at the household, again following Anderson (2008).

Although decision-making is central to women's empowerment, we also wanted to determine whether 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, additional labor time or inputs), they may still be constrained and decide to use a second-best technology. Thus, we 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 male co-head decided unilaterally and adopted the practice that was promoted in the video, and for which the female and male co-head decided and adopted a recommended practice jointly.[6] We measure adoption of the following 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 18 to 20 days after planting. As before, we use the same method to construct a women's, men's and joint adoption index.

We also measure the use of inputs such as diammonium phosphate (DAP), urea, organic fertilizer, maize hybrids, and open pollinated varieties (OPVs). Similar to the adoption of recommended practices, we consider the proportion

[6]It is important to note that our intervention may have changed both the likelihood that a co-head 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, for instance, the estimated joint likelihood that the female co-head decided about a practice and adopted it corresponds to the conditional probability that a recommended practice is adopted by the female co-head multiplied by the probability that the female co-head individually made the decision on the practice. This should be kept in mind when comparing effects of adoption to effects of decision-making.

of the household's maize plots for which a particular input was used and was decided unilaterally by the female co-head, unilaterally by the male co-head, or jointly. Again, the 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.

Finally, we measured outcomes related to production quantity, area, and yield on maize plots under female, male and joint management. Female-managed (male-managed, jointly managed) plots are defined as plots on which, according to female co-head respondents, the female co-head alone (male co-head alone, female and male co-heads jointly) took at least three out of the five decisions listed above. 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 is an indicator variable that takes the value of one if the female co-head indicates that the yield on at least one of the maize plots under her management was greater than in a normal year. We also defined similar indicators for male-managed plots and for jointly managed plots. This family of outcomes is again summarized in production indices for female-managed, male-managed, and jointly managed plots.

Most of these outcomes are based on what women reported. However, it is well known that when male and female co-heads of the household are interviewed separately, they often provide different answers to the same set of questions. While part of these divergent responses may be attributable to measurement error, there is also a systematic component that may be due to spouses hiding decisions made, actions taken, or assets owned (Ambler et al., 2021).

Alternatively, differences may be due to prevailing gender roles and norms in society. For instance Acosta et al. (2020) find that men often report unilateral decision-making in areas where they are assumed to bear final responsibility, even if women had some degree of involvement, while women tend to view these scenarios as joint decisions. Peterman et al. (2021) find similar signs of social desirability bias in Uganda. This raises the question of who to believe when answers differ. For that reason, our implicit assumption that the female co-head's responses best reflect what we want to measure should be kept in mind when interpreting results.

5 Results

In this section, we present the impact of the treatments on women's, men's and joint knowledge, decision-making, adoption and production. We look at the impact of the information targeting treatment first, and then at the impact of the role model treatment. In both cases we report results for the two treatment levels: female alone and husband and wife together, respectively. We consider interaction effects separately.

5.1 The impact of targeting information

Figure 3 summarizes the effect of targeting video-mediated extension information to specific individuals within the household, with the comparison (control) group being those households in which information was targeted to the male co-head alone. The figure reports standardized coefficient estimates and corresponding confidence intervals.[7] In the left panel, coefficient estimates corresponding to β^W in Equation 1 are shown. In the right panel, coefficient

[7] Indices are standardized by design (see Anderson (2008)), individual outcomes are standardized by the control group standard deviation. Non-standardized coefficient estimates can be found in a series of Appendix Tables (A1-A5).

estimates for β^J are shown. As mentioned in Section 4.4, we examine effects on women's outcomes, men's outcomes, and joint outcomes separately, hence we provide three estimates for each outcome in each treatment.

Judging by the overall index, the left panel of the figure shows that exclusively targeting female co-heads with information within the household (as opposed to targeting only the male co-head) significantly increased women's outcomes, while it significantly reduced men's outcomes. Joint outcomes were not affected by this shift in information targeting from the male co-head to the female co-head.

The overall increase in women's outcomes and the reduction in men's outcomes are largely driven by important effects on decision-making, with large reductions in male unilateral decision-making and an increase in female unilateral decision-making in all decision-making areas we measured. The shift in decision-making as a result of directly targeting female co-heads with information instead of male co-heads seems at least partly the result of a knowledge effect. The figure shows that women scored significantly better on the multiple choice question that tested knowledge related to recommended spacing and seeding rate: in the group of households where male co-heads were shown the video, less than 13 percent of women indicated the correct option, while this increased to more than 19 percent when female co-heads alone were shown the video. When male co-heads were targeted with the information, about 26 percent of them knew the correct answer, and this reduced to 14 percent when the information was provided exclusively to female co-heads. A similar pattern was found for knowledge about the recommendation to combine practices, although baseline knowledge levels were higher and the impact of the recipient treatment was smaller. As expected, we also find no impact of the intervention on knowledge related to how to deal with fall armyworm, as this was not covered in the

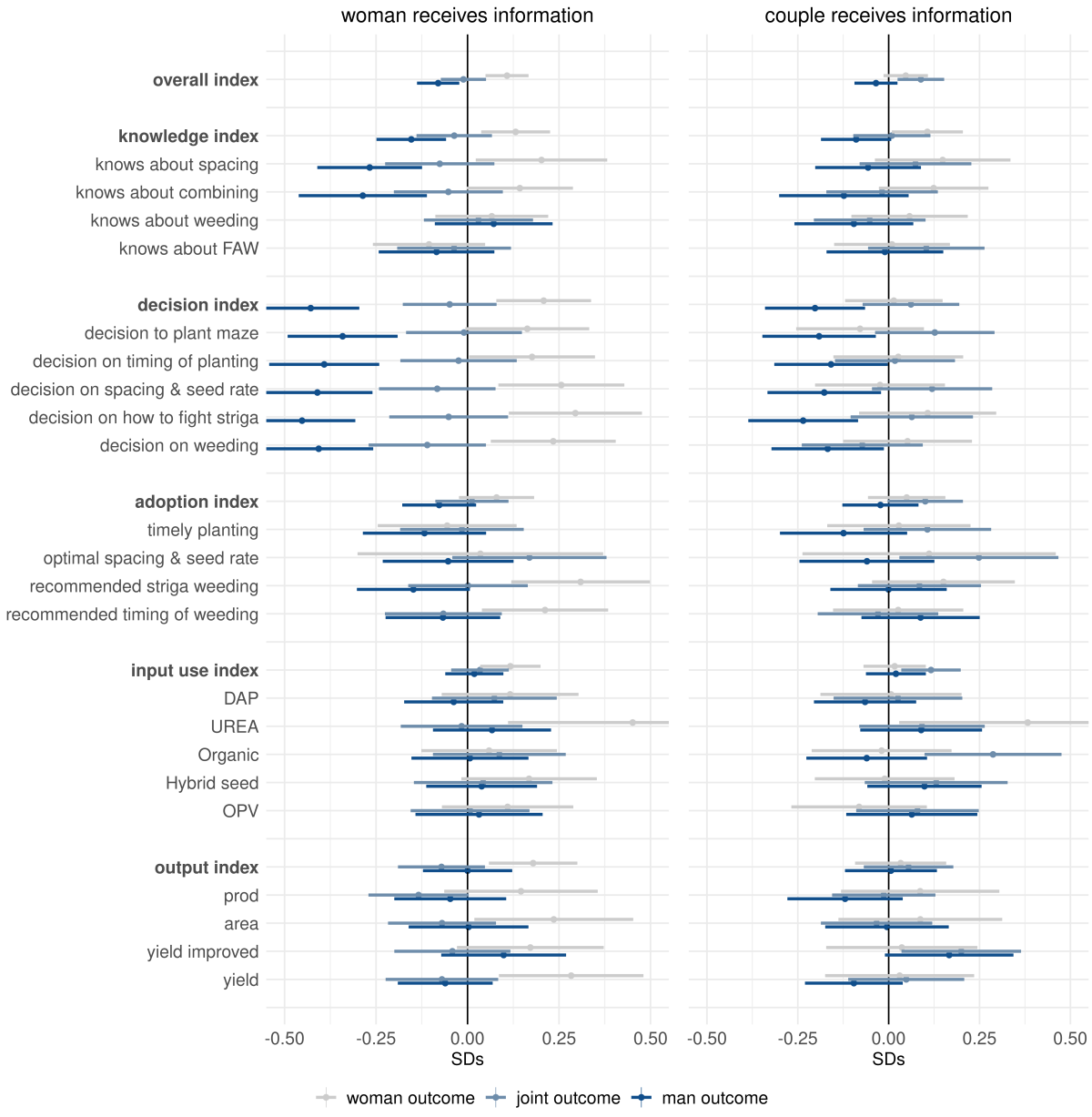

Figure 3: Impact of targeting information

video. Joint knowledge was not affected by targeting female co-heads instead of male co-heads as the recipients of information, suggesting female co-heads do not necessarily share the information with their spouse. See Appendix Table A1 for detailed results.

Women also gained individual decision-making power when information is exclusively targeted to them. The left panel in Figure 3 shows a positive impact on women's decision-making index and all its components. The largest effect is found for the decision about how to combat striga: in households where only male co-heads were shown the video, women decided on strategies to combat striga on only 11 percent of maize plots within the household. This increased to 20 percent of maize plots where female co-heads were shown the video alone. We registered even larger reductions in men's unilateral decision-making as a result of targeting female co-heads alone instead of male co-heads. Continuing with the example of decisions related to combating striga, we see that in the comparison group, men decided on 30 percent of the maize plots within the households. This reduced by almost 20 percentage points in the subgroup of households where female co-heads were shown the video, while joint decision-making remained unchanged. See Appendix Table A2 for more details.

The change in intra-household decision-making as a result of targeting information to female co-heads alone does not seem to fully translate into actual adoption of the practices that were recommended in the video, as is evident from the statistically insignificant effect on the women's adoption index. However, empowering women with information seems to have increased the likelihood that they adopted improved inputs unilaterally. In particular, we find a of significant increase in the use of urea and hybrid seed, albeit from a very low base. The only cases where the shift in decision-making about recommended practices also translated into action is for the female-decided adoption of the recommended

strategy to combat striga and to start weeding about 18 to 20 days after planting. The fact that both of these practices are related to weeding may indicate that it is easier for women to adopt practices that are culturally more in line with prevailing norms and customs in agriculture. At the same time, the fact that women also increased their use of urea and hybrid seed seems to suggest that access to financial resources for buying inputs is not necessarily a constraining factor. Additional details are provided in Appendix Tables A3 and A4.

Turning to production outcomes, we again find a large impact of exclusively empowering women with information on women's production index. We find that, in the comparison group where male co-heads were targeted with information, women produced on average only 59 kg of maize on an average acre under their management. When female co-heads are targeted with information, yields more than double. The effect on production-related outcomes is evident both at the extensive and intensive margins, with women producing higher quantities of maize on larger plots (although total production quantity is too noisy for a precise coefficient estimate). Interestingly, exclusively targeting female co-heads with information does not seem to affect yields on male-managed or jointly managed plots. A possible explanation for the absence lack of yield effects on jointly managed plots may be the fact that yields on these plots actually benefit from information provision, both in the treatment group where female co-heads gained knowledge and in the comparison group. These knowledge gains may have induced (approximately) equal yield increases, explaining the lack of treatment effects. Another explanation may relate to the fact that female co-heads do not necessarily share information with their spouse, which is evident from an absence of effects on joint knowledge when targeting female co-heads alone with information. Women possibly prefer to keep their information advantage and apply their gained knowledge to maize plots under their

management, of which they have more certain access to the product and/or income relative to jointly managed plots . See Appendix Table A5 for details.

When information is directed towards the couple (female and male co-heads together instead of only to the male co-head), we expect the largest effects on joint outcomes. Judging by the overall index in the right panel of Figure 3, this seems to be the case. The significant increase in joint outcomes is now primarily driven by an increase in the jointly decided adoption of recommended practices and use of improved inputs. In particular, details on jointly decided adoption of recommended practices show that targeting the couple led to a 2.7 percentage point increase in the share of households maize plots where recommended seed spacing and seeding rates were applied (as a result of joint decision-making). We also find a significant positive impact of targeting information to the couple instead of only to the male co-head on jointly decided use of organic fertilizer. While use of organic fertilizer was already higher when male and female co-heads jointly decided on its use rather than unilaterally, pointing out the importance of organic fertilizer to male and female co-heads together more than doubled the joint use of organic fertilizer. 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. Details can again be found in Appendix Table A3

Somewhat surprisingly, the positive impact on jointly decided adoption and input use occurs despite the fact that the treatment did not increase joint knowledge, nor joint decision-making. Furthermore, the increase in jointly decided use of organic fertilizer and adoption of optimal plant spacing and seeding rate did not translate in higher production on jointly managed plots. We also see that

targeting couples with information reduced the likelihood that male co-heads take decisions unilaterally. However, effect sizes are generally only half of what they are if the female co-head was targeted individually rather than the couple. Equality of coefficients is rejected for all decisions.

Taken together, the above results suggest that, to some extent, both female and male co-heads monopolize agricultural extension information. Involving female co-heads in receiving extension information (either alone or as part of the couple)[8] increases women's individual knowledge. This finding suggests that male co-heads do not necessarily pass information to their spouse. The fact that men's knowledge is reduced when the information if targeted exclusively to female co-heads suggests that female co-heads also do not necessarily share information with their spouse.

The fact that we cannot reject the hypothesis that women's knowledge gains are similar regardless of whether the female co-head saw the video alone or together with her male co-head suggests that the presence of the male co-head in the treatment does not influence her knowledge.[9] This also suggests 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 sharing/transfer point of view, if the aim is to increase women's knowledge, it seems most effective to exclusively target the female co-head.

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 would have only occurred in the former case, men's reduced decision-making could have been

[8] Appendix Table A1 shows we can not reject the null that coefficients for targeting female co-heads and targeting couples are the same.

[9] Interestingly, unlike for the female co-head, the presence of the spouse in the exposure process does influence the knowledge of the male co-head, who appears to learn somewhat less when information is provided to the couple than when this information is targeted to him alone, although the reduction is only significant at the 10 percent level and only for the knowledge index (see Appendix Table A1)

related to a lack of information. The fact that the reduction occurs in both cases suggests that men's unilateral decision-making does not only decrease due to a lack of direct access to information. The fact that women can also access information may lead men to refrain from unilateral decision-making. This may mean that men became more accepting of women taking up a role in the decision-making process.

Women seem to gain in maize production outcomes if they receive extension information alone. However, these effects are not present if the information is given to the couple. This suggests that a woman's monopoly over information is essential for her individual achievements in terms of maize production. 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 jointly decided adoption) but not joint achievements (in terms of maize production) implies that despite women's greater (joint) agency, these joint achievements 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 providing extension information exclusively also leads to greater time and work burdens. We consider this in the context of women applying the recommended practices and inputs and managing larger areas of maize cultivation as a result of our treatment. 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 with information (instead of only the male co-head). Women appear to increase the adoption of labor-intensive improved agronomic practices such as weeding and combatting striga. This suggests the need for further research on the time, labor and drudgery implications of these outcomes and the need to reflect upon making less labor-intensive agronomic practices accessible to women.

5.2 Role model effects

Figure 4 summarizes the effect of showing the video in which the information is conveyed by a female actor (left panel) or by the male and female actors acting as a couple (right panel). The comparison group here is the video in which all information is conveyed by a male actor alone. The left panel now shows (standardized) coefficient estimates corresponding to γ^W in equation 1; in the right panel, coefficient estimates for γ^J are shown. See Appendix Tables A6 to A10 for additional details.

As noted earlier, the combination of role model, peer, and gender homophily effects were hypothesized to lead to women gaining more knowledge when they were provided information by women actors in the video. We also hypothesized that these female role models would increase women's aspirations, leading to increased agency in the sphere of decision-making and action in the sphere of adoption, with commensurate results for women's production-related outcomes. The left panel of Figure 4 shows no overall impact of the treatment where a female actor is the messenger relative to the comparison group. Nor do we see effects on any of the outcome family indices. Some individual effects, such as increased male knowledge about seed spacing and subjective positive yield assessments on jointly managed plots, appear significant, but there is no clear pattern in our estimation to suggest a systematic result.

We had also hypothesized that showing female and male actors as a couple would encourage more cooperation within the household. However, the right panel of Figure 4 shows that outcomes are also not significantly different in the subgroup of households where a couple conveyed the information relative to the comparison group. There are, however, negative effects on men's unilateral decision-making, which may make way for more involvement of women in decision-making and action.

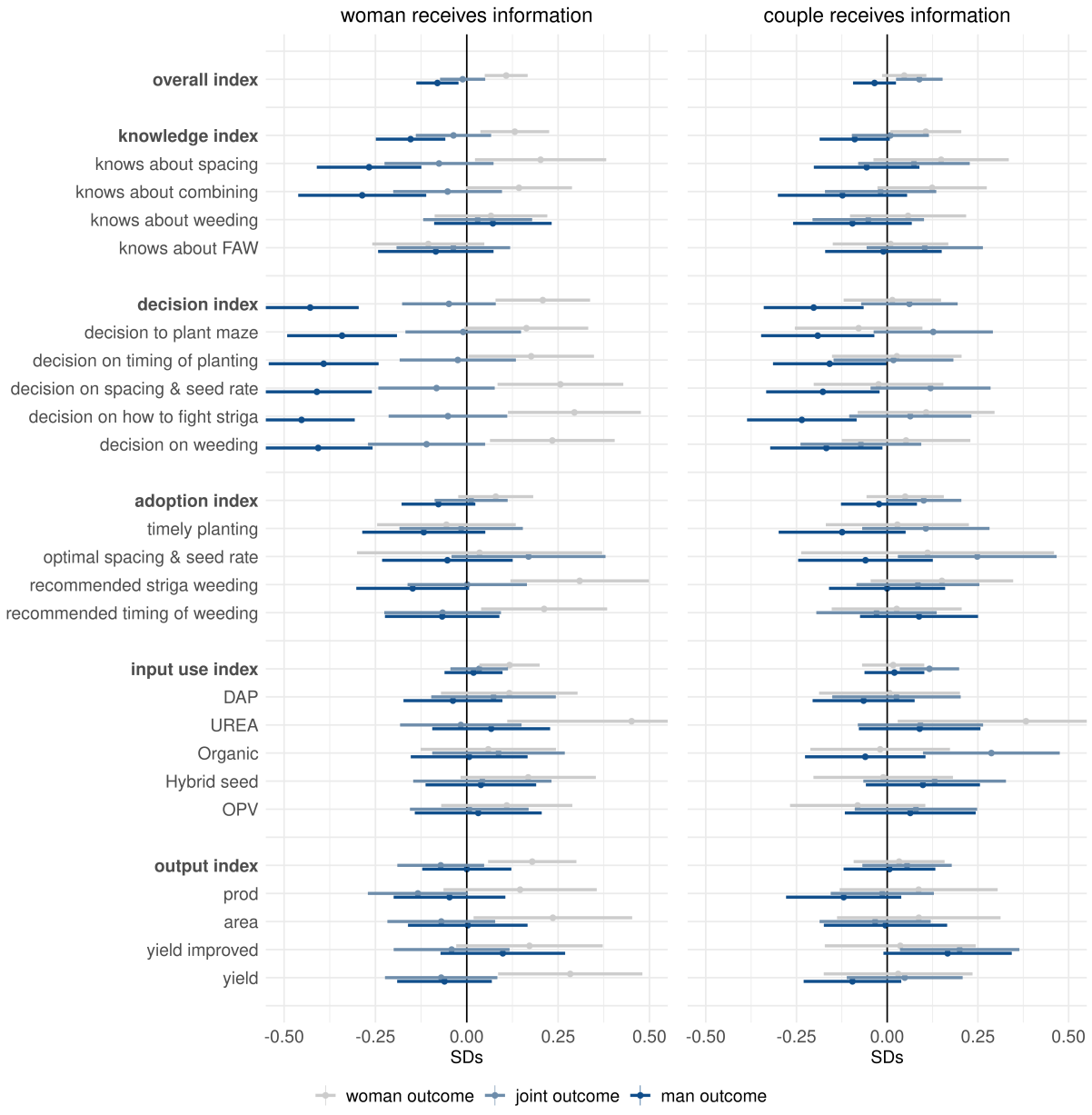

Figure 4: Impact of targeting information

5.3 Interaction effects

Until now, we have only considered the main effects of our experiment, examining each treatment while controlling for the orthogonal treatment. However, for some outcomes and hypotheses, interaction effects may be more relevant. Therefore, in this section, we report some of the more striking interaction effects ($\delta^{T_R T_M}$ in Equation 1). While we only report results for outcome indices for brevity, additional results are available upon request.

For the overall index, none of the interaction effects are significant, nor are they significant for the knowledge indices. This may indicate that for learning, there are no gender homophily effects, implying that women learn equally well from men and women.

With respect to decision-making within the household, we have seen above that men take fewer unilateral decisions in households when the messenger is a couple. We also find a significant and positive interaction effect between the recipient being a women and the messenger being a couple, offsetting the negative couple-messenger effect. The interaction effect between the recipient being a couple and the messenger being a couple is not significantly different from zero. This pattern—where a couple role model reduces male unilateral decision-making only if the male co-head was exposed to the role model—is consistent with the indirect effect of involving women as role models that challenge men's beliefs and stereotypes about their female co-heads' role in agriculture.

Finally, while we find no overall effects of female role models on female-decided adoption of recommended practices, we do find a significant interaction effect of the messenger being a woman and the recipient being a woman on female-decided adoption of recommended practices. Specifically, the interaction effect is positive and significant, albeit at the 10 percent level. This suggests that female role models, peer and/or gender homophily effects may play a role

in encouraging the adoption of recommended practices decided upon by women. However, we do not find similarly significant interaction effects for input use, nor for production-related outcomes.

6 Conclusions

In smallholder agriculture in developing-country contexts, women often perform an extensive amount of the work, yet have little say in which crops to plant or what technologies, inputs, or practices to use. In this paper, we test how gender-related attributes of ICT-mediated video based agricultural extension information campaigns affect individual household member's informational capital, their agency, and their achievements in farming. 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, we assess the importance of the gender of the person within the household who is targeted with information for outcomes related to women's, joint, and men's knowledge, decision-making, adoption of recommended agronomic practices and inputs, and production-related outcomes. In a cross treatment, we test if the gender of the person who provides this information makes a difference for the same outcomes.

The results of this study clearly show that in our study context, significant advances in women's empowerment in agriculture in terms of knowledge, decision-making, input use and achievements can be made by giving women direct and exclusive access to ICT-mediated agricultural extension information videos. Providing information to the couple leads to increases in the jointly decided use of improved inputs and recommended practices. Furthermore, results 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.

Our study also reveals that–consistent with non-unitary models of the household–information is not fully shared between household members. Households that are targeted with information within the household seem to be able to use this information to improve outcomes, especially if the benefits accrue directly to the targeted individual. This is something that needs to be recognized by generic agricultural extension systems that, often for reasons of convenience, mainly inform the male co-head within the household. If the aim is to empower women in agriculture within the household, women should be targeted alone to provide them with an informational advantage vis-à-vis their spouse that they can exploit.

We further find some evidence that including women as role models affects outcomes in agriculture, both directly by increasing aspirations of women and indirectly by challenging the idea that maize growing is a male activity. This suggests that governments should hire more female extension staff. But changing prevailing gender norms is likely beyond what government can do. Other stakeholders in the sector will need to play their part as well. For instance, journalists reporting on agricultural related issues could feature more stories where women take center stage. Agro-input dealers that sell improved maize seed varieties should actively reach out to female farmers.

The assessment of the interaction effects of the treatments allows for an understanding of simultaneously addressing constraints to women's empowerment related to information asymmetry and normative gender roles. We acknowledge that reducing these constraints may have had greater impact on women's empowerment in agriculture if, at the same time, women's insecure land ownership and use rights, access to complementary resources including credit, group membership, skill training, and norms related to time use, among others, would have

been addressed. Evaluating such complex interventions, however, would need an appropriate research design, for instance, a factorial design with additional factors, which was not within the scope of this study. Besides, testing hypotheses about the effect of more secure land ownership and user rights for women, for instance, is not easily done in an experimental framework unless there are opportunities arising from newly implemented policy or certification (eg. Ali et al., 2014, 2016). In our study, the multiple other constraints are treated as a given and because of our randomization strategy we can be confident there is no omitted variable bias. In principle, it would be possible to investigate treatment heterogeneity, for instance to examine if the information or role model treatment work better among spouses that have ownership of the maize plot. However, the study would have needed to be designed for such analyses and sample sizes sufficiently large for adequate statistical power, which was out of the scope of this project.

In terms of transferability, our study's findings could apply to other crops grown in the study region which similarly are both food and cash crops and not exclusively male- or female-managed, such as, for instance, millet and cassava. One could expect similar effects in other regions of Uganda and East Africa, where smallholder semi-subsistence household farming, in majority by monogamous dual households, is the dominant agricultural system, and women's access to information, role models, resources and their intrahousehold decision-making power tend to be constrained. Firm conclusions about transferability to other crops and other contexts, be it with other agricultural systems or with other gender norms and roles in agriculture, however, would require an assessment of the extent of difference in the effects of the same interventions.

Three policy recommendations follow from the results of this study. Although they are specific to our study context and country, these recommenda-

tions may nonetheless lend support to efforts to reform extension policy and practice in other contexts and countries (Davis et al., 2020). First, if the aim of extension services is to empower women by increasing their own agricultural knowledge, decision-making autonomy, and adoption of recommended practices to ultimately to boost yields and output, then there is considerable value in providing information directly to women. This argues less for gender-sensitive extension reforms and more for intensive gender-transformative approaches (Farnworth and Colverson, 2015). Examples of tested gender-transformative approaches include household methodologies influencing intrahousehold gender relations and decision-making, often using a couple coaching approach (Lecoutere and Wuyts, 2021), involving both women and men in nutrition, agricultural, farmer field school programs (Choudhury and Castellanos, 2020; Cole et al., 2020; Kerr et al., 2016; Quisumbing et al., 2021)and participatory action learning methods with communities and/or households that question and try to shift discriminatory gender relations and norms, such as, for instance, the Gender Action Learning System, Nurturing Connections, Journeys of Transformation or Community Conversations (FAO et al., 2021) . Second, it may be possible to further capitalize on role model effects with more extensive experimentation in design. There are no silver bullets for extension policy and practice, however. Both gender-sensitive and gender-transformative extension systems will require both experimentation along the lines of what is demonstrated in this study, and a willingness to experiment by extension providers so that more light can be shed on the question of what works most effectively, for whom, and in what context. Third, our study tests effects of addressing only two out of multiple compounding constraints to women's empowerment in agriculture. Apart from information and role models, other constraints relating to women's more limited access to land, assets, financial services, and gender-responsive agricultural

technology, as well as gender norms and roles defining women's time use, mobility, and decision-making power will need to be tackled simultaneously to unlock women's full potential and reduce gender gaps in agriculture.

References

Acosta, M., S. van Bommel, M. van Wessel, E. L. Ampaire, L. Jassogne, and P. H. Feindt (2019). Discursive translations of gender mainstreaming norms: The case of agricultural and climate change policies in uganda. *Women's Studies International Forum 74*, 9–19.

Acosta, M., M. van Wessel, S. van Bommel, E. L. Ampaire, J. Twyman, L. Jassogne, and P. H. Feindt (2020). What does it mean to make a 'joint' decision? unpacking intra-household decision making in agriculture: Implications for policy and practice. *The Journal of Development Studies 56*(6), 1210–1229.

Alderman, H., P.-A. Chiappori, L. Haddad, J. Hoddinott, and R. Kanbur (1995). Unitary versus collective models of the household: Is it time to shift the burden of proof? *The World Bank Research Observer 10*(1), 1–19.

Ali, D., D. Bowen, K. Deininger, and M. Duponchel (2016). Investigating the gender gap in agricultural productivity: Evidence from uganda. *World Development 87*, 152–170.

Ali, D. A., M. Collin, K. Deininger, S. Dercon, J. Sandefur, and A. Zeitlin (2016). Small price incentives increase women's access to land titles in tanzania. *Journal of Development Economics 123*, 107–122.

Ali, D. A., K. Deininger, and M. Goldstein (2014). Environmental and gender impacts of land tenure regularization in africa: Pilot evidence from rwanda. *Journal of Development Economics 110*, 262–275. Land and Property Rights.

Alkire, S., R. Meinzen-Dick, A. Peterman, A. Quisumbing, G. Seymour, and A. Vaz (2013). The women's empowerment in agriculture index. *World Development 52*, 71–91.

Ambler, K., C. Doss, C. Kieran, and S. Passarelli (2021). He says, she says: Spousal disagreement in survey measures of bargaining power. *Economic Development and Cultural Change 69*(2), 765–788.

Anderson, M. L. (2008). Multiple inference and gender differences in the effects of early intervention: A reevaluation of the abecedarian, perry preschool, and early training projects. *Journal of the American Statistical Association 103*(484), 1481–1495.

Andersson Djurfeldt, A. (2020). Gendered land rights, legal reform and social norms in the context of land fragmentation - a review of the literature for kenya, rwanda and uganda. *Land Use Policy 90*, 104305.

Ashraf, N. (2009, September). Spousal control and intra-household decision making: An experimental study in the philippines. *American Economic Review 99*(4), 1245–77.

Bargain, O., D. Boutin, and H. Champeaux (2019). Women's political participation and intrahousehold empowerment: Evidence from the egyptian arab spring. *Journal of Development Economics 141*, 102379.

Beaman, L., R. Chattopadhyay, E. Duflo, R. Pande, and P. Topalova (2009, 11). Powerful women: Does exposure reduce bias?*. *The Quarterly Journal of Economics 124*(4), 1497–1540.

Beaman, L. and A. Dillon (2018). Diffusion of agricultural information within social networks: Evidence on gender inequalities from mali. *Journal of Development Economics 133*, 147–161.

Beaman, L., E. Duflo, R. Pande, and P. Topalova (2012). Female leadership raises aspirations and educational attainment for girls: A policy experiment in india. *Science 335*(6068), 582–586.

Benin, S., E. Nkonya, G. Okecho, J. Randriamamonjy, E. Kato, G. Lubade, and M. Kyotalimye (2011). Returns to spending on agricultural extension: the case of the national agricultural advisory services (naads) program of uganda†. *Agricultural Economics 42*(2), 249–267.

BenYishay, A. and A. M. Mobarak (2019). Social learning and incentives for experimentation and communication. *The Review of Economic Studies 86*(3), 976–1009.

Bernard, T., S. Dercon, K. Orkin, and A. Seyoum Taffesse (2015, 07). Will video kill the radio star? assessing the potential of targeted exposure to role models through video. *The World Bank Economic Review 29*(suppl_1), S226–S237.

Choudhury, A. and P. Castellanos (2020). Empowering women through farmer field schools. In *Routledge Handbook of Gender and Agriculture*, pp. 251–262. Routledge.

Cole, S. M., A. M. Kaminski, C. McDougall, A. S. Kefi, P. A. Marinda, M. Maliko, and J. Mtonga (2020). Gender accommodative versus transformative approaches: a comparative assessment within a post-harvest fish loss reduction intervention. *Gender, Technology and Development 24*(1), 48–65.

Croppenstedt, A., M. Goldstein, and N. Rosas (2013). Gender and agriculture: Inefficiencies, segregation, and low productivity traps. *The World Bank Research Observer 28*(1), 79–109.

Davis, K. E., S. C. Babu, and C. Ragasa (2020). *Agricultural extension: Global status and performance in selected countries*. Intl Food Policy Res Inst.

de Brauw, A., D. O. Gilligan, J. Hoddinott, and S. Roy (2014). The impact of bolsa família on women's decision-making power. *World Development 59*, 487–504.

Doss, C. R. (2001). Designing agricultural technology for african women farmers: Lessons from 25 years of experience. *World Development 29*(12), 2075–2092.

Doss, C. R. and M. L. Morris (2000). How does gender affect the adoption of agricultural innovations? *Agricultural Economics 25*(1), 27–39.

Duflo, E. and C. Udry (2004). Intrahousehold resource allocation in cote d'ivoire: Social norms, separate accounts and consumption choices. Technical report, National Bureau of Economic Research.

Eagly, A. H. and S. J. Karau (2002). Role congruity theory of prejudice toward female leaders. *Psychological review 109*(3), 573.

Evans, A. (2014). Co-education and the erosion of gender stereotypes in the zambian copperbelt. *Gender & Development 22*(1), 75–90.

FAO, IFAD, and WFP (2021). Gender transformative approaches for food security, improved nutrition and sustainable agriculture – a compendium of fifteen good practices. Technical report, Rome.

Farnworth, C. R. and K. E. Colverson (2015). Building a gender-transformative extension and advisory facilitation system in sub-saharan africa. *Journal of Gender, Agriculture and Food Security (Agri-Gender) 1*(302-2016-4749), 20–39.

Fermont, A. and T. Benson (2011). Estimating yield of food crops grown by smallholder farmers. *International Food Policy Research Institute, Washington DC 1*, 68.

Fiala, N. and X. He (2016, 04). Unitary or noncooperative intrahousehold model? evidence from couples in uganda. *The World Bank Economic Review 30*(Supplement_1), S77–S85.

Fisher, M. and E. R. Carr (2015). The influence of gendered roles and responsibilities on the adoption of technologies that mitigate drought risk: The case of drought-tolerant maize seed in eastern uganda. *Global Environmental Change 35*, 82–92.

Fletschner, D. and D. Mesbah (2011). Gender disparity in access to information: Do spouses share what they know? *World Development 39*(8), 1422–1433.

Ghani, E., W. R. Kerr, and S. D. O'Connell (2014). Political reservations and women's entrepreneurship in india. *Journal of Development Economics 108*, 138–153.

Gilligan, D. O., N. Kumar, S. McNiven, J. Meenakshi, and A. Quisumbing (2020). Bargaining power, decision making, and biofortification: The role of gender in adoption of orange sweet potato in uganda. *Food Policy 95*, 101909.

Gourlay, S., T. Kilic, and D. B. Lobell (2019). A new spin on an old debate: Errors in farmer-reported production and their implications for inverse scale - productivity relationship in uganda. *Journal of Development Economics 141*, 102376.

Iversen, V., C. Jackson, B. Kebede, A. Munro, and A. Verschoor (2011). Do spouses realise cooperative gains? experimental evidence from rural uganda. *World Development 39*(4), 569–578.

Kabeer, N. (1999). Resources, agency, achievements: Reflections on the measurement of women's empowerment. *Development and Change 30*(3), 435–464.

Kabunga, N., T. Mogues, E. Bizimungu, A. Erman, and B. Van Campenhout (2016). *The State of Public Service Delivery in Uganda: Report of a baseline survey*. Intl Food Policy Res Inst.

Kabunga, N. S., T. Dubois, and M. Qaim (2014). Impact of tissue culture banana technology on farm household income and food security in kenya. *Food Policy 45*, 25–34.

Kandpal, E. and K. Baylis (2019). The social lives of married women: Peer effects in female autonomy and investments in children. *Journal of Development Economics 140*, 26–43.

Kerr, R. B., E. Chilanga, H. Nyantakyi-Frimpong, I. Luginaah, and E. Lupafya (2016). Integrated agriculture programs to address malnutrition in northern malawi. *BMC Public Health 16*(1), 1–14.

Kjær, A. M. and J. Joughin (2019). Send for the cavalry: Political incentives in the provision of agricultural advisory services. *Development Policy Review 37*(3), 367–383.

Kondylis, F., V. Mueller, G. Sheriff, and S. Zhu (2016). Do female instructors reduce gender bias in diffusion of sustainable land management techniques? experimental evidence from mozambique. *World Development 78*, 436–449.

Lambrecht, I., B. Vanlauwe, and M. Maertens (2016, 11). Agricultural extension in eastern democratic republic of congo: does gender matter? *European Review of Agricultural Economics 43*(5), 841–874.

Lecoutere, E. and L. Jassogne (2019). Fairness and efficiency in smallholder farming: The relation with intrahousehold decision-making. *The Journal of Development Studies 55*(1), 57–82.

Lecoutere, E. and E. Wuyts (2021). Confronting the wall of patriarchy: Does participatory intrahousehold decision making empower women in agricultural households? *The Journal of Development Studies 57*(6), 882–905.

Lodin, J. B., S. Paulson, and M. S. Mugenyi (2012). New seeds, gender norms and labor dynamics in hoima district, uganda. *Journal of Eastern African Studies 6*(3), 405–422.

Lundberg, S. and R. A. Pollak (1994). Noncooperative bargaining models of marriage. *The American Economic Review 84*(2), 132–137.

Macours, K. and R. Vakis (2014). Changing households' investment behaviour through social interactions with local leaders: Evidence from a randomised transfer programme. *The Economic Journal 124*(576), 607–633.

Magruder, J. R. (2018). An assessment of experimental evidence on agricultural technology adoption in developing countries. *Annual Review of Resource Economics 10*(1), 299–316.

McPherson, M., L. Smith-Lovin, and J. M. Cook (2001). Birds of a feather: Homophily in social networks. *Annual Review of Sociology 27*(1), 415–444.

Pan, Y., S. C. Smith, and M. Sulaiman (2018, 04). Agricultural extension and technology adoption for food security: Evidence from uganda. *American Journal of Agricultural Economics 100*(4), 1012–1031.

Peterman, A., B. Schwab, S. Roy, M. Hidrobo, and D. O. Gilligan (2021). Measuring women's decisionmaking: Indicator choice and survey design experiments from cash and food transfer evaluations in ecuador, uganda and yemen. *World Development 141*, 105387.

Pollak, R. A. (1994). For better or worse: The roles of power in models of

distribution within marriage. *The American Economic Review 84*(2), 148–152.

Porter, C. and D. Serra (2019). Gender differences in the choice of major: The importance of female role models. *American Economic Journal: Applied Economics*.

Quisumbing, A., A. Ahmed, J. Hoddinott, A. Pereira, and S. Roy (2021). Designing for empowerment impact in agricultural development projects: Experimental evidence from the agriculture, nutrition, and gender linkages (angel) project in bangladesh. *World Development 146*, 105622.

Riley, E. (2022, 01). Role Models in Movies: The Impact of Queen of Katwe on Students' Educational Attainment. *The Review of Economics and Statistics*, 1–48.

Turyahikayo, W. and E. Kamagara (2016). Trust, perception and effectiveness of extension services in uganda: A case of national agricultural advisory services (naads). *Journal of Agricultural Extension and Rural Development 8*(11), 224–231.

Udry, C. (1996). Gender, agricultural production, and the theory of the household. *Journal of Political Economy 104*(5), 1010–1046.

Wodon, Q. and C. M. Blackden (2006). *Gender, time use, and poverty in sub-Saharan Africa*. The World Bank.

Zeltzer, D. (2020, April). Gender homophily in referral networks: Consequences for the medicare physician earnings gap. *American Economic Journal: Applied Economics 12*(2), 169–97.