Agricultural Extension through Information Technologies in Schools: Do the Cobbler's Parents go Barefoot?

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Abstract

We investigate the effectiveness of upper intergenerational transmission of knowledge (from children to parents) to promote awareness and behavior changes among adults. We designed and implemented a field experiment in a rural high school in the northern highlands of Peru, where we screened agricultural extension videos to students in the school's computer lab. We separately interview the parents of these high school students to assess their knowledge about the agricultural practices taught to their children. We find that, even when the information was not directly available to them, the information provided to the teenagers increased parents' knowledge of agricultural practices by 26%-34%. We also find that our intervention increased parents' adoption of the agricultural practices in the videos by 14-18%. Our intervention highlights the potential of Information and Communication Technologies (ICTs) to deliver information to children and reach adult populations (who are not usually familiar with ICTs). While our intervention delivered agricultural advice, this method can potentially be expanded to provide other types of information to increase the knowledge and change the behavior of ICT-illiterate populations.

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1 Introduction

There is abundant evidence of the impact that parents have on their children's development. Parents substantially affect their kids' welfare (Hanson et al. 1999), emotional competence (Volling et al. 2002), risk and trust attitudes (Dohmen et al. 2012), education (Behrman et al. 1999), and health (Case and Paxson 2002). More recently, an emerging literature (Ambert 2001) — mostly from sociology and psychology — have questioned this unidirectional perspective of the relationship between parents and kids: children can affect their parents' beliefs, attitudes, and decisions just as much.

In this paper, we analyze the potential transmission of knowledge from children to parents, and whether this knowledge can spur changes in parents' decisions. We investigate this research questions within an intervention that provided agricultural advice to students in one rural high school in the northern highlands of Peru. In particular, we test two hypotheses. First, we assess if the agricultural advice provided to the teenagers is transmitted to their parents. Second, we examine if this new knowledge can translate into changes in parents' behavior. In this line, we assess if parents adopt the practices that are taught to their kids.

We designed a field experiment, where high school students were randomly assigned to receive individual advice through internet clips during their regular computer classes. Upon logging into the computers using unique IDs, the system prompted a short internet clip (of about one to two minutes) displayed in individual screens and headsets. Half of the students were assigned to the treatment group and watched clips with improved agricultural practices. Each student received information about the prevention and treatment of problems that affect farming of potatoes, corn, chicken, or guinea pigs. The videos provided simple and affordable practices to prevent and treat these problems. Another half of the students were assigned to a control group and watched placebo videos encouraging oral hygiene (i.e., not related to any agricultural practice).

Our intervention took place over an eight-month period (excluding a three-month Summer break), in which farmers usually go through two crop cycles (on the wet and dry seasons). At the end of the intervention, we conducted household interviews with farm managers to assess their knowledge and adoption of the agricultural practices that were disseminated by the videos. Because we wanted to determine whether parents had learned about the new agricultural practices, the interviews were unannounced and students were required not to be present during the survey collection.

Relative to the control group, farm managers with children in the treatment group were, on average, 8-10 percentage points (i.e., a 26-34% increase relative to the mean knowledge rate in the control group) more familiar with an agricultural practice that was showcased by the extension videos. Importantly, increases in knowledge did not arise from just any practice, but precisely from those targeted individually to students in the household. We are also able to show that knowledge gains were mostly concentrated among male, younger, and more educated farm managers. Moreover, we find positive effects of our intervention on technology adoption: households in the treatment group were 3-5 percentage points (14-18% relative to the control group) more likely to adopt an agricultural practice that was explained to teenagers in the media messages.

Our research contributes to three strands of the economic literature. First, we provide new evidence on how children can transmit information to parents and alter their behavior. With very few exceptions[1], the economic literature has focused almost exclusively on human capital transmission from parents to children. However, it is important to understand that children are not only beneficiaries of information through parents, but can also constitute agents of change within the household. The idea that children can transmit agricultural knowledge to their parents has been intuitively applied in the past. For example, the Food and Agriculture Organization (FAO) has developed School Gardens, where children can learn how to grow different crops in their schools and eventually replicate this practices in their own homes. In the United States, the 4-H program has hosted various learning clubs for school-aged children since the early 20th Century. While its scope has considerably widened, the program was originally conceived to teach kids about new farming methods and indirectly expose their parents to this information (Van Horn et al. 1998)[2]. While this intuitive approach seems to have had some traction in the design of some extension programs; to our knowledge, we are the first ones to provide experimental evidence of how children can alter their parents' knowledge and behavior.

Second, we contribute to the literature on agricultural extension and technology adoption in developing countries[3]. Traditional extension programs have been plagued by high costs of reaching isolated areas. They also face agency problems: it is hard to monitor extension agents' effort and even difficult to verify their visits to remote villages (Gautam 2000). As a consequence, governments and development agencies have been recently promoting the delivery of agricultural extension through Information and Communication Technologies - ICTs (Aker 2011; Nakasone et al. 2014), as a cost-effective mechanism to disseminate advice[4]. We show that a media-based training program for teenagers can have positive spillover effects to their parents (farm managers) and can lead to the adoption of new agricultural practices.

[1] For example, Kuziemko (2014) analyzes the transmission of English proficiency from migrant children in the United States to their parents. Dauphin et al. (2011) and Moehling (2005) investigate the influence of adolescents in household purchases.

[2] The 4-H program was founded by the Cooperative Extension System of land-grant universities during the early 20th Century. Van Horn et al. (1998, p. 1) argue that, during its inception, "extension educators conceived the idea of involving youth as mediaries between the university researcher/educator and the farmer in the community... Through the young peoples' involvement and accomplishments in the corn clubs, the parents were exposed to new farming methods and were convinced to try and adopt new practices."

[3] While there have been substantial research on agricultural extension, the evidence is still mixed and little is known about its impact (Evenson 2001; Anderson and Feder 2007).

[4] Some recent programs have used other technologies, such as voice-based agricultural advisory through phones (Cole and Fernando 2012), SMS (Fafchamps and Minten 2012), smartphones for extension workers (Fu and Akter 2012), and community participatory videos (Gandhi et al. 2009). To our knowledge, we are the first ones to test internet as a delivery mechanism for extension programs.

Finally, our paper sheds light on alternative strategies to expand other types of information programs through ICTs in rural areas. Despite their cost-effectiveness, one of the most significant barriers to expand ICT-based programs in developing countries is the low level of technological (especially computer) literacy among adult populations. In contrast, teenagers and adolescents are usually more educated than their parents, more computer savvy, and tend to be earlier adopters of technology. As in most developing countries, the share of internet users in rural Peru is still quite low (10% of the population). However, usage is heavily concentrated among younger cohorts: high school-aged students (i.e., 13 to 18 year olds) have a usage rate of 27% and account for 42% of the total internet users in rural areas. In contrast, only 7% of adults 40 years or older use internet[5]. Our study shows that it is possible to expand training and information programs intended for adults by targeting younger populations. While our paper focuses on the provision of agricultural extension advice, our framework can potentially be extended to other types of information that teenagers can convey to older members of their households. As governments in developing countries increasingly expand access to computers and internet in public schools, this can constitute an important tool to disseminate information among rural populations[6].

The the paper (excluding this introduction) is organized in five sections. The second section describes our study design and provides details about out field experiment. The third section presents summary statistics, examines the balance achieves between the treatment and control groups, and discusses compliance with our random assignment. Section 4 outlines our empirical strategy and presents our estimations. In this section, we also examine whether some particular groups benefited more from our information intervention and rule out some potential threats to our identification strategy. Section 5 of the paper has some concluding remarks.

2 Study Design

2.1 The Setting

Agriculture is the most important source of livelihood in Cajamarca and employs 80% of its population. This region concentrates 11% of the total number of farmers and12% of agricultural land in the country. However, yields are significantly below national averages and 78% of farmers' incomes are below the poverty line . Low levels of productivity are, at least partially, related to the traditional nature of their agricultural sector and the limited technical assistance (Zegarra and Calvello 2006).

[5]The 2014 Peruvian National Household Survey (ENAHO) asks whether individuals have used internet in the last 30 days. We use this information to estimate internet usage rates by geographic area and age group.

[6]For example, the number of students per computer in rural high schools decreased dramatically from 195 in 2005 to 5 in 2015. Similarly, the share of high schools with internet connection increased from 1% to 28% during the same ten-year period.

In late 2010, we conducted a local scoping study to identify the most important agricultural activities and the diseases that affect them. Most households in the area grew potatoes and corn in their fields and raised chicken and guinea pigs. Potatoes were usually affected by the blight (*Phytophthora infestans*), a type of fungus that attacks the plant's leaves. This fungus reduces the plant's ability to photosynthesize, which affects the plant's health and reduces the size and quality of the tuber. When it is severe, it can cause the plant's death. While blight is difficult to prevent, there are some measures that mitigate its likelihood. For example, farmers should carefully remove any residues of previously diseased plants at the beginning of a new agricultural season. Higher hilling of the plant at early stages is also highly advised. However, once the fungus attacks the plant, farmers can only combat the disease with fungicides. In general, there are two types of fungicides: contact (the chemical components remain on the leaves' surface and act on the fungus) and systemic (the active ingredients move through the plant). Farmers usually choose one or the other and do not alternate. Over time, plants develop resistance to the particular type of fungicide that the farmer choose[7]. Therefore, experts advise farmers to rotate between contact and systemic fungicides between agricultural seasons (Pérez and Forbes 2001; Egúsquiza 2012). Potato growers in the area are also affected by flea beetles (*epitrix tuberis*) and leaf beetles (*diabrotica*). These insects are 1-2 millimeters and feed on the plants' leaves. The perforation that the insects create on the leaves when they feed affect the plant's photosynthesis process. The insects' larvae tunnel into the roots and feed directly from the tuber, further affecting the crop. Once flea beetles and leaf beetles attack the potato plants, farmers should apply insecticides to eliminate them.

Corn is another important crop in Cajamarca. Corn plants in the area are affected by corn earworm (*helicoverpa zea*), corn earfly (*euxesta mazorca*), and fall armyworm (*spodtera frugiperda*). In their adult stage (i.e., when they are moths or flies), these insects deposit their eggs around the corn silk or ears. When the eggs hatch, the larvae feed on the cob damaging the corn plant. The larvae eventually enter the pupal stage, become butterflies or flies, and start their reproductive circle again. Farmers can apply insecticides to kill earmworms, earflies, or armyworms. However, there are different cost-effective ways to prevent them or treat them early. One simple way is to apply a few drops of vegetable oil around the corn silk during the early stages of the plant (Catalán 2012). The vegetable oil can kill the insect eggs by penetrating into the shell and interfering with its respiratory processes. This prevents the eggs from hatching and developing into larvae. Rather than attacking the insects' eggs, farmers can also prevent earworms, earflies, and armyworms by controlling their adult populations. The idea is simple: to attract moths and flies through food or texture, trap them, prevent them from laying eggs on the corn plants, and stop their reproductive

[7] For example, Ortiz et al. (1999) surveyed potato farmers in Cajamarca to analyze their perceptions and strategies to mitigate blight. They argue that "the adequate combination of contact and systemic fungicides is relatively unknown. Most farmers do not adopt it (p. 118)." Perez et al. (2001) found high levels of resitance to metalaxyl (a popular systemic fungicide used to treat blight) in potatoes from the central and southern Peruvian Andes.

cycle. Farmers can build home-made traps using molasses (through the smell) or a fabric sack (through its texture) to lure the moths and flies into the trap.

Farmers in Cajamarca also raise guinea pigs for food. Our scoping study revealed that guinea pigs are mainly affected by three problems: ticks, salmonellosis, and bloating. The first problem can be prevented by thoroughly and constantly cleaning the guinea pigs' corral. If guinea pigs are already infested with them, they can be bathed with a mix of water and common insecticides (such as cypermethrin). Salmonellosis is usually transmitted when guinea pigs are exposed to the feces of other infected guinea pigs or rodents (e.g., mice, rats, etc.). Quarantine of recently purchased guinea pigs and fencing the animals' corrals can prevent infection. When guinea pigs are already infected, they can be treated with oral doses of water mixed with (locally available) enrofloxacin. Bloating is caused by an inadequate supply of food: guinea pigs usually bloat when they are fed with fresh grass. Fresh grass create gases inside their organism which increase pressure on the animals' stomachs, lungs, and other organs. The solution to this problem is straightforward: experts advice to air fresh grass in the shade for 8-12 hours before feeding the guinea pigs.

The second common livestock in this area is chicken. The most common disease that affected this animals in the area was the avian laryngotracheitis (LT)[8]. LT causes flu-like symptoms on chicken, hens, and other birds. In severe cases, LT can directly kill infected birds. More often, while it does not kill chicken directly, the virus compromises the animal's immune system and makes chicken more prone to other deadly bacterial infections. The disease can be treated with medication such as tylosin. The likelihood of animal infection can be significantly reduced through vaccination (using vaccines as *triple aviar*).

2.2 The Intervention

We partnered with a public high school in Cajamarca region for our intervention. The school's enrollment rate is about 240 students, and covers grades 1 through 5 of the second level of education. The school received 20 computers in 2009 and, shortly after, their computer lab got access to internet connection. Our partnership with the school allowed us to conduct a field experiment, where students were randomly assigned to receive different types of media messages during their regular computer lab classes[9].

[8]Note that this disease is not related to the avian influenza that affected the poultry industry in the early 2000s. The avian influenza is caused by the highly pathogenic virus A/H5N1 and has been reported to infect human beings. The Peruvian Ministry of Agriculture tested the most important clusters of poultry production and discarded the presence of the A/H5N1 virus in the country (MINAGRI 2009). In contrast, the avian laryngotracheitis (LT) is caused by a different virus (*gallid herpesvirus*). LT has been recognized as a chicken disease in the U.S. since 1926, and there is no evidence about its transmission to human beings. While it economically harm farmers, there are no health risks associated with the husbandry or consumption of infected chicken.

[9]Table 1 compares our sample with other high school students in rural areas of Peru. Note that, while our study took place in a particular school, in general, the students of this school have similar characteristics (or are slightly worse off) than others in rural Peru.

We present the timeline of our intervention in Figure 1. Our 2010 scoping study helped us identify the most relevant agricultural problems in the area (described in Section 2.1). This study was complemented with a survey among students to measure their involvement in agricultural chores, internet usage patterns, social networks, and cognitive ability. We also collected a survey among students' parents to measure their socio-economic status. In this survey, we also identified the household members who were primarily in charge of the crop and livestock management[10]. The primary crop and livestock managers also provided information about their households' agricultural practices and helped us confirm the presence of the diseases we identified in the scoping study.

Once we identified the most relevant local agricultural diseases, we developed extension videos for the students during 2011. The videos provided advise on how to prevent and treat the most important diseases in the area. We prepared 11 videos with agricultural advice for corn (4), potatoes (3), guinea pigs (2), and chicken (2). The videos were structured in four sections. The first one explained how to recognize particular diseases (e.g., crop damage, animal symptoms, etc.). The second one provided a brief explanation of how the problem affected farmers' crops or livestock. The third one provided solutions to the problem, discussing both preventative measures and appropriate treatments to mitigate negative effects. The fourth part of the videos explained the rationale behind the recommendation, spelling out how the solution prevented or cured the disease.

We provide an example to illustrate the information provided through the videos. Figure 2 presents some screenshots of the video with advice about corn armyworms. First, we explain how to recognize the presence of armyworms in a plot. We show locally shot pictures of the most notorious symptom of armyworm infestation: the presence of large holes in the plants' leaves. We also show a picture of the insect, which is characterized by a large "Y" in its head. To provide some background, the video explains the reproductive cycle of an armyworm. The armyworm's cycle starts when an adult moth lays eggs in the corn's silk. When the eggs hatch, a caterpillar emerges and feeds on the plant's leaves (creating sizable holes). This is the stage in which the insect causes most damage to the corn plant. The caterpillar then spins a cocoon around itself and evolves into a pupa. The pupa becomes a moth after a few weeks, and the reproductive cycle of the insect starts again. After this brief explanation of the armyworm's symptoms and reproductive cycle, we introduce molasses traps as simple technique to prevent infestation. The procedure to set up a molasses trap is pretty simple: fill three quarters of a bucket with a mix of one part molasses with one part water; support the bucket on four sticks; and place it in the surroundings of the corn field. The video explains how the solution works by controlling the insects' adult population. The smell of the molasses attracts the adult armyworm moths, which get stuck in the bucket and cannot lay

[10] In 87% of the cases, the students' parents were the crop and livestock managers. There were some cases in which other relatives — such as grandparents (12%) or uncles (1%) — were the primary managers in the household.

eggs on the corn plants.

For the sake of brevity, we will not discuss the content of the other ten videos[11]. They all illustrated straightforward ways to detect the presence specific diseases in corn, potatoes, chickens, and guinea pigs. They also explained in detail how to implement simple and cost-effective solutions for these diseases.

We randomly assigned the students in the school to watch a specific video during the intervention. We used our 2010 baseline survey to identify the specific agricultural disease(s) that each student's household may have[12]. Within students whose households were affected by each disease, half of them were assigned to watch a video that explained how to prevent and treat one of the following problems: (1) blight (2) potato flea / leaf beetles, (3) corn earworms / earflies, (4) armyworms, (5) guinea pig bloating, (6) ticks / salmonellosis, and (7) chicken LT. The other half were assigned to watch a placebo video that encouraged oral hygiene.

Because our baseline was collected in 2010, some students had already graduated or dropped out of school by the time we started the screening of the videos in 2011. Out of the 241 students enrolled in 2010, 35 graduated and 26 dropped out of school[13,14] (Figure 3). Additionally, there were 56 new students who enrolled in the school in 2011[15]: 50 first-graders and 6 transfers from other schools. Unfortunately, we do not have baseline information for most of the students that enrolled for the first time in 2011, and do not know the specific agricultural problems that affected their households. In these cases, one of the agricultural extension videos or the placebo video was randomly assigned.

The video screening started in September 2011. The school already had in place a system in which students had to log into the computers using their (unique) user ID codes. In our intervention, upon logging into the computer and before they could access any programs, students had to watch a 1-2 minute video. The videos were watched by students individually through each computer monitor. Each computer in the lab had a headset and did not have speakers to avoid disturbing other students watching different videos in the room. Students were exposed to the videos during eight months (from September 2011 to August 2012, excluding a three-month Summer break). During this period, their households had gone through two agricultural cycles to implement the

[11] Videos are available upon request.

[12] Rather than reporting the specific names, enumerators were trained to diagnose certain agricultural diseases through respondents' explanation of the symptoms and characterization of the problems. Respondents also reported how severe they thought each problem was. When households reported more than one agricultural problem, we prioritized the most severe one. When there was a tie in choosing the most severe one, we randomly chose one of them.

[13] Some of these students had siblings that remained enrolled in 2011. Out of the 61 students who either graduated or dropped out in 2010, 22 (36%) had siblings who were already enrolled (and remained) in the school or registered for the first time (freshmen) in 2011.

[14] Note the dropout rate of our sample is 11%. This rate is similar to the average dropout rate in secondary schools in rural Peru.

[15] Out of these 56 new students, 20 (36%) had siblings who were already students in the school in 2010 (for which there is baseline information from their household surveys).

crop-related recommendations provided by the videos: one during the rainy and one during the dry season.

Because the intervention covered parts of two academic years, there were some students who were only partially exposed to the video screenings: 47 students graduated in December 2011 and other 33 dropped out of school. While these students could have potentially only watched the videos during the last quarter of 2011, they are still part of our estimation sample. Our intervention excluded new students who joined the school in 2012. All in all, most of our estimations are based on a sample of the 236 students registered in 2011.

Upon the end of the video screenings, we collected a follow-up household survey in September 2012. The survey was conducted among the students' parents (or other legal guardians). We collected information about the parents' knowledge of the agricultural practices taught in the extension videos and whether they had adopted any of these practices. Our aim was to assess if students had discussed with their parents what they had learned through the videos and if parents had learned from the intervention. Therefore, students were required *not* to be present during the interview. To minimize the possibility of children telling their parents about the extension video contents in anticipation of our survey, the interviews were unannounced and collected over a short period of time. We conducted 75% of interviews in five days (and 88% of them in a week).

3 Baseline Results and Compliance with Video Screening

Table 2 presents the summary statistics for our baseline sample of students (which was only collected among those who were enrolled in 2010[16]). We examine whether students in the treatment group (i.e., those who were assigned to watch any of the agricultural extension videos) and the control group (i.e., those assigned to watch the placebo video encouraging oral hygiene) are similar along several dimensions. Using administrative data from school records, we compare their age, grade in which they are enrolled, and their school performance (GPA in 2010). Based on our baseline survey, we also compare the time why spend working on agricultural chores, their patterns of internet usage, and their social networks. In addition, we also tested students' cognitive ability along five dimensions: identification, memorization, analysis, computation, and visualization[17]. Table 2 suggests that the random assignment yielded experimental groups that are balanced on observable characteristics.

We also present descriptive statistics of the students' households in Table 3. We consider that a household is in the treatment group if any of its members is a student who was assigned to

[16]Unfortunately, we do not have baseline information for students who joined the school for the first time in 2011.

[17]These cognitive tests were collected playing a Wii gam (*Big Brain Academy: Wii Degree*) during the third quarter of 2010..

watch one of the agricultural extension videos. We compare different dimensions that can affect the impact of the transmission of information from teenagers to parents; such as wealth, land ownership, and the characteristics of students' primary caretakers. We also identify members that act as farm managers in each household (one member who primarily decided about crop management and one who decides about livestock management), and compare the characteristics of farm managers with children in the treatment and control groups. Results in Table 3 suggest that, while the treatment was randomly assigned at the student level, this process also yielded households with similar observable characteristics in the treatment and control groups.

3.1 Compliance

We tracked students' login through their ID codes and were able to determine whether they watched our intervention's videos and the number of times they did. Overall, there was a reasonable rate of compliance: 75% of students watched the videos to which they were assigned at least once. The average number of times students watched the videos was 7. Among those who watched the videos at least once, the average number of times was 9.2 (with large variation, ranging from 1 to 70 times).

Still, one quarter of the students did not watch the videos at all. Table 4 shows the characteristics of the compliers and non-compliers in our intervention. There are several reasons that can explain the relatively large rate of non-compliance. First, our sample includes all students who were registered in school in 2011. We started screening the videos in September 2011, and the school year in Peru ends in mid December. Students who did not some back to school in 2012 (which includes 45 seniors who graduated in 2011 and other dropouts), only had a couple of months to watch the videos: only 56% of those who did not return to school in 2012 watched the video at least once. Second, as many other developing countries, student absenteeism is common in secondary schools in Peru. Our assignment of videos to students was based on the original enrollment lists, and the high rate of non-compliance might reflect students not attending school. The Peruvian Ministry of Education (2015) randomly visits public schools and estimates that, on any given day, 15% of students are not present in school[18]. This does not only reflect sporadic missed days of school, but also reflects a sizable degree of continued absenteeism from school: in 2010, 11% of students missed a number of days large enough to automatically fail their grade. Third, there was a limited number of computers in the school lab: there were 20 computers and the average class size in the school was 23.6 (ranging from 21 to 28). Therefore, some students had to sit with a classmate in the lab. Upon sitting in the computer lab, one of the students would use their ID to login and the video corresponding to that ID would be displayed. We encouraged teachers to have

[18] Based on surveys, Rivas (2015) estimates that 14.2% of 15-year-olds students miss 1-5 days of schools every two weeks.

students alternate who logged in if they usually paired up. Unfortunately, it was not possible to enforce this and teachers did not keep track of students who shared computers.

Table 4 presents the summary statistics of the students watched the videos at least once (*compliers*). It also presents the correlation between students' characteristics and the number of times they watched the videos they were assigned to. Reassuringly, we find no differences in compliance between students who were assigned to the agricultural videos and to the placebo video. This suggests that the content of the videos were not making the students more likely to watch them. We do find that students who graduated or dropped out of school in 2011 were less likely to watch the videos of our intervention[19]. We also find that non-compliers had lower baseline GPAs and scores in our cognitive tests. It is likely that these students had a larger probability of dropping out of school. It is also possible that these students were the ones who trailed (and did not use their login information) when he / she shared a computer with a classmate.

4 Empirical Strategy and Results

Our follow-up survey — collected a year later after we started the screening of the videos in the school — included a set of questions to assess whether the farm managers of the students' households learned about the agricultural practices that were disseminated through the videos of our intervention. We collected information about parents' knowledge of 15 agricultural practices that we can link to specific videos[20]. We also collected 17 questions about managers' adoption of practices[21]. Our main specification matches each practice j to the particular video that the student in farm manager i's household was assigned to watch:

$$Y_{ij} = \beta V_{ij} + \gamma X_i + \alpha_j + \mu_i + \varepsilon_{ij} \quad (1)$$

[19] Because of students in the 2011 graduating class are relatively older, non-compliers are also older on average.

[20] he set of questions about knowledge included: (1) appropriate timing of potato plant hilling; (2) removal of unharvested residues in potato plots; (3) application of fungicides for blight; (4) application of pesticides for potato flea beetled and leaf beetles; (5) removal of unharvested residues in corn plots; (6) insecticides to eliminate corn earworm and earfly; (7) application of oil in corn silk to prevent armyworm damage; (8) molasses traps for corn armyworms; (9) oviposition traps for armyworms; (10) *triple aviar* vaccination for chicken; (11) tylosin for chicken LT; (12) appropriate cleaning of guinea pigs' corrals; (13) cypermethrin baths to prevent tick infestation of guinea pigs; (14) enrofloxacin dosage to treat guinea pig salmonellosis; (15) appropriate airing of grass for guinea pig feed.

[21] The questions about adoption were the following: (1) whether the manager hilled the farms' potato plants between 30 and 45 days after sow; (2) time before removing potato plants infected with blight; (3) name of fungicide used to prevent blight; (4) whether the manager rotated different types of fungicides; (5) name of insecticides used for potato flea / leaf beetles; (6) frequency of weeding corn plants; (7) time before removing infected corn plants; (8) whether the manager used insecticides for corn worms; (9) whether the farm built oviposition traps for corn armyworms; (10) usage of oil drops on corn silk to prevent armyworm damage; (11) whether the farmer used *triple aviar* vaccines to prevent chicken LT; (12) whether the manager gave his / her chicken tylosin for LT treatment; (13) keeps guinea pigs in a specially designated corral; (14) frequency of cleaning guinea pig corrals; (15) bathes guinea pigs with cypermethrin; (16) number of hours of airing grass before feeding guinea pigs; (17) appropriate method of disposal of dead guinea pigs. For comparability of adoption of these practices, we recoded the adoption responses to binary variables.

where Y_{ij} is a binary variable of farm manager i's knowledge or adoption of practice j, V_{ij} indicates whether a student in farm manager i's household was assigned to watch a video with advice about practice j, X_i is a vector of control variables (including manager and household characteristics and stratification variables[22]), α_j is an indicator variable for practice j, $\mu_i \sim N(0, \sigma_\mu)$ is a random effect for farm manager i[23], and ε_{ij} is an error term[24]. Our sample size is relatively small and does not allow us to estimate the impact of the intervention on the knowledge or adoption of specific practices. We estimate the impact of the intervention on the *average* rate of knowledge and adoption across all the practices taught through our extension videos.

Equation 1 is based on the original video assignment (V_{ij}) — regardless of students actually watching the videos — and provides an Intention-to-Treat (ITT) estimate of the intervention. However, Section 3.1 suggest that students who watched the videos had overall different characteristics than those who did not: in general, they are younger, perform better in school, and have higher cognitive ability. Therefore, we also estimate Local Average Treatment Effects (LATE) using the video assignment as an instrument for the videos that students watched[25]. In particular, we estimate the following system of equations:

$$Y_{ij} = \theta W_{ij} + \gamma X_i + \alpha_j + \mu_i + \varepsilon_{ij} \quad (2)$$

$$W_{ij} = \delta V_{ij} + \lambda X_i + \tau_j + \eta_i + \nu_{ij} \quad (3)$$

where W_{ij} is an indicator variable for whether the student in farm manager i's household watched the video that was assigned to him / her, $\tau_j \sim N(0, \sigma_\tau)$, ν_{ij} is an error term, and θ is the LATE of teenagers' watching the agricultural extension videos.

4.1 Impact on Farm Managers' Knowledge

Table 5 presents the Intention-to-Treat estimates of the impact of our information intervention on farm managers' knowledge of agricultural practices. We present the results of our basic specification in the first column. We also include estimates controlling for manager and household

[22]This captures whether the student was assigned to a video based on the information collected at baseline or if he / she was new to the school in 2011 (and had no baseline information) and was assigned to a video at random.

[23]We assume that V_{ij} is not correlated with μ_i. Tables 2 and 3 show that the video assignment is not correlated with a large set of observable characteristics. Due to the random assignment, it is plausible to assume that it is not correlated with any other household unobservables either.

[24]While our analysis is based on a linear specification, note that other non-linear models — such as random effects probits — yield qualitatively similar results (not reported).

[25]Angrist and Pischke (2009, p. 161-162) argue that "An especially important case is when the instrument is generated by a randomized trial with one-sided noncompliance. In many randomized trials, participation is voluntary among those randomly assigned to receive treatment. On the other hand, no one in the control group has access to the experimental intervention. Since the group that receives (i.e., complies with) the treatment is a self-selected subset of those offered treatment, a comparison between those actually treated and the control group is misleading.... IV using randomly assigned treatment intended as an instrumental variable for treatment received solves this sort of compliance problem. Moreover, LATE is the effect of the treatment on the treated in this case."

characteristics in Columns 2 and 3. Unfortunately, these controls are only available for households with baseline information (i.e., these are not available for students who joined the school in 2011).

A year later after the start of the video screening among students, the ITT estimate suggests that our intervention increased farm managers' knowledge of agricultural practices by 8-10 percentage points (Panel A). This represents an increase of 26-34% of knowledge among farm managers whose children were assigned to watch videos with agricultural extension content, compared to those whose children watched the placebo videos. Students that graduated or dropped out of school in 2011 were only exposed to the videos for a few months. When we restrict our sample to students that remained enrolled in the school in 2012 (Panel B), the impact of our intervention is larger: parents of teenagers in the treatment group increased their agricultural knowledge by 37-50% compared to the control group.

Following equations 2 and 3, we also estimate the LATE of students watching the videos on farm managers' knowledge of practices. Table 6 presents the first-stage regressions (i.e., a regression of students watching the agricultural videos based on the random assignment) and the LATE (i.e., the effect of having a teenager watch the agricultural videos on farm managers' knowledge of agricultural practices) of our intervention. The LATE suggests that farm managers' knowledge of agricultural practices increase by 33-43% in the entire sample and by 43%-55% among household who had students that remained in school during 2012.

4.2 Impact on Farm Managers' Adoption

We also investigate if the information provided to teenagers encouraged the adoption of agricultural practices among farm managers. Table 7 presents our ITT estimates of the intervention on the adoption of 17 agricultural practices taught to school students through our extension videos. The ITT estimates based on all students in the sample are positive and relatively large (though not statistically significant at conventional levels): the adoption rate in the treatment group (with extension videos) was 13.7% to 17.6% larger than the one in the control group (who were assigned to watch placebo videos). However, when we restrict the ITT estimates to households with students who remained in the school in 2012, the estimates are larger (and statistically significant): the effect of the intervention on adoption was 19.4 - 32.2%.

Our estimates of the LATE are qualitatively similar to the ITT (Table 8). However, because the regression is based on those who *effectively* watched the videos, the results are somewhat larger: we find that farm managers with teenagers that watched the video increased their adoption of agricultural practices by 18 - 38% (albeit from a lower rate of adoption in the control group of about 20%) compared to those in the control group.

4.3 Differential Impacts of the Intervention

Our intervention was designed to assess whether information diffusion among teenagers can increase farm managers' knowledge and adoption of (previously unknown) agricultural practices. However, we are also interested to find out if increases in knowledge and adoption were relatively homogeneous or if they were heavily concentrated among certain groups. In this line, we investigate any differential impacts by age, levels of education, or gender of the farm managers. We estimate the following variation of Equation 1 to calculate heterogeneous ITT effects[26]:

$$Y_{ij} = \beta V_{ij} + \delta X_i V_{ij} + \gamma X_i + \alpha_j + \mu_i + \varepsilon_{ij} \tag{4}$$

where X_i is either the age (i.e., <45, 45-55, >55 years old), education (i.e., no education, primary, secondary or higher), or gender of the farm manager.

We present our estimates in Table 9. We find that younger farmers benefit more than older ones. In fact, the impact of our intervention on knowledge and adoption is very close to zero among farm managers that are 55 years or older. It is likely that older farmers had been implementing their own methods for much more extended periods of time and it might prove difficult to change their ways. We also find that our intervention might have been more effective among farmers with either low (with no education or incomplete primary) or high (complete secondary education or higher). We conjecture that this might be because the former might have had previous limited access to information and the latter might be better prepared to process the information provided about new agricultural practices. Finally, we find no differences in knowledge by gender (though we find that women are more likely to adopt new agricultural practices than men).

These results suggest that — while our intervention was quite successful increasing farmers' overall knowledge and adoption of new agricultural practices — there are distributional aspects that affect the intergenerational transmission of information. However, the distributional impact or our intervention is consistent with previous work that find differential impacts of education and age on technology adoption without intergenerational transmission of information (Abdulai and Huffman 2005; Fafchamps and Minten 2012).

4.4 Threats to Validity of Results

In this section, we discuss two particular threats to the validity of our results. The first one is households' misreporting their knowledge of agricultural practices: it might be the case that farm managers would report that they know about certain practices because of shame[27]. They might

[26] The LATE estimates — where we instrument W_{ij} and $W_{ij}X_i$ with V_{ij} and $V_{ij}X_i$— yield qualitatively similar results (not reported).

[27] For certain practices, we asked questions to assess farm managers; knowledge of particular details of a practice (e.g., how many days after sowing did you hill the potato plants?). However, for other practices, it was not possible to

have also felt that "gratitude" for the intervention that provided their children with educational videos at school. One possibility is that there was no intergenerational transmission of information at all and that our results are purely driven by misreporting. However, this is unlikely. Teenagers in the school were assigned to receive agricultural extension videos or a placebo video, but their parents were not directly informed about this. Therefore, for parents in the treatment group to systematically report higher rates of knowledge, they would at least have to be told by their children the broad content of the videos they watched (i.e., agricultural vs. placebo).

The evidence suggests that (at the very least) parents did find out through the teenagers whether they were assigned to videos with agricultural or placebo content. However, we can also check whether teenagers talked with their parents about the particular agricultural practices they were told about in the videos. We can exploit variation in the content of the particular agricultural video that was assigned to each student: within the treatment group, each student was assigned to watch videos related to one set of agricultural problems. For this purpose, we can estimate:

$$Y_{ij} = \beta V_{ij} + \delta V_i + \gamma X_i + \alpha_j + \mu_i + \varepsilon_{ij} \tag{5}$$

where V_i is an indicator variable for students who received *any* agricultural extension videos. If there is a systematic misreporting, $\delta > 0$ would reflect if parents reported increased knowledge of practices their children were not taught in the videos. Our estimates in Table 10 suggest that this is not the case. Our estimate of δ is very close to zero. In this line, improvements of knowledge among parents are taking place precisely in practices that were taught to their children in the intervention, and not from other sources. This suggests that the impact of our intervention is coming from intergenerational transmission of information.

Another threat for our identification strategy is the possible contamination of the control group. Our intervention took place in one school in rural Peru, where parents and children in this school had permanent contact with one another. On one hand, children who were assigned to watch agricultural videos could tell their school peers in the control group about the information on the practices they were taught in the videos. These peers in the control group might subsequently have told their parents about these practices (even when they did not receive the information directly through our intervention). On the other hand, parents who might have learned about agricultural practices from their children can convey this information other farmers (such as relatives, friends, or neighbors). These concerns would imply that there is contamination in the control group. However, this contamination would act *against* our results: parents in the control group would have higher knowledge rates than in the absence of any information spillovers. Therefore, our estimates would provide a lower bound of the true effect of our intervention. If anything,

ask these details (e.g. do you know about the importance of rotating contact and systemic fungicides to avoid blight resistance in potato plants?). While misreporting would be difficult for the former set of questions, it might be a concern for the latter.

our strategy for disseminating information would have been even more effective than our results suggest.

While we cannot control for information spillover effects between parents, we did collect information about the students' social networks at baseline. At baseline, we asked students to identify their two closest friends in the school. Using the random assignment of the treatment, we can determine the particular videos that each student's best friends were assigned to watch and can estimate:

$$Y_{ij} = \beta V_{ij} + \theta Fr_{ij} + \gamma X_i + \alpha_j + \mu_i + \varepsilon_{ij} \tag{6}$$

where Fr_{ij} indicates whether any of student i's closest friends were assigned to watch a video teaching practice j. We present our estimates for Equation 6 in Table 11. We find that social teenagers' social networks might have had a role in the diffusion of information. Parents of students who did not receive the information directly — but had close friends who did — reported higher knowledge rates.

5 Conclusion

We investigate the potential role of upper intergenerational transmission of information (from children to parents) to provide farm managers with agricultural advice. We set up a field experiment in a rural high school of Peru where half of the students were assigned to watch agricultural extension videos explaining simple and inexpensive farm management practices. The other half of the students in the school were assigned placebo video encouraging oral hygiene and provide a control group for our intervention. Students watched these videos (individually) in the school's computer lab during eight months. By the end of our field experiment, we collected a survey among the managers (usually the students' parents) in charge of the students' household farms. The survey gauged farm managers' knowledge and adoption of the agricultural practices taught to the students through the videos.

We find that farm managers of households with students that were assigned to watch the extension videos were more knowledgeable. On average, their probability of knowing about agricultural practices increased by 33%-50%, compared to farm managers with students in the control group. Even when parents did not *directly* receive information about agricultural practices, students were able to convey the information they had received. Albeit more modest, we also find positive effects on the adoption of agricultural practices taught in the videos among households with students who were provided with extension advice. We also investigate if our intervention had heterogeneous effects, and find that increases in knowledge and adoption rates were significantly higher among younger and more educated farm managers.

Due to the high costs of traditional extension systems, there is an increasing interest to adopt Information and Communication Technologies (ICTs) to provide farmers with agricultural advice. However, large levels of ICT illiteracy among farm managers in developing countries have thwarted this interest. Our research shows an innovative to bypass this constraint by channeling information through (more ICT-literate) children in their households.

Additionally, while our paper has focused on the potential role of upper intergenerational transmission of information to provide agricultural extension, this mechanism can potentially have many other applications. While more research is required, ICT-based information campaigns that target children can potentially be effective to indirectly provide adults with information and alter their decisions.

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Table 1: Comparison between Sample in the Study and Secondary Students in Rural Peru

	Sample	Rural Peru
School Characteristics[1]		
Enrollment	238	189.5
		(269.9)
% of female students	0.45	0.46
		(0.12)
Average age of students	14.8	14.9
		(0.9)
Number of teachers	12.0	13.0
		(13.4)
Pupil-teacher ratio	19.8	13.5
		(15.7)
Dropout rate	0.11	0.11
		(0.10)
Grade Promotion Rate	0.90	0.91
		(0.09)
Household Characteristics[2]		
Household Income	6.50	6.19
	(0.63)	(1.07)
Connection to electric grid	0.73	0.72
	(0.45)	(0.45)
Mother's years of education	3.85	4.05
	(3.10)	(3.30)
Student Characteristics[3]		
Height (cm)	148.71	151.28
	(3.56)	(5.40)
Weight (cm)	51.30	51.14
	(5.11)	(6.64)

[1] School data comes from the 2011 National School Census (*Censo Escolar).*

[2] Data for household income, connection to electricity grid, and mother's years of education come from our baseline survey and from the 2012 National Household Survey (ENAHO). To increase comparability, the statistics for rural Peru have been limited to households with students enrolled in public secondary schools.

[3] Data for students' height and weight come from the 2012 Demographic and Health Survey (ENDES). ENDES only provides data for girls 15 years or older. To increase comparability, we have restricted our sample to girls in the project school that are also 15 years or older.

Figure 1: Timeline of the Intervention

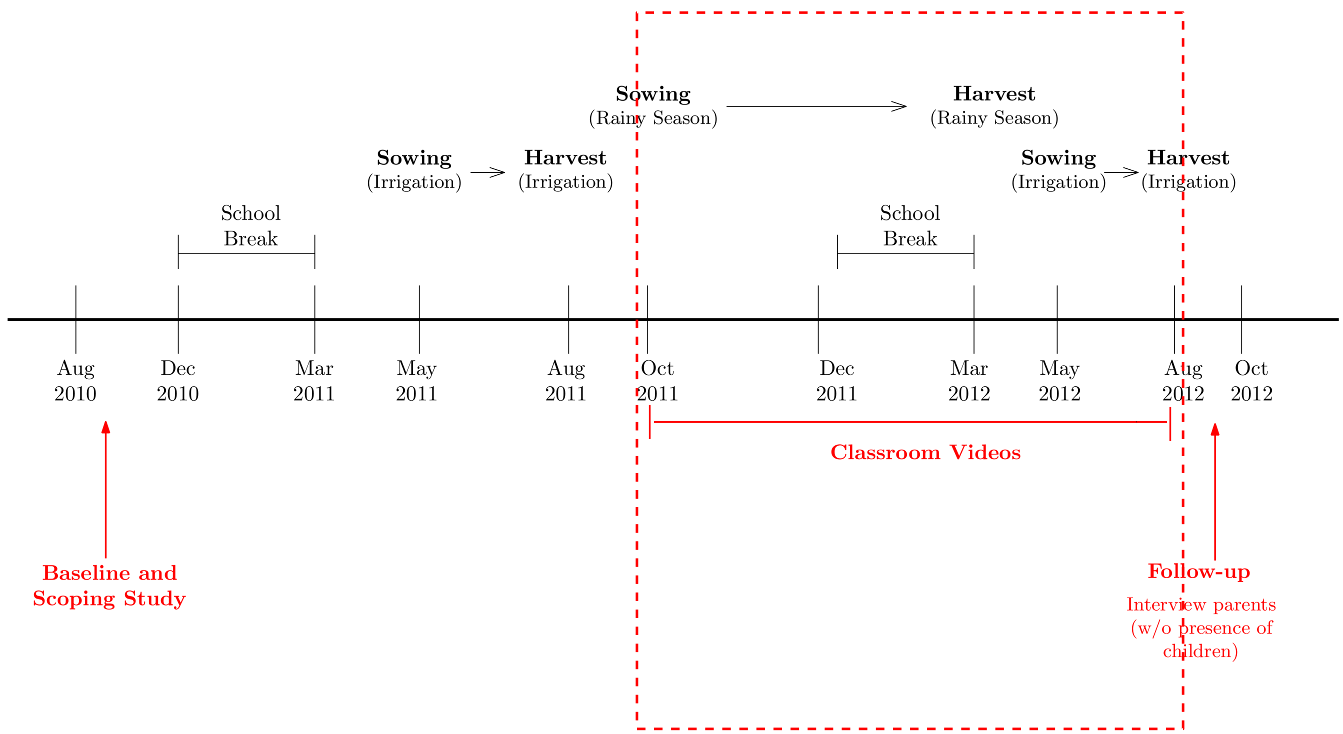
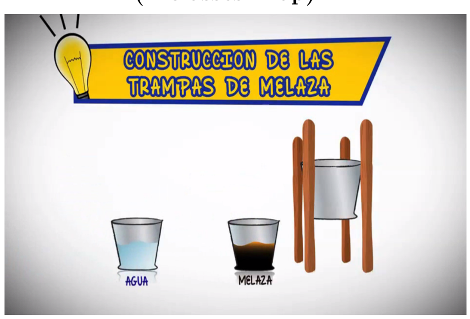


Figure 2: Video Example 1 - Molasses Trap for Corn Armyworm

How to identify the problem?

Explain the problem

Simple Solution (Molasses Trap)



How does the solution work?

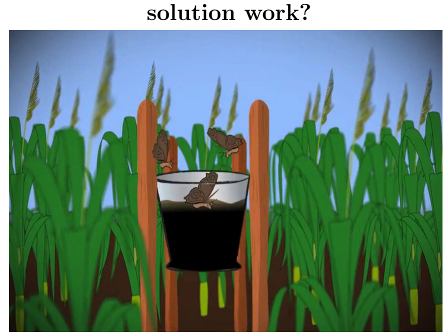


Figure 3: Sample of Students

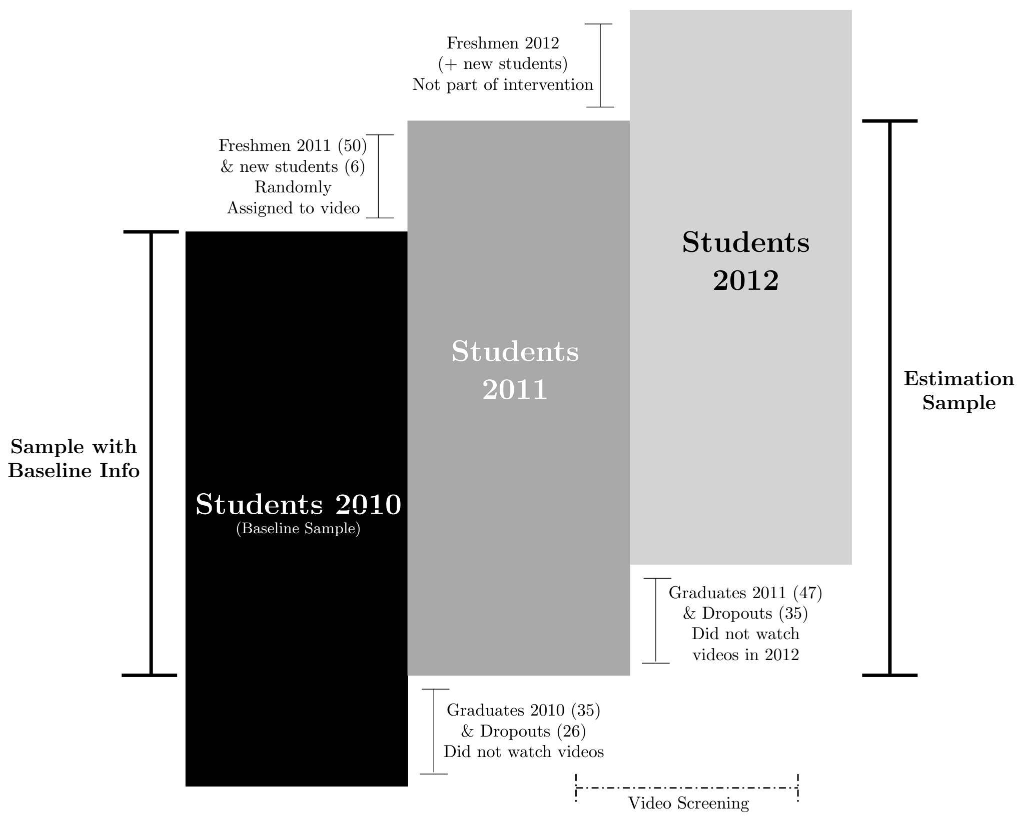


Table 2: Student Characteristics at Baseline[1]

Variable	Control	Treat	Diff	N_C/N_T
Age	13.52	13.84	0.32	87 / 92
	(1.55)	(1.54)	(0.23)	
Weekly hours of work in farm	16.10	18.04	1.95	87 / 92
	(12.76)	(13.93)	(2.00)	
GPA 2010 (standardized) [2]	0.04	-0.04	-0.07	86 / 92
	(0.92)	(1.07)	(0.15)	
Grade in 2010				
Grade 1 (2010)	0.26	0.26	0.00	87 / 92
	(0.44)	(0.44)	(0.07)	
Grade 2 (2010)	0.25	0.26	0.01	87 / 92
	(0.44)	(0.44)	(0.07)	
Grade 3 (2010)	0.25	0.24	-0.01	87 / 92
	(0.44)	(0.43)	(0.06)	
Grade 4 (2010)	0.23	0.24	0.01	87 / 92
	(0.42)	(0.43)	(0.06)	
Cognitive Function[3]				
Identify	-0.04	0.04	0.08	86 / 89
	(1.08)	(0.92)	(0.15)	
Memorize	0.01	-0.01	-0.01	86 / 89
	(0.97)	(1.03)	(0.15)	
Analyze	-0.01	0.01	0.03	86 / 89
	(0.93)	(1.07)	(0.15)	
Compute	-0.04	0.04	0.09	86 / 89
	(1.00)	(1.00)	(0.15)	
Visualize	-0.04	0.04	0.08	86 / 89
	(1.00)	(1.00)	(0.15)	
Average monthly hours of internet use	2.04	1.93	-0.11	79 / 85
	(2.59)	(2.14)	(0.37)	
Any friends in treat group [4]	0.82	0.80	-0.02	79 / 85
	(0.38)	(0.40)	(0.06)	
Joint Diff (Wald Test) - χ^2		7.04		
Wald Test (p-value)		0.90		

[1] Sample of students enrolled in 2010 (when the baseline survey was collected) and in 2011 (when the experiment was implemented).
[2] Grades come from administrative data provided by the school. GPAs were standardized ($\bar{x} = 0, \sigma = 1$).
[3] Cognitive dimensions were measured using Wii Big Brain Academy. Tests were conducted in May 2010. Results were standardized $\bar{x} = 0, \sigma = 1$.
[4] We collected information about each student's closest four friends and determine whether any of them was assigned to the treatment group.

Significance levels denoted by: *** 99%, ** 95%, * 90% .

Table 3: Household Characteristics at Baseline

Variable	Control	Treat	Diff	N_C/N_T
Household size	5.71	5.95	0.24	68 / 80
	(1.85)	(1.85)	(0.31)	
Log Monthly Household Income	6.55	6.46	-0.09	68 / 80
	(0.61)	(0.65)	(0.10)	
Log land size (m^2)	7.39	7.14	-0.25	63 / 74
	(1.92)	(1.95)	(0.33)	
HH owns any plot with irrigation	0.70	0.61	-0.09	63 / 74
	(0.46)	(0.49)	(0.08)	
Log irrigated land (m^2)	7.17	6.97	-0.20	44 / 45
	(1.92)	(1.84)	(0.40)	
Age of male caretaker[1]	43.58	45.45	1.86	60 / 67
	(11.04)	(9.95)	(1.86)	
Years of education of male caretaker [1]	5.83	5.87	0.03	60 / 67
	(3.09)	(3.33)	(0.57)	
Age of female caretaker [1]	40.66	42.14	1.48	68 / 80
	(10.13)	(9.88)	(1.65)	
Years of education of female caretaker [1]	3.82	3.53	-0.30	68 / 80
	(2.77)	(3.32)	(0.51)	
Household with agriculture	0.93	0.93	0.00	68 / 80
	(0.26)	(0.27)	(0.04)	
Farm Crop Manager[2]				
Ag Farm Manager is parent	0.79	0.81	0.02	68 / 80
	(0.41)	(0.39)	(0.07)	
Male Ag Manager	0.70	0.69	-0.01	63 / 74
	(0.46)	(0.47)	(0.08)	
Age - Ag Manager	44.46	45.97	1.51	63 / 74
	(10.88)	(11.58)	(1.93)	
Years of Education - Ag Manager	5.26	4.69	-0.57	62 / 74
	(3.07)	(3.15)	(0.54)	
Household with livestock	1.00	0.96	-0.04	68 / 80
	(0.00)	(0.19)	(0.02)	
Livestock Manager[3]				
Livestock Manager is parent	0.87	0.84	-0.03	68 / 80
	(0.34)	(0.37)	(0.06)	
Male Livestock Manager	0.32	0.32	0.00	68 / 77
	(0.47)	(0.47)	(0.08)	
Age - Livestock Manager	42.75	44.44	1.69	68 / 77
	(11.13)	(11.54)	(1.89)	
Years of Education - Livestock Manager	4.69	3.91	-0.78	68 / 77
	(3.25)	(2.64)	(0.49)	

[1] Information about student's parents. When parents are not present, we include information for grandparents or uncles / aunts in the household.
[2] Member of the hosuehold who makes agricultural farm decisions (crops).
[3] Member of the hosuehold who makes livestock decisions.
Significance levels denoted by: *** 99%, ** 95%, * 90% .

Table 4: Characteristics of Compliers and Non-Compliers

	Watched assigned video? [1]			# of times	N_{No} / N_{Yes}
Variable	No	Yes	Diff	watched video [2]	
Student assigned to	0.64	0.58	-0.06	-0.64	58 / 178
Ag video	(0.48)	(0.50)	(0.07)	(1.32)	
Student in 2012	0.42	0.76	0.35***	3.68**	55 / 174
	(0.50)	(0.43)	(0.07)	(1.40)	
Age in 2011	14.15	13.54	-0.60**	-0.20	41 / 138
	(1.46)	(1.56)	(0.27)	(0.52)	
GPA (standardized)[3]	-0.30	0.09	0.39**	0.96	41 / 137
	(1.06)	(0.97)	(0.18)	(0.82)	
Identify[4]	-0.23	0.06	0.29	1.27	37 / 135
	(0.98)	(1.00)	(0.18)	(0.84)	
Memorize[4]	-0.22	0.06	0.28	0.69	34 / 131
	(1.11)	(0.97)	(0.19)	(0.87)	
Analyze[4]	-0.25	0.07	0.32*	1.57*	39 / 134
	(1.04)	(0.98)	(0.18)	(0.83)	
Compute[4]	-0.33	0.10	0.42**	0.39	40 / 135
	(1.16)	(0.93)	(0.18)	(0.83)	
Visualize[4]	0.07	-0.02	-0.09	1.33	31 / 127
	(1.21)	(0.95)	(0.20)	(0.87)	
Log Monthly Household	6.54	6.45	-0.09	-1.11	41 / 138
Income	(0.48)	(0.66)	(0.11)	(1.30)	
Log land size (m2)	7.44	7.20	-0.24	-0.26	37 / 128
	(2.02)	(1.92)	(0.36)	(0.41)	
HH owns any plot	0.620	0.630	0.00	-1.09	37 / 128
with irrigation	(0.49)	(0.49)	(0.09)	(1.65)	
Log irrigated land, m2	7.19	7.02	-0.17	0.44	23 / 80
	(1.87)	(1.82)	(0.43)	(0.51)	
Age of	44.05	45.60	1.55	-0.10	37 / 128
Ag Manager	(7.34)	(11.86)	(2.06)	(0.07)	
Years of Education of	5.05	5.02	-0.04	0.24	37 / 127
Ag Manager	(3.13)	(3.12)	(0.58)	(0.26)	
Age of	43.00	43.53	0.53	-0.14*	41 / 135
Livestock Manager	(8.31)	(11.85)	(1.99)	(0.07)	
Years of Education of	4.17	4.39	0.22	0.56*	41 / 135
Livestock Manager	(2.83)	(2.99)	(0.53)	(0.28)	
Mean N Videos				6.990	

[1] Administrative information from server's log.
[2] Coefficients from the following regression: $NW_i = \theta X_i + \varepsilon i$, where NW_i is the number of times student i watched the intervention's videos and X_i is one of the student's characteristics (e.g., assignment to treatment, age, GPA, cognitive ability, etc).
[3] Grades come from administrative data provided by the school. GPAs were standardized ($\bar{x} = 0, \sigma = 1$).
[4] Cognitive dimensions were measured using Wii Big Brain Academy. Tests were conducted in May 2010. Results were standardized $\bar{x} = 0, \sigma = 1$.

Standard errors in parentheses. Significance levels denoted by: *** 99%, ** 95%, * 90% .

Table 5: Farm Managers' Knowledge[1]

A. All Students in the Intervention

	(1)	(2)	(3)
Student assigned to info about practice	0.0720*** (0.0222)	0.0992*** (0.0258)	0.1001*** (0.0258)
N. of obs.	2730	2220	2220
N of households	182	148	148
Manager's characteristics[2]	No	Yes	Yes
Household characteristics[3]	No	No	Yes
Control Mean	0.303	0.298	0.298

B. Students who remained in school throughout 2012

	(1)	(2)	(3)
Student assigned to info about practice	0.1084*** (0.0260)	0.1432*** (0.0303)	0.1428*** (0.0303)
N. of obs.	1965	1575	1575
N of households	131	105	105
Manager's characteristics[2]	No	Yes	Yes
Household characteristics[3]	No	No	Yes
Control Mean	0.304	0.290	0.290

[1] All regressions include indicator variables for practices and stratification variables.
[2] Manager characteristics: age, gender, years of education, and whether farm manager is student's parent.
[3] Household characteristics: log of landsize, whether household owns any plots with irrigation, and log of household monthly income.

Standard errors in parentheses. Significance levels denoted by: *** 99%, ** 95%, * 90% .

Table 6: Farm Manager's Knowledge (Local Average Treatment Effects)[1]

A. All Students in the Intervention

	(1)		(2)		(3)	
Dep Variable	Watch [2]	Know [3]	Watch [2]	Know [3]	Watch [2]	Know [3]
Student assigned to info about practice	0.7531*** (0.0087)		0.7902*** (0.0092)		0.7905*** (0.0092)	
Student watched Ag practice video		0.0955*** (0.0295)		0.1254*** (0.0327)		0.1266*** (0.0327)
N of obs.	2730		2220		2220	
N of Households	182		148		148	
Manager controls[4]	No		Yes		Yes	
Household controls[5]	No		No		Yes	
Control Mean	0.303		0.298		0.298	

B. Students who remained in school throughout 2012

	(1)		(2)		(3)	
Dep Variable	Watch [2]	Know [3]	Watch [2]	Know [3]	Watch [2]	Know [3]
Student assigned to info about practice	0.8229*** (0.0093)		0.8743*** (0.0092)		0.8741*** (0.0092)	
Student watched Ag practice video		0.1315*** (0.0316)		0.1635*** (0.0347)		0.1631*** (0.0348)
N of obs.	1965		1575		1575	
N of Households	131		105		105	
Manager controls[4]	No		Yes		Yes	
Household controls[5]	No		No		Yes	
Control Mean	0.304		0.290		0.290	

[1] All regressions include indicator variables for practices and stratification variables.\
[2] Indicator variable for student in household who watched the Ag Extension video assigned to him / her at least once. First stage of the Instrumental Variable Regression (following Equation 3).
[3] Indicator variable that measures whether the farm manager learned about the agricultural practices taught to their children. Local Average Treatment Effect of watching agricultural videos (following Equation 2).
[4] Manager characteristics: age, gender, years of education, and whether farm manager is student's parent.
[5] Household characteristics: log of landsize, whether household owns any plots with irrigation, and log of household monthly income.

Standard errors in parentheses. Significance levels denoted by: *** 99%, ** 95%, * 90% .

Table 7: Farm Managers' Adoption of Agricultural Practices[1]

A. All Students in the Intervention

	(1)	(2)	(3)
Student assigned to info about practice	0.0280 (0.0206)	0.0322 (0.0238)	0.0345 (0.0238)
N. of obs.	3094	2516	2516
N of households	182	148	148
Manager's characteristics[2]	No	Yes	Yes
Household characteristics[3]	No	No	Yes
Control Mean	0.204	0.199	0.199

B. Students who remained in school throughout 2012

	(1)	(2)	(3)
Student assigned to info about practice	0.0417* (0.0245)	0.0657** (0.0286)	0.0642** (0.0286)
N. of obs.	2227	1785	1785
N of households	131	105	105
Manager's characteristics[2]	No	Yes	Yes
Household characteristics[3]	No	No	Yes
Control Mean	0.216	0.205	0.205

[1] All regressions include indicator variables for practices and stratification variables.
[2] Manager characteristics: age, gender, years of education, and whether farm manager is student's parent.
[3] Household characteristics: log of landsize, whether household owns any plots with irrigation, and log of household monthly income.

Standard errors in parentheses. Significance levels denoted by: *** 99%, ** 95%, * 90% .

Table 8: Farm Manager's Adoption of Agricultural Practices (Local Average Treatment Effects)[1]

A. All Students in the Intervention

	(1)		(2)		(3)	
Dep Variable	Watch [2]	Know [3]	Watch [2]	Know [3]	Watch [2]	Know [3]
Student assigned to info about practice	0.7416*** (0.0084)		0.7748*** (0.0090)		0.7747*** (0.0090)	
Student watched Ag practice video		0.0376 (0.0278)		0.0414 (0.0307)		0.0443 (0.0307)
N of obs.	3094		2516		2516	
N of Households	182		148		148	
Manager controls[4]	No		Yes		Yes	
Household controls[5]	No		No		Yes	
Control Mean	0.204		0.199		0.199	

B. Students who remained in school throughout 2012

	(1)		(2)		(3)	
Dep Variable	Watch [2]	Know [3]	Watch [2]	Know [3]	Watch [2]	Know [3]
Student assigned to info about practice	0.8166*** (0.0090)		0.8544*** (0.0094)		0.8545*** (0.0094)	
Student watched Ag practice video		0.0513* (0.0301)		0.0769** (0.0335)		0.0753** (0.0335)
N of obs.	2227		1785		1785	
N of Households	131		105		105	
Manager controls[4]	No		Yes		Yes	
Household controls[5]	No		No		Yes	
Control Mean	0.216		0.205		0.205	

[1] All regressions include indicator variables for practices and stratification variables.
[2] Indicator variable for student in household who watched the Ag Extension video assigned to him / her at least once. First stage of the Instrumental Variable Regression (following Equation 3).
[3] Indicator variable that measures whether the farm manager learned about the agricultural practices taught to their children. Local Average Treatment Effect of watching agricultural videos (following Equation 2).
[4] Manager characteristics: age, gender, years of education, and whether farm manager is student's parent.
[5] Household characteristics: log of landsize, whether household owns any plots with irrigation, and log of household monthly income.

Standard errors in parentheses. Significance levels denoted by: *** 99%, ** 95%, * 90% .

Table 9: Heterogeneous Effect of Information on Farm Managers' Knowledge and Adoption (ITT estimates)[1]

	Knowledge			Adoption		
	(1)	(2)	(3)	(4)	(5)	(6)
Student assigned to info about practice[2]	0.1260***	0.1017***	0.0909**	0.0338	0.0861***	0.0726**
	(0.0405)	(0.0332)	(0.0390)	(0.0368)	(0.0303)	(0.0356)
Student assigned to info about practice x]40 - 55 years old]	-0.0303			0.0441		
	(0.0564)			(0.0513)		
Student assigned to info about practice x [55 + years old [	-0.0930			-0.0488		
	(0.0745)			(0.0673)		
Student assigned to info about practice x Primary or Incompl Secondary education		-0.0114			-0.1492***	
		(0.0559)			(0.0498)	
Student assigned to info about practice x Secondary education or higher		0.0551			0.1392	
		(0.1137)			(0.1036)	
Student assigned to info about practice x Male Farm Manager			0.0125			-0.0503
			(0.0522)			(0.0470)
N. of obs.	2220	2220	2220	2516	2516	2516
N of Households	148	148	148	148	148	148

[1] All regressions include indicator variables for practices, stratification variables, controls for household and manager characteristics (other than the ones for which each heterogeneous effect is estimated).

[2] Base categories are: (1) 40 years or younger, (2) no education or incomplete primary, and (3) female.

Standard errors in parentheses. Significance levels denoted by: *** 99%, ** 95%, * 90% .

Table 10: Effect of Receiving Any Advice on Farm Managers' Knowledge[1]

	(1)	(2)	(3)
Student assigned to	0.0721***	0.0995***	0.1004***
info about practice	(0.0223)	(0.0260)	(0.0260)
Student assigned to ANY	-0.0019	-0.0049	-0.0034
video with Ag advice	(0.0380)	(0.0390)	(0.0388)
N. of obs.	2730	2220	2220
N of households	182	148	148
Manager's characteristics[2]	No	Yes	Yes
Household characteristics[3]	No	No	Yes

[1] All regressions include indicator variables for practices and stratification variables.
[2] Manager characteristics: age, gender, years of education, and whether farm manager is student's parent.
[3] Household characteristics: log of landsize, whether household owns any plots with irrigation, and log of household monthly income.

Standard errors in parentheses. Significance levels denoted by: *** 99%, ** 95%, * 90% .

Table 11: Effect of Teenagers' Social Networks on Farmers' Knowledge[1]

	(1)	(2)	(3)
Student assigned to	0.0732***	0.1026***	0.1018***
info about practice	(0.0222)	(0.0258)	(0.0258)
Students' friends received	0.0519**	0.0672***	0.0671***
info about practice	(0.0234)	(0.0239)	(0.0239)
N. of obs.	2730	2220	2220
N of households	182	148	148
Manager's characteristics[2]	No	Yes	Yes
Household characteristics[3]	No	No	Yes

[1] All regressions include indicator variables for practices and stratification variables.
[2] Manager characteristics: age, gender, years of education, and whether farm manager is student's parent.
[3] Household characteristics: log of landsize, whether household owns any plots with irrigation, and log of household monthly income.

Standard errors in parentheses. Significance levels denoted by: *** 99%, ** 95%, * 90% .