The Role of Gender in ICT-mediated Agricultural Information Campaigns

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Abstract:

In agricultural information dissemination campaigns through agricultural advisory services, seemingly small design attributes, such as the way the information is delivered, who delivers the information, or who is targeted by the message, can result in significant differences in effectiveness and inclusiveness of the intervention. In the context of Information & Communication Technology (ICT) mediated knowledge transfer, this study investigates the importance of the gender composition of the person(s) who provide(s) the information and the gender composition of the person(s) who receive(s) the information. In particular, we set up a field experiment among smallholder maize farmers in Uganda to assess if reducing asymmetric information within the household leads to improved outcomes. In addition, we study the effectiveness of promoting a more cooperative approach to household farming. Finally, we test for gender homophily effects, where female farmers learn more from female trainers. Effectiveness is assessed in terms of knowledge gained, adoption of modern inputs and recommend practices, yield, and poverty reduction. Outcomes are dis-aggregated by gender to study changes in intra-household equity and women empowerment. While endline of the study is planned for February 2018, we preview encouraging effects on knowledge transfer as measured immediately after administering the treatments.

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JEL Codes: O12, O33

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Introduction

Often, the poor appear to make sub-optimal decision because they lack critical pieces of information, fail to notice (Hanna, Mullainathan, and Schwartzstein, 2014), or hold beliefs that are not true (Jensen, 2010; Dupas, 2011). Therefore, in many instances, simple information campaigns designed to address these information inefficiencies can make a big difference (Banerjee, Banerjee, and Duflo, 2011). Also in the context of smallholder agriculture, it has been argued that a lack of information about the existence, use, and profitability of modern inputs and recommended practices is a major constraint to sustainable crop intensification (Jack, 2013). This, together with new possibilities offered through innovations in Information and Communication Technologies (ICT) has led to several initiatives aimed at revitalizing agricultural advisory services in developing countries. However, it has also been found that not all information campaigns are equally effective and that seemingly small design attributes such as the way the information is delivered, who delivers the information and who was targeted can make a big difference.

This paper investigates gender related attributes that are thought to be key in effective and inclusive agricultural extension information delivery. In particular, we zoom in the the role of (i) the gender composition of the receiver(s) of the agricultural extension information messages and (ii) the gender composition of the messenger(s) of the information message. Together, particular combinations of these two attributes enable us to test three hypotheses. The first hypothesis is related to information asymmetries within the households, and we ask if it is more effective if both spouses within dual households receive the same information then if only one of them is given the information. The second hypothesis asserts that promoting a household cooperative approach to farming leads to better outcomes than when farming is framed as an idiosyncratic activity. Finally, a third hypothesis tests the existence of gender homophily in agricultural advisory services and investigates if information is more effective if comes from someone that is of the same gender than if it is provided by someone of the opposite sex.

The research hypotheses are tested using a field experiment, where farmers are randomly assigned to a group that receives a particular intervention, and their outcomes are compared to the outcomes of a group of farmers that did not receive this particular intervention (de Janvry, Sadoulet, and Suri, 2017). As we want to test more than one research hypothesis and are particularly interested in comparing the relative effectiveness of various attributes of an ICT-mediated extension approach (instead of simply finding out what works and compare treatment to control groups), we opt for a factorial design. Generally, in such a design, a smaller sample size is needed to answer a fixed number of research questions as opposed to parallel designs.

We work with maize farmers in eastern Uganda. The information interventions take the form of short videos that explain simple yet effective ways to increase maize productivity, such as best practices in row spacing and soil fertility management. To test hypotheses that depend on the gender composition of the person or persons targeted by the information, we show the video to either the man only, the woman only, or man and women together as a couple within dual households. To test hypotheses that depend on the gender composition the person or persons providing the information, we produced different versions of the video. In one version of the video, the information is provided by a male farmer. In a second version of the video, the same information is provided by a woman farmer. Finally, in a third version of the video, the information is given by a couple. Power calculations suggested we needed a sample of about 3,600 farmers, which was drawn from five districts. The videos were shown twice to farmers, once before the beginning of the main season, in July 2017, and once in the beginning of the season, in August 2017.

The current version of this paper shows some initial results from this ongoing study. For instance, we have already established that the intervention is effective in transferring information: farmers that are shown a video are significantly more likely to select the correct answer from a set of alternative answers to a question. We also find that the information is more effective if the couple is targeted. An endline survey is planed in January 2018. As such, we will be able to assess outcomes further down the causal chain, such as whether the interventions also affect adoption of modern technologies and recommended practice, which in turn are expected to increase yields and well-being.

Research Questions and Hypotheses

Agricultural extension information services are generally biased toward men. Most often, extension officers are male who target the main decision maker with respect to agriculture within households, which is also often assumed to be the male farmer. The assumption that extension messages targeting one household member will trickle down to the rest of the household, including women and younger household members, may be false. Men do not necessarily discuss production decisions or transfer extension knowledge to women household members, especially if extension messages focus on men's priorities and crops (Fletschner and Mesbah, 2011). Gender homophily effects, where men learn more from other men and women learn more from other women, have also been reported in the context of agricultural extension services (Doss and Morris, 2001). At the same time, farms are essentially run and managed at the household level, and it may therefore be more effective if information is both provided and targeted at this level. The analysis of a Digital Green project in Ethiopia also concluded that there is much to be learned from observing the interactions between men and women who learn about the same technologies and practices (Bernard et al., 2016).

In this paper, we investigate the relative importance of (i) the gender composition of the messenger(s), and (ii) the gender composition of the audience for effective and inclusive agricultural extension information delivery to encourage sustainable crop intensification in smallholder household farms and for improving gender equity in household farming. By comparing groups of farmers where the messenger - recipient combinations differ, we can test a range of interesting hypotheses. In particular, our research is designed to answer three research questions.

In a first hypothesis, we will test if information is more effective if it is targeted to the couple within the household, instead of to an individual. It is related to the existence of asymmetric information within the household, which may lead to a sub-optimal intra-household allocation of productive resources and intensification investments. For instance, Kabunga, Dubois, and Qaim (2012) find that female farmers are less likely to adopt tissue banana culture technology in Kenya, but that they would have an equal chance to adopt innovations, provided that they acquire sufficient knowledge about the innovation. Lambrecht, Vanlauwe, and Maertens (2016) investigate the effect of participating in extension training as a couple. They investigate whether participation of female farmers in an agricultural extension programme in South-Kivu increases adoption of three technologies: improved legume varieties, row planting and mineral fertilizer. In their study, joint male and female programme participation leads to the highest adoption rates. Knowledge may also affect technology adoption and subsequent yields through changes in relative bargaining power of the actors. Doss and Morris (2001) find that adoption of agricultural technologies among female farmers is lower than among male farmers. They find that this is due to gender-linked differences in access to complementary inputs.

A second hypothesis we will test is whether bringing the messages as a couple leads to better outcomes than when the information is given by an individual. This hypothesis is based on the assumption that social norms prevent women from playing a more prominent role in household agriculture. Gender stereotyping, where women are expected to tend to small gardens used to produce for home consumption and men are responsible for cash crops using inputs obtained from the market, may contribute to inefficient allocation of resources within the household as a single unit of production. Research on how information campaigns can be used to change beliefs, norms and perceptions has been ongoing in pubic health and has only recently started to trickle through to other disciplines. Encouraging results emerge with respect to the importance of role models (Porter and Serra, 2017; Riley, 2017).

In a third hypothesis, we will test if matching the gender of the recipient with the gender of the messenger leads to better outcomes. Homophily effects, documented in a variety of social interactions, presume people learn more from people they can relate to (McPherson, Smith-Lovin, and Cook, 2001). In Mozambique, Kondylis et al. (2016) find evidence of such a gender-matching or homophily effect in extension, whereby women seem to learn more from fellow women and men seem to learn more from fellow men. In particular, they find that among men who received information about pit planting from a male messenger, the proportion that are aware of pit planting is 10 percentage points higher. Female awareness, knowledge and adoption is the same irrespective of the presence of a male extension worker. However, if a female extension worker is added, awareness, knowledge and adoption among female farmers also increases by roughly the same proportions.

Experimental Design and Corresponding Sampling Frame

The three hypotheses, in addition to the overall effectiveness of the ICT mediated information intervention, will be tested with a field experiment. The experiment was implemented as 3 by 2 factorial design to which a control group was added. We define two different factors, each with three levels.

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		Messenger		
		Male	Female	couple
Recipient	Male	385	385	369
	Female	385	385	369
	Couple	342	342	369

Figure 1: Experimental Design

The first factor corresponds to the person(s) who provide the message and has three levels (male, female, and couple). Similarly, the second factor corresponds to the person who receives the information message. This factor also has three levels (male, female, and couple). A separate control group receives no information. The design, together with the sample size in each cell, is illustrated in Figure 1.

The design in Figure 1 allows us to test the three hypotheses outlined above, in addition to simply testing if the information intervention works. To test if the information campaign works, we simply compare the average outcome among farmers in the control group to the average outcome of farmers that received the information intervention, irrespective of who received the information and who provided the information. This is illustrated in Panel (A) of Figure 2. To test if information is more effective if it is targeted to the couple instead of the individual within the household (and hence test the asymmetric information hypotheses), we compare households where the couple received the information (irrespective of who provided the information) to households where the information was given to an individual (again irrespective of who provided the information). This is shown in Panel (B) of Figure 2. To test if projecting a household cooperative approach is more effective, we compare outcomes of farmers where the information was provided by a couple of farmers, irrespective of who within the household received the information, to outcomes of farmers where the information was provided by a single farmer, again irrespective of who received the information (Panel (C) in Figure 2). Finally, the gender homophily hypothesis can be tested

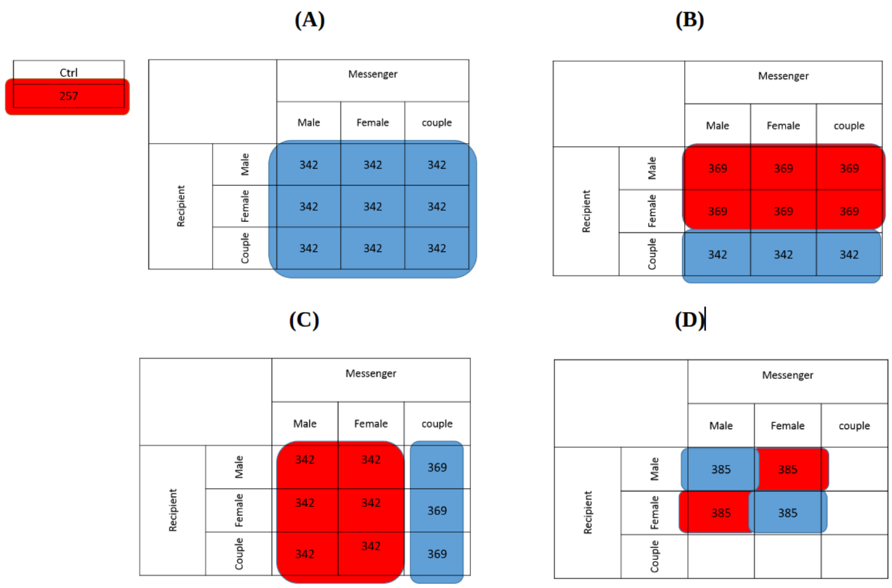

Figure 2: Hypothesis tests

by comparing outcomes of farmers where the information was provided by a woman to a woman in the household and information was provided by a man to a man, to outcome of farmers where the messenger was a man and the recipient was a woman and farmers where the messenger was a woman and the recipient was a man (Panel (D) in Figure 2).

The sample size and its distribution over different treatment combinations was based on an elaborate series of power calculations. Instead of determining power analytically, we used simulation techniques. Simulation allows one to sample from actual data on outcome variables instead of from a theoretical distribution with an assumed mean and standard deviation, which is a much more intuitive way to think about statistical power. It is straightforward to build in flexibility, such as allowing for more than one treatment arm, or account for sampling design effects such as cluster sampling. Power calculations were based on two outcome variables, one that reflects efficiency at the household level (maize yield) and one that reflects inclusiveness (the gender productivity gap, where women managed plots are farmed less extensively than male managed plots resulting in significantly lower yields), and sample size was determined for each of the three hypotheses above (plus the treatment versus control). As can be seen, the gender homophily hypothesis is the most stringent, as it is based on only 4 cells of the design in Figure 1. The power calculations and its underlying assumptions are described in great detail in the pre-analysis plan of this study, which is available from the The American Economic Association's registry for randomized controlled trials. The algorithm that was used to perform the power calculations can be found in the git repository.

Context

We ran the experiment among maize farmer in Uganda. Maize is widely consumed, yet its value to weight ratio is sufficiently high to also make it an important traded commodity. Therefore, increasing maize productivity at the farm household level has the potential to lead to improvements in both nutritional outcomes and income. Maize yields in Uganda are relatively low. While on-station trials report potential yields of about 1.6 metric tons per acre (improved varieties, no fertilizer used), according to Uganda National Household Survey 2005/06 data, average maize yields are much lower, at about 618 kg per acre for the main growing season of 2014. There is a lot of variation in yields, with the top 10 percent of best farmers getting yields in excess of 1.1 metric tons per acre. At the same time, the use of modern inputs such as inorganic fertilizer and modern technologies such as row planting is very low in Uganda. For example, use of inorganic fertilizer is on average only 2.4 kg of nutrient per acre per year, compared to Kenya (75 kg/ac); Rwanda (70 kg/ac); and Tanzania (15 kg/ac).

Maize is especially important in the East. We sampled from five districts eastern Uganda known for their maize production: Bugiri, Mayuge, Iganga, Namayingo and Namutumba. From this, we removed town councils and also two sub-counties that consisted of islands in lake Victoria. Our study population consists of maize farmers within this region[1]. Because of cost considerations, however, we used two-stage cluster sampling to obtain a representative sample of this population. In particular, we first randomly selected parishes (proportional 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 the households, from which we then sampled households to be included in the study. At the same time, we suspect that outcomes within

[1] In particular, given the subject of our study, we target monogamous dual households that are growing maize.

villages will be correlated, for instance due to local weather conditions, or development programs that are implemented in certain areas. We therefore used the village as a blocking factor. In other words, in each village, we made sure all possible treatment combinations related to the 2 factors (plus control) are administered. The experimental design described above shows that the messenger and the recipient factor combine into 9 different treatment combinations. Adding the control leads to 10 different households being selected in each village.

In the East, there are two maize cropping seasons. For our study, we concentrated on the second maize growing season, which runs from about August to January. In August, fields are prepared and planting is done in September. First weeding happens around the end of September or the beginning of October. By late October, a second round of weeding takes place as maize starts to flower. Mid to late December, harvesting starts. In higher areas, harvesting can go on until mid January. During the second season, farmers prefer early maturing varieties, as the rains are short. However, in general, early maturing varieties have lower yields. The full cycle from planting to harvesting in lowland areas takes about 3 to 3.5 months. In high altitude areas this can take up to 5 months. In our study, we concentrate on lowland areas.

Interventions

The information interventions are implemented as videos that were shown using 10 inch Android tablet computers. In accordance with the first factor in our factorial designs (to be able to vary the gender composition of the person(s) who provide the agricultural extension information) three videos were produced: one where the information was provided by a male farmer, one where the information was provided by a female farmers, and one where the information was provided by a couple (man+woman). Apart from varying this attribute of the treatment, the rest was exactly the same in the three videos. These videos were then shown to farmers according the second factor in the factorial design (related to who receives the information). In particular, in part of the sample, the video was shown to only the man within the household. In another part the video was shown to the woman within the household. In a final subgroup of the sample, it was shown to the couple together. The control group receives a placebo treatment. They got to see a music video with a traditional dance that has no information related to farming. Videos were shown twice to each farmer in the sample, once before planing (July 2017) and once immediately after planting (August 2017).

The treatments consist of the provision of information that is assumed to increase maize productivity through encouraging adoption of modern technologies and recommended practices. The goal was to select those practices and technologies that are likely to have the largest impact on yield, household income and intra-household equity. The topics to be included in the video script were obtained from interviews with key stakeholder and experts, such as maize farmers, value chain actors, maize seed breeders, extension workers and other government staff such as the district agricultural officer. These interviews took place in May 2017.

The main factors affecting maize productivity are related to pests, poor soils, and poor seed quality. The three most important **pests** that affect maize farming are Striga, maize stalk borer, and now also Fall Armyworm. We choose to focus on striga, as maize stalk borer seemed less problematic and at the time of the research, there was no consistent strategy to address Fall Armyworm. Striga (in particular the *Striga hermonihica* variety), also called whichweed, is a parasitic plant that feeds off the roots of maize. Doing so, it starts to draw nutrients from the host, leading to severe stunting of the host crop. As maize needs most nutrition at early stages of growth, weeding becomes less effective over time. In addition, each striga plant produces up to 50,000 seeds, which can remain dormant in the soil for a very long time. Striga can reduce production from about 30 percent up to total loss of the crop. No single method is effective to control striga. A new hybrid seed called Longe 7 HR, boosted with a herbicide, is said to be less affected by striga, but it is expensive at 10,000 Ugandan Shillings (UGX) per kg and does poorly under dry conditions and in areas where the rains are short such as in the East[2]. Crop rotation with sweet potato or beans can reduce striga infestation. Furthermore, (additional) inorganic fertilizer use has also been recommended to counter striga. It has been observed that striga proliferates when soils are poor. In addition, one can make up for the nutrients drained by the parasite by boosting the maize plant with DAP or NPK. Weeding, especially the first time the striga comes up before it has had the chance to dig into the roots of the maize, is recommended, also to reduce the spread of

[2]In the East, early maturing varieties are preferred, such as Longe 10. In the future, a similar HR strain of Longe 10 is expected to be released.

seeds.

Poor soils, exhausted by continuous cultivation with little rotation, is the second main limiting factor. Soils lack macro-nutrients such as nitrogen (N), phosphorous (P) and potassium (K). Farmers rarely use organic fertilizer. Experts say it is virtually impossible to get decent yields without using inorganic fertilizer. In particular, at planting stage, DAP or NPK should be used in the soil. After about 4 weeks, a nitrogen based fertilizer such as Urea should be applied on the topsoil near the plants to boost vegetation. Sometimes it is also advised to split the application of urea, administering half a doze at 4 weeks and half a dose at tasseling stage. Fertilizer can easily double yields. Especially used in combination with improved seeds, the effects of fertilizer are significant.

Throughout Sub-Saharan Africa, farmers mainly rely on saved **seeds**, and maize in Eastern Uganda is no exception (McGuire and Sperling, 2016). However, as maize is cross pollinated, recycling leads to fast degeneration. Hybrid seeds such as Longe 7, Longe 9 are available and have also been distributed through Operation Wealth Creation. Hybird seeds potentially triple yields. In addition to hybrid seeds, which need to be procured every seasons as they can not be recycled, the government also released Open Pollinated Varieties (OPV). These are improved varieties that can be reused for about 3 or 4 seasons. In general, they are lower yielding than hybrid seeds. Still, yield are likely to be about 30 to 40 percent higher than when saved seeds are used, up to 100 percent if OPVs are also used with fertilizer. OPVs are generally recommended to poorer farmers as they can be reused as seeds to some extent.

Most hybrid seeds take long to mature. Farmers also complain that hybrids do not withstand drought very well. However, new varieties have entered the market that are both high yielding and early maturing. For example, UH5354, marketed as Bazooka, yields about 20 percent more than other hybrids and is drought resistant. Farmers that use these seeds report up to 40 bags of maize per acre[3]. Similarly, there are several OPVs on the market that are also early maturing.

Finally, there are also **agricultural practices** that affect yields, but the effects are generally smaller than those related to improved seeds and inorganic fertilizer use. The most important are:

- **Timely planting**: maize should be planted at the onset of the rains.

[3]Today, yields are about 7-8 bags per acre.

However, many farmers delay planting for several reasons. For instance, they may not be certain that the rains have really started. There may also be bottlenecks in land preparation, where the poor are often the last in line for the use of oxen or tractors. Experts estimate that for each day a farmer delays planting, yields are reduced by 1.5 percent.

- **Plant spacing**: Plant that are too close to each other compete for light and nutrients, reducing yields. Plants that are to far from each other means space is wasted, also leading to lower yields. Related is the number of seeds that farmer plant in each hill. Farmers want to be sure of germination and put more than one seed, sometimes up to 5. If they all germinate, there is competition for nutrients and sun. Usually there is also not enough thinning, or this is done too late when competition has already occurred. One expert told us that standard spacing is 75cm x 60cm with two plants per hill. However, several experts mentioned a new way of plant spacing of 75cm x 30cm with 1 plant per hill which leads to a 35 percent increase in yields.

- **Weeding**: The first weeding should be at 18-20 days after planting at the three leaf stage, and the second weeding at 2-3 weeks after first weeding. From emergence to 8 leave stage (knee height), the maize plant is a very poor competitor and unwanted stress such as weed competition must be prevented. Weeding must therefore be done within that period. A third weeding is optional. It is only dependent on weed pressure after the second weed. If needed, it should be done at tasseling stage. Weeding removing Striga at early stage before it can attach to the roots of the maize can also have a significant impact on yields. In addition, removing striga before it flowers reduces the spread of the pest. Proper weeding can increase yield by about 50 to 70 percent.

Given the above, an important part of the video focuses on providing technical information on seed choice, soil nutrient management (including promoting organic fertilizer application), weeding, timely planting and plant spacing[4]. We make sure to include information that is likely to be unknown

[4]As mentioned above, pest control also ranks high among technologies that increase yields. However, we felt uncomfortable promoting chemicals in our videos that are potentially hazardous to humans, animals and the environment. In Uganda, Endosulfan, DDT, Glyphosate, Linden and others—are still being used. Many of these are on the World Health Organization's list of banned chemicals and blacklisted by the Stockholm

to the farmer, as it is often assumed that information is most valuable when farmers learn about a new technology or institutional innovation (eg. Glennerster and Suri, 2015). However, it is also thought that for behavioural change to take place, common knowledge can become more salient through repetition. Evidence of such a compounding or re-emphasis effects have been found in Duflo, Keniston, and Suri (2014). Therefore, in the video, we also include information that farmers are assumed to know, but do not seem to act upon.

Often, access and affordability was mentioned as a problem[5]. While for some households, the combination of particular household specific market failures and heterogeneity in the production function may mean adoption is not profitable, we feel that in many cases the returns to the investment as perceived by the farmer may not correspond well to actual returns. Investments in agricultural inputs or technologies require the farmer to compare costs today to a stream of uncertain future incomes. However, farmers may not have precise information about fixed and variable costs involved, about the level and variability of the stream of future income, or about the time frame. Inter-temporal decision making requires a long run perspective, and concepts such as compounding may be poorly understood by subsistence farmers[6].

Convention on Persistent Organic Pollutants.

[5]Farmers indeed often mention they do not use modern inputs because they have no money, suggesting liquidity is the main constraining factor, and thus instead of providing information, a more effective strategy would be to provide credit or subsidize inputs. Recent research, however, finds that despite what farmers claim, liquidity is often not the most important constraining factor. Duflo, Kremer, and Robinson (2011) note that in Kenya, fertilizer is relatively cheap and can be bought in small quantities, putting it in reach of even the poorest households. They suggest the main reason for low fertilizer adoption rates should be attributed to the farmer's failure to commit. Ashraf, Gine, and Karlan (2009) find that lack of credit was not the main reason why farmers did not produce high-value export crops, and that farmers that did produce export crops found access to credit on their own. Emerick et al. (2016) find that increasing access to drought tolerant seed that reduced downside risk increased the use of credit from existing sources. Finally, Karlan et al. (2014) compare outcomes related to agricultural production between households that were given cash to households that were provided with insurance and find that when provided with insurance, farmers are able to find resources to increase expenditure on their farms.

[6]The fact that farmers do not engage in a cost benefit analysis, where inputs are used to generate output, was illustrated by a complaint made by one of the farmers. He complained that farmers get low prices. To him, it did not make sense to buy seed at 6000 per kg and sell maize at only 300-400 per kg.

Perceived returns that are lower than actual returns has been found to affect decision making related to schooling in both the Dominican Republic and Madagascar, and in both cases, simply providing information increased demand for schooling (Jensen, 2010; Nguyen, 2008). However, a recent study among rice farmers in Uganda does not find that providing objective information about the returns to different inputs and practices increased adoption (Van Campenhout et al., 2017). In our videos, we will also pay considerable attention to pointing out the costs and benefits of the different technologies and practices we promote. In addition, we will encourage farmers to start small, using combinations of fertilizer and seeds (instead of investing all the money in eg. only seed) on a small area of their field to experiment and see for themselves, and reinvest in subsequent years.

We also pay considerable attention to how the information is packaged. For instance, it is found that farmers find communicators who face agricultural conditions and constrains most comparable to themselves to be the most persuasive (BenYishay and Mobarak, 2014). Several studies point out the importance of role models to behaviour change in context of strong norms and believes (Nguyen, 2008; Riley, 2017; Porter and Serra, 2017). Videos of successful farmers in Ethiopia has been found to affect future-oriented behavior (Bernard et al., 2015). A growing strand of the literature investigates how non-cognitive farmer characteristics such as aspirations, locus of control and self esteem can lead to behavoural change such as technology adoption (Abay, Blalock, and Berhane, 2017). Therefore, in our video, the message is brought by "peer farmers" and the information is framed as a success story.

The video starts with a farmer (a male farmer, a female farmer, or a couple) introducing themselves. The farmers[7] talks about how he used to struggle with his maize gardens and how at one point in time, he decided things needed to change. It is shown how the farmer sells a hen, and obtains a small loan from a friend. This money is than used to buy small quantities of improved seed and fertilizer in a local shop. It is then shown that, before planting the improved seed, the farmer prepares the garden. He is shown collecting manure and applying it to a small corner of the field of 20m by 20m. Next, it is shown in detail how the maize seeds are spaced 75cm x 30cm with 1 plant per hill and how the DAP should be applied. The viewer is reminded to plant in time. The next scene depicts the field after about 10 to 12 days when the maize has emerged from the ground. At this stage, it is

[7]We will proceed here with the description for the version of the male farmer.

recommended that the farmer engages into gap filling to replace seeds that did not germinate with new seeds to preserve optimal plant density. The next shot shows the field at 18 to 20 days after planing, when first weeding is done. Particular attention is paid to identification of striga at an early stage. It is also advised to weed again two to three weeks later. The next scene zooms in on Urea fertilizer application. Here, the field is shown at about 4 weeks after planting when the maize is knee high. It is shown how Urea topsoil dressing should be applied. Finally, it is recommended to do one more round of weeding around the tasseling stage of the maize.

We then spend some time on the concept of investing now to get more yields over time. We point out that it may indeed be difficult to raise cash, but that the farmer can always start small (eg. on one tenth of an acre) and reinvest returns. It is explained that following recommended practices and using improved inputs led to 2.5 bags of maize on the small plot, which they sold for 125,000 shillings, giving them a profit of almost 90,000 shillings. It is reminded that, if they had not used modern inputs or followed recommended practices, they would only have harvested one bag on that same area, and profit would be 40,000. It is further explained that they reinvested the difference between the profit they got and the profit they would have gotten without using inputs to increase the area under intensive maize cultivation year after year. Pretty soon, they are able to cultivate an entire acre using modern inputs. In the final part of the video, the farmer recapitulates and once more directly addresses the viewer to encourages him or her to try this as well.

Results

Balancing Checks

While we did not do a dedicated baseline survey, we did ask some questions before the first intervention to investigate balance. The choice of variables was based on what variables other researchers in similar studies use in their orthogonality tests. In particular, we looked at balance tables in studies that investigate the adoption of yield improving methods and technologies using RCTs. These studies include Duflo, Kremer, and Robinson (2011), Karlan et al. (2014), Ashraf, Gine, and Karlan (2009) and Bulte et al. (2014). In addition, we also add some variables that may be useful to investigate

Table 1: Balance tests

	mean	H0	H1	H2	H3
Maize yield (kg/ac)	287.5	-1.29	1.55	-0.37	-0.78
Age of HH head (years)	39.76	0.8	-6.39**	0.27	-0.38
HH head finshed primary school (%)	36.75	-0.01	-5.26**	-0.63	0.02
HH size	7.62	0.46	-2.59**	0.46	-1.47
Number of bedrooms in residence	2.24	1.09	-1.4	0.53	-1.84+
Access to extension last year (%)	10.96	-0.21	0.69	-0.68	1.67+
Has used fertilizer last season (%)	20.59	-1.55	3.09**	1.72+	1.63
Has used improved seed last season (%)	38.19	-1.49	0.71	0.74	2.13*
Distance nearest agro input shop (km)	5.5	-1.16	-0.6	0.55	-0.92
# obs	3588	3335	3240	3159	1540

note: table entries (H0-H3) are t-statistics; ** denotes significant at 1 percent, * at 5 percent and + at 10 percent.

heterogeneity in treatment effects. In particular, we collect some household characteristics such as household size, age and education level of both wife and husband. We then ask more specific questions related to maize farming, such as acreage and quantities produced in the last season. Furthermore, we ask if the household received agricultural extension, whether improved maize seeds were used, and whether fertilizer was applied. We also collect data on housing conditions (material of wall and number of bedrooms) and access to off-farm income. In Table 1, we provide descriptive statistics, as well as balance tests for the information treatment versus control hypothesis (H0) and for the three hypotheses outlined above (H1-3).

The table shows that few farmers that were included in our study had access to agricultural extension in the previous year. We also see that only about 20 percent of farmers reported to have used fertilizer in the previous maize growing season (April – July 2017) and about 38 percent reported to have used improved seed bought from a shop or agro-input dealer during the last cropping season. This suggests ample scope to increase intensification investments through extension. We also find that farmers produced on average only 287 kg of maize per acre in the first cropping season of 2017. This is substantially lower than the average yield of 618 kg per acre we find when using the Uganda National Household Survey of 2005/06. The low yields illustrate the devastating impact of the Fall Armyworm that ravaged maize yields in East Africa in 2017 (Stokstad, 2017).

The table also shows some imbalance, particularly with respect to the asymmetric information hypothesis (H1), where farmers that were shown the video individually are compared to farmers that received the information treatment as a couple. In particular, we find that households where the information was shown to a couple were significantly younger, and this difference is also reflected in other variables. For instance, the fact that they are younger apparently also means they have fewer children, are more likely to have used fertilizer in the previous growing season. They also seem less likely to have finished primary education.

Knowledge effects

In this section, we investigate the effect of showing the video and of changing the messenger and the recipient of the video message on knowledge. This was done through a small quiz immediately after the video was shown. As videos were shown twice, we also did the quiz two times. The quiz consisted of 3 multiple choice question. For each question, three possible answers were read out to the farmer, who was then asked to indicate what answer he or she though was correct. The respondent was also allowed to indicate he or she did not know what the correct answer was.

The first question was related to planting. In our video, we recommended a spacing of 75cm x 30cm with 1 plant per hill and this was the correct option among the alternatives. Other options were 75cm x 60cm with two plants per hill, which is standard for many farmers and recommended by most agricultural extension agents. We also added an intermediate alternative answer of of 75cm x 30cm with 2 seeds per hill. As we recommend a technique that deviates from what is assumed to be standard spacing, we assume that the recommended practice is new to most of the farmers. The second question is less related to technical knowledge, but more to viewing farming as a business. In the video, we pay ample attention to promoting an approach where farmers start small and grow over time through reinvesting. We wanted to see if farmers internalize this advice and ask what a successful farmer should you do if you only have 40,000 shillings. The correct option was to use it to buy improved seed and fertilizer and start intensified farming on a small area. Alternative options were to: “use all the money to buy hybrid seed, because without good seed, yields will be low”; and to “use all the

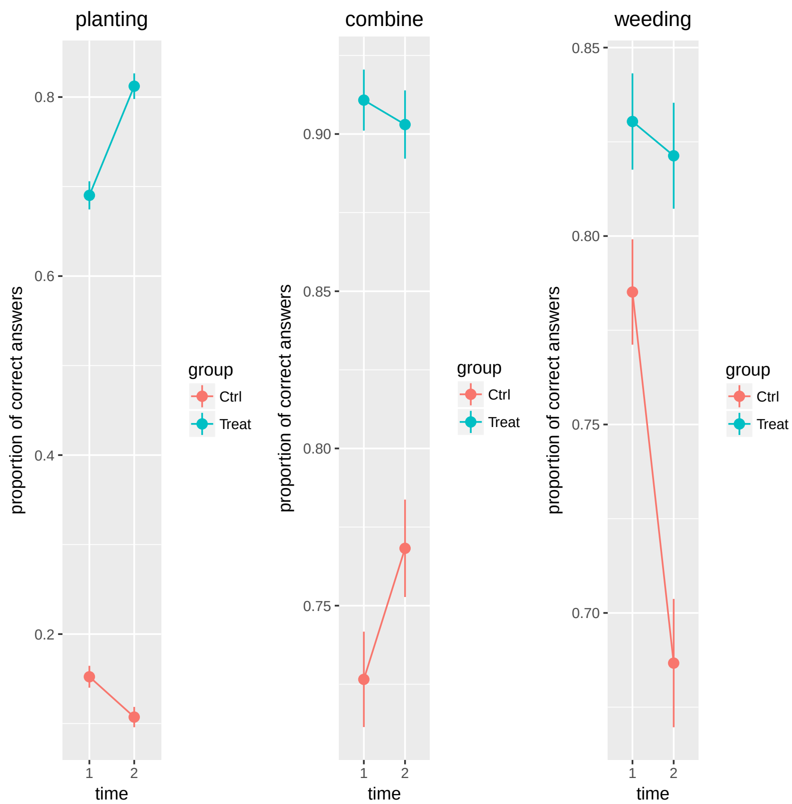

Figure 3: Does the intervention increase knowledge?

money to buy fertilizer, because in poor soils, yields will be low". Finally, we asked when is weeding is most important. Weeding is most important during the first four weeks after planting, as maize is a poor competitor for light and nutrients. Alternative answers were: "when the maize is knee high" and "when the maize is at tasseling stage". It is assumed that most farmers would know this.

Figure 3 shows that the information interventions though video significantly increase the proportion of farmers that answer correct on all three questions, and that this is the case after both the first and second screening. Especially for information that can be assumed to be new to the farmers, the video seems to substantially increase knowledge: the first panel in Figure 3 shows that after the videos were shown the first time, about 15 percent of farmers in the control group was able to identify the correct response to the question on optimal planting. This proportion rises to almost 70 among farmers that did get to see the video. This proportion increases further when these farmers are reminded about the correct spacing during a second screening, to more than 80 percent.

The second panel in Figure 3 reveals that about 70 percent of farmers in the control group responded that the best way to invest money is combine inputs and start small instead of investing everything in either seed or fertilizer. Among the farmers that received the information treatment, this increases to about 92 percent, and this proportion stays the same after the second screening. In the control group, the proportion increases to about 77 percent, which may indicate some extent of spillover, which is consistent with findings from a similar intervention among rice farmers in Uganda (Van Campenhout et al., 2017). The third panel in Figure 3 shows that after the first screening of the videos, about 88 percent of farmers in the control group were able to indicate the correct answer to the question when weeding is most important. This proportion increases to about 86 percent in the treatment group. Also after the second screening of the video, the treatment groups does significantly better in answering the question than the control group. The reduction in the proportion of farmers that answer correctly in the control group over time may be caused by the fact that, in the absence of information on the correct answer, farmers in this group start to doubt about their initial answer and choose an (incorrect) alternative after the second screening.

Figure 4 plots results for the hypothesis that reducing information asymmetries within the farm household increases knowledge. It compares the

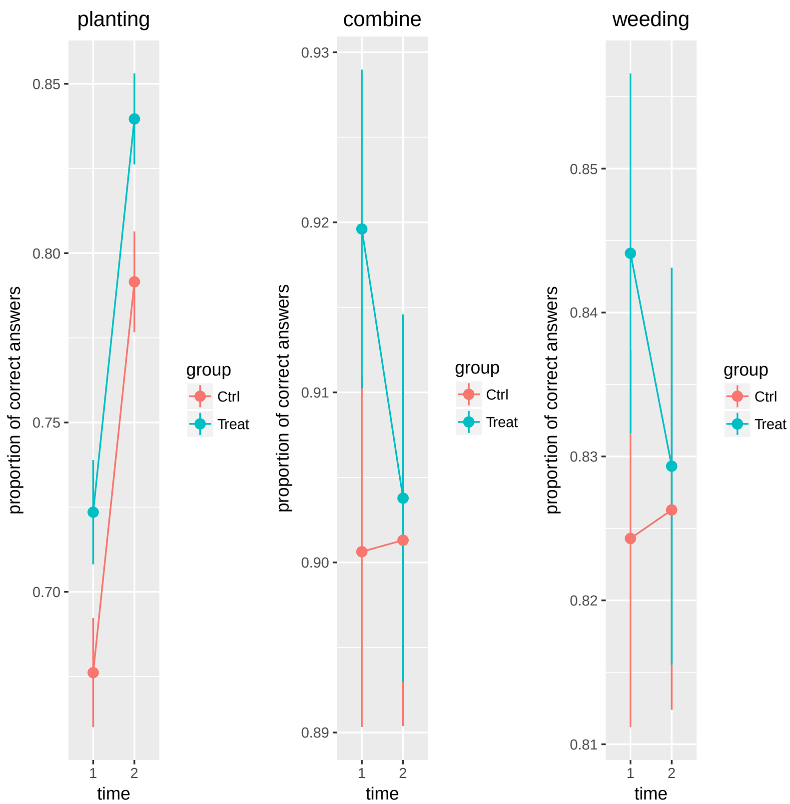

Figure 4: Does reducing information asymmetry increase knowledge?

proportion of farm households that answer correctly in households that were shown the video as a couple to the proportion of farm households that answer correctly in households were the video was shown to either the woman or the man (corresponding to panel (B) in Figure 2). We see that households where the videos were shown to the couple are significantly more likely to answer the first question related to planting correctly than households where the video was shown to only one of the spouses. The difference is present after both the first and the second screening of the videos. Also here, the increase of the proportion of households that answer correct in the control group from 65 percent to almost 80 percent suggests substantial spillover from the control to the treatment group. The difference between treatment and control is not significant for the second question in our quiz related to the benefits of combining inputs at a smaller scale. Knowledge on optimal time for weeding also does not seem to be affected by whether the information was given to a couple or to an individual within the household.

One may argue that a significant effect found in the first panel of Figure 4 is not necessarily due to a reduction of information asymmetry, but simply the result of providing double the amount of information at the household level. The fact that we showed the videos twice allows us to test this hypothesis. In particular, if a dose-response interpretation is the most appropriate, we would expect that the difference between treatment and control after the first screenings in Figure 4 matches the difference between the first and second screening in the control group. Doubling the dose among households where the video was shown to only one person within the household (the control) increases the proportion of correct answers by almost 18 percent (from about 67.5 % to about 79 %). However, the increase in proportion of correct answers between treatment and control after the first screening is much smaller, from about 67.5 to about 72.5 %, corresponding to about 7 percent. At the same time, the increase in proportion of correct answers in the treatment group between the first and second screening matches the increase in the control group over time. Taken together, this suggests that the information asymmetry effect is different from the effect that emanates from simply showing the information message twice.

Figure 5 tests the hypothesis that promoting a household cooperative approach to farming leads to increased knowledge on planting, on combining inputs at a small scale, and on weeding. The graph corresponds to panel (C) in Figure 2. We do not find that farmers learn more when the video features a couple as opposed to a single individual. Even more, for the question related

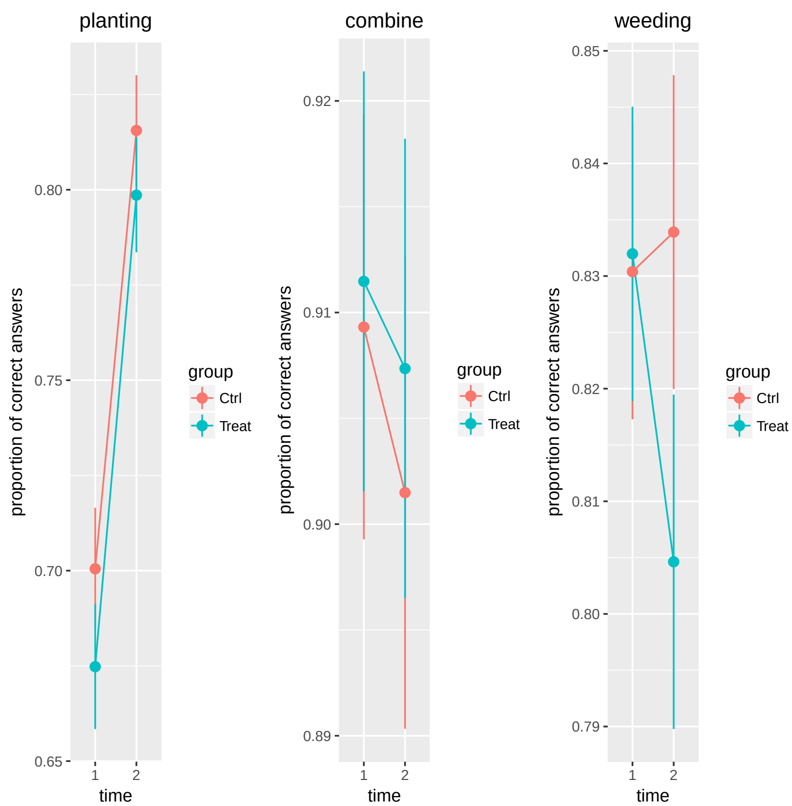

Figure 5: Does projecting a household cooperative approach increase knowledge?

to weeding, it seems that the proportion of correct answers is lower among households that were provided the information by a couple the second time the video was shown.

The fact that we do not find significant effects of projecting a household cooperative approach on knowledge transfer does not mean such effects are irrelevant for the effectiveness of agricultural extension. While the source of information may not affect knowledge transfer, it may still affect the likelihood that farmers act upon this information. For instance, we expect that projecting a household cooperative approach to farming will affect the way in which resources are allocated between men and women controlled plots within the household, in turn affecting outcomes such as household productivity and the gender productivity gap. However, this can only be assessed after we have collected endline data.

Finally, in Figure 6, we test if farmers learn more from farmers that have the same gender than if messenger and recipient of the information are from opposite sex. This corresponds to the experimental setup depicted in panel (D) in Figure 2. Similar to the hypothesis on projecting a cooperative approach, we do not find significant differences between gender matched and gender mixed farmers on any of the knowledge questions. As for the previous hypothesis on projecting a cooperative approach, the fact that we do not find evidence on gender homophily effects on knowledge does not mean such effects are irrelevant. In fact, we expect that gender homophily effects matter much more for the decision to believe the information and hence act upon it. Again, to test this we need endline information.

Conclusion

In a world characterized by incomplete and asymmetric information, targeted efforts to fill knowledge gaps can make a big difference (Banerjee, Banerjee, and Duflo, 2011). However, not every information campaign is equally effective, and often, seemingly small attributes, such as the way a message is framed, how it is delivered, who is targeted by the message and who delivers the message, can result in significant differences in impact. Understanding and quantifying the importance of each of these design attributes through rigorous evaluation research should therefore be an essential part of any knowledge exchange model.

Motivated by the observation that most agricultural advisory services are

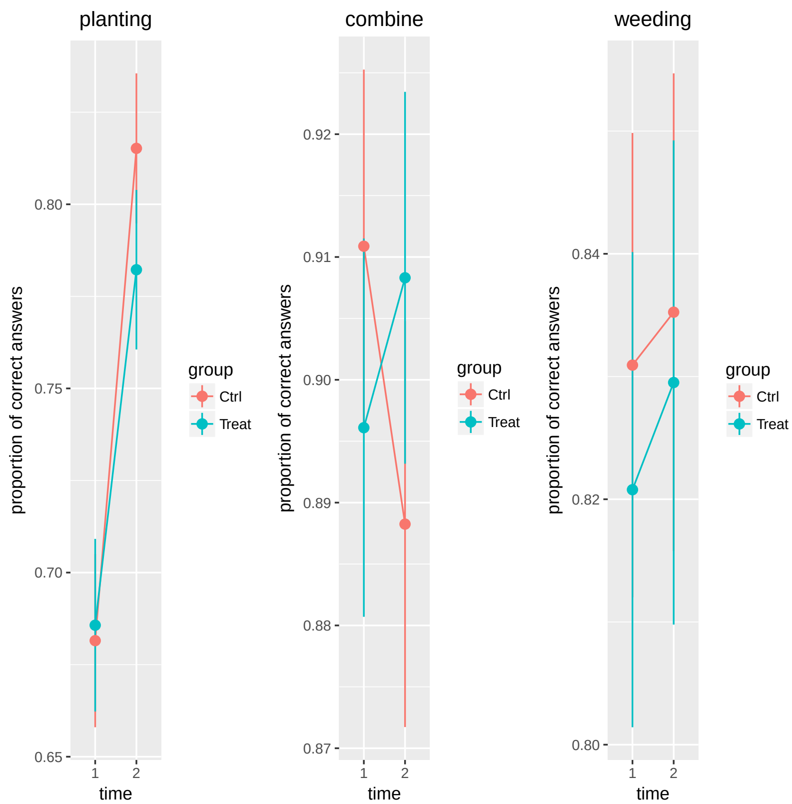

Figure 6: Is there gender homophily in learning?

biased toward men, this study looked at two gender related attributes of an Information and Communication Technology mediated agricultural extension information campaign. The first attribute consists of the gender composition of the person or persons that provide the information. The second attribute is the gender composition of the person or persons to which the information is targeted. This allows us to test a range of hypotheses. We focus on three important hypothesis related to (1) information asymmetries within the household; (2) a cooperative approach to farming; and (3) gender homophily. In addition, we also test if the information intervention in itself is effective.

The various hypotheses are tested using a field experiment where the messenger of the information and the recipient of the information is randomly altered according to a 3 by 2 factorial design. The study population were maize farmers in Eastern Uganda, from which we sampled about 3,600 farmers. The information treatments were implemented as short videos that were shown to the farmers on tablet computers. The videos showed how inputs and improved farming practices can be used to increase production. It also explains important concepts in inter-temporal decision making. The messages are also packaged in an attractive way, with role model farmers explaining how intensification of maize production improved their lives. The videos were shown twice, once just before the the planting season, and once early in the season.

We find that the information campaign increased knowledge about recommended agricultural practices and about how to invest in farming. Especially if the information is about a new technology and it can be assumed that previous knowledge is limited, we find big and persistent increases in knowledge that can be attributed to the intervention. We find that information about new technologies and practices are more effective in terms of knowledge creation if targeted to the couple, instead of an individual within the household. We do not find that farmers learn more from farmers that are from the same sex. We also do not find that farmers learn more if the information is brought by a couple as opposed to by either a man or a woman.

The fact that farmers appear to absorb the information provided through the video and that this happens more efficiently if the information is given to a couple is encouraging, as knowledge transfer is only the first link in the causal chain between information and outcomes. For instance, increased knowledge about proper spacing may lead farmers to also adopt the practice, resulting in higher yields and welfare more general. Especially if the couple was targeted, spouses may encourage each other to experiment, leading to higher rates of adoption and subsequent outcomes. The fact that we did not find knowledge effects for promoting a cooperative farming approach or for gender matching does not automatically mean there will be no impact on intermediate or final outcomes. For example behavior change may depend on whether you actually believe the information, which may be conditional on gender matching. To find out the impact of the intervention on intermediate and final outcomes, we first have to collect endline data, which is planned for February 2018.

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