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Accelerating Technical Change through ICTs:

Evidence from a Video-Mediated Extension Experiment in Ethiopia

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The use of information and communications technologies (ICTs) to address a wide array of development issues has gained considerable attention among governments, practitioners, and researchers in recent years (Lwoga and Sangeda 2019). While early studies focused on mobile phones and text messaging, attention is quickly shifting to other media, including video. Many studies on the use of video as a medium explore how increased access and consumption of information can lead to behavior changes that ultimately result in welfare-improving outcomes.

This study explores whether video-mediated extension leads to the increased, sustained uptake of productivity-enhancing agricultural technologies and practices by small-scale farmers. Over the two-year period of 2017–2018, the Government of Ethiopia and Digital Green conducted the large-scale rollout of a video-mediated extension approach. We examine the impact of this rollout on a range of outcome indicators, including whether targeting the video-mediated approach to both spouses of a household was more effective than targeting the (typically male) household head alone. Our main outcomes of interest include farmer uptake of the subject technologies and the yield gains resulting from these technologies. Our study provides insights into the mechanisms behind the observed effects and an analysis of the approach's cost effectiveness.

Our results demonstrate that the video-mediated extension approach led to increases in farmer uptake of improved agricultural technologies and practices. In the first year of the experiment, we find an overall 6 percentage point increase in technology uptake, which translates into a 10 percent increase over the mean of the control group. An analysis of uptake by type of technology shows that the video-mediated approach resulted in an increase of 13, 20, and 15 percent over control group means for row planting, precise seeding rate, and urea top/side dressing, respectively. These results endure in the second year of the experiment, pointing to farmers' effective uptake of the technology beyond a mere trial in one production season.

Upon exploring the mechanisms that explain these adoption effects, we find that the video-mediated extension approach led to an increase in extension reach, with a 35 percent increase in farmers' attendance at extension sessions (likely due to interest in the video medium). Among farmers assigned to the video-mediated extension approach, we also find a higher level of technical understanding of focal agricultural technologies and practices. While our results suggest greater participation and knowledge gains among (typically female) spouses who also participated in the video-mediated extension approach, we do not find clear evidence that targeting both spouses led to higher rates of technology uptake.

BACKGROUND AND CONTEXT

Advantages of the video-based extension approach

Our study expands on existing research by providing new evidence on the effectiveness of video to convey information to farmers and to advance gender-relevant, low-cost enhancements to public extension services (see periodic reviews by Spielman et al. 2021; Fabregas, Kremer, and Schilbach 2019; Nakasone and Torero 2016). We shift the focus of inquiry from small experiments to the evaluation of a large-scale public program designed to accelerate productivity growth in staple food production. The study also shifts attention from the role of ICTs in accelerating the adoption of discrete technologies (such as new varieties or inorganic fertilizers) to more complex management practices, and from conventional input-targeting models to more complex multi-object learning models (Barrett et al. 2021; Banerjee et al. 2019; Hanna, Mullainathan, and Schwartzstein 2014). The study's multi-year duration allows for an exploration of both learning externalities (Conley and Udry 2010) and dis-adoption dynamics (Barrett et al. 2021). The inclusion of gender within the study also helps to shed light on knowledge accumulation and decision-making within agricultural households (for example, Hoel et al. 2017; Palacios-Lopez and Lopez 2015; Doss et al. 2015).

Studies also show that the video medium offers several advantages over many other ICT-based information dissemination approaches, such as automated calls, text messages, and interactive voice response systems. Videos can be tailored and customized to address localized information needs and contexts. The importance of locally relevant information is demonstrated by economics research on education (Jensen 2012), entrepreneurship (Jensen 2010), and agriculture (Hanna, Mullainathan, and Schwartzstein 2014). Positive relationships have been found between locally relevant information and public health (Bull, Kreuter, and Scharff 1999; Marcus et al. 1998), weight gain (Campbell et al. 1994), smoking habits (Prochaska et al. 1993; Shiffman et al. 2000), and education (Kim and Keller 2008).

Videos can also promote positive changes through exposure to role models. By sharing various attributes of character or identity, role models can encourage individuals to receive, accept, and internalize messages that lead to desirable changes in behavior (Bandura 1977, 1986). Video-based content can substitute for the individual's experience or that of their peers, while framing messages to promote changes in attitude and behavior (Bernard et al. 2014).

In addition, video allows for the consistent delivery of content, thereby reducing errors in conveying sensitive, detailed technical information, and countering the adverse effects of unmotivated extension agents. These effects can be particularly important when communicating complex behaviors or practices (Barrett et al. 2021; Hanna, Mullainathan, and Schwartzstein 2014). Lastly, videos can be produced at a relatively low fixed cost, and their cost effectiveness rises with the number of viewers. Whether used alone or in tandem with other approaches to information dissemination, video can be a powerful medium.

Ethiopia's extension system

As one of Africa's largest extension systems in terms of personnel and coverage, Ethiopia's system has undergone both small experiments and large reforms during the past three decades (Davis et al. 2010). Significantly increasing the number of agricultural extension agents—known locally as Development Agents (DAs)—deployed to advise farmers has been a pillar of these reforms. During the past 10–15 years, approximately 90,000 DAs have been trained and 18,000 Farmer Training Centers (FTCs) constructed. Recent estimates from the Ministry of Agriculture (MoA) indicate that about 72,000 DAs are on duty throughout the country (roughly one DA for 235 farm households),

making Ethiopia's extension agent-to-farmer ratio one of the highest in the world.[1] DAs reportedly reach more than 75 percent of farm households in Ethiopia (CSA 2017), and every *kebele* (village cluster) hosts an average of three DAs, each of whom provides a different technical specialization and reports to the *woreda* (district) level.[2]

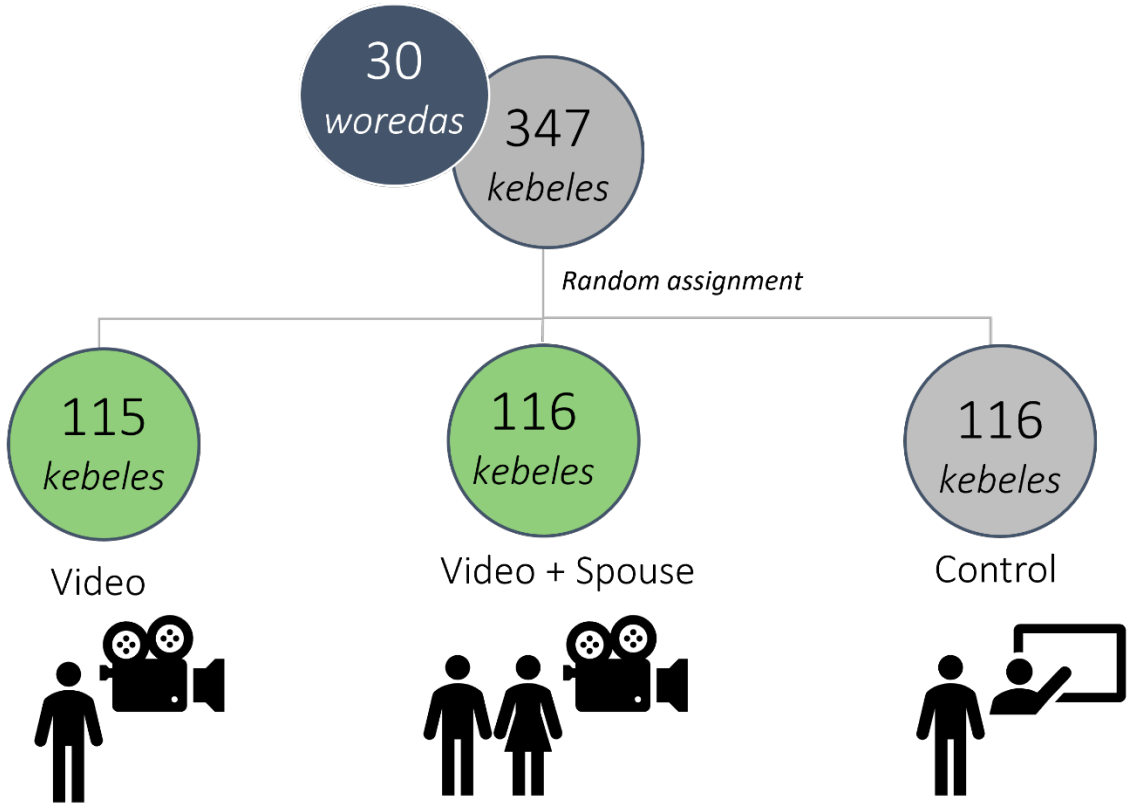
However, it is often difficult to establish a robust causal link between an extension system's size and approach and its outcomes on farming practices, such as technology adoption or productivity growth (see, for example, Dercon et al. 2009; Spielman et al. 2010; Krishnan and Patnam 2014; Abay et al. 2019). Studies of Ethiopia's extension system generally suggest a weak relationship between the technical support provided by DAs and productivity growth. Effects on yields are more likely to result from the extension service's role in supplying physical inputs—such as inorganic fertilizers and improved cultivars—than from improvements in farmers' awareness, understanding, and ability to innovate and adapt through better farming practices, marketing tactics, and risk management strategies. While these findings may be unexpected given the scale and reach of Ethiopia's extension system, the results are supported by deeper analysis of the system's organizational culture, daily practices, the technical and functional skills of DAs, and professional incentives (Leta et al. 2017; Davis et al. 2010; Gebremedhin et al. 2006; Kassa 2002).

Experimental design

To assess the effect of video-mediated extension on our outcomes of interest, we compare how farmers respond to the same information on selected technologies using two different dissemination approaches: the conventional extension approach[3] and the video-mediated approach. The study was designed as a three-arm stratified randomized controlled trial, clustered at the *kebele* level, and implemented during the 2017 and 2018 *meher* (rainy) seasons.

The study design ensures that the only differences across groups was participation in video-mediated DA training sessions (the main treatment arm) and the involvement of female farmers in these video-mediated sessions (the secondary treatment arm) (Figure 1). Across all arms of the experiment, extension providers promoted the same set of technologies—row planting, precise seeding rates, and urea side and top dressing—for teff, wheat, and maize, Ethiopia's three main cereal crops. These technologies have been topics of considerable research in Ethiopia: while some are relatively novel, others have been a standard part of the extension messaging (such as row planting of maize) for at least two decades.

Figure 1. Experimental design



Note: In each *kebele*, 7 households were randomly selected for the study survey, resulting in a total sample size of 2,345 households.

The intervention was launched by Digital Green, MoA, the bureaus of agriculture in each regional state, and local extension staff at both the *woreda* and *kebele* levels. The video-mediated approach comprises three interlinked components: localized video production, video screenings with farmers, and performance monitoring (see Abate et al. 2019 for complete details).

Within each *woreda* (district), *kebeles* (village clusters) were randomly allocated to one of three groups:

1. A control group that received the Government of Ethiopia's conventional extension approach and targeted the (typically male) household head;
2. A treatment group ("T1") that received the video-mediated approach (described above) and targeted the (typically male) household head; and
3. A treatment group ("T2") that received the video-mediated approach and targeted both the household head and his/her spouse.

With this design, we were able to test the impact of the video-mediated approach on our outcomes of interest for any household that participated in the treatment (T1+T2) and the distinct treatments (T1, T2) separately.

The same suite of agricultural technologies was promoted to farmers using the video-mediated extension approach in the treatment *kebeles* and the conventional extension approach in the control *kebeles*. Using homogeneous content in both *kebeles* allowed us to evaluate the dissemination medium rather than the content itself.

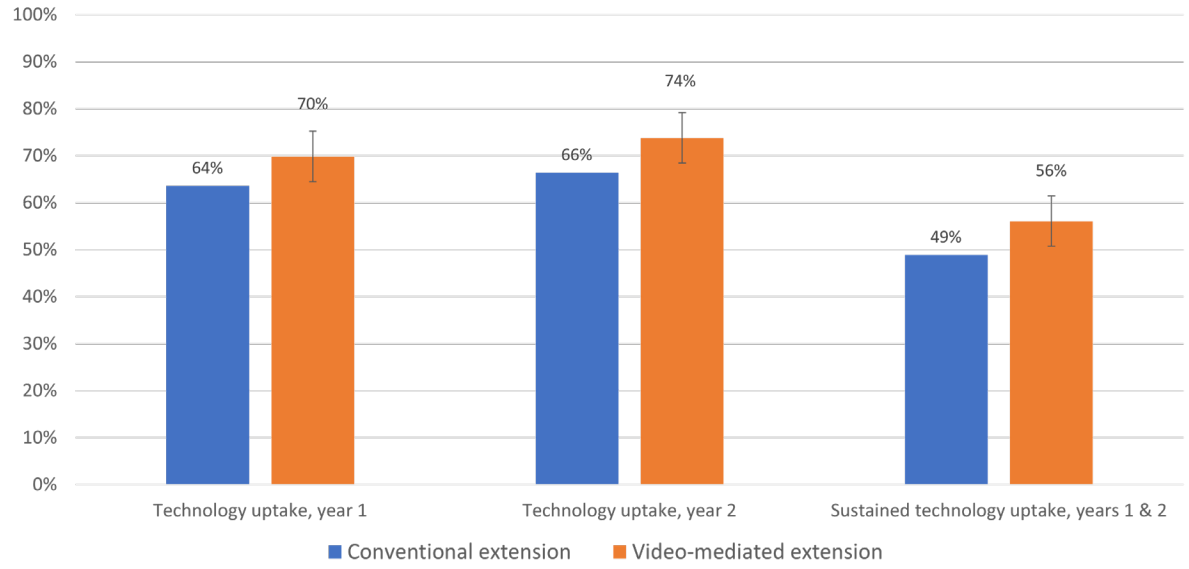
A total of 2,450 farm households were randomly selected from 30 *woreda*s and 350 *kebele*s in the study area, of which 2,422 households in 347 *kebeles* were interviewed during the first year. In the second year, 2,345 (97 percent) of these households were re-surveyed. For the sake of comparison, we focus our analysis on households that were surveyed in both years.

The primary outcomes of interest are: (1) farmers' uptake of the subject technologies in the 2017 *meher* season and their adoption in the 2018 season, and (2) yield gains. To understand the mechanisms driving these outcomes, we also examine the following: (3) access to extension services and advice from DAs, and (4) farmers' awareness and understanding of the subject technologies. We are further interested in (5) variations in these outcomes that result from the distinct gender-targeting strategies used in the two treatment arms. See Abate et al. (2019) for additional details.

RESULTS

The results indicate that the video-mediated extension approach had a clear and meaningful effect on technology uptake. Specifically, the results show a 6 percentage point increase in uptake in the first year and a 7 percentage point increase in the second year, which represent increases in mean uptake of 10 and 11 percent, respectively, as compared to the control group (Figure 2). These results represent a sustained uptake of technologies (that is, adoption in both years) by treatment households over the two-year period.

Figure 2. Difference in technology uptake rates among participating farmers in years 1 and 2



Note: Intent-to-treat estimates with robust standard errors clustered at the *kebele*-level with *woreda* fixed effects and controls for distance to key infrastructures.

Similar patterns emerge when the results are disaggregated by type of technology. Overall, the video-mediated approach resulted in an increase in uptake of 13, 20, and 15 percent over control group means in year one for row planting, precise seeding rate, and urea top/side dressing, respectively.

Comparable results are observed in year two for the first two technologies, despite large increases in uptake in the control group.[4] Crop-specific estimates vary, but are generally positive and statistically significant across both years for most crops. The novelty of the promoted practices varies by crop (for instance, row planting is new for teff and wheat, but not for maize), which explains the heterogeneous results by crop. The effects were not statistically different in magnitude across T1 and T2 for either year, suggesting that the addition of (typically female) spouses to the video-mediated approach did not incrementally affect uptake.

The results for yields are slightly less encouraging. Using self-reported household yield measurements, we find that the video-mediated approach led to a slightly significant and positive impact on teff yields in year one, but had no significant impact on wheat or maize yields. The effect on teff yields effectively disappeared in year two. These results are robust to our other measurements of yield: self-reported plot-level yield measurements do not provide additional evidence of significant increases resulting from the treatment, apart from a slightly significant and positive impact on teff yields when plot area is measured with GPS devices. No differences were observed between the standard video-mediated treatment and the gendered version of the treatment. These null results may be attributed to measurement challenges and to the subject technologies themselves, many of which have a history of mediocre performance despite being flagships of the Ethiopian government's efforts to increase yields and improve food security (Abate et al. 2018; Vandercasteelen et al. 2020, 2018).

Because the video-mediated extension approach is designed to augment the existing extension system, we investigate the cost per additional uptake (or "adoption") of a subject technology resulting from the video-mediated approach. Specifically, we measure marginal cost-effectiveness, which is the cost of an additional adoption that results from adding the video-mediated extension approach to the existing system. We examine two scenarios: (1) the actual cost of Digital Green's project per adoption attributable to the video-mediated approach (the experimental scenario), and (2) the estimated cost of a larger-scale rollout that covers the target villages and districts more completely (the saturation scenario). Overall, we find that while the cost of an additional adoption of a subject technology under the experimental scenario ranges from US$16–30, it declines significantly to US$3–6 at scale in the saturation scenario. This suggests that at a saturation scale, the program is potentially cost effective.

CONCLUSION AND POLICY IMPLICATIONS

Overall, several important findings on reach, knowledge, and uptake emerge from our evaluation of the video-mediated extension approach used by MoA, Digital Green, and the regional bureaus of agriculture across Ethiopia's main agricultural regions. First, the approach has a demonstrated capacity to reach a wider audience than the conventional approach employed by DAs and *woreda*-level extension staff, with gains also observed for spouses of the (typically male) heads of household. Second, the approach leads to higher levels of knowledge about the subject technologies in the first year, with gains observed for both household heads and spouses. Third, the approach results in an increased uptake of technologies that are central to the extension program.

While these results hold when both the head of household and the spouse are jointly targeted by the video-mediated approach, we do not observe any marginal gains in uptake rates by treating just the (male) household head versus the (male and female) couple. Further analysis is likely needed of the gender dimensions of video-mediated extension. But this should not be taken as support for a gender-blind approach to extension or a unitary model of household behavior in which the choices of male and female members are closely aligned. Rather, it reminds us that

more attention must be paid to constraints, opportunities, and context in gender analysis (see, for example, Doss et al. 2015).

Importantly, we do not find statistically significant effects on yields resulting from the video-mediated approach. This finding can be attributed to challenges in accurately measuring both output and area. Research is needed that integrates more accurate ground-truthing methods for yield measurement, such as crop cuts with yield estimation using satellite imagery and associated analytical tools.

The findings of this study are directly relevant to public policy in Ethiopia. Unlike many prior studies on ICTs in agricultural extension, this study examines a large-scale intervention of the Ethiopian Government that is fully integrated into existing policy and practice. We provide clear evidence of the potential contribution of video mediation to existing extension policy and programming in Ethiopia, and we encourage further innovation in the program's design to generate additional outcomes. The marginal cost-effectiveness of the video-mediated approach is also assessed under experimental and full saturation scenarios. The cost of each additional adoption under the experimental scenario ranges from US$16–30, but costs decline to US$3–6 when the video-mediated approach is extended to all *kebeles* in the treatment *woredas*.

Further, this study helps shift the national and global discourse on agricultural extension to focus on the power of ICTs to augment—rather than replace—extension services and agents. This shift may, in turn, draw attention to more constructive ways of lowering costs, improving efficiency, and increasing the impact of existing extension systems.

As Ethiopia and other developing countries explore new ways to strengthen their extension and advisory services for farmers, these findings provide evidence on what works—and for whom—in the arena of innovative extension methods and tools.

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[1] This estimate is based on the CSA (2016) estimate of more than 17 million farm households that are active in agriculture. See Davis et al. (2010) for comparison figures from other countries.
[2] A *woreda* in Ethiopia is analogous to a district or county in other countries, while *kebeles* are village clusters that constitute the lowest administrative unit in Ethiopia.
[3] The current extension approach is the Participatory Extension System (PES), highlighted by the organization of farmers in development groups and social networks such as the "one-to-five" syndicates to share information. However, there is little to suggest that these approaches innovate on the traditional top-down training methods implicit in previous approaches.
[4] We interpret this increase in uptake among the control group as evidence that efforts to promote the subject technologies using the conventional extension approach were also successful to a measurable degree.

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