BLUE SPOONS: SPARKING COMMUNICATION ABOUT APPROPRIATE TECHNOLOGY USE

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Abstract. An enduring puzzle regarding technology adoption in developing countries is that new technologies often diffuse slowly through the social network. Two of the key predictions of the canonical epidemiological model of technology diffusion are that forums to share information and higher returns to technology should both spur social transmission. We design a large-scale experiment to test these predictions among farmers in Western Kenya, and we fail to find support for either. However, in the same context, we introduce a technology that diffuses very fast: a simple kitchen spoon (painted in blue) to measure out how much fertilizer to use. We develop a model that explains both the failure of the standard approaches and the surprising success of this new technology. The core idea of the model is that not all information is reliable, and farmers are reluctant to develop a reputation of passing along false information. The model and data suggest that there is value in developing simple, transparent technologies to facilitate communication.

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1. Introduction

In developing countries, agricultural technologies often diffuse slowly between farmers, even when they appear beneficial for those who take them up (Kondylis et al., 2017; Duflo et al., 2020; Beaman et al., 2021). Slow farmer-to-farmer diffusion lowers the effectiveness of a standard approach to introduce new agricultural technologies—relying on a few pilot farmers to experiment with new technologies and diffuse them to their peers (Franzel et al., 2013; Taylor and Bhasme, 2018; Dar et al., 2020). The slow rate of technological diffusion may be one factor underlying the slow adoption of new agricultural practices in much of the developing world, particularly in Africa (Morris et al., 2007; Suri and Udry, 2022). Why is it that, in many contexts, farmers do not appear to learn much from each other? A leading explanation is motivated by classic epidemiological models of information transmission in social networks: farmers may be stuck in a "low communication-low innovation" equilibrium, and reducing the cost of communication or increasing the benefits of innovation would spur transmission (Kermack and McKendrick, 1927; Bass, 1969; Bailey et al., 1975; Jackson, 2008; Jackson et al., 2014). This explanation is consistent with the fact that in settings of rapid technological change in agriculture, there also does seem to be more social learning (Conley and Udry, 2010; Foster and Rosenzweig, 1995).

In this paper, we design an experiment to test implications of this standard model, and we show that it is not supported by the data. We then propose a new model that introduces the idea that information may be unreliable and that farmers may not like to develop a reputation for sharing unreliable information—as in Chandrasekhar et al. (2019) and Banerjee et al. (2021). The data is much more consistent with this new model, suggesting that it is important to take into account social norms when trying to understand why people chose to share information and when designing interventions to help them to so.

This work was motivated by a set of pilot experiments with small-scale maize farmers in Western Kenya over six subsequent seasons in the early 2000s, which showed that social learning was very limited (Duflo et al., 2008). Farmers were randomly chosen from the community and encouraged to set up experimental test plots on their fields to experiment with fertilizer and hybrid seeds—as in the subsequent work of Duflo et al. (2020) and Dar et al. (2020). The fertilizer adoption rates among the farmers were measured over several subsequent seasons, as well as among their neighbors and social contacts.

The findings from these experiments were striking: farmers were 10 percentage points (62.5%) more likely to continue using fertilizer in a given season if they had been test plot farmers in the previous season. However, their neighbors and friends did not increase their own usage unless they were explicitly invited by the experimenter to witness the key moments of the demonstration—planting, fertilizer application, and harvest—in which case their adoption increased as much as that of the test plot farmers. These results suggest that learning from what is happening on another field is possible, but does not occur spontaneously in this context.[1]

This lack of social learning is consistent with a "susceptible, infected, susceptible" (SIS) model. The basic model posits some cost to seeking people out to discuss agriculture. With some probability, people in the community will receive information about agriculture, and with some probability, they might also forget it. If a farmer decides to share their information, others also get to learn it. This simple setup can lead to multiple equilibria: when the cost of communicating is high or information is not very valuable, farmers may not seek out information, and ideas die before they can spread. The overall stock of information in the community is low, and there is little communication. In contrast, when the cost of communicating is lower or when the information is more valuable, people find it worthwhile to communicate, and ideas spread before they are forgotten. There is thus more information in the network, which spurs even more communication.

While the empirical facts were consistent with this model, these first experiments were not set up to test it explicitly. The model has the straightforward implication that if the cost of communication drops or the value of information increases, we should see more communication (and potentially much more). To test this prediction, we designed and implemented a full-scale experiment where we lowered the costs of communication and increased the value of correct information about fertilizer. Critical to our experimental design was the ability to trace the diffusion of a new technology and a new piece of information. Thus, we introduced a new technology to random seeds in the network and then traced its diffusion in the network under various experimental conditions.

Specifically, we implemented an RCT with 26,856 small-scale maize farmers across 184 clusters (school catchment areas) in Western Kenya. Our experiment features two treatment arms that are cross-randomized across clusters. First, the *cooperative* treatment sought to lower the cost of communication for a random subset of clusters by encouraging them to form cooperatives to discuss agricultural issues. Participants were nudged to attend meetings through the provision of soft drinks, but no specific information was provided. The idea was to see whether getting farmers together and creating a space specifically devoted to discussing agriculture would lead them to share knowledge and experiences.

Second, the *coupon* treatment was designed to increase the value of communication by offering farmers time-limited coupons for a 15% discount on fertilizer redeemable at local fertilizer shops. This treatment was motivated by a finding in our previous work that showed offering free delivery of top-dressing fertilizer right at harvest time (when people have money)

[1]More recently, Duflo et al. (2020) find very similar results from a program where coffee farmers were trained using a demonstration plot method: farmers invited to the training learned even if the demonstration was not held on their plot, but farmers in their social network who were not invited did not. In contrast, Dar et al. (2020) find that awareness of a new rice seed increased in villages where demonstration plots were set up, suggesting that this prompted communication. They do not study adoption, however.

led to a considerable increase in fertilizer adoption (Duflo et al., 2011). The idea was to spur fertilizer adoption (and potentially experimentation by new people) and increase the value of getting useful information about fertilizer usage.

Finally, we introduced the *blue spoon*, a new technology that we could trace through social networks. This was a kitchen measuring spoon, with the handle dipped in blue paint (Figure 1), meant to help farmers measure out the recommended quantity of fertilizer to be applied for each hole mid-season. In each cluster, a randomly selected 15% of farmers received a free blue spoon (*blue spoon farmers*) along with information that the quantity measured by the spoon had been found to yield the highest profits in previous trials in the region (Duflo et al., 2008). Farmers were encouraged to spread awareness of the spoon. The remaining farmers were not directly informed of the blue spoon but could purchase them for a nominal fee (Ksh 5, $0.05) at a local fertilizer shop.

The experiment covered two farming seasons: some schools were visited in the first season, some were visited in the second season, and some were visited twice. At the end of the second season, farmers were given a publicly administered *short endline survey* assessing their knowledge of the blue spoon and fertilizer and their usage of fertilizer. We also conducted an in-depth, *detailed survey* three to six months after the end of the second season. Our primary outcome variables in these in-depth surveys measure (i) communication (about fertilizers, blue spoons, and other topics such as seeds and storage), (ii) knowledge of the amount to use per planting hole for top-dressing fertilizer, and (iii) usage of fertilizers and purchase of blue spoons. To further assess communication, at baseline, we randomly selected a quarter of the farmers to list up to three contacts with whom they regularly discussed agriculture, and then later also followed up with a randomly selected contact (*friends*).

The treatments were well implemented and had the intended immediate impacts: cooperatives were formed and met regularly, and coupons were redeemed and increased the take-up of fertilizer, as in Carter et al. (2021).[2] Meanwhile, the blue spoon treatment significantly increased knowledge of the recommended quantity of fertilizer. Knowledge and ownership of the blue spoon rapidly circulated in the network: friends of blue spoon farmers were more likely to have heard about the blue spoon, to own one themselves, and to know the recommended quantity of fertilizer to use. Given this, we can test the empirical predictions of the SIS model, and we do not find strong support for it. First, looking at friends of blue spoon farmers—most of whom are from the same school cluster and would thus be in the same treatment groups—we find no impact of either the coupons or cooperative treatment on the probability that a blue spoon farmer's friend had heard of the blue spoon or knew the recommended quantity of fertilizer. Second, in the network more broadly, we find no impact

[2]Carter et al. (2013, 2021) evaluate a temporary fertilizer coupon program in Mozambique and find persistent increases in maize yields, as well as spillovers in social networks on fertilizer adoption, yields, and beliefs about the returns to fertilizer.

of the coupons on the probability that a non-blue spoon farmer knew about the blue spoon or about the recommended quantity of fertilizer. We do find a positive effect of the cooperative treatment on these outcomes, suggesting that this topic may have come up in meetings: non-blue spoon farmers in cooperative groups were 6 percentage points more likely to have heard about the blue spoon, to know its price, and to own one (relative to 28% owning one in control schools). However, they are no more likely to know the recommended quantity of fertilizer. In fact, overall knowledge of the appropriate quantity of fertilizer is significantly lower in cooperative schools than in other schools in the season following the program.

These results are consistent with farmers' answers to direct questions on communication. The blue spoon itself seemed to spur a host of conversations among people who received it: blue spoon farmers not only report talking more about the blue spoon and the right quantity of fertilizer, but also about all the other agricultural topics we asked about as well. In contrast, in coupon schools, farmers talk only slightly more about fertilizer, while in cooperative schools, if anything, they talk *less* about fertilizer and agriculture in general. Thus, school-level treatments did not seem to have succeeded in spurring communication.

While this set of results was unexpected, it is consistent with a growing literature on endogenous communication in networks (e.g., Niehaus, 2011; Galeotti and Rogers, 2013; Calvó-Armengol et al., 2015; Bursztyn et al., 2019). This literature shows that making communication more public can under some conditions reduce information exchange and knowledge (Chandrasekhar et al., 2019; Banerjee et al., 2021). Building on this work, we propose a modification of the baseline SIS model that introduces information reliability as well as an image concern in the decision to engage in information sharing (as in Chandrasekhar et al. (2019) and Banerjee et al. (2021)). In the model, people receive information that is reliable with some probability r (and otherwise unreliable). There are two kinds of people: those who like to talk no matter how reliable their information is, and those who only want to spread reliable information. Everyone would like to be considered reliable. In the absence of any intervention, there is a mix of reliable and unreliable information in the network.

While this is certainly not the only model appropriate for our setting, it can be parsimoniously mapped to the interventions in our experiment, and its implications are consistent with our results. First, discussion cooperatives decrease communication costs but also make information sharing more public. In the model, this may lead to a reduction in the willingness to share, especially among reliable types, which can lead to a reduction in the quality of information available — consistent with what we find in our experiment. Second, coupons change the marginal value of communication for those who are not already purchasing the fertilizer. In the model, this may have ambiguous effects depending on the marginal value of the information and the reputational costs of low-reputation types' increased willingness to communicate. However, beyond some threshold, coupons generally increase information sharing, which is what we find in this case. Third, blue spoons give people a reliable piece of information, making reliable types more willing to share, which in turns reduces reputation risks and makes everyone else more willing to share as well. This is consistent with the increased communication in response to the blue spoon treatment.

Most experimental studies find very slow diffusion of new technologies through social networks. The introduction of the blue spoon was an exception, as it diffused extremely rapidly. The model suggests an explanation for the original puzzle: farmers are reluctant to share information when they can be blamed if it is inaccurate. This helps highlight the key features of the intervention that enabled the blue spoon to spread: it was transparent, credible, simple to use, and easy to explain to others. These insights can help guide the design of future agricultural innovations to maximize their adoption.

2. Setting, Pilot Experiment and Motivating Model

Our study investigates communication and fertilizer use among maize farmers in Busia district, a poor rural district in Western Kenya. In the early 2000s, we conducted a series of small-scale experiments that documented a lack of communication among farmers and limited social learning. Motivated by the results of this experiment, we developed a model of communication based on a standard SIS model and in 2010, designed and implemented a large-scale field experiment to test its implications. In this section, we report on the setting and the key findings of the pilot experiments conducted in the 2000s, and we present the simple model inspired by these earlier findings.

2.1. **Setting.** The vast majority of households in Western Kenya are engaged in small-scale maize farming. Each year, there are two farming seasons, defined by the duration of the rains. The "short rains" usually last from late October to December, while the "long rains" last from March to May. For maize, two types of fertilizer were generally available at the time: *diammonium phosphate* (DAP) fertilizer, used at planting, and *calcium ammonium nitrate* (CAN) fertilizer, used as top dressing when the maize plant is knee-high (approximately one to two months after planting).

2.2. **Pilot Experiment.** We previously documented two facts based on our pilot experiments (Duflo et al., 2008). First, there are high returns to the adoption of CAN fertilizer if farmers have proper knowledge of how much to use per planting hole. Second, despite these documented returns, usage remains relatively low: in a 2000 survey, only 19% of households reported using any fertilizer in the past year.[3] Below, we report the impacts of experimental trials on fertilizer use among farmers and their social contacts.

[3]In later surveys, we find some evidence of increased usage: in a separate 2011 survey, only 33% of farmers reported using CAN in the past 12 months, while 60% reported using either CAN or DAP.

Design. Beginning in July 2000, we conducted six field trials over three seasons. Together, the trials involved about 559 farmers, plus 868 of their friends and neighbors.[4] Farmers were randomly selected from lists of parents of students enrolled at local schools. Before each experiment, we asked farmers in treatment and control groups to nominate up to three farmers with whom they regularly discussed agriculture (whom we refer to as "friends"). We also identified geographic neighbors of the farmers. Across all treatments, friends and neighbors were welcome to drop in on the field at any time. However, in some of the trials, we explicitly invited a randomly selected friend to attend the key phases of the trials.

The trials took place at experimental test plots on farmers' fields. Before each planting season a field officer measured three adjacent 3-by-10-meter plots on the farm of each treatment farmer. These plots comprised a very small fraction of the acreage typically devoted to maize (which is close to one acre on average). For each farmer in the treatment group, some small sub-plots of their experimental test plot were randomized to receive additional inputs while other small sub-plots served as a control group.

In the first two trials, one sub-plot was randomly assigned to receive CAN fertilizer to be applied as top dressing. On a second sub-plot, the full package recommended by the Ministry of Agriculture was implemented. Beyond CAN fertilizer, this also entailed hybrid seeds in place of traditional varieties, as well as DAP planting fertilizer. The third plot was a comparison plot on which farmers were instructed to farm as usual with traditional seed and without fertilizer. There were some small variations in the specific field treatment conducted in subsequent years (in particular, in some trials farmers simultaneously experimented with different quantities of CAN fertilizer per plant), but the overall design remained the same.

The study paid for the cost of the extra inputs (fertilizer and hybrid seed). Field workers applied fertilizer and seeds with the farmers, followed the farmers throughout the growing season, assisted them with the harvest, and weighed the maize yield from each plot. Aside from these visits, the farmers were instructed to farm their plots just as they otherwise would have. Interviews with the farmers and field observation suggest that they did so. At the end of a growing season, the maize was harvested and weighed with the farmer.

Results. In Duflo et al. (2008), we report the average yields and profits for the different experimental conditions, finding large returns to using the usually recommended quantity of CAN fertilizer as top dressing (half a teaspoon). Here, we focus on three key findings related to subsequent adoption by treated farmers and their social contacts.

First, having a demonstration plot on one's own farm increases subsequent fertilizer use for up to three seasons (Table 1, Panel A). In the first season after the program, adoption of fertilizer increased by 10 percentage points, or 63% ($p = 0.06$, Column 1). Participating farmers could have learned that fertilizer was profitable, or they could have learned how to

[4] Duflo et al. (2008) provide additional details on the design of these trials.

use it properly in order to make it profitable. The fact that the results persisted over time suggests that they were satisfied with adoption: the effects were relatively stable at 10 and 9 percentage points on second and third subsequent seasons, respectively, but were more noisy ($p = 0.13$ and $p = 0.39$, Columns 2 and 3, respectively).

Second, however, neither their neighboring farmers nor the people they nominated as their information contact increased their fertilizer use (Table 1, Panel B). One possible explanation is that results are very farmer-specific and that there is not much to learn from the experience of a neighbor or a friend (Munshi, 2004). Another is that farmers do not spontaneously discuss agriculture with others, even when they have learned something that they found useful.

To distinguish the two hypotheses, we examine in the second row of Table 1 Panel B adoption by the friends who had been explicitly invited to witness the key phases of the treatment (planting, fertilizer adoption, and harvest). Our third finding is that these invited friends are 10 percentage points more likely to adopt fertilizer in the next season ($p = 0.06$, Table 1, Panel B, Column 1, row 2). This is despite the fact that only 43% of them came to the training, making this an intent-to-treat effect. The results suggest that friends also adopt fertilizer in the first season after witnessing the treatment, although this effect is not persistent.

2.3. **A Motivating Model.** We present a model that can explain these results. We consider a "susceptible, infected, susceptible" (SIS) environment with endogenous participation. We assume a continuum of identical individuals who exchange information in a communication social network in continuous time. The stock of information contained in this social network is denoted by $I = I(t)$. Individuals receive private information at rate α, which captures private signals through experimentation or information obtained from outside the network. The social stock of information depreciates at rate η, which captures forgetting or changes in relevance of prior information.

Participation in social learning is endogenous: individuals have the option to join the communication network and share information with others. For simplicity, we model this as a once-and-for-all investment in social capital prior to the information exchange, denoted by $s_i \in \{0, 1\}$. Only those who choose to share information do so. As they share, not only do they contribute with their information α, but the social interactions also feeds back into the stock of information by a rate q, which may reflect the fraction of information retained in conversations. Specifically, let S denote the share of individuals socializing. The stock of information in the network evolves as follows:

$$\dot{I} = S\alpha + SqI - \eta I. \tag{2.1}$$

In the steady state equilibrium, we have $\dot{I} = 0$, and then we can define the steady-state stock of information $I^\star$ as a function of S:

$$I^\star(S) = \frac{S\alpha}{\eta - Sq}. \tag{2.2}$$

We now consider the decision to join the network. Define the marginal utility of endogenous communication as $g(I^\star) - c$, where c is a participation cost.[5] The function $g(.)$, which is weakly increasing, represents how farmers map the information they obtain into actual farming outcomes. For example, if farmers cannot act upon the information they obtain, perhaps because some inputs are too costly, then $g(I) = 0$. This marginal utility implies a cut-off strategy: an individual chooses to socialize ($s_i = 1$) if and only if $c < g(I^*)$. We capture heterogeneity in costs by assuming a stochastic cost, $c \sim F$ with mean μ. In equilibrium, the share of individuals socializing equals:

$$S := F\left[g(I^*)\right]. \tag{2.3}$$

This equilibrium condition is defined implicitly, since I^* also depends on S and is not necessarily unique. Naturally, the socialization rate increases or decreases with changes in the social stock of information, I^*, in the returns to information $g(.)$, or with shifts in the cost distribution F. In the general case, the share of people who participate in the social network—and thus the knowledge available on it—increases (i) when costs of communication fall; (ii) when the marginal payoff in information increases; or (iii) when the transmission rate increases. Proposition 2.1 formalizes these comparative statics.

Proposition **2.1** (Comparative statics)**.** *Fix all parameters of the model except the mean of the distribution F, the function $g(.)$, and the transmission rate q.*

(1) Let the mean of F go from μ to $\mu - \delta$ for some $\delta > 0$. Then, in any equilibrium, socializing increases: $\partial S/\partial\delta > 0$.
(2) Let $g' > g$. Then, in any equilibrium, socializing increases: $S' := F[g'(.)] > F[g(.)] = S$.
(3) Let the transmission rate change to $q' > q$. Then, in any equilibrium, socializing increases: $\partial S/\partial q > 0$.

All proofs can be found in Appendix A.

In summary, the simple model shows that a sufficiently high reduction in socialization cost or a sufficiently large increase in the marginal benefits of information can switch society from an uncommunicative to a communicative equilibrium. These insights motivated our

[5]Note that this does not necessarily mean that the small private information that the agent receives is entirely useless on its own. Rather, the model operates through net benefits and so focusing on the marginal utility is sufficient for the analysis.

experimental design—described below—which aimed to spur communication and technology adoption by lowering the cost of communication and increasing the potential value of information.

3. Experimental Design, Timeline, and Data

To test the predictions of this simple model, we designed and conducted a large-scale experiment with maize farmers in Western Kenya over two consecutive agricultural seasons in 2010 and 2011.

We recruited study participants by organizing meetings with parents of 184 primary schools. In each school, children were given a letter inviting their parents to a meeting to take place at the same school, scheduled around harvest time. Every parent or other family member who arrived at any of the school meetings was eligible to participate in the study, provided they were at least 18 years old. At these meetings, surveyors explained the purpose of the study and implemented the different school-level treatments (discussed below). They then conducted a brief baseline survey with each participant. In return, participants received a bar of soap (a popular reward) as compensation for their time. Subsequently, we collected follow-up data through similar short surveys conducted at schools as well as in-depth surveys of a randomly selected subset of farmers and their friends conducted at participants' homes.

3.1. **Experimental Design.** Figure 2 Panel A shows an overview of the experimental design. Our experiment has three main treatment arms, explained below: (1) discussion cooperatives, (2) coupons, and (3) blue spoon. The first two treatments were cross-randomized and implemented at the school level, with the goal of altering the cost and/or value of communicating. In contrast, the blue spoon treatment randomly introduced a new technology at the individual level and was designed as a diagnostic tool to measure the impact of the school-level treatments on the circulation of identifiable information in the network.

Discussion cooperatives. The cooperative treatment was designed to reduce communication costs by encouraging farmers to discuss and share knowledge about fertilizer and other agricultural practices.[6] During the school meeting, field officers encouraged farmers to create discussion groups to talk about agricultural issues and share information. Farmers could choose to form new groups or continue meet in their existing groups. Field officers helped facilitate and coordinate the first meeting without providing any direct agricultural information to farmers.[7] In this treatment group, farmers therefore knew that there was a public forum in which to ask each other questions.

[6]Scripts for all meetings can be found in Appendix C.

[7]Field officers were present in the groups' first meeting to hand out sodas and remind them of the benefits of discussing farming with others and ideas about topics to discuss.

Discount coupons. This treatment provided farmers with time-limited discounts for fertilizer around the time of harvest, motivated by previous work documenting how small time-limited encouragement to use fertilizer around the time of harvest (when farmers have liquidity) can substantially increase fertilizer use (Duflo et al., 2011). At the end of the school meeting that explained the benefits of fertilizer and the details of the coupons, each participant of the meeting was individually given a coupon redeemable for a discount at local fertilizer shops for about three weeks. The coupon entitled each farmer to a 15 percent discount for up to 25 kilograms of any combination of DAP and CAN fertilizer.

Control meetings. Study participants who received neither of the two school-level treatments were provided an active control intervention. The school meeting consisted of talks given by field officers about the importance of food safety (during the first season) and waste management and disposal (during the second season). These topics were chosen to be of interest to farmers but unrelated to fertilizer use and farming. As in the other meetings, all meeting participants were then invited to complete the baseline questionnaire.

Blue spoons. The final treatment was randomized at the individual level within each school and consisted of handing out a simple fertilizer measuring tool: a blue spoon (see Figure 1). This small spoon measures the amount of fertilizer that we had found yielded the highest average profits in the pilot experiments (Duflo et al., 2008). At each school, 15 percent of farmers were randomly selected for the blue spoon treatment (*blue spoon farmers*) and invited to a second meeting that took place in groups of up to five farmers at the school premises a few weeks after the first meeting.[8] All farmers who participated in this second meeting were given a blue spoon along with the information that the CAN quantity measured by the spoon had been found to yield the highest average profits among the three quantities tested. Since the previous trial had not considered planting fertilizer (DAP), no information about the quantity of DAP was provided.

Finally, to enable others to adopt this tool and thus to enable diffusion, blue spoons were also made available to anyone (regardless of their treatment status) for a nominal price (Ksh 5, or about $0.05) at shops in local market centers that also handled the discount coupons. To encourage diffusion of blue spoons, each blue spoon farmer was given ten small sheets of paper that contained information about where to purchase a blue spoon, which they could share with their friends and neighbors.

The rationale for this treatment was that since the blue spoon is a novel, easily identifiable object, it would be very straightforward to trace its diffusion in the network. The primary outcomes of the experiment were knowledge and ownership of the blue spoon itself, as well

[8]In the first season, the blue spoon meetings were randomized to take place 1, 3, or 6 weeks after the first meeting. In the second treatment season (the long rains), blue spoon delivery was delayed until just before the optimal time to apply top-dressing fertilizer on the maize plants.

as knowledge about the appropriate quantity of fertilizer. In addition, some properties of the blue spoon make it an interesting object to study by itself: it is unfamiliar and looks interesting (nobody had seen a measuring spoon painted in blue); it encodes credible information (given our partner NGO's reputation in the area and the written document we gave with it); and it is an easy-to-use complement to a familiar technology (to measure the right amount of fertilizer to use).

3.2. **Timeline.** Figure 2 Panel B summarizes a timeline of the experiment. The above treatments were administered in 184 schools between July 2010 and January 2011. The first set of meetings with 119 schools took place in July and August 2010, and the second set of meetings with 123 schools was conducted in December 2010 and January 2011. We visited about a third of the sample (61 schools) only in the first season, about a third (65 schools) only in the second season, and about a third (58 schools) in both seasons.

In schools that were visited twice, the coupon treatment was administered twice, i.e., farmers received coupons for fertilizer discounts in two consecutive seasons. The cooperative treatment was only administered once, i.e., farmers were only encouraged to form cooperatives during the school meeting in the first season. In the second season, farmers were encouraged to keep meeting in their cooperatives but not to form new cooperatives. In addition, we invited an agricultural extension officer to meet and talk with cooperative members about land preparation without offering information about fertilizer.[9] The corresponding control schools were visited twice as well and were again administered a control script about waste management and disposal. Finally, the blue spoon treatment was only administered during the first meeting at each school, i.e., blue spoon farmers were only given a spoon and the associated information on one occasion.

The experiment began with 119 schools in July 2010 in anticipation of the following short rains season. Since the coupon treatment was to be administered around the time of harvest, we chose the timing of school meetings such that most farmers had started harvesting the crops planted during the previous season. Field officers conducted baseline meetings in 119 schools during July and August, before planting had begun. The experiment continued in the following long rains season between late November 2010 and early January 2011. During this time, we visited 123 schools, 58 of which we had already visited in the short rains season sample and 65 of which were newly selected, bringing the total number of schools involved in the experiment to 184 schools.

3.3. **Data.** Our data analysis uses the following datasets:

Baseline survey. At the end of the first large-scale meeting at each school, we conducted brief baseline surveys with each of the 26,856 participants. In this survey, kept short due to

[9] If the audience asked questions about fertilizer during the session, they were instructed to quickly move on from the topic.

logistical constraints, we elicited information only on: (i) expected or past time of harvest in the particular season; (ii) usage of CAN and/or DAP fertilizer during the past 12 months; (iii) method of fertilizer application (spoon, hand, planter, etc.); and (iv) how much fertilizer should be used per planting hole.

In addition, for about 25% of participants (5,994 farmers), we also collected information about their social network at the end of the baseline survey.[10] Surveyors asked these participants for the name and contact information of up to three people outside of their household with whom they discussed agriculture on a regular basis, as well as the nature of their relationship with each person. Most common among those are "neighbors," with about 40% of respondents mentioning their neighbors in all three possible contacts.[11]

Short endline. In June and July 2011, at the end of the second season of the experiment, we invited all respondents to attend endline school meetings. For each respondent who had completed the social network module, we also invited one randomly selected agricultural contact from the baseline survey to the school farmers (if available). Surveys were conducted individually but in an open setting. They were kept short due to logistical and time constraints, covering information about usage of fertilizer, knowledge of fertilizer and blue spoons, and membership in cooperatives, but not about communication. We refer to the sample originating from this data as the *full sample.*

Detailed endline. To complement the short endline surveys with more granular data about communication, a few months after the harvest of the second season, we attempted to visit a randomly selected subset of the farmers who had provided a social network friend. For each of these respondents, about 16 in each school, we also attempted to visit one of their randomly selected contacts and, if they were found and gave consent, conducted the same detailed endline survey with them. The survey covered (i) demographics, including literacy, education, age, and income sources, (ii) more detailed questions about usage and knowledge of fertilizer and blue spoons for each farming season, and (iii) additional questions related to agriculture, covering seed usage, storage, and quantities harvested. Finally, we asked detailed questions about communication to gauge social interactions and discussions of agricultural and other topics, especially with the contact, whom we also attempted to visit. We refer to the sample originating from this data as the *detailed sample.*

Fertilizer coupon redemption. In addition to self-reports of fertilizer usage and other outcomes, we also collected administrative data on fertilizer coupon redemption for the

[10]These individuals were selected quasi-randomly by adding the short social network module to every fourth questionnaire in the baseline survey. The order of participants in the baseline surveys was arbitrary.

[11]Of those randomly selected to complete the social network section of the survey, about half were randomized to receive the blue spoon. This guaranteed that we would have enough social network information for participants in the blue spoon treatment arms.

subset of schools in the coupon treatment. Using participant-specific identifiers on fertilizer coupons, we collected data on coupon redemption as well as the type and quantities of fertilizer purchases using the coupons from fertilizer shops. We use these data to gauge differential redemption rates for the cooperative and blue spoon treatments.

3.4. **Summary Statistics.** Table 2 presents summary statistics based on the endline surveys. First, we present demographics for the detailed sample based on the detailed endline survey. Column 1 shows "original seed farmers" and Column 2 shows their corresponding agricultural contacts ("friends") while Column 3 presents data for everyone who completed the short endline survey.

Sample Statistics. The typical respondent in the detailed sample is around 43 to 44 years old, has 6 to 7 years of education, is married (81-84%), and has a primary income source of agriculture (78-79%). CAN usage among seed farmers is relatively low: only about a third report having ever used it. A greater share (62%) has used DAP before, and nearly all of the CAN usage comes from those who also use DAP. Farmers in the detailed and full samples (Columns 1 and 3 of Table 2, respectively) are very similar across all measures, which is expected since the detailed sample was a randomly chosen sub-sample of all recruited farmers.

Balance and Attrition. Appendix B presents a balance check (Table B.1) and the extent of attrition (Table B.2) for the different surveys. The treatment groups are balanced across the different samples, indicating a successful randomization procedure. For the short and detailed samples among original respondents and their contacts if available, we use demographics such as age and education reported in those surveys (as they are not affected by our treatments). For original respondents, we also use information on previous fertilizer use and knowledge from the baseline surveys. Our empirical analysis below controls for these variables using the post-double-selection method (Belloni et al., 2014).

Moreover, attrition is relatively low: 84 and 93 percent of participants in our original sample completed the short and detailed endline surveys, respectively. With one exception—blue spoon farmers are slightly more likely to be present for the short endline surveys—we find little evidence of differential attrition by treatment status.

4. Results: Treatment Implementation and First-Order Impacts

This section presents the impacts of the coupon, cooperative, and blue spoon treatments. We investigate the impacts of the treatments on fertilizer adoption and knowledge of fertilizer quantity, both among the original seeds and their friends.

4.1. **Regression Specifications.** Depending on the school and treatment, the treatment took place either in Short Rains 2010, Long Rains 2011, or both. Both endline surveys took place at the end of the experiment, with the short endline administered in mid-2011 and the detailed endline in late 2011. At the time, we collected retrospective recall data on fertilizer usage in every season, creating a two-season farmer panel for the short endline (Short Rains '10 and Long Rains '11) and a three-season farmer panel for the detailed survey (Short Rains '10, Long Rains '11, and Short Rains '11).

We therefore have information for the seasons of the program, as well as either one or two seasons after the program. The regression specification is

$$\begin{aligned} y_{ist} = \alpha &+ \beta_D \cdot \text{Cooperative}_{st} + \beta_C \cdot \text{Coupon}_{st} + \beta_B \cdot \text{Blue Spoon}_{ist} \\ &+ \gamma_D \cdot \text{Cooperative Post-Intervention}_{st} + \gamma_C \cdot \text{Coupon Post-Intervention}_{st} \\ &+ \gamma_B \cdot \text{Blue Spoon Post-Intervention}_{ist} + X'_{ist}\delta + \epsilon_{ist}, \end{aligned} \tag{4.1}$$

where i indexes either an original seed respondent or the friend of the seed depending on the regression, s is school, and t is a time period (farming season). The vector of controls, X_{ist}, is selected in each regression using the post-double-selection method (Belloni et al., 2014).

Cooperative$_{st}$ is a dummy for whether school s is exposed to the discussion cooperative treatment in season t, and Coupon$_{st}$ and Blue Spoon$_{ist}$ are defined analogously. The variable Cooperative Post-Intervention$_{st}$ is a dummy for whether the discussion cooperative treatment was applied in any *prior* season but not in season t. The other two "post-intervention" treatment variables are defined analogously. This regression structure allows us to investigate both contemporaneous and potentially persistent impacts. β_k for $k \in \{D, C, B\}$ captures the ongoing impact of the intervention, while γ_k captures the effect of an intervention that occurred in the past.

For all other outcomes, we have a single cross-section of (contemporaneous) data, but depending on the timing of the survey in relation to the timing of the experiment, that data is either available for the season of the intervention or for a post-intervention season. We estimate:

$$\begin{aligned} y_{ist} = \alpha &+ \gamma_D \cdot \text{Cooperative Post-Intervention}_{st} + \gamma_C \cdot \text{Coupon Post-Intervention}_{st} \\ &+ \gamma_B \cdot \text{Blue Spoon Post-Intervention}_{ist} + X'_{ist}\delta + \epsilon_{ist}. \end{aligned} \tag{4.2}$$

4.2. **Results: Direct Impact.** We begin by providing evidence that the treatments were implemented as intended and had the expected first-order impacts. The cooperative treatment led to more public meetings to discuss agriculture, the coupons were redeemed and led to more adoption of fertilizer, and the blue spoon was a popular technology that diffused in the network.

Cooperatives. The cooperative treatment nearly doubled participation in agricultural discussion cooperatives, from 31 to 59 percent in the short endline survey (Figure 3, Panel A).[12] By the time of the detailed endline surveys, up to 18 months after the treatment took place, 52 percent of farmers in the cooperative treatment group (compared to 39 percent in control) reported being a member in a cooperative. But Panel B also shows significant differences (reported in the detailed endline) in the fraction of farmers who meet in cooperatives at least monthly as well as between the fraction of farmers that meet from time to time but less than monthly.

Coupons. The fraction of coupons redeemed was 18 and 12 percent in the two seasons, respectively, which was relatively low given that about half of farmers reported using fertilizer in any given season (Figure 3, Panel C). That is, a significant share of farmers did not redeem their coupon despite reporting use of fertilizer in the season for which the coupon was valid. Further, they generally bought small quantities (smaller than farmers typically use and smaller than what was allowed). The discount might not have seemed like enough to change people's habit of how and where to buy fertilizer, such that many people who regularly bought fertilizer did not use the coupon. It seemed that many coupon users may have been new fertilizer users and were looking to experiment.

Indeed, we find evidence consistent with the coupon treatment increasing fertilizer usage (Table 3). In the season of the program, we are unable to reject no effect in the detailed survey sample (we find a 3 percentage point increase on a base of 50%, $p = 0.23$, Column 1), but we find larger and more precise impacts in the full sample (a 10 percentage point increase on a base of 64%, $p < 0.01$, Column 2). The difference between the two surveys may be that the short surveys were conducted on a much larger sample and were also conducted soon after the end of the season while the detailed surveys were conducted 12-18 months later, which may have caused some recall bias. On the other hand, there might have been some social desirability bias in the short public surveys. However, consistent with the short survey results, we also find evidence of persistent effects of the coupon treatments in both surveys. Usage increased 4 percentage points ($p = 0.11$, Column 1) on a base of 50% in the detailed survey sample and a 7 percentage point increase on a base of 64% ($p < 0.01$, Column 2) in the full sample.

Blue spoons. The goal of the blue spoon treatment was to introduce a new technology that was useful and had the potential to diffuse in the social network. For this to be the case, it had to be that blue spoon farmers found it useful themselves. Indeed, nearly all blue spoon farmers still owned a blue spoon during both the short and detailed endline surveys

[12]The estimates underlying Figure 3 are also presented in regression form in Table B.3. We only ask about membership in groups that meet regularly to avoid mechanical effects (since they were encouraged to form a discussion group).

(Panel D of Figure 3), and blue spoon farmers were much more likely than control farmers to know about the blue spoon, know its price, and own one (Table 4, Columns 1 through 5).

The blue spoon treatment also increased knowledge of the right amount of CAN fertilizer (Table 4, Columns 6 and 7), which was its original intended purpose. Since the blue spoon was distributed with the information that half a teaspoon of fertilizer per planting hole provided the best results in previous trials, we measure whether farmers identify half a teaspoon as the quantity that brings the best results. We combine a verbal and visual version of this question, i.e., we measure whether the farmer identifies half a teaspoon both verbally *and* visually.[13] The treatment had large effects on knowledge: for example, for the detailed sample, the probability of identifying the right fertilizer amount increased by 21 ppt on a base of 13% ($p < 0.01$)—a 162% increase. For the full sample, we find large effects for the concurrent season, which persisted beyond the intervention: treatment increased knowledge by 13 ppt on a base of 12% contemporaneously ($p < 0.01$)—a 108% increase—and by 10 ppt on a base of 12% post-intervention ($p < 0.01$)—an 83% increase.

Blue spoon farmers also used more fertilizer, suggesting that the knowledge delivered with and embedded in the spoons was valuable to farmers. Returning to Table 3, receiving a blue spoon increased contemporaneous fertilizer usage, which persisted in later seasons. For instance, we see a 5 ppt (or 10%) increase in utilization contemporaneously in the detailed sample ($p = 0.01$, Column 1) and a 3 ppt (6%) increase in subsequent seasons ($p = 0.02$). This impact is consistent with evidence of increased coupon redemption among farmers who received a blue spoon (Table B.3, Column 1), allaying possible concerns about misreporting due to demand effects.[14]

To serve as a useful diagnostic tool, the blue spoon also had to be interesting enough to diffuse in the network. This seems to have been the case. Even in the control group, about one-quarter of farmers owned a blue spoon (Table 4, Columns 2 and 5) and between 40% and two-thirds had heard about it (Columns 1 and 3). Focusing only on the friends sample, Table 5 shows that the blue spoon did indeed diffuse more among friends of the blue spoon farmers (compared to friends of non-blue spoon farmers).[15]

We also find evidence of persistence. Table 5 Columns 3-5 show that for the full sample, in the season of the experiments, friends of blue spoon farmers were themselves 13 ppt more likely to have heard of a blue spoon, 10 ppt more likely to know its price, and 9 ppt more

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[13]Appendix Table B.5 shows results for visual and verbal questions separately.

[14]In the second season, blue spoons were given out *after* the coupon redemption period, so we should find no effect of the blue spoon treatment on coupon redemption. Table B.3, Column 2 shows that this is indeed the case.

[15]Since blue spoon recipients were randomly selected within each school, and the friends sample contained one randomly selected friend of each farmer in a random subset of all farmers, being a "friend of a blue spoon farmer" is a randomly assigned treatment for the friend sample, and any coefficients reflect the causal effect of knowing someone who was randomly offered a spoon.

likely to own one than friends of control farmers, who did not receive a blue spoon (all $p < 0.01$). Columns 1-5 show that in both the detailed sample and the full sample, in later seasons, friends of blue spoon farmers are still more likely to own a spoon than friends of control farmers.

Just as the blue spoon itself diffused, the knowledge of the right quantity of fertilizer diffused through the social network (Table 5, Columns 6 and 7). For example, in the detailed survey sample, we find a 4 ppt increase on a base of 14%, corresponding to a 29% increase (Column 6, $p < 0.01$). This effect is even more notable given that the detailed survey sample took place between 6 and 12 months after the first interventions, suggesting persistent learning. When we look at the short sample in Column 7, we find large effects in the concurrent period (a 10 ppt increase on a base of 11%, $p < 0.01$), though this effect does not persist (2 ppt increase, $p = 0.31$). Overall, this evidence suggests that there are meaningful knowledge spillovers to friends of the blue spoon farmers.

In summary, the cooperative succeeded in creating discussion forums where the cost of communication should have been lower, the coupons succeeded in creating at least some space for experimentation on fertilizer, making information on the right mode of usage more useful, and the blue spoon turned out to be a relevant technology that increased awareness of the right amount of fertilizer. We now turn to testing the key prediction of the model outlined in Section 2.3.

5. Testing model predictions

According to the simple model from Section 2.3 that motivated the experiment, we should see an increase in diffusion of information when communication is cheaper ($\downarrow \mu$), when transmission of information is better ($\uparrow q$), and/or when the information is more useful ($\uparrow g$). Thus, the key prediction is that blue spoons diffuse faster in the network under the cooperative and coupon treatments. We conduct two different exercises that speak directly to this prediction. The first looks at directed diffusion by focusing on the friends of blue spoon original seeds. The second studies more organic network diffusion by examining learning among everyone who was not originally given a blue spoon.

5.1. **Did the cooperative and coupon treatments increase diffusion to friends of blue spoon farmers?** First, we focus on whether friends of blue spoon farmers learned about blue spoons differently in cooperative and coupon schools compared to friends of blue spoon farmers in control schools. Recall that these friends were also from school catchment areas, so they were likely also invited to join a cooperative or received a discount coupon, but most did not receive a blue spoon themselves.[16] In sum, they were connected to a

[16]Some could have by random chance, but at a smaller probability: only 15% of people in the network got one.

blue spoon farmer and had likely received a coupon or joined a cooperative, which reduced communication costs and increased the usefulness of information about fertilizer. We have already seen that, on average, friends of blue spoon farmers were more likely to get a spoon themselves and to learn the information about the right quantity of fertilizer than the friends of farmers who were not selected to receive a blue spoon. We now investigate whether they were even more likely to do so in coupon schools and cooperative schools, as predicted by our model.

We examine the following regression using the *friends sample only*:

$$\begin{aligned} y_{ist} &= \alpha + \mu_D \cdot \text{Cooperative}_{st} + \mu_C \cdot \text{Coupon}_{st} + \mu_B \cdot \text{Blue Spoon}_{ist} \\ &\quad + \mu_{BC} \cdot \text{Coupon}_{st} \cdot \text{Blue Spoon}_{ist} + \mu_{BD} \cdot \text{Cooperative}_{st} \cdot \text{Blue Spoon}_{ist} \\ &\quad + X'_{ist}\delta + \epsilon_{ist} \end{aligned} \tag{5.1}$$

where y_{ist} is either blue spoon awareness or fertilizer quantity knowledge.

The coefficients of interest, μ_{BC} and μ_{BD}, capture the *differential* diffusion of blue spoon awareness and fertilizer quantity knowledge for friends of original blue spoon seeds due to these treatments. The main prediction is that both $\mu_{BC} > 0$ and $\mu_{BD} > 0$. That is, friends of blue spoon farmers are more likely to know about blue spoons and to update their beliefs about optimal fertilizer quantities if they belong to schools where the cooperative and coupon treatments took place. We also run a similar regression for the "Post-Intervention" dummies (as in Eq. 4.1).

Table 6 presents the results of these regressions. Our main focus is on the first two rows in each of the two panels. The takeaway is clear: all estimated coefficients are small and, if anything, more likely to be negative than positive. Out of 22 coefficients, considering all outcomes and the interactions in the two panels, only two have $p < 0.1$.[17] Thus, overall, we fail to reject that knowledge related to blue spoons and fertilizer quantity diffused equally fast to friends of blue spoon farmers in the coupon or cooperative treatments compared to the control group.

5.2. **Did blue spoons diffuse faster to non-blue spoon farmers due to coupon and cooperative treatments?** Although the blue spoon and knowledge about fertilizer quantity did not diffuse faster along pre-existing friendship networks, they may have diffused faster in some networks via broadcasting (in the meetings) or via the formation of new relationships.

Thus, to test the model fully, we focus on non-blue spoon farmers—i.e., the subset of original seed farmers who were not randomly selected to receive a blue spoon—and test

[17] These are Column 1 row 2 of Panel B, which is positive, suggesting that blue spoon knowledge—but not ownership—diffused faster in cooperative schools, and Column 3, row 1 of Panel B, which is negative—suggesting that blue spoon knowledge—again, not ownership—diffused slower in coupon schools.

whether they were more likely to adopt the blue spoon or to be aware of the recommended fertilizer quantity in coupons and cooperative schools. Estimating Eq. 4.1 on this sample, we test the prediction that β_D and β_C, the coefficients on discussion cooperative and coupon treatments, respectively, are positive.

Table 7 presents the results. Cooperatives seem to have increased the diffusion of blue spoons to non-blue spoon farmers. This result is consistent across different samples and measurements. For instance, in the full sample, cooperative non-blue spoon farmers are 6 ppt more likely to own a blue spoon on a basis of 24% for both the ongoing and completed treatment dummies ($p = 0.04$ and $p < 0.01$, respectively).[18] However, this does not translate into a higher diffusion of knowledge about fertilizer quantities; non-blue spoon farmers in cooperatives are not more likely to know the right amount of CAN to use. The coupon treatment has generally null effects on diffusion.

In summary, the coupon and cooperative treatments do not seem to increase how quickly knowledge about fertilizer quantities diffuses. Coupons did not increase the diffusion of the blue spoon. In contrast, the cooperative treatment increased awareness and ownership of the blue spoon, which suggests communication about blue spoons in the cooperative environment. However, this did not translate into increased knowledge of the recommended fertilizer quantity. A key remaining question is why blue spoons diffused while knowledge of fertilizer quantities did not.

5.3. **Communication.** We next investigate communication between original farmers and their friends, a key mechanism that can shed light on the previous results. To do so, we use in-depth communication data from the detailed home surveys. We estimate the treatment effects of the three interventions on communication using regressions of the form:

$$y_{is} = \alpha + \beta_D \cdot \text{Cooperative}_s + \beta_C \cdot \text{Coupon}_s + \beta_B \cdot \text{Blue Spoon}_{is} + \delta' X_{is} + \epsilon_{is} \tag{5.2}$$

where i and s refer to farmers and schools, respectively. y_{is} denotes a farmer-specific outcome, such as whether farmer i in school s reports discussing CAN fertilizer with their friend. The set of controls, X_{is}, is selected in each regression using the post-double-selection method (Belloni et al., 2014).

We display communication results parsimoniously in Figure 4, pooling seven different discussion topics into three categories: (i) CAN fertilizer topics, (ii) general fertilizer topics, and (iii) seeds and storage of maize. All regressions are based on detailed surveys that collected specific measures of communication, as reported by original respondents (seeds). We

[18]Interestingly, this is consistent with the one positive result in the friendship network regression.

report the corresponding regressions in Table 8, including results for each of the underlying components individually.[19]

5.3.1. *Cooperatives.* We find no significant evidence of the communication cooperative increasing communication about CAN fertilizer or other agriculture-related topics. In fact, all point estimates for the cooperative treatment in Figure 4 are negative.[20] Most strikingly, the cooperative treatment *decreases* communication about CAN-related topics overall by 6.9% relative to a base of 58% ($p = 0.05$, first cooperative treatment bar in Figure 4). Similarly, we find negative, albeit statistically insignificant, point estimates for communication about other topics; for example, we find a 4.7% decline relative to a base of 64% in the probability of talking about fertilizer in general ($p = 0.11$, second treatment bar).

5.3.2. *Coupons.* The coupon treatment increased communication both about CAN fertilizer and other agricultural topics. Farmers who received a coupon are 9% more likely to report discussing CAN-related topics relative to a basis of 58% ($p = 0.02$, first coupon treatment bar in Figure 4). We also find positive communication effects on general fertilizer-related topics of about 9% relative to a basis of 64% ($p < 0.01$, second treatment bar in Figure 4). These results are consistent with coupons inducing some farmers to use fertilizer (potentially for the first time), perhaps this increasing the need for communication and learning from others, or maybe triggering questions from their friends about fertilizer. We also find some evidence of impacts on discussions about seeds and storage, with a 6% increase in talking about either two topics relative to a basis of 72% ($p = 0.03$).

5.3.3. *Blue spoons.* The blue spoon treatment increased all measures of communication. Blue spoon farmers were 21% more likely to report talking about CAN-related topics over the past year relative to a base of 58% ($p < 0.01$, first blue spoon treatment bar of Figure 4). Discussions about the timing, amount, and best results all significantly increased, by 16.7%, 31.7%, and 33.3% respectively (Columns 3, 4, and 5 of Table 8). Furthermore, the increase in the probability of having a conversation about CAN due to the blue spoon is more than double the increase due to the coupon, with this difference between treatment effects significant ($p = 0.02$). Similarly, the increased probabilities of having a conversation about timing, amount, and best results due to blue spoons are two to five times the increase due to coupons ($p = 0.05$, $p < 0.01$, and $p < 0.01$, respectively).

[19]Table 8 also displays results for talking about the blue spoon, which is not on the figure, in Panel A, Column 1. In Appendix Table B.4, we repeat this exercise using the fact that we also observe data from the friends of farmers. Results are qualitatively similar but overall attenuated, which may be an artifact of stronger recall problems among friends than with the original seeds.

[20]The sole exception is a suggestive but not statistically significant increase in discussions about blue spoons, a roughly 10% increase in original seeds reporting talking about it on a base of 29%, $p = 0.20$, reported in Column 1 of Table 8, Panel A.

The blue spoon treatment also increased communication about topics beyond CAN. Blue spoon farmers reported a 8% increase in talking about general fertilizer-related topics ($p < 0.01$, second blue spoon treatment bar of Figure 4) as well as a 7% increase in talking about seeds and storage ($p < 0.01$, third blue spoon treatment bar). While increased discussion of fertilizer-related topics could be explained by increased interest in CAN due to receiving a blue spoon, such an explanation is unlikely for the increased discussion of seeds and storage (third blue spoon treatment bar). The magnitude of these impacts is sizable (4 to 6 percentage points or 6-11%) and highly significant ($p < 0.01$ in each case), though smaller than the effects on CAN-related discussions.

In summary, the effects of coupons and cooperatives on measures of communication contrast with the predictions of the model from Section 2.3. If we interpret our intervention as reducing the costs of socializing or increasing the benefits of learning, then the coupon and cooperative treatments should each increase communication in equilibrium, which we reject empirically.

5.4. **Overall impact on knowledge stock.** Overall, the objective of the cooperative and coupon treatments was to increase the stock of knowledge (and good practice) about proper fertilizer use by increasing the diffusion of the blue spoon technology and the direct circulation of the information. The impacts on non-blue spoon farmers in Sections 5.1 and 5.2 suggest that this is unlikely to be the case. Despite the null effects among the non-blue spoon farmers, there could be large positive impacts among blue spoon farmers. Thus, Table 4 examines knowledge of fertilizer among original sample farmers (blue spoon and non-blue spoon together).

Consistent with previous results, the cooperative treatment affected blue spoon awareness and ownership positively: we see an increase of about 5 percentage points, or 12% ($p = 0.08$, Column 3), on whether people heard about the blue spoon, and a 5 percentage point, or 21% ($p = 0.05$, Column 5), increase in ownership. This suggests that cooperatives helped diffuse the new technology. However, there is little evidence of increased knowledge of the right quantity of fertilizer to use. There is no significant impact in the season of treatment, and, if anything, knowledge appears to have *decreased* in the post-intervention period. We find a 4 percentage point, or 31%, decline in knowledge relative to a control mean of 13% ($p = 0.03$) in the detailed survey sample. In the full sample, the point estimate is negative but insignificant ($p = 0.24$) (row 5 of Columns 6 and 7, respectively).

This result, which is the opposite of what was intended by this treatment, also rules out a simple explanation for the decrease in communication between friends in cooperative schools: that all relevant information was already spread inside cooperatives. If this were the case, we would see an increase in overall knowledge, not a decrease. Instead, it appears that the reduction in person-to-person communication in cooperative schools actually led to a depletion of the knowledge stock. In Appendix D we formally show that the reduction in knowledge helps rule out the idea that communication between friends decreased because knowledge had become a public good (due to the sharing of information in the cooperatives), which led to free-riding. In essence, as the number of people able to contribute to collective knowledge increases, under concave returns and weakly concave costs, it is always the case that if some free-ride, then others have incentives to fill the gap. This is because if an individual was willing to provide a certain level of information when he was alone, if the overall social value would fall short of this level in a group setting, then the individual would be more than happy to fill the gap. These ideas are discussed further in Banerjee et al. (2007); Galeotti and Goyal (2010); Banerjee et al. (2021).

In the next section, we adapt our motivating communication model to provide a possible (though certainly not the only possible) rationalization of the results.

6. Reconciling Results With Our Motivating Model: The Role of Perception Concerns

Neither the cooperative treatment nor the coupon treatment helped spur communication about fertilizer use despite creating a forum for discussion and increasing the value of the technology, respectively. However, the blue spoon technology itself diffused rapidly (and much faster than expected given previous experience with diffusion of new technology in agriculture), and seems to have increased conversation about agriculture more broadly.

One possible explanation, suggested by qualitative work, is that farmers may be concerned about the veracity of information and potential senders fear being perceived as spreading rumors. In this world, making information sharing more public might backfire (reputation-conscious people may be reluctant to express themselves publicly), and a widget with a simple and credible message attached to it may diffuse particularly well—and even benefit from public sharing of information when softer information does not—and increase communication.

6.1. **Model.**

We add two components to the SIS model presented in Section 2.3 to reflect these ideas. First, we introduce a notion of *reliability* as an attribute of each piece of information. By itself, this addition does not change any prediction from our original model since it only represents a shift in the average quality of information. Second, more substantively, we import *reputational concerns* from the model of endogenous communication developed in Chandrasekhar et al. (2019). When communicating, farmers now also consider their reputation, and dislike being perceived as a spammer—an unreliable sharer of information. When sharing or seeking information, individuals weight the instrumental value of additional information against the reputation effects of being potentially perceived as spammers.

Motivated by the results of the previous section, the model seeks to shed light on two main questions. First, why might an intervention exactly geared towards making conversational environments cheaper did not succeed in sparking information diffusion, and possibly even reduce conversations and knowledge? Second, why might a novel device that embeds hard information spur communication and increase knowledge, and even increase talking in other domains? While this may not be the only model that can explain our result, this model is a parsimonious way to include recent insights from the literature.

6.1.1. *Timing, Entry, and Individual Information.* As before, there is a continuum of agents indexed by $i \in [0,1]$, each of whom decides whether to share information by participating in a communication network. Time is continuous, $t \in \mathbb{R}_{\geq 0}$.

Before the start of the SIS process, at $t = 0$, all agents decide once-and-for-all whether or not to join the communication network, with the entry decision given by $s_i \in \{0,1\}$. The decision to enter is publicly observed among all agents. Let S denote the share of agents that have chosen to enter, which we model below.

At every instant of time $t > 0$, each agent receives a private unit of information x_i^t at rate α.[21] The information could be *useful* ($x_i^t = 1$) or *useless* ($x_i^t = 0$). Only useful information grows the stock of information in the network and useless information does not do anything. Let $r = \mathrm{P}\left(x_i^t = 1\right)$ denote the *reliability* of the information.

For $t > 0$, information aggregates and diffuses through the communication network which is comprised of the S nodes. Specifically, at a given t, an agent i contributes information to the SIS process, given by y_i^t. The agent either provides their unit of information ($y_i^t = x_i^t$) or says nothing ($y_i^t = \emptyset$).This is modeled below. Crucially, when contributed to the network, the usefulness of the unit of information is unobserved per se by the network members at large. While the fact is known, the utility/veracity is not immediately apparent nor is the identity of the contributor tagged as it circulates through the network. So, only s_i is publicly observed.

Then, the stock of information in the communication network evolves according to

$$\dot{I} = \alpha E\left(x_i^t \mid y_i^t \neq \emptyset, s_i = 1\right) S + qSI - \eta I.$$

In the baseline model described in Section 2.3, $x_i^t \equiv 1$ and $y_i^t \equiv 1$ since information was always useful and always communicated. So the only difference relative to (2.1) is that the average value of the information is not identically 1 but instead integrates over the quality of those who enter the communication network.

[21] This is irrespective of whether they have chosen to join the communication network or not. As discussed below, the $1 - S$ agents do not substantively matter for the analysis and there is no meaningful change in the dynamics of the equilibrium.

6.1.2. *Payoffs.* Individuals now have three payoff components: (i) instrumental network payoff, (ii) instrumental reliability payoff, and (iii) perception payoff.

Instrumental Network Payoff. Just as in the baseline model, the *instrumental network payoff* component of the utility is given by

$$g\left(I^{\star}\right)-c_i$$

where we maintain the same assumptions as before where c_i are drawn i.i.d. at $t=0$ from a continuous distribution F with full support on $\mathbb{R}$ with mean μ.

Instrumental Reliability Payoff. We say that individuals have a private type given by $a_i \in \{\mathrm{L}, \mathrm{H}\}$. The type is drawn i.i.d. with prior probability π of being a high type.

We say H-types are *reliable*. This means that they have a taste for sifting through and passing on facts that they deem to be useful. When they pass information, they mechanically pass information when it is thought to be useful but do not when it is not thought to be useful. So, $y_i^t = 1$ if and only if $x_i^t = 1$ and $y_i^t = \emptyset$ otherwise. Since only r-share of information x_i^t is reliable, they will contribute facts to the network at rate $\alpha \times r$ rather than α.

Meanwhile L-types are *spammers* and are unreliable. They derive utility from speaking irrespective of the veracity of the fact. So $y_i^t = x_i^t$ for these types.

From the perspective of the $t=0$ entry decision, the expected utility of sharing due to the instrumental reliability payoff component is modeled as

$$rv + \mathbf{1}_{a=L}\left(1-r\right)v.$$

This says if speaking gives utility v, then for high types it provides utility rv as they speak only when they deem it useful whereas for low types it gives utility v since they are not bothered by its perceived usefulness.

Perception Payoff. The final component of the payoff is a perception payoff. Recall that the only publicly visible action is the decision to enter the communication network, s_i, since the contributed fact is not tagged as it circulates through the network and the veracity/usefulness is only discovered through the aggregation in any case. Therefore, s_i will provide a signal about one's reliability type.[22] Assume that it is socially desirable (to everyone) to be viewed as a reliable type rather than a spammer. The *perception payoff* component of utility is

$$\lambda \cdot \varphi \ \cdot \mathrm{P}\left(a_i = \mathrm{H} \mid s_i\right),$$

[22] We explicitly assumed away any reputation concerns related to specific pieces of information. This simplification avoids the issue of repeatedly observing the quality of information and imposing dynamic reputation concerns, which can become intractable without further modeling choices. This setup represents a parsimonious way to capture the forces of interest and articulate our perspective.

where $\mathrm{P}(a_i = \mathrm{H} \mid s_i)$ is a third party observer's Bayesian posterior of i's reliability type given i's decision to join the network; $\varphi : [0,1] \to \mathbb{R}_{\geq 0}$ is a common utility component that is continuous, increasing, and bounded; and λ is simply a weight that is useful in analysis below. One natural interpretation is that it is the odds that i's decision is observed by a third party.

6.1.3. *Marginal Utility of Speaking.* Putting these pieces together, the total utility of communication has three payoff components: (a) instrumental network; (b) instrumental reliability; and (c) perception. The total utility is

$$u_a(s_i) = \left\{ \underbrace{g(I^\star) - c_i}_{\text{network payoff}} + \underbrace{rv + \mathbf{1}_{a=\mathrm{L}}(1-r)v}_{\text{reliability payoff}} \right\} \cdot s_i + \underbrace{\lambda \cdot \varphi \left\{ \mathrm{P}(a_i = \mathrm{H} \mid s_i) \right\}}_{\text{perception payoff}}.$$

Then the marginal utility is given by

$$\Delta_s u_a(s_i) = \underbrace{g(I^\star) - c_i + rv + \mathbf{1}_{a=\mathrm{L}}(1-r)v}_{V := \text{total instrumental payoff}} + \underbrace{\lambda \cdot \Delta_s \varphi \left\{ \mathrm{P}(a_i = \mathrm{H} \mid s_i) \right\}}_{\text{change in perception payoff}}$$

which drives the decision to speak and join the communication network. Given that c_i is stochastic, let G_a be the distribution of the total instrumental payoff V, noting that G_{H} is just a shift of G_{L}.

The distribution of the total instrumental payoff V for an L-type first-order stochastically dominates that for an H-type since it is just a mean-shift due to $rv < v$. That is, reliable types have less instrumental value in speaking relative to spammers since information may be faulty. So, even for the same returns to information and identical costs, they desire to speak less and speaking contains information about one's type in equilibrium.[23]

By Chandrasekhar et al. (2019), Proposition 1, an equilibrium exists, and is in cutoff strategies where an agent i speaks if and only if their total instrumental payoff V exceeds some cutoff $\bar{V}$, with

$$\underbrace{\bar{V}}_{\substack{\text{cut-off value of} \\ \text{total instrumental payoff}}} = \underbrace{-\lambda \cdot \Delta_s \varphi \left\{ \mathrm{P}_{\bar{V}}(a_i = \mathrm{H} \mid s_i) \right\}}_{\text{reputation loss in eqm.}}.$$

Here, $\mathrm{P}_{\bar{V}}(a_i = \mathrm{H} \mid s_i)$ is uniquely determined by the equilibrium posterior odds,

$$\frac{\mathrm{P}_{\bar{V}}(a_i = \mathrm{H} \mid s_i = 1)}{1 - \mathrm{P}_{\bar{V}}(a_i = \mathrm{H} \mid s_i = 1)} = \frac{\pi}{1-\pi} \cdot \frac{1 - G_{\mathrm{H}}(\bar{V})}{1 - G_{\mathrm{L}}(\bar{V})} \text{ and } \frac{\mathrm{P}_{\bar{V}}(a_i = \mathrm{H} \mid s_i = 0)}{1 - \mathrm{P}_{\bar{V}}(a_i = \mathrm{H} \mid s_i = 0)} = \frac{\pi}{1-\pi} \cdot \frac{G_{\mathrm{H}}(\bar{V})}{G_{\mathrm{L}}(\bar{V})}.$$

[23] A natural question to ask is whether it matters that the instrumental payoffs of not sharing could differ by type, for example if H-types have higher quality information in autarky. It does not substantively matter, since all that is required for the results is that the distribution of total instrumental payoff V for an H-type is first-order stochastically dominated by that of an L-type. Another interpretation of setting the autarkic option to 0 is that individual facts are not particularly valuable and only a stock of information matters.

6.1.4. *Steady-state Determination of Information and Speaking in the Social Network.* The information stock now depends on the composition of which types of agents share as well as the usefulness of said information. At any t, an H-type only shares information when it is useful, so $y_i^t = 1$ for H-types. Meanwhile, since L-type always share, only in a share r of times is an L-type's contributed information useful.

Corresponding to Equation (2.1) in the basic model, the stock of information in the network in a world with reputational concerns evolves as follows:

$$\dot{I} = \alpha \cdot \{\pi S_{\mathrm{H}} + r(1-\pi)S_{\mathrm{L}}\} + q \cdot \{\pi S_{\mathrm{H}} + (1-\pi)S_{\mathrm{L}}\} \cdot I - \eta I,$$

where the first term represents the total stock of private information being added at each t (observing L-types only contribute r share of the time), the second term is the network multiplier effect with the equilibrium network size, and the last term is depreciation.

The equilibrium information stock analogous to Equation (2.2) is

$$I^*(S_{\mathrm{H}}, S_{\mathrm{L}}) = \frac{\alpha \cdot \{\pi S_{\mathrm{H}} + r(1-\pi)S_{\mathrm{L}}\}}{\eta - q \cdot \{\pi S_{\mathrm{H}} + (1-\pi)S_{\mathrm{L}}\}}. \tag{6.1}$$

6.1.5. *Equilibrium Communication.* Finally, extending Equation (2.3) in the basic model, we define the total population share speaking as a function of λ, r, $g(\cdot)$, as

$$S(\lambda, r, g) = \pi\left[1 - G_H\left(\bar{V}\right)\right] + (1-\pi)\left[1 - G_L\left(\bar{V}\right)\right].$$

6.2. **Analysis and Interpretation.** Key parameters in the model correspond to our interventions and allow us to interpret our findings.

6.2.1. *Observability (λ) and Cooperatives.* Discussion cooperatives intrinsically are more public than the status quo. Intuitively, making actions more observable increases reputation costs. We can interpret λ as the probability that some third party observes the decision to share, since the perception payoff is the odds of being observed times the equilibrium inference (given those odds, of course). Going from low to high observability, focusing on the case of unique equilibrium, the equilibrium sharing cutoffs are ordered: a higher share of individuals seek information when a third party is less likely to observe the interaction.

PROPOSITION **6.1** (Observability). *Fix all parameters of the model except λ. There exists $\underline{\lambda}$ such that for any $\lambda < \underline{\lambda}$ the equilibrium is unique. There exists $\overline{\lambda}$ sufficiently high such that for all $\lambda > \overline{\lambda}$, the equilibrium is essentially unique and satisfies*

$$S\left(\lambda_{\mathrm{Low}}, .\right) > S\left(\lambda_{\mathrm{High}}, .\right) \text{ for all } \lambda_{\mathrm{Low}} < \underline{\lambda}, \lambda_{\mathrm{High}} > \overline{\lambda}.$$

This is consistent with the results we have seen in Figure 4 and Table 4: the cooperative treatment lead to a decline in sharing information about farming and possibly reduce knowledge about fertilizer quantity as well.

6.2.2. *Reliability (r) and Blue Spoons.* The Blue spoon increase the expected reliability of the information, since it is a tangible object, provided by an reputable NGO with written explanations. The model suggests it can have multiple effects. First, holding all else fixed, it directly increases the equilibrium stock of information (see Equation (6.1)). Second, since the willingness for H-types to share due to instrumental reasons (rv) increases, G_{H} approaches G_{L}.

The first effect, improving reliability increases the instrumental value for H-types, unambiguously promotes sharing since it only directly affects H-types, thus both increasing the value of information and alleviating the reputation damage of sharing.

The second, the direct effect of r on $I^\star$, increases $g(I^\star)$ for both types. While intuitively this appears to increase sharing—both types find it worthwhile and therefore reputation costs in equilibrium are lower—it is theoretically possible based on the variance of the cost distribution that reputation costs increase and sharing actually declines. If a change in I^* is such that too many marginal L-types are encouraged to share, then sharing becomes a stronger signal of being a L-type, which actually deters sharing in equilibrium. This pathological case only occurs when the cost densities are sufficiently concentrated, so the observer is able to make a very accurate inference as to the decision-maker's type. A small increase in reliability can serve to increase L-type's incentives to share because the stock of information is higher. But since the inferences about type are easy to make since costs between types differ widely but are very concentrated, sharing becomes a signal of low ability. As long as the distribution of costs has dispersion beyond a minimal threshold, increases in reliability must actually have a positive effect.[24]

Proposition **6.2** (Reliability)**.** *Fix all parameters of the model except r. Assume that $\sup_x f(x) < M$, for some $M > 0$ sufficiently low and λ such that the equilibrium is unique. Then sharing increases in reliability, that is, $\partial_r S(r, .) > 0$.*

The result is consistent with our empirical findings that blue spoons promote sharing.

6.2.3. *Returns to Information ($g(\cdot)$) and Coupons.* Recall that we interpret coupons as increasing the usefulness of information obtained from social learning. If input prices are prohibitively high, then learning about how to properly adopt inputs is useless. Since coupons lower prices and induced new use to experiment with fertilizer, they expand possibilities

[24]Our proposition uses an upper bound on the density to establish this result. A special, pedagogical case would be to assume $F \sim \mathcal{N}(\mu, \sigma^2)$. Then, for any $\sigma^2 > \overline{\sigma}^2$ for some finite lower bound, sharing increases in reliability. That sharing declines in reliability is only possible, though not guaranteed, for $\sigma^2 \in [0, \overline{\sigma}^2]$.

of adoption, which in turn makes learning about fertilizer more useful. As such, we take coupons to be a monotone shift of the function $g(.)$.

The direct effect on the instrumental payoff is clear: for the same cost c_i, the net benefits of participating are higher under $\tilde{g}(.) \geq g(.)$ pointwise. However, again there may be increases in the equilibrium reputation costs, but if the cost densities f are reasonably behaved, sharing increases unambiguously.

Proposition **6.3** (Usefulness of information)**.** *Fix all parameters of the model except $g(.)$. Consider a monotonically greater function, $\tilde{g}(I) > g(I)$, $\forall I$. Assume that $\sup_x f(x) < M$, for some M sufficiently low and λ such that the equilibrium is unique. Then sharing increases in usefulness of information, that is, $S(\tilde{g}, .) > S(g, .)$.*

7. Conclusion

Why is it that, in many contexts, farmers do not appear to learn much from each other? There is more than one possible answer to this question, which we discussed in the introduction. This paper focused on one in particular. Farmers may not share information because they are reluctant to do so when they know that there is a lot of unreliable information around, and they do not want to be known for spreading falsehoods.

This particular explanation has a number of implications for the best way to spread new technological innovations.

First, there is value in making sure that as many people as possible have access to first-hand knowledge. When setting up demonstration plots in villages, for example, the impact on adoption in the village would be much greater if more farmers were invited to witness all key stages of the trials than if we relied on the seed farmers to relay the information spontaneously. This is consistent with our early trials in Kenya, and also with recent evidence from Rwanda (Duflo et al., 2020), which found that farmers invited to demonstration plots to learn new coffee production techniques adopted the new techniques and improved their profits, but other people in their social network did not. Conveying simple information to a large number of farmers by text messages (Fabregas et al., 2019) may be more effective than relying on natural diffusion. One caveat, thought, is that if the information is complicated and people need clarification, they may not seek it when they know that everyone has gotten it (Banerjee et al., 2021).

Second, public forums may not always be the best methods to invite farmers (or other) to share information. Those forums may seem obviously beneficial: everyone can share and discuss their experience in one go, saving time and making sure fact checking can happen. But in any setting where there may be some reputation costs associated with sharing, this may backfire, either by reducing communication or, perversely, by leaving only those who really like to talk (and may not have the best filter) to express themselves, silencing those who may have useful information.

Third, more positively, technologies that are simple, transparent, and that do not require much explanation may circulate much faster than others. This goes beyond the fact that they are easier to understand for the seed farmer themselves: even a technology that is useful and perfectly well understood by a farmer may not spread if sharing it would involve much convincing or explaining. The blue spoon had all these features, and therefore it spread very well, regardless of the environment. An added benefit is that such simple technologies can spur more conversations, and potentially help the circulation of other, not directly related, ideas. This calls for the development of technologies similar to blue spoons in agriculture and in other contexts: simple, cheap, devices that encode information and help people act on it.

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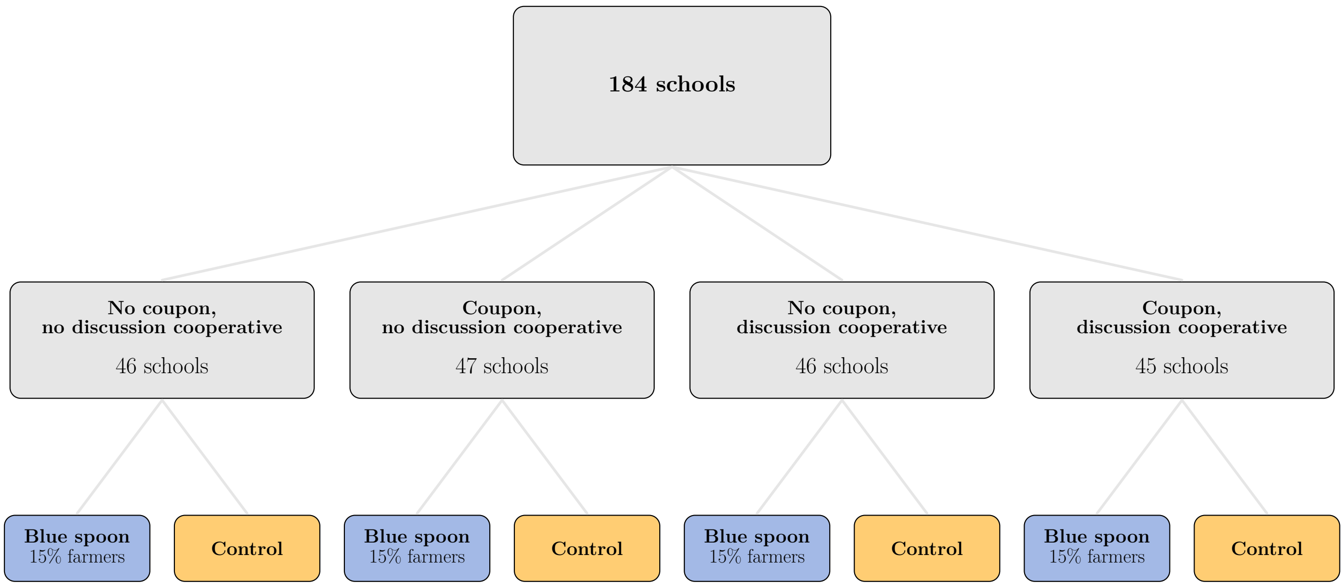
Tables and Figures

Figure 1. Blue Spoon

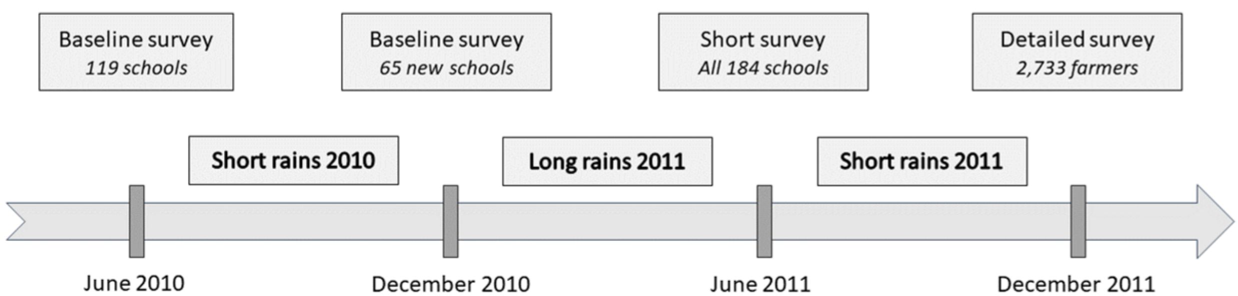
Notes: This figure shows one of the blue spoons that were distributed to farmers as part of the study. The blue spoon is a standard kitchen measuring spoon that measures 1/2 teaspoon, painted in blue at the handle. This quantity of CAN top-dressing fertilizer had been found to yield the highest profits in a previous field experiment that compared different quantities of inputs (Duflo et al., 2008).

Figure 2. Experimental Design and Timeline

Panel A: Treatment groups



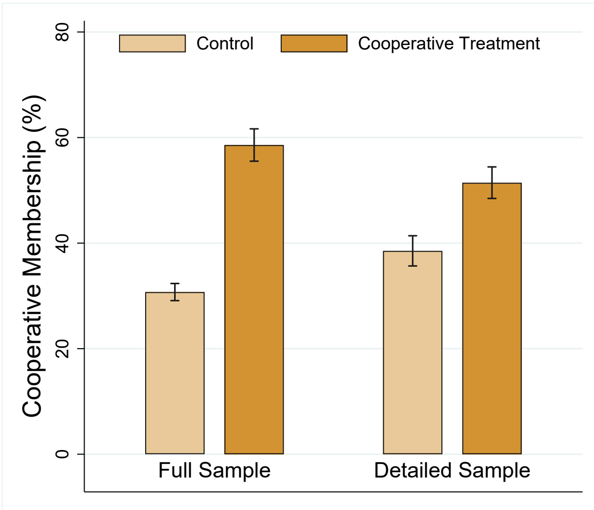
Panel B: Timeline of experiment



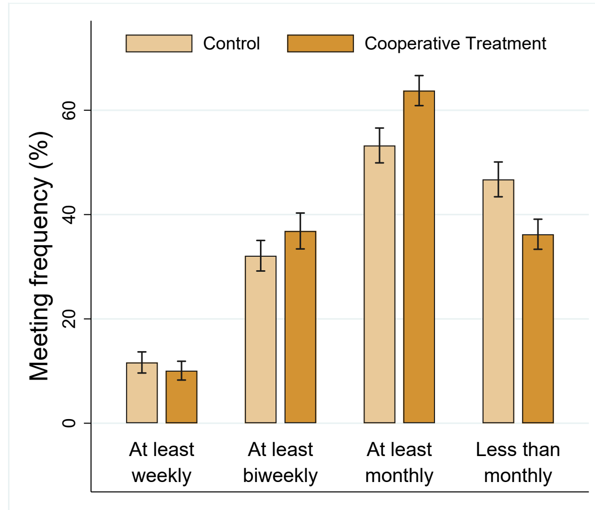
Notes: This figures presents the experimental design and timeline of the study.

- The upper panel shows the overall experimental design, described in Section 3.1. First, farmers were cross-randomized at the school level into two treatments: cooperatives and coupons. Then, within each school, about 15% of farmers in each one of the four groups was randomized to receive a blue spoon.
- The lower panels illustrates the timeline of the study, described in Section 3.2. Shortly before the beginning of the short rains season in July and August 2010, we visited 119 schools, administered a short baseline survey as well as the treatments described in Panel A. Shortly before the second season (in December 2010 and January 2011), we revisited 58 of those schools, along with 65 newly selected schools. In June and July 2011, at the end of the second season, we conducted short endline surveys at large school meetings before visiting a sub-sample of study participants at their homes for a detailed endline survey.

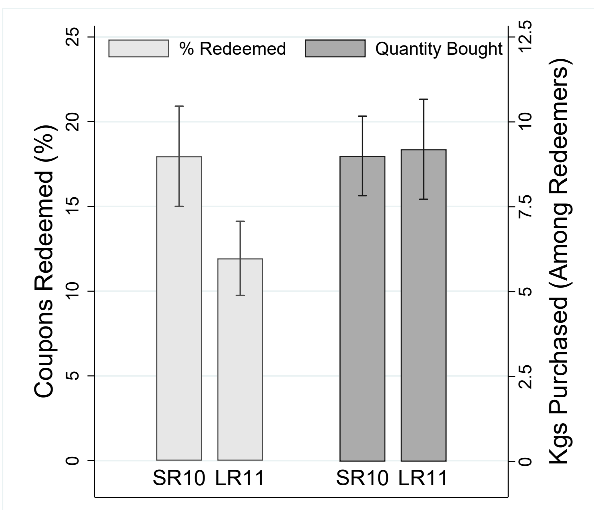
Figure 3. Treatment Implementation, Cooperative Treatment



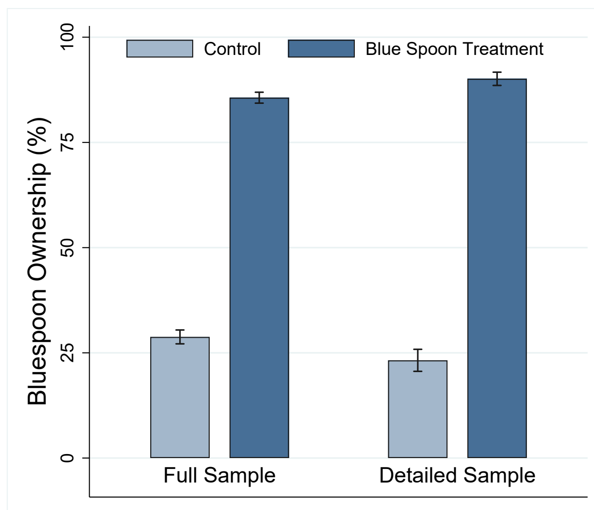
Panel A: Cooperative membership



Panel B: Cooperative meeting frequency



Panel C: Coupon redemption

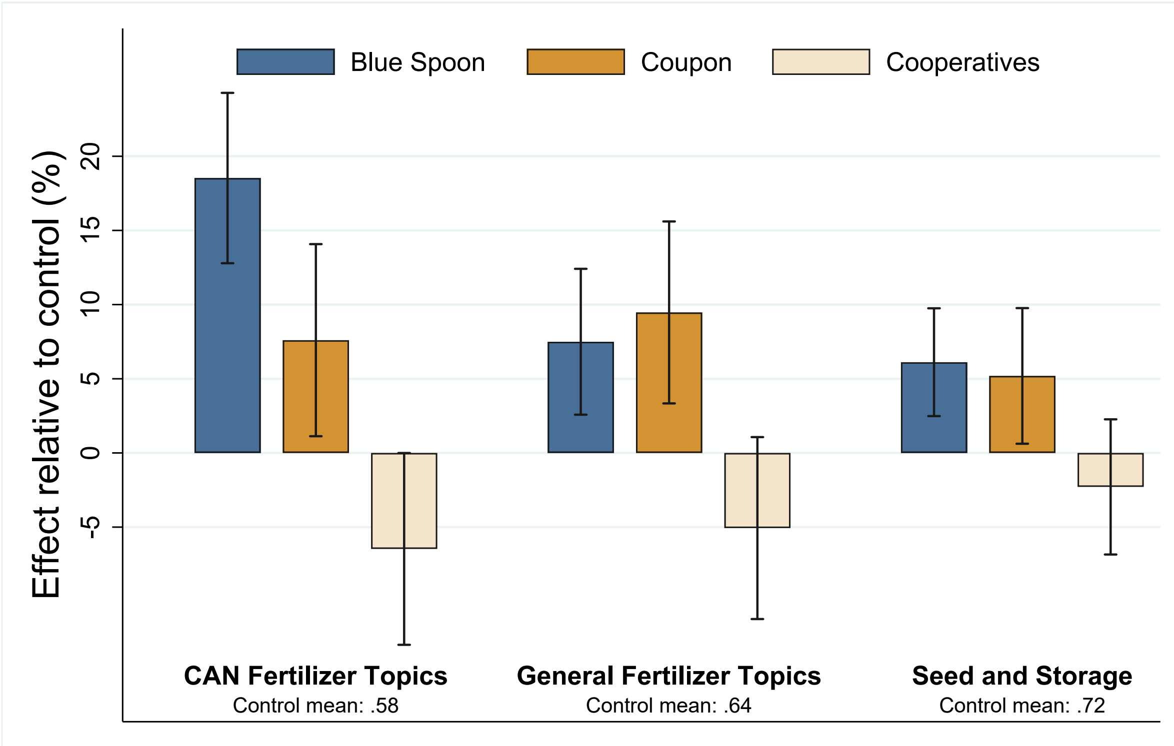


Panel D: Blue spoon ownership

Notes: These figures present an overview of intermediate outcomes for each of the three interventions. Appendix Table B.3 shows detailed regressions for these outcomes.

- Panel A displays the proportion of farmers that report being a member of an agricultural discussion cooperative that meets regularly, comparing the cooperative treatment group with the control group. The figures split results by survey type: full sample (N = 21,872) and detailed sample (N = 2,719). For the short endline survey, agricultural cooperative is defined by asking if in more than half of the meetings the group discusses agriculture; for the detailed endline survey, we ask whether the group has discussed agriculture in the past 12 months.
- Panel B displays the meeting frequency reported by farmers. This variable takes on the value "Less than monthly" for farmers who reported not being members of cooperatives. We only have data on meeting frequency for the detailed sample.
- Panel C displays the average coupon redemption rate in the two treatment seasons. Since the control group receives no coupons, the figure only displays the average redemption rate for coupon treatment schools. The two bars on the left show the fraction of coupons that were redeemed at a local shop for a 15% discount on up to 50 kgs of fertilizer. The two bars on the right display the amount redeemed, conditional on redeeming the coupon. "SR10" and "LR11" refer to the short and long rains harvest seasons of 2010 and 2011, respectively.
- Panel D displays the proportion of farmers who report owning a blue spoon for the blue spoon treatment and control groups. The figures split results by survey type: short endline survey (N = 22,230) and detailed endline survey (N = 2,711).

FIGURE 4. Treatment Effects on Communication Between Original Seeds and Their Friends



Notes: This figure presents an overview of the results on communication outcomes for the three treatments. The regressions are based on several categorical dependent variables representing discussion topics, which take the value 1 if the respondent (an original seed farmer) reports talking with a friend about a given topic. The dependent variable pools different discussion topics by considering whether the respondents spoke about "any" of these topics.

(1) "CAN fertilizer topics" pools discussion topics about "the right time to apply CAN", "how much CAN to use per planting hole", and "how much CAN per planting hole yields best results".
(2) "General Fertilizer Topics" pools discussion topics about "experiences with different types of fertilizer" and "which fertilizer type to apply on maize".
(3) "Seed and Storage" pools discussion topics about "experiences with different varieties of maize seeds" and "the best way to store maize".

Table 8 reports the results of regressions on each of the categorical communication variables. Regressions under the header "Any Topic" (Column 1, Panel A and Columns 1 and 4, Panel B) correspond to the regressions reported in this figure. Standard errors are clustered at the school level. Controls are selected among variables displayed in Table 2, using the post-double-selection method Belloni et al. (2014).

Table 1. Fertilizer Adoption in Demonstration Plot Experiments

Panel A: Test plot farmers

	Whole Sample			Sample With Data on All Three Seasons		
	(1) 1 Season After	(2) 2 Seasons After	(3) 3 Seasons After	(4) 1 Season After	(5) 2 Seasons After	(6) 3 Seasons After
Test Plot Farmers	0.10	0.10	0.09	0.15	0.13	0.10
	(0.05)	(0.06)	(0.10)	(0.08)	(0.09)	(0.11)
	[0.06]	[0.13]	[0.39]	[0.09]	[0.15]	[0.42]
Control Mean	0.16	0.18	0.19	0.14	0.18	0.17
Observations	559	497	426	352	352	352
Schools	15	14	13	13	13	13

Panel B: Neighbors and friends

	Friends of Original Farmers			Neighbors of Original Farmer		
	(1) 1 Season After	(2) 2 Seasons After	(3) 3 Seasons After	(4) 1 Season After	(5) 2 Seasons After	(6) 3 Seasons After
Friends of Test Plot Farmers	0.01	-0.02	-0.00			
	(0.03)	(0.04)	(0.03)			
	[0.67]	[0.63]	[0.91]			
Friends of Test Plot Farmers, Invited to Witness	0.10	0.02	-0.04			
	(0.05)	(0.09)	(0.05)			
	[0.06]	[0.79]	[0.40]			
Neighbor of Test Plot Farmers				-0.04	-0.03	-0.02
				(0.04)	(0.04)	(0.06)
				[0.33]	[0.48]	[0.72]
Control Mean	0.18	0.22	0.17	0.21	0.23	0.21
Observations	645	524	505	278	400	382
Schools	15	14	13	9	9	8

Notes: This table presents the results of the demonstration plot experiments on fertilizer adoption, i.e., fertilizer use reported by farmers.

Panel A shows impacts on farmers who had demonstration plots on their land (compared to the corresponding control group). The first three columns show the whole sample while the remaining three columns only consider the sample of farmers with data for all three seasons.

Panel B shows impacts on farmers' friends and neighbors. The regressions in the first three columns refer to adoption among friends (or "agricultural contacts") of the pilot farmers. The last three columns refer to the geographic neighbors of the pilot farmers.

The regressions only control for school (sampling level) fixed effects. Standard errors are displayed in parentheses, while p-values are displayed in brackets. Standard errors are clustered at the school level.

Table 2. Sample Characteristics of Large-Scale Experiment

	Detailed sample		**Full sample**
Variable	Original Seeds	Friends	Original Seeds
Demographics			
Age	43.20	44.38	-
	(13.56)	(14.06)	
Female	0.35	0.47	-
	(0.48)	(0.50)	
Can read and write	0.68	0.73	-
	(0.46)	(0.44)	
Years of education	6.42	7.00	-
	(4.08)	(4.21)	
Married	0.81	0.84	-
	(0.39)	(0.37)	
Primary income source is farming	0.78	0.79	-
	(0.42)	(0.41)	
Previous fertilizer usage and knowledge			
Used CAN (last year)	0.32	-	0.33
	(0.47)		(0.47)
Used CAN (ever)	0.37	-	0.37
	(0.48)		(0.48)
Used DAP (last year)	0.56	-	0.57
	(0.50)		(0.49)
Used DAP (ever)	0.62	-	0.62
	(0.49)		(0.48)
Used CAN or DAP (ever)	0.64	-	0.65
	(0.48)		(0.48)
Says 1/2 teaspoon is best quantity of CAN	0.24	-	0.24
	(0.43)		(0.43)
Number of participants	2733	2314	22230

Notes: This table presents summary statistics (mean and standard deviation) for participants in the large-scale experiment and their agricultural contacts.

- Column 1 contains information about farmers sampled in the baseline survey who also completed the detailed endline survey at their home. Column 2 contains information about agricultural contacts of those farmers. Column 3 contains information about all participants sampled in the baseline survey.
- The Demographic information is from the detailed survey, as it was not collected in the short endline survey. Information about previous fertilizer usage and knowledge is from the baseline survey. Baseline surveys were not conducted with agricultural contacts (since baseline surveys were used to define the agricultural contacts of original seeds).
- "Says 1/2 teaspoon is best quantity of CAN" refers to answering "half a teaspoon" when asked, "What quantity of CAN should you use per planting hole?"

Table 3. Usage of Fertilizer among Original Seed Farmers and Their Friends

	Original Seeds		**Friends**	
	(1) Detailed Sample	(2) Full Sample	(3) Detailed Sample	(4) Full Sample
Treatment Effects: Ongoing Intervention				
Blue Spoon Treatment	0.05	0.05	0.01	0.04
	(0.02)	(0.01)	(0.02)	(0.02)
	[0.01]	[0.00]	[0.55]	[0.02]
Cooperative Treatment	-0.03	-0.01	-0.03	-0.03
	(0.02)	(0.02)	(0.03)	(0.03)
	[0.20]	[0.78]	[0.29]	[0.32]
Coupon Treatment	0.03	0.10	0.04	0.02
	(0.03)	(0.02)	(0.04)	(0.04)
	[0.23]	[0.00]	[0.33]	[0.67]
Treatment Effects: Post-Intervention				
Completed Spoon Treatment	0.03	0.02	-0.00	0.01
	(0.01)	(0.01)	(0.01)	(0.02)
	[0.02]	[0.03]	[0.96]	[0.43]
Completed Cooperative Treatment	0.02	-0.02	-0.01	-0.01
	(0.02)	(0.01)	(0.03)	(0.03)
	[0.36]	[0.21]	[0.64]	[0.71]
Completed Coupon Treatment	0.04	0.07	0.02	0.01
	(0.02)	(0.02)	(0.03)	(0.04)
	[0.11]	[0.00]	[0.45]	[0.79]
Control Mean	0.50	0.64	0.55	0.56
Control SD	0.50	0.48	0.50	0.50
Observations	7384	35601	6196	4380
Schools	184	183	184	182

Notes: This table presents results of the main treatments on usage of fertilizer among original seeds and friends of seeds. The coefficients are estimated using Equation 4.1 and data from original seeds, i.e., farmers who attended the school meetings in which the treatments were implemented and who completed the baseline survey, both from the short endline and detailed endline surveys. Fertilizer usage is a self-reported measure of whether the farmer has made use of CAN or DAP fertilizer during a given farming season.

- The treatment indicators in rows 1 to 3 refer to the farming season in which treatment is being administered, while "Post-Intervention" in rows 4 to 6 indicators refer to farming seasons after the treatment. Section 3 provides more information on the surveys and the timing of the interventions.
- As the detailed survey (Columns 1 and 3) was conducted between August 2011 and January 2012, it is possible to analyze an extra farming session for the 61 schools that were sampled during the first farming season of the intervention (short rains season, 2010). Consequently, the post-intervention seasons include up to two subsequent farming seasons. Since the questions asked about fertilizer usage in each season, columns in this table feature observations for several farming season per participant, and thus have more observations than other tables.
- Controls are selected among the variables displayed in Table 2 using the post-double-selection method (Belloni et al., 2014). Control availability can vary depending on survey and if the respondents are original seeds or friends. Only original seeds have baseline information, while only the detailed survey has demographic information. Standard errors are clustered at the school level.

Table 4. Blue Spoon Awareness & Knowledge of Fertilizer Qty (Original Seeds)

	Awareness of blue spoon					**Knowledge of fertilizer quantity**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Detailed Sample		Full Sample			Detailed Sample	Full Sample
	Heard about	Owns	Heard about	Knows Price	Owns		
Treatment Effects: Ongoing Intervention							
Blue Spoon Treatment			0.46	0.52	0.61		0.13
			(0.02)	(0.02)	(0.02)		(0.02)
			[0.00]	[0.00]	[0.00]		[0.00]
Cooperative Treatment			0.05	0.05	0.05		0.02
			(0.03)	(0.02)	(0.02)		(0.02)
			[0.08]	[0.04]	[0.05]		[0.24]
Coupon Treatment			0.00	-0.03	-0.00		0.02
			(0.02)	(0.02)	(0.01)		(0.01)
			[0.93]	[0.05]	[0.92]		[0.18]
Treatment Effects: Post-Intervention							
Completed Spoon Treatment	0.30	0.67	0.41	0.45	0.55	0.21	0.10
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Completed Cooperative Treatment	0.04	0.03	0.06	0.06	0.05	-0.04	-0.01
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
	[0.01]	[0.04]	[0.00]	[0.00]	[0.00]	[0.03]	[0.24]
Completed Coupon Treatment	-0.04	-0.03	0.01	-0.01	0.01	-0.00	0.02
	(0.02)	(0.01)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)
	[0.01]	[0.08]	[0.61]	[0.64]	[0.73]	[0.97]	[0.22]
Control Mean	0.67	0.23	0.42	0.28	0.24	0.13	0.12
Control SD	0.47	0.42	0.49	0.45	0.43	0.34	0.33
Observations	2678	2659	22230	22230	22230	2634	21176
Schools	184	184	184	184	184	184	183

Notes: This table presents results of the main treatments on (i) awareness of the blue spoon (Columns 1 through 5) and (ii) knowledge about fertilizer quantities (Columns 6 and 7). The coefficients are estimated using Equation 4.1 and data from original seeds, i.e., farmers who attended the school meetings in which the treatments were implemented and who completed the baseline survey, both from the short endline and detailed endline surveys.

- The treatment indicators in rows 1 to 3 refer to the farming season in which treatment is being administered, while "Post-Intervention" in rows 4 to 6 refers to farming seasons after the treatment. Section 3 provides more information on the surveys and the timing of the interventions.
- 'Owns' refers to whether the respondent owned a blue spoon at the time of the survey. As surveys took place in participants' homes, blue spoon ownership was verified in the detailed sample. 'Knows price' refers to whether the respondent answered 'Ksh 5' when asked about the price of a blue spoon.
- Knowledge of fertilizer quantity refers to answers to questions about how much fertilizer to use per planting hole, which respondents were asked about in two ways: verbally (stating the amount) and visually (choosing one of four small containers with different quantities of fertilizer). The outcome variable equals 1 if the respondent chooses the quantity of 'half a teaspoon' in both questions, as this quantity was found to yield the highest expected profits in previous trials (Duflo et al., 2008).
- As the detailed survey (Columns 1, 2, and 6) was conducted between August 2011 and January 2012 but mainly after September, we consider the knowledge outcomes collected in this survey as "post-intervention" only. The short survey, however, was conducted between June and July 2011 and thus can be interpreted as collecting information during the season of treatment.
- Controls are selected among the variables displayed in Table 2 using the post-double-selection method (Belloni et al., 2014). Standard errors are clustered at the school level.

TABLE 5. Blue Spoon Awareness & Knowledge of Fertilizer Quantity (Friends)

	Awareness of blue spoon					Knowledge of fertilizer quantity	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Detailed Sample		Full Sample			Detailed Sample	Full Sample
	Heard about	Owns	Heard about	Knows Price	Owns		
Treatment Effects: Ongoing Intervention							
Blue Spoon Treatment			0.13	0.10	0.09		0.10
			(0.03)	(0.03)	(0.03)		(0.03)
			[0.00]	[0.00]	[0.00]		[0.00]
Cooperative Treatment			0.00	0.03	-0.04		0.06
			(0.04)	(0.04)	(0.03)		(0.04)
			[0.94]	[0.43]	[0.23]		[0.17]
Coupon Treatment			-0.03	-0.05	-0.02		0.03
			(0.03)	(0.03)	(0.03)		(0.03)
			[0.32]	[0.07]	[0.45]		[0.26]
Treatment Effects: Post-Intervention							
Completed Spoon Treatment	0.12	0.07	0.15	0.14	0.13	0.04	0.02
	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.31]
Completed Cooperative Treatment	0.05	0.06	0.01	0.01	-0.00	0.03	-0.00
	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)	(0.03)
	[0.02]	[0.01]	[0.70]	[0.82]	[0.98]	[0.10]	[0.98]
Completed Coupon Treatment	-0.01	0.00	-0.03	-0.05	-0.01	0.00	0.01
	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.02)	(0.04)
	[0.63]	[0.93]	[0.30]	[0.17]	[0.74]	[0.85]	[0.69]
Control Mean	0.56	0.20	0.26	0.18	0.12	0.14	0.11
Control SD	0.50	0.40	0.44	0.39	0.32	0.34	0.32
Observations	2267	2257	2394	2394	2394	2226	2258
Schools	184	184	182	182	182	184	182

Notes: This table presents results of the main treatments on (i) awareness of the blue spoon (Columns 1 through 5) and (ii) knowledge about fertilizer quantities (Columns 6 and 7). The coefficients are estimated using Equation 4.1 and data from the friends sample, i.e., people who were listed in the baseline survey by original seeds as people with whom they discussed agriculture.

- The treatment indicators in rows 1 to 3 refer to the farming season in which treatment is being administered, while "Post-Intervention" in rows 4 to 6 refers to farming seasons after the treatment. Section 3 provides more information on the surveys and the timing of the interventions.
- 'Owns' refers to whether the respondent owned a blue spoon at the time of the survey. As surveys took place in participants' homes, blue spoon ownership was verified in the detailed sample. 'Knows price' refers to whether the respondent answered 'Ksh 5' when asked about the price of a blue spoon.
- Knowledge of fertilizer quantity refers to answers to questions about how much fertilizer to use per planting hole, which respondents were asked about in two ways: verbally (stating the amount) and visually (choosing one of four small containers with different quantities of fertilizer). The outcome variable equals 1 if the respondent chooses the quantity of 'half a teaspoon' in both questions, as this quantity was found to yield the highest expected profits in previous trials (Duflo et al., 2008). We also explore either the visual or the verbal measurements in Table B.5.
- As the detailed survey (Columns 1, 2, and 6) was conducted between August 2011 and January 2012 but mainly after September, we consider the knowledge outcomes collected in this survey as "post-intervention" only. The short survey, however, was conducted between June and July 2011 and thus can be interpreted as collecting information during the season of treatment.
- Controls are selected among the variables displayed in Table 2 using the post-double-selection method (Belloni et al., 2014). Standard errors are clustered at the school level.

Table 6. Impact of Cooperatives and Coupons on Blue Spoon and Knowledge Diffusion among Friends

	Awareness of blue spoon					Knowledge of fertilizer quantity	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Detailed Sample		Full Sample			Detailed Sample	Full Sample
	Heard about	Owns	Heard about	Knows Price	Owns		
Treatment effects: ongoing intervention							
Blue spoon interactions							
Blue Spoon Treatment × Cooperative Treatment			0.01	-0.03	-0.03		0.01
			(0.06)	(0.06)	(0.06)		(0.05)
			[0.85]	[0.64]	[0.65]		[0.79]
Blue Spoon Treatment × Coupon Treatment			-0.04	-0.06	-0.07		-0.03
			(0.05)	(0.05)	(0.05)		(0.05)
			[0.43]	[0.30]	[0.15]		[0.59]
Treatments							
Blue Spoon Treatment			0.14	0.14	0.14		0.10
			(0.04)	(0.05)	(0.05)		(0.04)
			[0.00]	[0.00]	[0.00]		[0.01]
Cooperative Treatment			-0.01	0.05	-0.03		0.04
			(0.06)	(0.05)	(0.04)		(0.05)
			[0.91]	[0.38]	[0.49]		[0.36]
Coupon Treatment			-0.02	-0.03	0.01		0.04
			(0.04)	(0.03)	(0.03)		(0.03)
			[0.66]	[0.32]	[0.86]		[0.20]
Treatment effects: post-intervention							
Blue spoon interactions							
Completed Spoon Treatment × Completed Cooperative Treatment	-0.05	-0.02	-0.10	-0.07	-0.08	0.03	-0.04
	(0.04)	(0.04)	(0.05)	(0.04)	(0.04)	(0.03)	(0.04)
	[0.23]	[0.69]	[0.08]	[0.10]	[0.06]	[0.27]	[0.30]
Completed Spoon Treatment × Completed Coupon Treatment	0.10	0.02	0.02	-0.07	-0.02	0.03	-0.02
	(0.04)	(0.04)	(0.06)	(0.05)	(0.05)	(0.03)	(0.04)
	[0.01]	[0.61]	[0.79]	[0.19]	[0.71]	[0.30]	[0.61]
Treatments							
Completed Cooperative Treatment	0.07	0.07	0.07	0.05	0.05	0.01	0.03
	(0.03)	(0.03)	(0.05)	(0.04)	(0.03)	(0.02)	(0.04)
	[0.02]	[0.02]	[0.11]	[0.14]	[0.12]	[0.54]	[0.46]
Completed Spoon Treatment	0.09	0.07	0.20	0.19	0.17	0.01	0.05
	(0.04)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)
	[0.01]	[0.02]	[0.00]	[0.00]	[0.00]	[0.65]	[0.13]
Completed Coupon Treatment	-0.06	-0.01	-0.05	-0.00	0.00	-0.01	0.03
	(0.03)	(0.03)	(0.05)	(0.04)	(0.04)	(0.02)	(0.05)
	[0.05]	[0.78]	[0.39]	[0.96]	[0.95]	[0.60]	[0.52]
Control Mean	0.56	0.20	0.26	0.18	0.12	0.14	0.11
Control SD	0.50	0.40	0.44	0.39	0.32	0.34	0.32
Observations	2267	2257	2394	2394	2394	2226	2258
Schools	184	184	182	182	182	184	182

Notes: This table presents results from estimating Equation 5.1, i.e., we estimate the impacts of the main treatments and their interactions on (i) awareness of the blue spoon (Columns 1 through 5) and (ii) knowledge about fertilizer quantities (Columns 6 and 7) in the friends sample, i.e., people who were listed in the baseline survey by original seeds as people with whom they discussed agriculture.

- The treatment indicators and their interactions in rows 1 to 5 refer to the farming season in which treatment is being administered, while "Post-Intervention" in rows 6 to 10 refers to farming seasons after the treatment.
- The outcome variables measuring awareness of blue spoons and knowledge of fertilizer quantity are the same as in Tables 4 and 5.
- Controls are selected among the variables displayed in Table 2 Column 2 using the post-double-selection method (Belloni et al., 2014). Standard errors are clustered at the school level.

Table 7. Impact of Cooperatives and Coupons on Blue Spoon and Knowledge Diffusion among Non-Blue-Spoon Farmers

	Awareness of blue spoon					**Knowledge of fertilizer quantity**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Detailed Sample		Full Sample			Detailed Sample	Full Sample
	Heard about	Owns	Heard about	Knows Price	Owns		
Treatment Effects: Ongoing Intervention							
Cooperative Treatment			0.06	0.06	0.06		0.01
			(0.03)	(0.03)	(0.03)		(0.02)
			[0.06]	[0.03]	[0.04]		[0.42]
Coupon Treatment			0.00	-0.03	-0.00		0.02
			(0.02)	(0.02)	(0.02)		(0.01)
			[0.84]	[0.13]	[0.96]		[0.13]
Treatment Effects: Post-Intervention							
Completed Cooperative Treatment	0.07	0.05	0.07	0.07	0.06	-0.01	-0.01
	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
	[0.01]	[0.05]	[0.00]	[0.00]	[0.00]	[0.80]	[0.45]
Completed Coupon Treatment	-0.07	-0.04	0.02	-0.00	0.02	-0.03	0.02
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)
	[0.02]	[0.11]	[0.46]	[0.95]	[0.53]	[0.19]	[0.18]
Control Mean	0.67	0.23	0.42	0.28	0.24	0.13	0.12
Control SD	0.47	0.42	0.49	0.45	0.43	0.34	0.33
Observations	1319	1307	18563	18563	18563	1295	17701
Schools	184	184	184	184	184	184	183

Notes: This table presents results from estimating Equation 4.1, i.e., we estimate the impacts of the main treatments on (i) awareness of the blue spoon (Columns 1 through 5) and (ii) knowledge about fertilizer quantities (Columns 6 and 7) among original seeds who were *not* given a blue spoon (as such, there are no coefficients for the blue spoon treatments).

- The treatment indicators in rows 1 and 2 refer to the farming season in which treatment is being administered, while "Post-Intervention" in rows 3 amd 4 refers to farming seasons after the treatment.
- The outcome variables measuring awareness of blue spoons and knowledge of fertilizer quantity are the same as in Tables 4 and 5.
- Controls are selected among the variables displayed in Table 2 Column 1 using the post-double-selection method (Belloni et al., 2014). Standard errors are clustered at the school level.

Table 8. Communication About Blue Spoons, Fertilizer, and Other Topics

Panel A: Blue Spoons and CAN (topdressing)

		CAN fertilizer (topdressing)			
	(1) Blue Spoon	(2) Any Topic	(3) Timing	(4) Amount	(5) Best Results
Blue Spoon	0.37	0.12	0.09	0.13	0.14
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Cooperative School	0.03	-0.04	-0.03	-0.01	-0.00
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
	[0.20]	[0.05]	[0.23]	[0.58]	[0.97]
Coupon School	0.01	0.05	0.03	0.05	0.03
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
	[0.54]	[0.02]	[0.19]	[0.03]	[0.15]
p-val: Blue Spoon = Cooperative School	0.00	0.00	0.00	0.00	0.00
p-val: Blue Spoon = Coupon School	0.00	0.02	0.04	0.00	0.00
p-val: Coupon School = Cooperative School	0.65	0.00	0.07	0.06	0.27
Control Mean	0.29	0.58	0.54	0.41	0.42
Control SD	0.46	0.49	0.50	0.49	0.49
Observations	2483	2483	2483	2483	2483
Schools	184	184	184	184	184

Panel B: Other Agricultural Topics

	Fertilizer (general)			Seeds and Storage		
	(1) Any Topic	(2) Experiences	(3) Types	(4) Any Topic	(5) Seeds	(6) Storage
Blue Spoon	0.05	0.05	0.05	0.05	0.04	0.06
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]	[0.00]
Cooperative School	-0.03	-0.03	-0.03	-0.02	-0.01	-0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
	[0.11]	[0.22]	[0.15]	[0.32]	[0.70]	[0.30]
Coupon School	0.06	0.07	0.07	0.04	0.04	0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
	[0.00]	[0.00]	[0.00]	[0.03]	[0.04]	[0.39]
p-val: Blue Spoon = Cooperative School	0.00	0.00	0.00	0.00	0.04	0.00
p-val: Blue Spoon = Coupon School	0.62	0.62	0.64	0.75	0.92	0.11
p-val: Coupon School = Cooperative School	0.00	0.00	0.00	0.02	0.08	0.15
Control Mean	0.64	0.58	0.61	0.72	0.66	0.54
Control SD	0.48	0.49	0.49	0.45	0.48	0.50
Observations	2483	2483	2483	2483	2483	2483
Schools	184	184	184	184	184	184

Notes: This table shows results from estimating Equation 5.2, i.e., the impacts of the main treatments on different measures of communication between original seeds and their friends. The dependent variable is a dummy that equals one if the participant reported having talked about a specific topic with their friend during the past 12 months, as reported in the detailed endline survey.

Panel A focuses on discussions about (i) the usefulness of blue spoons for applying fertilizer (Column 1), (ii) the right time to apply CAN to maize (Column 2), (iii) how much CAN they have each used per planting hole (Column 3), (iv) how much CAN per planting hole yields the best results (Column 4), and (v) a summary of the previous three measures (Column 5);

Panel B covers discussions about (i) their experiences with different types of fertilizer (Column 2), (ii) which fertilizer to apply (Column 3), their experience with different varieties of maize seeds (Column 5), and (iii) the best ways to store maize (Column 6), as well as summary measures of the those outcomes (Columns 1 and 4).

Controls are selected among the variables displayed in Table 2 using the post-double-selection method (Belloni et al., 2014). Standard errors are clustered at the school level.

Appendix A. Proofs

Proof of Proposition 2.1.

The amount of agents sharing is given by $\mathrm{P}(s_i = 1) = F[g(I^*)]$. Thus, direct comparative statics reveal that:

(1) Let F' be a mean-shifted distribution of F, with a lower mean; then $F'[g(I^*)] > F[g(I^*)]$ by standard properties of cumulative density functions.
(2) For $g' > g$, $F[g'(I^*)] > F[g(I^*)]$ since F is increasing.
(3) Under $q' > q$, $I^*(q') > I^*(q)$, which again implies $F[g'(I^*(q'))] > F[g(I^*(q))]$.

This completes the proof. ■

Proof of Proposition 6.1.

We begin by looking at the low observability regime. If we take $\underline{\lambda} < \xi^{-1}$, for $\xi := \sup_x \frac{\partial}{\partial V}|_{v=x} \left(\varphi(\mathrm{P}_V(a = \mathrm{H}|s = 0)) - \varphi(\mathrm{P}_V(a = \mathrm{H}|s = 1))\right)$, this immediately follows by Proposition 4 of Chandrasekhar et al. (2019), letting $V = (rv + \mathbb{1}_{a=\mathrm{L}}(1-r)v) + g(I^*) - c$. This can be seen by application of the mean-value theorem. We complete the proof turning to the high observability regime. From Proposition 4 of Chandrasekhar et al. (2018), we have that for any $\epsilon > 0$, there exists $\overline{\lambda}_\epsilon$ such that for every $\lambda > \overline{\lambda}_\epsilon$, $S(\lambda) < \epsilon$. That is, the equilibrium is essentially unique. So the result follows by picking $\epsilon < S(\underline{\lambda})$. ■

Proof of Proposition 6.2.

Recall that $G_H(.)$ is the cdf of V, and that shares seeking for each type are defined by $1 - G_H(\bar{V})$ and $1 - G_L(\bar{V})$. Further, note that we defined $V := rv + 1_{a=\mathrm{L}}(1-r)v + g\left(I^\star\right) - c_i$, so V varies for each type. Let V_H and V_L denote the distribution for H−types and L−types. The mean of V_H is equal to $rv + g(I^*) - \mu$, while the mean of V_L is equal to $v + g(I^*) - \mu$, where μ is the average of the cost distribution.

To simplify the mean-shifting effect of r, we change all calculations to use the CDF of costs, F, since:

$$
\begin{aligned}
1 - G_H(\bar{V}) &= \mathrm{P}(V_H \geq \bar{V}) \\
&= \mathrm{P}(rv + g(I^*) - c_i \geq \bar{V}) \\
&= \mathrm{P}(rv + g(I^*) - \bar{V} \geq c_i) \\
&= F(rv + g(I^*) - \bar{V}).
\end{aligned}
$$

For L-type, the expression is the same with v instead of rv. Using this, we have that:

$$\frac{\partial S(r,.)}{\partial r} = \pi\frac{\partial S_H}{\partial r} + (1-\pi)\frac{\partial S_L}{\partial r} = \pi\frac{\partial F(rv + g(I^*) - \bar{V})}{\partial r} + (1-\pi)\frac{\partial F(v + g(I^*) - \bar{V})}{\partial r}$$

$$\begin{aligned} &= \pi \times f(rv + g(I^*) - \bar{V}) \times \left[(v + \partial_r g(I^*) - \partial_r \bar{V})\right] \\ &+ (1-\pi) \times f(v + g(I^*) - \bar{V}) \times \left[(\partial_r g(I^*) - \partial_r \bar{V})\right] \end{aligned} \tag{A.1}$$

where the second line is a simple application of the chain rule. There are two unknown derivatives on the right-hand side of the expression above, $\partial_r \bar{V}$ and $\partial_r g(I^*)$, both which depend implicitly on the sharing rates.

The effect of r on the usefulness of the social stock is given by:

$$\frac{\partial g(I^*)}{\partial r} = g'(I^*) \times \left(\frac{\partial I^*}{\partial S_H}\frac{\partial S_H}{\partial r} + \frac{\partial I^*}{\partial S_L}\frac{\partial S_L}{\partial r}\right). \tag{A.2}$$

The effect on r on the cut-off level $\bar{V}$ is:

$$\frac{\partial \bar{V}}{\partial r} = -\lambda \times \left(\frac{\partial\left[\varphi\left\{P_{\bar{V}}(a_i = H|s_i = 1)\right\} - \varphi\left\{P_{\bar{V}}(a_i = H|s_i = 0)\right\}\right]}{\partial r}\right) \tag{A.3}$$

where we abuse notation by omitting the arguments of some functions that are held constant when we take derivatives. These expressions shows the change in reputation costs depend on how the share of each type seeking changes.

Again to simplify calculations, we translate these probabilities into odds-ratios. Note that odds-ratio are one-to-one with the actual posterior probabilities, $Pr_{\bar{V}}(a = H|s_i)$. Define $h : \mathbb{R}^+ \to [0,1]$ to be the function that maps the odds ratio to the posterior probability that an individual is a High type,

$$h(x) := \frac{x}{1+x}.$$

Accordingly, define $\psi : \mathbb{R}^+ \to \mathbb{R}$ as

$$\psi(x) = \varphi(h(x))$$

and, finally, led the odds-ratio be given by $b(0)$ and $b(1)$.

We use this property to rewrite A.3 as:

$$\frac{\partial \bar{V}}{\partial r} = -\lambda\left[\psi'\{b(1)\}\frac{\partial b(1)}{\partial r} - \psi'\{b(0)\}\frac{\partial b(0)}{\partial r}\right]. \tag{A.4}$$

As for the odds-ratios, note that $b(1) = \frac{\pi}{1-\pi}\frac{S_H}{S_L}$ and $b(0) = \frac{\pi}{1-\pi}\frac{1-S_H}{1-S_L}$, so we get

$$\frac{\partial b(0)}{\partial r} = \frac{\pi}{1-\pi} \frac{(S_L - 1)\frac{\partial S_H}{\partial r} - (S_H - 1)\frac{\partial S_L}{\partial r}}{(1-S_L)^2}. \tag{A.5}$$

$$\frac{\partial b(1)}{\partial r} = \frac{\pi}{1-\pi} \frac{S_L\frac{\partial S_H}{\partial r} - S_H\frac{\partial S_L}{\partial r}}{S_L^2}. \tag{A.6}$$

Thus, the change in the decision cut-off $\bar{V}$ is implicit, similar to the change in sharing. We have already obtained the derivates of S_H and S_L in A.1. It is helpful to proceed by focusing individually on the sharing effects for each type, $\partial_r S_H$ and $\partial_r S_L$. From

$$\begin{aligned}\frac{\partial S_H}{\partial r} =& f(rv + g(I^*) - \bar{V}) \times \left[(v + \partial_r g(I^*) - \partial_r \bar{V})\right] \\ =& f(.)v + f(.)g'(I^*)\left(\frac{\partial I^*}{\partial S_H}\frac{\partial S_H}{\partial r} + \frac{\partial I^*}{\partial S_L}\frac{\partial S_L}{\partial r}\right) + f(.)\lambda\left[\psi'\{b(1)\}\frac{\partial b(1)}{\partial r} - \psi'\{b(0)\}\frac{\partial b(0)}{\partial r}\right]\end{aligned}$$

To save space, let $f_H = f(rv+g(I^*)-\bar{V})$ and $f_L = f(v+g(I^*)-\bar{V})$. Also let $\psi'_0 = \psi'\{b(0)\}$ and $\psi'_1 = \psi'\{b(1)\}$. Opening up and isolating $\frac{\partial S_H}{\partial r}$, and doing a similar process for $\frac{\partial S_L}{\partial r}$ we obtain:

$$\frac{\partial S_H}{\partial r} = \frac{f_H v + f_H \frac{\partial S_L}{\partial r}\left\{\overbrace{g'(I^*)\frac{\partial I^*}{\partial S_L} - \lambda\frac{\pi}{1-\pi}\left[\psi'_0\frac{1-S_H}{(1-S_L)^2} + \psi'_1\frac{S_H}{S_L^2}\right]}^{A}\right\}}{\left(1 - f_H\left\{g'(I^*)\frac{\partial I^*}{\partial S_H} + \lambda\frac{\pi}{1-\pi}\left[\psi'_0\frac{1}{1-S_L} + \psi'_1\frac{1}{S_L}\right]\right\}\right)}. \tag{A.7}$$

$$\frac{\partial S_L}{\partial r} = \frac{f_L \frac{\partial S_H}{\partial r}\left\{\overbrace{g'(I^*)\frac{\partial I^*}{\partial S_H} + \lambda\frac{\pi}{1-\pi}\left[\psi'_0\frac{1}{1-S_L} + \psi'_1\frac{1}{S_L}\right]}^{B}\right\}}{\left(1 - f_L\left\{g'(I^*)\frac{\partial I^*}{\partial S_L} + \lambda\frac{\pi}{1-\pi}\left[\psi'_1\frac{S_H}{S_L^2} + \psi'_0\frac{1-S_H}{(1-S_L)^2}\right]\right\}\right)}. \tag{A.8}$$

Note that this implies equal signs for S_L and S_H provided that $f(x)$ is low enough for every x.

Note that we can further substitute (A.8) at (A.7) and further isolate $\frac{\partial S_H}{\partial r}$. Doing so reveals our final derivative:

$$\frac{\partial S_H}{\partial r} = \frac{f_H v}{1 - f_H\left(ABf_L + \left\{g'(I^*)\frac{\partial I^*}{\partial S_H} + \lambda\frac{\pi}{1-\pi}\left[\psi'_0\frac{1}{1-S_L} + \psi'_1\frac{1}{S_L}\right]\right\}\right)}$$

where A and B stand for the terms in brackets on the numerators of (A.8) and (A.7).

This expression implies that $\exists M$ such that, if $\sup_x f(x) < M$, then $\partial_r S_H > 0$, since both the denominator and the numerator will be positive. In particular, the numerator is always positive, but the denominator is decreasing in the density f. Note furthermore that the same condition implies that $sign(\partial_r S_L) = sign(\partial_r S_H)$. Thus, since both types increase their participation, overall participation must increase in r, concluding the proof. ∎

Proof of Proposition 6.3.

Fix $\tilde{g}(x) > g(x), \forall x$. We refer to variables x under the environment with $\tilde{g}$ as $\tilde{x}$. We proceed with an argument for H-types, and it applies analogously to L-types.

Consider the decision rule for sharing under g and $\tilde{g}$:

$$g(I^*) + rv - c - \bar{V} \geq 0. \tag{A.9}$$

$$\tilde{g}(I^*) + rv - c - \tilde{\bar{V}} \geq 0. \tag{A.10}$$

Comparing both, since we are focusing only on one type, we find that sharing will increase for H-types if, and only if,

$$\tilde{g}(I^*) - g(I^*) \geq \tilde{\bar{V}} - \bar{V}.$$

If $\tilde{\bar{V}} - \bar{V} < 0$, that is, reputation costs are smaller under $\tilde{g}$, we are done. We thus assume $\tilde{\bar{V}} - \bar{V} > 0$.

Recall the three following facts:

(1) $\bar{V} = \varphi\left\{P_{\bar{V}}(a_i = H|s_i = 0)\right\} - \varphi\left\{P_{\bar{V}}(a_i = H|s_i = 1)\right\} > 0$.
(2) $P_{\bar{V}}(a_i = H|s_i = 1) = \frac{\pi S_H}{\pi S_H + (1-\pi) S_L}$.
(3) $P_{\bar{V}}(a_i = H|s_i = 0) = \frac{\pi(1-S_H)}{\pi(1-S_H) + (1-\pi)(1-S_L)}$.

We proceed with a continuity argument. Let $\epsilon > 0$. Since φ is continuous and strictly increasing, we deduce the existence of $\delta > 0$ such that:

$$[P_{\bar{V}}(a_i = H|s_i = 0) - P_{\bar{V}}(a_i = H|s_i = 1)] < \epsilon \implies \bar{V} < \delta.$$

We can also apply this exact argument under $\tilde{g}$, for $\tilde{\varepsilon}$ and $\tilde{\delta}$.

Since both $\tilde{\bar{V}} > 0$ and $\bar{V} > 0$, pick $\bar{\epsilon}$ such that both $\delta < \tilde{g}(x) - g(x)$ and $\tilde{\delta} < \tilde{g}(x) - g(x)$. This implies that

$$\begin{aligned} &[P_{\bar{V}}(.|s_i = 0) - P_{\bar{V}}(.|s_i = 1)] < \bar{\varepsilon} \text{ and } [P_{\tilde{\bar{V}}}(.|s_i = 0) - P_{\tilde{\bar{V}}}(.|s_i = 1)] < \bar{\varepsilon} \\ &\implies \tilde{\bar{V}} - \bar{V} < \delta := \tilde{g}(x) - g(x). \end{aligned} \tag{A.11}$$

Thus, all we need to provide are conditions such that the posteriors are below this real number $\bar{\varepsilon}$. Note that the difference $P_{\bar{V}}(a_i = H|s_i = 0) - P_{\bar{V}}(a_i = H|s_i = 1)$ tends to zero in the limit as we shrink the distribution of F. Thus, we deduce the existence of some M such that, if $\sup_x f(x) < M$, then A.11 holds. This completes the proof. ■

Appendix B. Appendix Tables and Figures

Figure B.1. Containers used for Visual Questions to Measure Knowledge about Fertilizer Amounts

Notes: This figure shows containers with varying amounts of CAN fertilizer. These containers were used to measure farmers knowledge of fertilizer quantities by asking participants to select one of the four containers, without showing them the labels that verbally describe the quantities. The quantities used in the four different containers are (i) 1/4 teaspoon; (ii) 1/2 teaspoon; (iii) 1 teaspoon; (iv) 1 tablespoon.

Table B.1. Balance: Baseline and Short Endline Surveys

	Cooperative and Coupon: school-level, Blue spoon: farmer-level						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Δ by treatment			p-value of differences		
	Control	Coup.	Coop.	Blue sp.	(1 = 2)	(1 = 3)	(1 = 4)
Panel A. Baseline Sample (N = 26,856)							
Fertilizer usage and knowledge							
Ever used CAN	0.36	0.04	-0.01	-0.00	0.14	0.80	0.90
Ever used DAP	0.63	0.03	-0.03	-0.00	0.50	0.47	0.45
Ever used CAN or DAP	0.65	0.03	-0.02	-0.00	0.44	0.55	0.64
Knows about fertilizer amount	0.23	0.02	-0.00	0.01	0.03	0.85	0.37
Joint orthogonality test					0.26	0.72	0.79
Number of participants	5,390	13,203	13,569	4,253			
Panel B. Full Sample (N = 22,230)							
Fertilizer usage and knowledge							
Ever used CAN	0.36	0.05	-0.00	0.00	0.10	0.89	0.98
Ever used DAP	0.63	0.03	-0.02	-0.01	0.47	0.58	0.18
Ever used CAN or DAP	0.65	0.03	-0.02	-0.01	0.42	0.66	0.21
Knows about fertilizer amount	0.23	0.02	-0.01	0.00	0.06	0.59	0.60
Joint orthogonality test					0.26	0.81	0.67
Number of participants	4,576	10,883	11,086	3,667			

Notes: This table presents sample characteristics and balance checks. Panel A focuses on the baseline survey while Panel B presents balance checks for those who also followed up in the short endline survey. Panels C and D present results for the long endline survey for original seeds and their friend, respectively. We regress each dependent variable on treatment indicators, clustering standard errors by school, as in Equation (5.2) (without additional control variables).

- Column 1 reports the mean of the control group, i.e., those who received none of the three treatments. Column 2 shows the coefficient of the coupon treatment, i.e., the difference between the treatment and the control group. Columns 3 and 4 report the corresponding coefficients for the cooperative and blue spoon treatments.
- Columns 5, 6, and 7 display p-values for the difference in means between the groups indicated in the headers. This value is obtained by regressing (without controls) the relevant variable on the treatment indicators, following Equation (5.2). Standard errors are clustered at the school level.
- "Fertilizer usage and knowledge" variables are collected in the baseline survey. "Demographics" variables are collected in the detailed endline surveys.

Table B.1. Balance (cont.): Detailed Endline Surveys

	Cooperative and Coupon: school-level, Blue spoon: farmer-level						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Δ by treatment			p-value of differences		
	Control	Coup.	Coop.	Blue sp.	(1 = 2)	(1 = 3)	(1 = 4)
Panel C. Detailed Survey Sample (Original Seeds) (N = 2,733)							
Demographics							
Sex	0.33	0.02	-0.01	0.03	0.36	0.77	0.13
Age	43.34	0.70	-0.63	-0.37	0.20	0.25	0.51
Read & Write	0.67	-0.02	0.02	0.02	0.35	0.39	0.22
Education	6.37	-0.38	0.41	0.06	0.04	0.03	0.70
Married	0.80	0.00	0.02	0.00	0.83	0.22	0.88
Primary source of income is farming	0.78	0.02	-0.03	0.00	0.21	0.13	0.89
Fertilizer usage and knowledge							
Ever used CAN	0.33	0.06	0.01	0.01	0.08	0.86	0.37
Ever used DAP	0.60	0.04	-0.02	-0.00	0.31	0.68	0.91
Ever used CAN or DAP	0.63	0.04	-0.02	0.00	0.37	0.67	0.86
Knows about fertilizer amount	0.23	0.02	-0.01	0.00	0.20	0.47	0.94
Joint orthogonality test					0.06	0.37	0.76
Number of participants	336	1,370	1,347	1,384			
Panel D. Detailed Survey Sample (Friends) (N = 2,314)							
Demographics							
Sex	0.50	0.01	-0.03	-0.03	0.66	0.23	0.12
Age	44.66	-0.17	-0.18	-0.21	0.78	0.77	0.71
Read & Write	0.73	-0.01	0.02	-0.01	0.46	0.26	0.54
Education	6.97	-0.20	0.19	0.08	0.31	0.33	0.64
Married	0.84	0.01	-0.01	0.00	0.71	0.45	0.74
Primary source of income is farming	0.80	-0.02	0.00	0.00	0.36	0.83	0.96
Joint orthogonality test					0.64	0.48	0.54
Number of participants	289	1,162	1,135	1,174			

Notes: This table presents sample characteristics and balance checks. Panel A focuses on the baseline survey, while Panel B presents balance checks for those who also followed up in the short endline survey (displayed on the previous page). Panels C and D present results for the detailed endline survey for original seeds and their friend, respectively. We regress each dependent variable on treatment indicators, clustering standard errors by school, as in Equation (5.2) (without additional control variables).

- Column 1 refers to the control group for both the cooperative and coupon treatments. Column 2 refers to coupon treatment group, while Column 3 refers to the cooperative treatment group. Note that treatment was cross-randomized, so there are schools in both treatment groups. Column 4 refers to the blue spoon treatment.
- Columns 5, 6, and 7 display p-values for the difference in means between the groups indicated in the headers. This value is obtained by regressing (without controls) the relevant variable on the treatment indicators, following Equation (5.2). Standard errors are clustered at the school level.
- "Fertilizer usage and knowledge" variables are collected in the baseline survey. "Demographics" variables are collected in the detailed endline surveys.

Table B.2. Attrition

	Cooperative and Coupon: school-level, Blue spoon: farmer-level						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
		Δ by treatment			p-value of differences		
	Control	Coup.	Coop.	Blue sp.	(1 = 2)	(1 = 3)	(1 = 4)
Panel A. Full Sample - Original Seeds							
Completed Short Endline Survey	0.84	-0.01	-0.02	0.04	0.54	0.09	0.00
	(0.01)	(0.01)	(0.01)	(0.01)			
Number of Participants	6416	13203	13569	4253			
Panel B. Detailed Survey Sample - Original seeds							
Completed Detailed Endline Survey	0.93	0.00	-0.00	0.00	0.72	0.81	0.57
	(0.01)	(0.01)	(0.01)	(0.01)			
Completed Social Network Survey	0.92	0.01	-0.02	0.01	0.70	0.26	0.61
	(0.02)	(0.02)	(0.02)	(0.01)			
Number of Participants	729	1458	1438	1472			
Panel C. Detailed Survey Sample - Friends							
Completed Detailed Endline Survey	0.86	0.00	0.01	0.00	0.97	0.63	0.84
	(0.01)	(0.01)	(0.01)	(0.01)			
Number of Participants	672	1346	1310	1358			

Notes: This table assesses patterns of attrition across samples and surveys. Panel A presents completion rates for the sample that could answer the short endline survey. Panel B presents completion rates for the original seeds that were selected to answer the long endline survey, while Panel C presents completion rates for friends of the original seeds. We regress each an indicator variable on treatment indicators, clustering standard errors by school, as in Equation (5.2) (without additional control variables).

- The coefficients in Columns 2 through 4 refer to the difference between the completion rates of the survey of the group defined in the header and the control group. This value is obtained through a regression (without controls) of an indicator denoting completion of a given survey on the treatment indicators, following Equation (5.2), clustering standard errors by school (displayed in parenthesis).
- Column 1 refers to the control group for both the cooperative and coupon treatments. Column 2 refers to coupon treatment group, while Column 3 refers to the cooperative treatment group. Note that treatment was cross-randomized, so there are schools and farmers present in both treatment groups. Column 4 refers to the blue spoon treatment, which was randomized with a probability of 50% in the Detailed Survey Sample, and 15% in the Full Sample.
- Columns 5, 6, and 7 display p-values for the difference in means between the groups indicated in the headers.

Table B.3. Details of Treatment Implementation: Coupon Redemption, Group Membership and Blue Spoon Ownership

	Coupons		**Cooperative Membership**		**Blue spoon**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	SR10	LR11	Full Sample	Detailed Sample	Full Sample		Detailed Sample	
					Heard	Owns	Heard	Owns
Blue Spoon	0.03	0.00	-0.00	0.03	0.43	0.57	0.30	0.66
	(0.01)	(0.00)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
	[0.00]	[0.97]	[0.83]	[0.16]	[0.00]	[0.00]	[0.00]	[0.00]
Cooperative School	0.01	-0.01	0.28	0.13	0.06	0.05	0.04	0.02
	(0.03)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
	[0.83]	[0.54]	[0.00]	[0.00]	[0.00]	[0.00]	[0.01]	[0.09]
Coupon School	0.18	0.13	-0.02	-0.02	0.01	0.00	-0.04	-0.03
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
	[0.00]	[0.00]	[0.20]	[0.39]	[0.67]	[0.86]	[0.01]	[0.08]
Control Mean	0.00	0.00	0.30	0.39	0.42	0.24	0.67	0.24
Control SD	0.00	0.00	0.46	0.49	0.49	0.43	0.47	0.42
Observations	15921	14318	21872	2678	22230	22230	2678	2678
Schools	106	107	183	184	184	184	184	184

Notes: This table summarizes evidence that the three treatments were implemented as intended, using regressions similar to Equation (5.2). In contrast to Figure 3, the regressions include regressors for all treatments as well as for controls that were selected among the variables displayed in Table 2 using the post-double-selection method (Belloni et al., 2014). Columns 1-2 present coupon redemption rates in the two seasons. Columns 3-4 present cooperative membership rates, while Columns 5-8 present information about blue spoon diffusion. The number of schools in coupon columns (106 and 107, respectively) reflect the number of schools sampled in the two seasons (short and long rains). Standard errors are clustered at the school level.

Coupon Redemption: The first two columns present the average redemption rates of coupons across seasons. Note that the control group was not offered coupons, and thus the redemption rate is zero. We use the data from the short sample because coupon redemption is recorded through administrative datasets, and report all coupon redemptions in our data. Coupons were only distributed to coupon treatment schools, so the coefficients for the cooperative and blue spoon treatments are differences relative to the coupon-only treatment. In particular, in the second season coupon redemption was already finished by the time blue spoons were given out.

Cooperative Membership: Columns 3-4 present the average agriculture group membership for different seasons and surveys. The survey question asks respondents if they are member of any cooperative or self-help group that meets regularly.

Blue Spoon Diffusion: Columns 5-8 present results for blue spoon awareness as the average of respondents that have heard about, or own, a blue spoon.

Table B.4. Communication on Agricultural Topics - Friends of Original Seeds

Panel A: Blue Spoons and CAN (topdressing)		CAN fertilizer (topdressing)			
	(1) Blue Spoon	(2) Any Topic	(3) Timing	(4) Amount	(5) Best Results
Blue Spoon	0.18	0.11	0.03	0.03	0.04
	(0.02)	(0.06)	(0.02)	(0.02)	(0.02)
	[0.00]	[0.05]	[0.10]	[0.15]	[0.05]
Cooperative School	0.05	0.03	0.01	0.01	0.01
	(0.03)	(0.08)	(0.03)	(0.03)	(0.03)
	[0.06]	[0.70]	[0.65]	[0.67]	[0.85]
Coupon School	-0.02	-0.02	-0.00	-0.01	0.00
	(0.03)	(0.08)	(0.03)	(0.03)	(0.03)
	[0.53]	[0.85]	[0.91]	[0.62]	[0.96]
p-val: Blue spoon = Cooperative School	0.00	0.42	0.55	0.56	0.28
p-val: Blue spoon = Coupon School	0.00	0.20	0.31	0.18	0.23
p-val: Coupon School = Cooperative School	0.07	0.68	0.67	0.52	0.92
Control Mean	0.29	1.37	0.54	0.41	0.42
Control SD	0.46	1.33	0.50	0.49	0.49
Observations	1981	1981	1981	1981	1981
Schools	184	184	184	184	184

Panel B: Other Agricultural Topics	Fertilizer (general)			Seeds and Storage		
	(1) Any Topic	(2) Experiences	(3) Types	(4) Any Topic	(5) Seeds	(6) Storage
Blue Spoon	0.04	0.02	0.02	0.03	0.03	-0.00
	(0.04)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)
	[0.30]	[0.26]	[0.38]	[0.42]	[0.09]	[0.94]
Cooperative School	0.02	0.01	0.01	0.07	0.03	0.04
	(0.05)	(0.03)	(0.03)	(0.04)	(0.02)	(0.02)
	[0.70]	[0.72]	[0.69]	[0.07]	[0.15]	[0.13]
Coupon School	0.04	0.02	0.01	0.01	0.01	-0.00
	(0.05)	(0.03)	(0.03)	(0.04)	(0.02)	(0.02)
	[0.49]	[0.37]	[0.65]	[0.81]	[0.50]	[0.93]
p-val: Blue spoon = Cooperative School	0.78	0.72	0.86	0.38	0.90	0.22
p-val: Blue spoon = Coupon School	0.99	0.92	0.91	0.75	0.52	0.98
p-val: Coupon School = Cooperative School	0.82	0.69	0.97	0.23	0.58	0.22
Control Mean	1.19	0.58	0.61	1.20	0.66	0.54
Control SD	0.94	0.49	0.49	0.85	0.48	0.50
Observations	1981	1981	1981	1981	1981	1981
Schools	184	184	184	184	184	184

Notes: This table presents results of the main treatments on communication about agriculture-related topics in the sample of friends of original seeds. The friends answered the same detailed endline survey as the original seeds.

Panel A focuses on topics related to calcium ammonium nitrate (CAN). The dependent variable is a dummy that equals one if the participant reported having talked with their agricultural contact about CAN-related issues during the past 12 months, including (i) the right time to apply CAN on maize (Column 2), (ii) how much CAN they have each used per planting hole (Column 3), (iii) how much CAN per planting hole yields the best results (Column 4), and (iv) how useful blue spoons are for applying fertilizer (Column 5).

Panel B covers discussions about fertilizer as well as about seeds and storage of maize. The dependent variable is a dummy that equals one if the participant reported having talked with their agricultural contact about these topics during the past 12 months, including (i) their experiences with different types of fertilizer (Column 2), (ii) which fertilizer to apply (Column 3), their experience with different varieties of maize seeds (Column 5), and (iii) the best ways to store maize (Column 6).

Regressions have no controls (for the main version, see Table 8). Standard errors are clustered at the school level.

Table B.5. Knowledge of Fertilizer Quantity (Original Seeds) - Visual and Verbal Questions Separately

	Original Seeds				Friends			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Detailed Sample		Full Sample		Detailed Sample		Full Sample	
	Verbal	Visual	Verbal	Visual	Verbal	Visual	Verbal	Visual
Treatment Effects: Ongoing Intervention								
Blue Spoon Treatment			0.26	0.08			0.11	0.10
			(0.02)	(0.02)			(0.03)	(0.03)
			[0.00]	[0.00]			[0.00]	[0.00]
Cooperative Treatment			0.02	0.01			0.06	0.07
			(0.02)	(0.02)			(0.05)	(0.04)
			[0.21]	[0.63]			[0.21]	[0.11]
Coupon Treatment			0.01	0.02			0.06	0.00
			(0.01)	(0.01)			(0.03)	(0.03)
			[0.63]	[0.16]			[0.06]	[0.96]
Treatment Effects: Post-Intervention								
Completed Spoon Treatment	0.23	0.27	0.23	0.05	0.03	0.04	0.03	0.06
	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.10]	[0.05]	[0.15]	[0.01]
Completed Cooperative Treatment	-0.04	-0.03	-0.01	-0.01	0.03	0.02	-0.00	-0.03
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.03)	(0.03)
	[0.09]	[0.06]	[0.44]	[0.58]	[0.18]	[0.31]	[0.99]	[0.44]
Completed Coupon Treatment	0.01	-0.00	-0.00	0.01	-0.01	-0.00	-0.00	-0.03
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.04)	(0.04)
	[0.69]	[0.80]	[0.97]	[0.29]	[0.81]	[0.88]	[0.94]	[0.48]
Control Mean	0.23	0.49	0.22	0.34	0.25	0.52	0.18	0.32
Control SD	0.42	0.50	0.41	0.47	0.43	0.50	0.39	0.47
Observations	2663	2646	22230	21176	2256	2235	2263	2262
Schools	184	184	184	183	184	184	182	182

Notes: This table presents results of the main treatments on knowledge about fertilizer quantities. The coefficients are estimated using Equation 4.1. Columns 1 through 4 use data from original seeds, i.e., farmers who attended the school meetings in which the treatments were implemented and who completed the baseline survey, both from the short endline and detailed endline surveys. Columns 5 through 8 use data from the friends sample, i.e., people who were listed in the baseline survey by original seeds as people with whom they discussed agriculture.

- "Verbal" refers to answers to questions about how much fertilizer to use per planting hole, verbally (stating the amount). The outcome variable equals 1 if the respondent chooses the quantity of 'half a teaspoon' as this quantity was found to yield the highest expected profits in previous trials (Duflo et al., 2008).
- "Visual" refers to answers to questions about how much fertilizer to use per planting hole, visually (choosing one of four small containers with different quantities of fertilizer). The outcome variable equals 1 if the respondent identifies the quantity of 'half a teaspoon' as this quantity was found to yield the highest expected profits in previous trials (Duflo et al., 2008).
- For the main versions of this table, which pools both "Verbal" and "Visual" answer into a single variable, refer to Tables 4 and 5, Columns 6 and 7.
- As the detailed survey (Columns 1, 2, 5, and 6) was conducted between August 2011 and January 2012, but mainly after September, we consider the knowledge outcomes collected in this survey as "post-intervention" only. The short survey, however, is conducted between June and July 2011 and thus can be interpreted as collecting information during the season of treatment.
- Controls are selected among the variables displayed in Table 2 using the post-double-selection method (Belloni et al., 2014). Standard errors are clustered at the school level.

Appendix C. Scripts and Other Project Implementation Details

SCHOOL ID:
TREATMENT: COUPON [ ] COOPERATIVE [ ]

Field Officer Script for Parental Meetings
[FOR SCHOOLS NOT PARTICIPATING IN COUPONS, NOR COOPERATIVES in the SHORT RAINS OF 2010]

-**Introduce the project**: we would now like to start a new project in which we will be working with parents' groups at schools in the area for the next year.

We would like to use this occasion to give a small talk about the importance of safe food on your daily lives. The availability of safe food improves the health of people and is a basic human right. Safe food contributes to health and productivity and provides an effective platform for development and poverty alleviation.

Up to one-third of the populations of developed countries are affected by foodborne illness each year, and the problem is likely to be even more widespread in developing countries. The poor are the most susceptible to ill-health. Food and waterborne diarrheal diseases, for example, are leading causes of illness and death in less developed countries, killing an estimated 2.2 million people annually, most of whom are children.

FACTS ABOUT FOOD SAFETY

- **More than 200 diseases are spread through food**. Millions of people fall ill every year and many die as a result of eating unsafe food. Proper food preparation can prevent most foodborne diseases.

- **Foodborne diseases are increasing worldwide**. Rapid urbanization worldwide is adding to risks, as urban dwellers eat more food prepared outside the home that may not be handled or prepared safely - including fresh foods and fish, meat and poultry.

- **Food safety is a global concern.** Globalization of food production and trade increases the likelihood of international incidents involving contaminated food.

- **Emerging diseases are tied to food production**. Many of these diseases in people are related to the handling of infected domestic and wild animals during food production - in food markets and at slaughterhouses.

- **Minimize the risk of avian influenza**. The vast majority of H5N1 avian influenza cases in people follow direct contact with infected live or dead birds. There is no evidence that the disease is spread to people by eating properly cooked poultry.

- **Chemical hazards can contaminate food**. Avoid overcooking when frying, grilling or baking food.

- **Everyone plays a role in food safety**. Food contamination can occur at any stage from farm to table. Everyone on the food delivery chain must employ measures to keep food safe - farmer, processor, vendor and consumer. Safety at home is just as vital to prevent disease outbreaks.

- **School is a place for food safety**. Educating children on safe food handling behaviors is key to preventing foodborne diseases today and in the future.

1

Figure C.1. Treatment script for controls schools

SCHOOL ID:
TREATMENT: COUPON [ ] COOPERATIVE [ ]

- **Seven keys to food safety are:**

  1. keep clean and wash your hands
  2. separate raw and cooked
  3. cook all foods thoroughly
  4. keep food at safe temperatures
  5. use safe water and raw materials.
  6. separate raw meat from other foods
  7. cook thoroughly (until meat is 70 °C in all parts, with no pink areas)

We would like to help you start complying with the "7 Keys to Food Safety" by providing you with a bar of soap. For you to get it, all you have to do is register with us and complete a small questionnaire. When you register with us, please give us the little sheet of paper with the number on it that we gave you before the meeting started. If you and your spouse are both present, only one of you should come forward.

2

Figure C.1. Treatment script for controls schools (cont.)

SCHOOL ID:
TREATMENT: COUPON [ ] COOPERATIVE [X]

Field Officer Script for Parental Meetings
[FOR SCHOOLS RECEIVING COOPERATIVES in the SHORT RAINS OF 2010 AND NOT PARTICIPATING IN THE COUPONS]

Introduction
Innovations for Poverty Action (IPA) is a nonprofit, research organization that creates and evaluates solutions to social and development problems, and works to scale up successful ideas through implementation and dissemination to policymakers, practitioners, investors, and donors. Our office is based in Busia from where we operate. We work on many projects in Western Kenya.

Introduce the project: We are now starting a new project in which we will be working with parents' groups at schools in the area to encourage you to talk about agricultural issues and to share information/experiences/knowledge you have regarding agriculture.

Rationale for Cooperative Intervention. Why is it important to create a cooperative?

- **Why is it important to discuss agricultural matters**?

We have noticed that many farmers do not usually know what their neighbours are doing in terms of agriculture, what their agricultural experiences (whether successful or unsuccessful) have been, or the degree of agricultural expertise they have. Talking about agriculture with your friends, neighbours and family in a group is a very valuable activity: you can learn a lot from each other.

- **How can you start discussing agricultural matters?**

A great way to learn from each other is to set up your own cooperative groups which meet on a regular basis. This group can serve as your own forum for ideas/initiatives/activities regarding agriculture that you feel is worth sharing with each other.

If you are already meeting in a different group (like a church group, or a ROSCA, merry-go-round) you might start considering devoting some time from that meeting to the discussion of agricultural matters so you can raise agricultural issues and questions/problems to your fellows.

We encourage you to have a moderator or leader for your own group, somebody who can help you set up the meetings when the agricultural discussions will take place.

- **What topics could you raise during those meetings?**

There are many agricultural topics that you could discuss in your meetings; here you can find a list of the potential topics and questions that might be of interest to you:

1. **New methods of farming:** Who of you has tried new techniques of farming? Which techniques have you tried? What were your experiences? What can you learn from these experiences?
2. **Profitability of different crops**: Which crops are profitable? What is the yield of maize, sukuma wiki and of other crops? For how much could you sell those yields? Who of you has experimented with new crops? Would you recommend any of those crops to your fellow farmers?

1

FIGURE C.2. Treatment script for cooperative schools

SCHOOL ID:
TREATMENT: COUPON [ ] COOPERATIVE [X]

3. **Methods of land preparation**: Do you prepare your land using an oxen, tractor or by hand?
4. **Purchase of seeds**: Do you buy hybrid or local seeds, or both? What is the optimal combination of the two kinds of seeds? How do you decide what hybrid seed is best for each season (short or long rains)?
5. **Purchase of fertilizer**: How much does fertilizer cost? Is using fertilizer a good idea? Which type of fertilizer works best? When do you buy it? For those who have used fertilizer in the past, has using fertilizer increased output by a lot?
6. **Storage of harvest**: What are the best conditions to store your harvest, and for how long should you store it? What do you do to control losses during storage to pests/moisture?
7. **Marketing what you harvest:** What are the different options to market what you harvest? Do you sell it directly in a market or through a middleman?
8. **Timing for your agricultural activities:** When do you acquire your inputs? When do you use them? When is a good time to buy fertilizer? When is a good time to apply fertilizer? How do you decide what is the best timing for planting and how do different factors, for example the arrival of the rains, affect it?
9. **Crop diseases & pests:** What diseases are common? How do you control pests/diseases? Have you tried insecticides? How effective are these? How do you control stringa weed? Do the herbicides control these effectively? Is there a cheap and effective way of controlling stringa?
10. **Joint activities** with the fellow members of your cooperative such as farming a cash crop, acquiring seeds, buying fertilizer, renting agricultural tools, rotational labour.

- **Where can you seek assistance?**

  You can always seek the assistance of the agricultural extension officers that operate in your community.
  If you have any question regarding agriculture or if you would like to go see them, you can call PENNINA APUKO (KABULA) AT 0723 204 319.

We are aware that some of you belong to many different groups and that you meet regularly. We encourage you to use these groups as platforms to discuss about agriculture or to create your own new groups that will serve the purpose stated above. Anybody can be in these groups, even if they're not here at the meeting today. However the cooperatives should be of maximum 25 people.

IPAK wants to help you start these groups
We realize that it's hard to organize these groups on your own. We would therefore like to help you in setting up your cooperatives. To encourage people to form cooperatives, we would like to provide sodas for one of your meetings.

We are going to give you some time now to think about whether you would like to start your own group, or whether you feel motivated to lead a new group. If the leaders can come forward and register with _____________ [*FO:show person who will register cooperatives*], we will register their name, his or her contact information, and a name for the group.
Only **one leader from each cooperative** should register their names with __________________. Cooperatives should be maximum 25 members.

2

FIGURE C.2. Treatment script for cooperative schools (cont.)

SCHOOL ID:
TREATMENT: COUPON [ ] COOPERATIVE [X]

Once you register your cooperative, we will then give you a cooperative information sheet that you need to fill out during your first cooperative meeting. *[FO: Show how this information sheet looks like]* This short information sheet, asks about where do you generally meet, on what days, asks all members of the cooperative register their names, contact information, and sign, also, we ask you for some minutes of what you talked about on your first meeting.

After your first meeting has occurred we will contact your group leader and ask him or her about that first meeting and how many participants were present. We will then arrange with them the delivery of sodas, so your cooperatives can have them for their next meeting. On the day that we deliver the sodas for your cooperatives, we will be picking up the information sheets. We will not deliver sodas unless the information sheet is fully completed. Also we will only provide the number of sodas equivalent to the number of participants registered on that information sheet (up to 25 sodas per cooperative). We will contact cooperative leaders in about one month, to make sure they have had enough time to plan their first meeting.

Also at the time you register with __*(name of FO who is registering)*__ we will provide you with the list of suggested topics that you can discuss in the cooperatives. You could bring that list to your first meeting and use it as a starting point for discussion in your cooperative.

[FO: we let the farmers present in the meeting talk among themselves, discuss these ideas and come up with some potential leaders/organizers/moderators of cooperatives. We are going to allocate between 5-10 meetings minutes for this. Afterwards, someone should be registering the cooperative leaders in the COOPERATIVE REGISTRATION SHEET]

3

Figure C.2. Treatment script for cooperative schools (cont.)

SCHOOL NAME: ________________________________
SCHOOL ID: _____________________________________
TREATMENT: SPOON DISTRIBUTION [X]

Field Officer Script for *bluespoon* Distribution

Introduction

Good morning. My name is __________________ and I work with IPA in Busia. We recently spoke to you at a meeting at ________________ school. Do you remember the meeting?

I have come here today to talk about fertilizer use when you or your household is doing maize farming. Many farmers use different devices and methods to apply their fertilizer, however sometimes more fertilizer is used than is required and sometimes it is not enough. In addition, I would like to give you something that may make it easier for you to apply fertilizer effectively.

Our research shows that many farmers do not know how much fertilizer to use, or they might use a quantity that is not profitable. The official recommendation from the government of Kenya is ½ teaspoon for top dressing fertilizer (CAN). However, we have found that many people use more than this quantity.

Our research shows that **½ a teaspoon** is the right amount of CAN (top dressing fertilizer) to apply per planting hole, when the maize is knee-high. Our research shows, that this is the most **profitable quantity** that you could use. What does this mean? It means that overusing fertilizer is not a very good idea because you might lose money. Using more than ½ a teaspoon, might give you a higher yield but it will cost you a lot of money in fertilizer, which will not be compensated from that higher yield.
Hence, ½ teaspoon is the right amount for you to get the largest profit.

Example:
Let's say you can sell 1 bag full of maize you at 1000 Ksh.
Imagine that if you don't use fertilizer you would a yield of 10 bags.
You then would earn 10bags*1000Ksh=10,000 Ksh.
Imagine that using fertilizer the yield would be 20 bags of fertilizer.
You then would earn 20bags*1000Ksh=20,000 Ksh.
What is profitable?
If you had spent 5,000 Ksh on fertilizer it would be profitable because you make 20,000 -5,000 = 15,000 Ksh. If the fertilizer you bought had cost 30,000 Ksh, then you would have made 20,000-30,000 =-10,000. You are at loss! This is what we mean by profitable, your yield might be higher, if you use more than ½ teaspoon, but at the end you would be spending too much money on fertilizer.

To help you with getting the right quantity on your maize, we would like to give you a *bluespoon* that will help you measure the correct amount of fertilizer to put in each maize planting hole. When you use it, you can be sure that the fertilizer you apply is helping your plants and that you are earning the most of out of it. Here is the *bluespoon*. (Show the bluespoon.)

Do you have any questions?

If you like this device and find it useful, there are some available at __________ and __________ agrovet in ___________ town. We encourage you to tell your friends or other contacts about this information on the right quantity to use. In addition, you can tell your friends that if they ask at the ________ Agrovet, they can obtain one *bluespoon* for a price of 5 shillings. We will leave you with 10 vouchers to give to your friends, so they can take them to the agrovet, this voucher guarantee that they will get a *bluespoon* at a 5 Ksh price. Otherwise we will also sell the spoons, but only until the stock lasts.

1

FIGURE C.3. Treatment script for blue spoon farmers

SCHOOL NAME: ________________________________
SCHOOL ID: _____________________________________
TREATMENT: SPOON DISTRIBUTION [X]

Please tell your friends to take the voucher to the Agrovet when they go to purchase their IPA-spoon. It will help us track the person that gave them the IPA spoon on the first place. This will help us do some research, on how information about spoon is diffused.

Do you understand that this is purely voluntary and you are under no obligation to take this *bluespoon* or vouchers?.
<<Wait for group to agree or disagree>>

Also, I would like to remind you that although we have done extensive research measuring the profitability of fertilizer, sometimes things that aren't related to this advice but that could affect your crops could go wrong. For instance, the might not be enough rainfall. IPA is not responsible for this, and won't be held liable,

Do you understand that the use of the bluespoon is your own choice and that IPA cannot be held liable for your yield?
<<Wait for group to agree or disagree>>

Demonstration

Here is the *bluespoon* you will be receiving today (show bluespoon). I would now like to show you how it can help your fertilizer application by measuring the correct amount that should be put on your planting hole.

1. Take a scoop of fertilizer using the *bluespoon* and show the recipients what it should look like. It should be a full teaspoon with a small heap on the top.

2

Figure C.3. Treatment script for blue spoon farmers (cont.)

SCHOOL ID:
TREATMENT: COUPON [X] COOPERATIVE [ ]

Field Officer Script for Parental Meetings
[FOR SCHOOLS RECEIVING COUPONS in the SHORT RAINS OF 2010 AND NOT PARTICIPATING IN FARMERS' COOPERATIVES]

Introduction
Innovations for Poverty Action (IPA) is a nonprofit, research organization that creates and evaluates solutions to social and development problems, and works to scale up successful ideas through implementation and dissemination to policymakers, practitioners, investors, and donors. Our office is based in Busia from where we operate. We are working on many projects in Western Kenya.

Introduce the project: we are now starting a new project in which we will be working with parents' groups at schools in the area to provide people with a 15% discount for fertilizer when they buy at local shops during harvest time. Your school has been selected to benefit from the 15% discount on fertilizer. Each family present at this meeting will be given a coupon that looks like this.

PLEASE KNOW THAT YOU SHOULD FEEL FREE TO STAY AND PARTICIPATE IN THE MEETINGS EVEN IF YOU DO NOT KNOW MUCH ABOUT FERTILIZER OR EVEN IF YOU DO NOT USE IT. EVERYONE SHOULD FEEL FREE TO PARTICPATE AND BE APART OF THIS MEETING.

Rationale for Coupon Intervention: Why are we offering these discounts?
We have found that many farmers would like to use fertilizer at planting and/or top dressing, but do not have money available when it is time to plant or top dress. We would like to facilitate this purchase for you by offering a time-limited discount of 15% value on up to 25 Kgs of DAP and/or CAN. It is possible to buy fertilizer now and keep it at your homestead until it is the time to use it (fertilizer does not go bad if you stock it).

- **What does the 15% discount mean?**

  It means that for every Kg of fertilizer that you buy, you do not have to pay the full price, since IPA will cover a 15% of it. That is for every 100 Ksh you spend, IPA will pay 15 Ksh and you will only have to pay 85 Ksh.

  As we all know, fertilizer prices vary over time, but let me give you some examples of how our discount will make fertilizer cheaper for you.

  The price of 1 kg of CAN at NALULINGO FARM INPUTS AGROVET in KABULA market centre is about 60 Ksh. If you purchase fertilizer at this shop using our coupon during the next three weeks, your discount of 15% will be worth 15% * 60 Ksh = 9 Ksh per kg of CAN. Hence, you will only have to pay 60 Ksh – 9 Ksh = 51 Ksh per kg of CAN.

  As time goes by, prices may vary, but you will always get a 15% discount on the price at NALULINGO FARM INPUTS AGROVET.

- **Where do I have to go to use the discount**? NALULINGO FARM INPUTS AGROVET in KABULA market centre. If you want to benefit from the discount, you should bring the coupon to this shop between the dates indicated on the coupon. A field officer from IPA will be stationed during those dates to monitor the redemption and to ensure that you get your discount! The field officer will also make sure that there is no fraud by the shop or by the farmers redeeming the

1

Figure C.4. Treatment script for coupon schools

SCHOOL ID:
TREATMENT: COUPON [X]   COOPERATIVE [ ]

coupons. Remember, the coupon is for you **only**: you cannot give it to somebody else. You can only redeem one coupon per household.

- **What does time-limited redemption mean**?

The discount that we are going to give you has a time-limited duration: you can use it starting from today and it will remain valid for the next 3 weeks. Just to be clear with the dates: the discount can be used from today, AUGUST 19, 2010, until SEPTEMBER 9, 2010. If you buy fertilizer at the shop NALULINGO FARM INPUTS AGROVET in KABULA market during those dates and give the coupon to the shopkeeper, you will benefit from the 15 % discount. It is important that you keep in mind these two dates, because after the deadline has passed, you will not be able to benefit from the discount. The dates are printed on the coupons.

- **What does it mean that you can buy DAP and/or CAN**?

The coupon allows you to benefit from a discount when you buy planting fertilizer (DAP), or topdressing fertilizer (CAN) or any combination of the two types of fertilizer that you want.

The discount is available for DAP and CAN, the fertilizer that is applied for maize crops. It is not valid for any other type of fertilizer (like urea, which is designed for sugarcane crops).

- **What does the 25 Kgs limit mean**?

You are free to buy as many kgs of DAP and/or CAN as you want, however we are only able to provide the 15% discount on the first 25 Kgs of fertilizer that you purchase. If you want to buy more than 25 Kgs, you can do so, but the discount will only be applicable on the first 25 Kgs.

For instance, if you buy a bag of 50 Kgs of DAP using the discount, you will pay the following: 25 Kgs at a discount, the remaining 25 Kgs you will have to pay the full price.
Another example: if you want to buy 5 Kgs of DAP and also 10 Kgs of CAN, in total you will buy 15 Kgs. You will benefit from the 15% discount for the entire 15 Kgs, since it is below the limit of 25 Kgs.

- **How many times can I benefit from the discount?**

The discount can only be used once. When you go to the shop in the market centre that we have indicated, you will have to bring along the coupon to benefit from the discount. The shopkeeper and the FO have been instructed to collect the coupon from you after you use it at the duka. You can also only get 1 coupon per household**.**
[FO: If the husband has several wives who live and plant their own separate plots, issue each of them with their own coupon.]

- **What do I have to do to get the discount**?

If you want to benefit from the discount, all you have to do is register with us to get the coupon. IT IS NOT REQUIRED THAT YOU ALREADY USE FERTILIZER OR KNOW ABOUT FERTIILIZER to get a coupon. We are going to get your contact information and also conduct a brief questionnaire regarding your farming practices. We will proceed to do that after this meeting is over and there are no more questions/doubts about the functioning of the coupons or the cooperatives. We would kindly ask you to be patient while we register all of you present here.

2

FIGURE C.4. Treatment script for coupon schools (cont.)

ID: 1150 101 **Redemption Date: | _ | _ | _ | _ | _ | _ |**

Kijikaratasi hiki kinakupa upungufu wa bei ya asilimia kumi na tano (15%) kwa kila ununuzi wa hadi kilo 25 za DAP ama CAN. Kwa kila kilo ya mbolea unayonunua zaidi ya kilo 25 utalipa bei kamili ya mwenye duka. Upungufu huu wa bei ni wa muda tuu.

Hiki ni kijikaratasi ambacho unaweza kuwasilisha kwenye duka la BUYOFU AGROVET (kwenye soko la BUYOFU), ambalo limesajiliwa na (IPA).

Muda wa matumizi ya kijikaratasi hiki ni

Kuanzia Jumanne, 20/07/10 hadi Jumanne, 10/08/10.

Figure C.5. Example of Fertilizer Coupon

Appendix D. A Model of Public Goods

Here we briefly review a model of public goods adapted to information provision. This is discussed further in Banerjee et al. (2007), Galeotti and Goyal (2010), and Banerjee et al. (2021). The goal of the exercise presented here is as follows. There is a temptation to rationalize the reduction in communication under the discussion cooperatives treatment relative to control by a public goods type of information procurement model. It may be the case that because the scope to communicate has now expanded—rather than only having access to one's network neighbors, one now has been placed in a setting with free access to many more individuals (i.e., a cooperative) — each individual may have a lower need to participate in conversation with their contacts. However, we note that on first principles a standard model of public goods for the most part cannot deliver the result that aggregate knowledge *declines* relative to control, which we observe on Table 4.

To see this, consider the very simple setup where s_i denotes i's contribution to the social stock of information, with $s_i \geq 0$. To maintain parallelism with our other models, consider that the social stock I equals the total contribution across individuals, $\sum_j s_j$. Contributing with information comes with a private weakly convex cost $c(s_i)$, which can represent both the costs of obtaining and sharing information. The instrumental network payoff to each individual i can be written as:

$$U(s_i) := \underbrace{g\left(\sum_j s_j\right)}_{\text{instrumental network benefit}} - \underbrace{c(s_i)}_{\text{cost}}$$

where $g(\cdot)$ is some increasing and smooth function capturing the return to aggregate provision. In principle this can be convex, concave, or even sigmoid-shaped (initially convex and then with concave returns). We provide some examples for each of these shapes below.

In this setup, instead of deciding whether to socialize or not (as in the models in Sections 2.3 and 6), the individual instead chooses the amount of information to contribute.

It is instructive to look at the most "adversarial" case, in which the returns to aggregate provision are concave. Despite this, aggregate provision must weakly increase in the number of agent in such a public goods game.

Proposition D.1. *Let $I(k)$ denote the social stock of information when k identical agents are contributing. If $g(.)$, as above, is concave and $c(.)$ is convex, then $I(k)$ is weakly increasing in k.*

Proof. Let $s^*(k)$ denote the optimal contribution with k individuals. Assume $k = 1$. The optimal contribution to the social stock of information, $s^*(1)$, depends on the single agents' decision, defined at the point in which $g'(s_i^*) = c'(s_i^*)$.

Now, consider the case where $k = 2$. Then, the optimal amount, s^* is given by

$$s^*(2) : g'\left(2 \cdot s^\star(2)\right) = c'\left(s^\star(2)\right)$$

By the concavity of $g(.)$ and the convexity of $c(.)$, we must have $s^*(2) \in [s^*(1)/2, s^*(1)]$. If $s^*(2) > s^*(1)$, then individuals will find it optimal to reduce the contribution. If instead $s^*(2) < s^*(1)/2$, at least one individual will find it optimal to raise this amount to such that $I(2) = s^*(1)$.

Now consider two settings, one with k' individuals and one with $k < k'$ individuals who can communicate. Under mild assumptions, for every $k' > k$

$$g\left(k' \cdot s^\star(k')\right) \geq g\left(k \cdot s^\star(k)\right).$$

This follows again from the concavity of $g(.)$ and the weak convexity of $c(.)$, which then implies that $I(k) = ks^*(k)$ is weakly increasing in k. ■

The proposition shows that it is always worthwhile for an individual in a society to fill the effort gap, even in the concave $g(\cdot)$ case where ex-ante one may have suspected that aggregate provision would decline. After all, when others free ride an individual has more of a reason to fill the effort gap since they were certainly willing to apply $s^\star(1)$. In the best scenario, the other individuals all contribute and the effort is split; in the worst case scenario, a single agent will find it optimal to provide the optimal level of public goods as if 1 individual only was contributing.

One simple example to illustrate the point is warranted: consider linear costs: $c(s_i) = Cs_i$. In this case

$$g'\left(\sum_i s_i\right) = C.$$

And therefore, if g is concave the social stock of information in the network $\sum_i^k s_i$ is independent of k and in particular cannot decline in k, while optimal amount of each individual's contribution are decreasing in k.

However, as noted above, in general the expression determining agent i individual contribution will depend on the first order-condition $g'(\sum_j^k s_j) = c'(s_i)$, for each agent i. For any increase in the contribution of others, $\sum_{j \neq i} s_j$, if $g(\cdot)$ is concave then the marginal returns diminish and s_i must decrease. In particular, how s_i responds to k will depend on the relative curvatures of $g(\cdot)$ and $c(\cdot)$. When the marginal benefit is not too much decreasing, individual contributions will only decrease by a bit.

If $g(\cdot)$ is convex, the situation is more subtle. Again the relative curvatures of benefits and costs will determine the direction. For instance, if marginal benefits weakly increases as the contributions increases, and costs are very steep, then once more people start contributing, you are able to contribute more and pay the costs of doing so – individual contributions then increase, highlighting a sort of "coordination" feature.

Even in the case of convex $g(\cdot)$, it is possible for individual contributions to decline in the number of people, though typically aggregate provision will increase. It also possible to construct specialized cases where aggregate provision declines as well, though as seen here these are very constructed, tuned models.

In general, in a public goods setting, it is reasonable to assume $c(\cdot)$ is convex. Whether $g(\cdot)$ is concave, convex, or even sigmoid (S-shaped) depends on context, especially when we consider low levels of contribution. For instance, one may imagine that the returns to a sub-group in a civic or political gathering, such as a village gram panchayat meeting, may be initially convex since there is no political voice even with a few individuals from one's community but then may steeply increase and then become concave with sufficient people. Similarly, without enough contribution a well may not be built but above some threshold the well will function reasonably and returns then go from convex to concave. Finally, a public health clinic may benefit from having either a doctor or a nurse, but when contributions are high enough and you can hire both, then their labor complementarity may represent an increase in marginal returns. But for the most part, aggregate provision must go up in almost all cases and, further, in cases of local convexity individual contributions may very well increase.

A final comment is that these observations are both robust to natural extensions and echoed in other work. For example if agents gain some small private utility from contributing that increases in provision for small provision levels, then this places a lower bound on aggregate knowledge that increases in group size. Relatedly, as noted in Galeotti and Goyal (2010), when a network forms endogenously to aid in public good provision, only a few individuals provide the good but the total provision does not decline in size.

This discussion links to our empirical results. Under a public goods perspective, the results about communications reported in Section 5.3 suggests that discussion cooperatives reduced both individual contributions and the aggregate stock of information (see Table 4). For this to be possible, undert this model g would need to be locally convex, and much steeper than c, such that as the number of agents increases, the free-rider problem increases strongly. Importantly, the data shows suggestively that aggregate knowledge decline with cooperatives, which is entirely inconsistent with the model under the most general of assumption of a concave benefit function g.