Demand and supply factors constraining the emergence and sustainability of an efficient seed system: Midline report

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Abstract

Agricultural technology remains under-adopted among smallholder farmers in Sub-Saharan Africa. We investigate how the variation in (perceptions of) the quality of an agricultural technology—improved maize seed—affects its adoption. Using a randomized controlled trials among agro-input dealers and smallholder farmers in Uganda, we test three hypotheses. In a first hypothesis, quality issues that constrain uptake are caused by knowledge gaps at the level of agro-input dealers; a training on proper storage and handling of seed at the agro-input dealer level is expected to increase adoption on the farm. A second hypothesis conjectures that information asymmetries similar to the lemons problem constrain technology adoption. We test this hypothesis by setting up an information clearing house that relies on crowd-sourcing to make hidden features of the technology visible to both agro-input dealers and farmers. We also test a behavioral explanation, whereby we assume that farmers attribute poor outcomes to the wrong causes. In this report, we present results obtained from the midline survey that was collected one agricultural seasons after the interventions took place.

keywords: seed systems, information clearinghouse, learning failures, information, input quality, agricultural technology adoption

JEL codes: O13; Q12; Q16; D82; D83

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1 Introduction

One of the most effective ways to increase agricultural productivity is through the adoption of improved agricultural technologies and practices. These include mechanization, but the Green Revolution has demonstrated that the largest gains can be expected from improved inputs such as inorganic fertilizers and high yielding cultivars. However, technology adoption remains lower than projected, particularly among the poor in sub-Saharan Africa (Gollin, Morris, and Byerlee, 2005). As a result, differences in yields between sub-Saharan Africa and areas that experienced a green revolution have nearly doubled since 1961 (Magruder, 2018). To reduce this yield gap, it is important to identify the drivers of, and constraints to, technology adoption.

There are various reasons why some people adopt new technologies while other stick to what they have been doing for ages. Key constraints to technology upgrading include poor access to information (Van Campenhout, 2021; Ashraf, Giné, and Karlan, 2009), procrastination and time-inconsistent preferences (Duflo, Kremer, and Robinson, 2011), heterogeneity in the net benefits to the technology due to high transaction costs (Suri, 2011), the lack of access to insurance (Karlan et al., 2014), and learning failures (Hanna, Mullainathan, and Schwartzstein, 2014).

In this study, we investigate quality related considerations about the technology as a particular constraint to adoption, a topic that has received considerable attention recently (Bold et al., 2017; Michelson et al., 2021). Indeed, as the quality of a technology (like improved seed or fertilizer) is not readily observable and can only be (imperfectly) inferred ex-post, inconsistent quality will lead to lower adoption than would be the case if quality would be consistent and/or perfectly observable. Our study tests three hypotheses to assess the relative importance of potential sources of these (perceived) quality issues. We do this using a field experiment that involves agro-input dealers and smallholder farmers in Uganda, where the focus is on improved maize seed.

In a first hypothesis, quality concerns that constrain uptake of the technology are caused by knowledge gaps at the level of the agro-input dealers, who are assumed to lack awareness and skills related to proper storage and handling of improved agro-inputs. To test this hypothesis, we implement and intensive training program that is expected to lead to improved maize seed quality sold by agro-input dealers, in turn increasing adoption by farmers. A second hypothesis conjectures that information asymmetries between seller and buyer with respect to the quality of seed—a classic lemons technology—leads to under-adoption. To test this hypothesis, we implement a crowd-sourced information clearinghouse similar to yelp.com, where we ask farmers about their experience with agro-input dealers, aggregate this data into rankings and feed this data back to both farmer and agro-input dealers. A third hypothesis targets farmers directly, as sub-optimal adoption is assumed to be caused by a particular type of learning failures: As farmers have to pay more for improved seed, this may also lead to altered expectations and behavior. In particular, we argue that farmers may expect too much from seed and as a result exert less effort than they normally would, use less complementary inputs, and plant the improved seed on sub-optimal plots. Disappointing outcomes may then be attributed to poor input quality. An ICT-mediated information campaign that stresses that even when using improved seed is is important to pay attention to all input dimensions is implemented to test this hypothesis.

This report documents impact at midline after one agricultural seasons had passed since the intervention. A similar report exists using endline data, looking at impact after two full agricultural season. Both reports closely follow a mock report, that was prepared after baseline data was collected, and well as a pre-analysis plan, that was created at the time the study was conceptualized and designed.[1]

We find that at midline, the information clearing house seems to work as predicted by our theory of change. Farmers adopt commercial seed and agro-input dealers sell more improved seed varieties. Effects are, however, weak. Still, the strongest effect is related to the fact that farmers seem to switch agro-input dealer more often (likely from lower ranked agro-input dealers in their area to higher ranked dealers). It is our expectation that this will instigate a range of behaviors that may further improve outcomes for this treatment in subsequent seasons.

For the treatment at the farmer level, we find suggestive evidence that farmers revert to farmer saved seed when confronted with the message that they should not have unrealistic expectations from seed. Finally, the agro-input dealer training does not have a measurable impact on outcomes.

This report starts with an outline of the research questions and hypotheses. The interventions that were used to test the hypotheses are explained in the subsequent section. This was done using a field experiment that is presented in Section 4. Next, there is a section on data, that presents characteristics of farmers and agro-input dealers are baseline, demonstrates balance between treatment groups, and looks at attrition. We then present the results from the impact analysis of the midline data.

2 Research Questions and Hypotheses

Seed quality issues, or the perception thereof, may arise at different stages in the seed supply chain. Poor seed quality may occur as a result of input dealer practices. This may be unintentional when the agro-input dealers is unaware of proper handling and storage practices, or intentional if the agro-input dealer tries to reduce cost by for example mixing poor quality seed with good quality

[1] This document was written using the open source lyx/Latex typesetting software. The analysis is contained in an R script called "mock_report.R", which is run from within lyx/latex using the knitr engine. All code, data and documents are also under revision control using git and publicly accessible via github (https://github.com/bjvca/Seed_systems_project). The fact that the entire project is under revision control using git/github provides detailed and time-stamped recording of any changes made over the course of the project, further reducing scope for fishing by the researchers and increasing transparency with respect to the decisions made.

seed. The problem may also be situated at the level of the smallholder farmer. For instance, a farmer may lack confidence in the input dealer or his/her products, and the nature of the input may make it difficult for the farmer to objectively assess quality. It may also be that the farmer wrongly attributes poor outcomes caused by factors other than seed quality to seed quality.

We test potential quality related reasons for low uptake of improved maize seed. One has its origins at the agro-input dealer level and is cognitive in nature. A second reason is situated at the interaction between agro-input dealer and farmer and tests a classic economic explanation. A third potential reason is behavioral and happens in the farm. We discuss each research hypothesis in detail below. In the next section we present the interventions that we will use to test these hypotheses.

H1: Seed is of poor quality due to poor handling and storage at the input dealer level

Lack of information is pervasive in developing countries and often leads to sub-optimal outcomes for the rural poor. As a result, a simple piece of information can make a big difference (Duflo and Banerjee, 2011). Also in the context of agricultural technology adoption among smallholders, knowledge gaps have been identified as a key constraint, and governments around the world invest in public agricultural advisory services (Anderson and Feder, 2004). While the need for policies and interventions that strengthen input marketing capacity and infrastructure has been acknowledged decades ago (Tripp and Rohrbach, 2001), we find few examples of studies that look at knowledge gaps at the input dealer level.

The first hypothesis asserts that poor handling and storage at the level of the input dealer may lead to poor seed quality, in turn reducing the profitability of seeds at the farmer level, resulting in low adoption. There is indeed some evidence of input quality reduction at this level. In a comprehensive study of the seed supply chain in Uganda, Barriga and Fiala (2020) document various issues related to handling and storage that may reduce the quality of the input. For example, farmers often need smaller quantities than what is in the standard bags, and input dealers thus often repackage in smaller bags in sub-optimal environments. Poor rotation of seed stock and storage in open bags in moist conditions or in direct sunlight also reduce seed quality.

H2: Mismatch between seed quality delivered by agro-input dealers and seed quality perceived by farmers

The second hypothesis focuses on the information asymmetry between seed sellers and seed buyers. As argued in Bold et al. (2017), the market for seed in Uganda appears similar to the market for used cars as described in Akerlof's classic study (1970). In such a market, the quality of goods can degrade in cases where the quality is known by the seller, but not (yet) by the buyer. This problem can be solved by reducing information asymmetries between the two parties.

Information asymmetry implies that agro-input dealers are better informed about the quality of the products they sell than the farmers they sell to. This means agro-input dealers can compromise on quality to cut costs. In Uganda, there are some indications that adulteration happens at some point in the seed value chain. Bold et al. (2017) find that hybrid maize seed contains less than 50% authentic seed, while Ashour et al. (2019) find that nearly one in three bottles of herbicide contains less than 75% of the labeled concentration of the active ingredient.

H3: Seed is of good quality but have inflated expectations and face learning challenges

In the context of new agricultural technology, production functions are not known. Farmers learn from own experience (Foster and Rosenzweig, 1995) as well as from observing the experience of others (Conley and Udry, 2010). Learning involves an iterative process of forming and updating beliefs about yield or profit distributions. Many researchers have addressed how individuals process information and update beliefs when making repeated decisions (e.g. Camerer and Hua Ho, 1999). Barham et al. (2015) analyze how learning heuristics vary across farmers and how they affect technology adoption decisions. Gars and Ward (2019) test whether farmers' learning heterogeneity is a barrier to adoption. They find that even though Bayesian learning is well suited to learn about hybrid rice, it is also more cognitively demanding, such that only 25 percent of farmers can be characterized as pure Bayesian learners while 40 percent rely on first impressions. Present-biased learning and relying on first impressions is likely to hinder technology adoption.

Erroneous perceptions and false beliefs at the farmer level may complicate learning and affect technology uptake. For instance, high yielding varieties may be less resistant to particular pests and diseases or to droughts than local maize varieties that farmers in a particular area selected themselves over the course of centuries. Therefore, additional inputs such as pesticides, insecticides and irrigation may be needed to bring the seed to its full potential. Worse, farmers they may think that improved seed is a guarantee for higher yield, leading them to reduce management and use of other inputs. This may lead to disappointing yields, and farmers may erroneously attribute these low returns to poor input quality, which may lead to dis-adoption. The problem may thus be rooted in negative experiences which conflate low product quality with incorrect management practices and can be characterized as a learning failure. Consistent with this, Michelson et al. (2021) find that fertilizers in Tanzania meet the requisite quality standards even though Tanzanian farmers persistently believe that the fertilizer they purchase from the market is adulterated.

3 Interventions

To test the three hypotheses outlined in section 2, we designed three corresponding interventions. In this section, we provide more details on these interventions.

I1: Input dealer training on proper seed handling and storage

To test if lack of adoption is due to poor seed quality as a result of poor handling and storage at the input dealer level, an intensive input dealer training to increase input dealer skills regarding seed handling and storage was implemented. This is expected to improve seed quality, in turn reducing risk and increasing profitability at the level of the farmers. This will lead to more farmers adopting improved seed and agro-input dealer to sell more improved seed. It is important to note that this hypothesis implicitly assumes that the dealer is not aware of the fact that he or she sells poor quality seed. In other words, sales of poor quality seed is not intentional.

The trainings were developed based on expert consultations from the Ugandan ministry of agriculture, from the seed sector and from input dealer associations in Uganda prior to the experiment. A consultation workshop was organized in Bugiri, as well as a series of semi structured interviews with experts of different institutions and organizations. During the workshop or the semi-structured interviews, the facilitator kept the focus on "seed storage and handling". First, problems were identified by determining what input dealers typically do wrong in terms of seed storage and handling, leading farmers to end up with sub-optimal seed quality. These problems were then ranked according to how badly they affect seed quality and how many agro-input dealers are affected by these problems. In a next step, solutions were associated to each of the problems. The solutions were also ranked in terms of effectiveness and it was discussed if these solutions would be within reach of the majority of agro-input dealers.[2]

Based on the information collected, we developed detailed training manuals that the trainers were instructed to adhere to. This ensured standardized treatment. We also created visually appealing posters showing the most important best practices that were given to input dealers to mount in their shop. The training was implemented by three trainers, one from ISSD, one from UNADA, and one agronomist that was part of the research team. It was organized at a location that was easily reachable for all sampled agro-input dealers within the treated catchment area. For each treated shop, we invited the shop owner and the shop manager. As an additional incentive, we also provided treatment agro-input dealers with a portable seed moisture meter. The input dealer trainings were organized in May 2021, such that dealers can use the handling and storage practices for seeds they buy in June/July 2021, which are going to be purchased by farmers for the second agricultural season that begins in August 2021.

[2]This led to the exclusion of capital intensive investments such as air conditioners or freezers to preserve quality.

I2: Information clearinghouse

This classic lemons technology problem can be solved by reducing information asymmetries between the two parties. In Kenya, seed companies have started marketing their seed using novel packaging features to signal product quality and authenticity (Gharib et al., 2021). Uganda does regulate seed quality by means of certifications and standards, but they provide farmers with a relatively weak and unreliable indication of quality. For instance, during baseline data collection, we purchased seed bags from agro-input dealers in our sample, and only 8% of them had a certification sticker from an inspection agency. Alternatives such as electronic verification systems have also been experimented with, but the cost of implementation has proven challenging, and they depend on the reliability of the underlying seed certification system.

In our study, we test an alternative, decentralized clearinghouse that is based on crowd-sourced information and works through reputational mechanisms, much like yelp.com or tripadvisor.com. Studies in other contexts have shown that new crowd-based sources of pre-purchase information can be particularly useful. For instance, Reimers and Waldfogel (2021) compare the impacts of professional critics and Amazon star ratings of books on consumer welfare. The aggregate effect of star ratings on consumer surplus is more than ten times the effect of traditional review outlets.

The information clearinghouse treatment we implement is a fairly complex intervention that required collecting indicators of perceived quality of seed sold by agro-input dealer from farmers. These quality ratings were then used to construct scores to rank agro-input dealers, and these rankings and scores were then provided back to farmers and agro-input dealers in an appealing way. This entire process also happened twice, as we target two full growing cycles. In particular, prior to the clearinghouse intervention, we collected baseline data of farmers in catchment areas of the input dealers that were enrolled in the study. During this baseline interview, we asked farmers to rate input dealers in their catchment area on a number of characteristics. This was done in the ODK app, which had pre-loaded data on the agro-input dealers such as name, location, and a picture of the store front. Depending on the location of the farmer, the ODK app iterated through all agro-input dealers in the vicinity of the farmer. Furthermore, depending on the treatment status of the agro-input dealer, farmers were also asked to rate the seed the agro-input dealer sold.[3]

To construct the rankings of agro-input dealers, we used various questions that farmers were expected to answer on a likert scale. These included whether seed yields are generally as advertised, are drought tolerant as advertised, are pest/disease tolerant as advertised, and if time to maturity is as promised. We also asked to rate seed germination, and the quality of the seed in general. These

[3] It may be argued that by asking farmers to rate agro-input dealers in a particular area, you are also making farmers aware of the existence of all agro-input dealers in the area, and this awareness effect may potentially confound the clearinghouse effect. We thus also iterate through the agro-input dealers for control subjects, to make control farmers similarly aware of the existence of agro-input dealers in their vincinity.

ratings were translated into words (ok, good, very good, excellent) and stars, so that they are easily understandable for farmers and dealers who are not used to interpreting numbers.

The ratings were then fed back to farmers and agro-input dealers in various forms before farmers start buying seed for the next agricultural season. To farmers, ratings were disseminated both in-person, as well as through a series of sms messages. During in-person dissemination to farmers, enumerators revisited all farmers in our sample. We designed a visually appealing dissemination app which was shown to farmers on tablet computers which cycled through all dealers in the proximity of each farmer (again showing picture of store front etc.) and stated: "We wanted to let you know that customers from *shop name* rate the quality of maize seed sold there as okay/good/very good/excellent! The quality of the maize seed that this agro-input shop sells got a score of *score* out of 5!" in treated catchment areas. The app also showed the stars associated with the score.[4] For the sms based dissemination, we sent farmers one text message per dealer in their proximity with similar information.[5]

Agro-input dealers received their ratings in the form of a report on laminated paper which was delivered to their shops. The front shows a visually appealing certificate with a logo and the shops general rating both in word and in stars. Enumerators advised shopkeepers to display the ratings in the shop, similar to a "certificate of excellence" of TripAdvisor. An example of the front of a report can be found in the Appendix Figure A.1. The back of the report shows more detailed information. In addition to the dealer's general rating, it shows the dealer's specific ratings (overall quality, yield, drought and disease resistance, time to mature, and germination) and the average ratings of other agro-input dealers in the same catchment area in a table and visualized by stars. This shows dealers their relative position in the area and is expected to motivate agro-input dealers to perform better on areas where they can improve relative to the immediate competition.

Information clearinghouse mechanisms in developing countries have been studied to some extent, but mostly to address market price information asymmetries between smallholder farmers and middlemen. Assuming that middlemen are better informed about prevailing prices in the market than farmers, theory suggests that providing farmers with price information increases their bargaining power. However, evidence on their effectiveness is mixed: while Goyal (2010) finds that internet kiosks that provide wholesale price information significantly increased soy prices in India, Fafchamps and Minten (2012) do not find a statistically significant effect of market information delivered to farmers' mobile phones in a neighboring state. A study by Hasanain, Khan, and Rezaee (2019), who set up a rating system for public veterinary services in Pakistan is probably

[4] As before, to account for the fact that simply visiting farmers and reminding them about the existence of agro-input dealers may confound the clearing house effect, we revisited all farmers in control catchment areas and also cycled through dealers, but simply asked a couple of questions like e.g. "Do you know this *shop name*?".

[5] Also in control catchment areas, farmers received text messages with the names of dealers in their proximity, so that they were aware of the presence of these dealers.

the closest to ours. They find that farmers who use the clearinghouse enjoy a 25% higher success rate of artificial insemination. Their research suggests that this is mostly due to increased veterinarian effort, as few farmers seem to be switching from veterinaries that receive poor ratings to veterinaries that receive good ratings.

An information clearinghouse could work through different impact pathways. First, farmers who did not buy (or who bought only a little) seed before may start adopting (or start adopting more) improved seed when they realize that an agro-input dealer in their vicinity has a better rating than what these farmers expected. The literature indicates that this pathway of improving the perception of quality without actually improving quality could be very relevant. Michelson et al. (2021) establish that the nutrient content of fertilizer in Tanzania is good and meets industry standards but that farmers believe that it is adulterated. One would simply need to correct farmers' beliefs which are inconsistent with the reality to increase adoption. Also Wossen, Abay, and Abdoulaye (2022) show that farmers in developing countries routinely misperceive input quality and that rectifying this misperception may improve farmers' investment choices and productivity outcomes. Second, farmers could switch from low rated shops to higher rated shops after learning that their preferred agro-input dealer received a poor rating. Thirdly, farmers may pressure their usual dealers to increase efforts. Fourth, dealers could also start improving on their own (i.e. without the pressure of farmers) after they have learned that their seed is rated poorly and want to improve their products. Lastly, dealers could also increase their efforts after seeing that they were rated well and feel motivated and satisfied due to this reward.

I3: Addressing learning failures at the farmer level

The intervention that was used to test the learning failure hypothesis was built around short, visually appealing videos, shown to the farmers on tablet computers. Video's featuring role models have been found effective in changing people's behaviour in a range of applications (Riley, 2019; Van Campenhout, Spielman, and Lecoutere, 2020; Vandevelde, Van Campenhout, and Walukano, 2018; Bernard et al., 2015). Similar to how the content for the input dealer seed storage and handling training was determined, we consulted experts from the Ugandan ministry of agriculture, from the seed sector and from input dealer associations in Uganda prior to the experiment. Also here, a consultative workshop and semi structured interviews were organized with experts of different institutions and organizations.

Based on the information obtained from these consultations, we developed a video that shows what complementary inputs and practices are important to create an enabling environment for improved seed to flourish. A treatment and a control version of the video was produced. The only difference between the treatment and the control video is that in the treatment video, after each complementary input or practice that is shown, the actor stresses that these inputs or practices are particularly important if improved seed varieties are used. The videos were shown to farmers individually on tablet computers.

4 Experimental design

To test the three hypotheses, the three interventions are combined in a field experiment where various treatment and control groups are randomly assigned to either a treatment or control condition. The randomized control trial (RCT) takes the form of a 2^3 factorial design, with each intervention corresponding to one hypothesis. Factorial designs allow recycling of treated units in the orthogonal factor to be used as controls. As such, to estimate main effects, less observations are needed than would be the case in parallel designs. The factorial design is essentially a split plot trail, where the crossed interventions are randomized at different levels. For the first two factors, corresponding to the input-dealer training and the information clearinghouse, randomization happened at the level of the catchment area. For the third factor that address learning failures of farmers, randomization happened at the level of the village.[6]

The resulting layout, with sample sizes indicated in each treatment cell is illustrated in Figure 1. The first two interventions are implemented at the catchment area level. A total of 112 catchment areas are included in the study. Half of these are randomly allocated to the first treatment: all input dealers in 56 catchment areas received the input dealer training, while input dealers in the remaining 56 catchment areas functioned as the control for this treatment. Orthogonal to the first factor, the second factor is placed, corresponding to the second treatment that is also implemented at the catchment area level. Also here, in half of the 112 catchment areas an information clearinghouse was implemented, and half of the catchment areas functioned as a control for this treatment. However, this was done in such a way that balance with respect to the first treatment was preserved in both treatment and control groups for the second treatment. This means that the treatment group of the second treatment consisted of 28 catchment areas that received the first treatment and 28 catchment areas that functioned as the control for the first treatment. Similarly, for the control catchment areas for the second treatment, half consisted of catchment areas where input dealers received the input dealer training and half of catchment areas where input dealers did not get trained.

Even though the third treatment was implemented at the level of the village, it is also important to preserve balance in the orthogonal factors. In other words, we needed to make sure that an equal number of villages that were assigned to receive a treatment against learning failures are drawn from catchment areas where input dealers received the training as from catchment areas where the input dealer training did not take place. Similarly, orthogonality should also be

[6] The main motivation to randomize at the village level is to eliminate potential spillover effects for the third treatment. However, as we will discuss later, we make sure there is correspondence between villages and input dealers, which would allow us to also look at the impact of the farmer training treatment on outcomes at the input dealer level. However, at that level, spillovers may affect results.

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Figure 1: Design

maintained for the second treatment. Therefore, in each of the four treatment cells formed by interacting the first two treatments, 40 villages (347 villages in 130 catchment areas, ie. 2,67 villages per catchment area, so that 14 areas correspond to 37,37 villages) will be randomly assigned to the third treatment while another 40 villages will be assigned to the control.

5 Data

5.1 Sample

Our sample consists of agro-input dealers and smallholder maize farmers who live in the catchment areas of these dealers. The dealer sample was obtained by listing all input shops in 11 districts in southeastern Uganda, which roughly corresponds to the Busoga kingdom, during a census. It consists of 348 dealers, sufficient to detect treatment effects according to our power simulations. After the census, agro-input dealers were assigned to catchment areas. The 348 shops in Busoga were assigned to 130 catchment areas. Between 1 and 18 dealers operate in an area, with a mean of 2.7. A computer algorithm used this list of catchment areas for the allocation of the treatment as the catchment area was the level of randomization for the first two treatments (I1 and I2).

To connect agro-input shops and villages, we asked every dealer where most of his or her customers came from. Then enumerators were instructed to randomly sample ten households that grow maize in these villages. Consequently, about 3500 smallholder maize farmers were sampled, sufficient to detect treatment effects according to our power simulations. For some outcome variables, e.g. seed spacing or rate, details at the plot level are needed. However, farmers often have more than one field. As outcomes on different plots from the same farmer are likely to be strongly correlated, it is not cost effective to ask questions about all fields. An unbiased estimate of the outcome at the household level can be obtained by randomly selecting one plot. To do so, we ask enumerators to first list all fields, with names farmers use to refer to these plots (e.g. home plot, plot near the sugar cane factory). The Computer-Assisted Personal Interviews software then randomly selects one plot for which detailed questions are asked.

We measure the outcomes of interest before and after the intervention, so that we can condition the treatment effect estimates on baseline values of the outcome variables to increase power. Baseline data was collected from dealers in September and October 2020 and from farmers in April 2021. Midline data was collected in January and in February 2022; endline data will be collected in July and August 2022.

5.2 Descriptive statistics and orthogonality tests

In this section, we provides descriptive statistics and orthogonality tests for the baseline data.

Information about the average *agro-input shop* can be found in the first column of the top panel of Table 1, with standard deviations in brackets below the means. For example, we see that the average respondent that was interviewed in the shop, usually the shop manager, is about 32 years old. In 60 percent of the cases, the person interviews was male. The average shop received about 41 customers on a give day and sold 911 kilograms of maize seed in the season preceding the baseline survey. We see that 65 percent of shops reported that they had problems with pests such as mice and rats.

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## Error in ‘$<-.data.frame‘(‘*tmp*‘, mid_exp, value = structure(numeric(0),
class = "Date")):  replacement has 0 rows, data has 348
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Table 1 also reports means and standard errors in the *farmer* sample (first column of the bottom panel). Here, we see that 78% of household heads in our sample are male and the average household head is 49 years old. About half of the farmers in our sample indicate that they used improved seed varieties on at least one plot in the season preceding the baseline survey. We further asked farmers to rate the quality of the seed they used in the previous season on a scale of 1 (poor) to 5 (excellent). We see that farmers rate the quality of the seed they use fairly high (3.4/5). The average farmer harvested 500 kg of maize from one acre.

Detailed tables with descriptives can be found in the appendices, including minimum and maximum variables for each variable and the number of observations. Tables A.1 to A.3 report baseline summary statistics at the agro-input dealer level. Tables A.4 to A.7 reports baseline summary statistics for the farmers in our sample.

To test if treatment and control groups are comparable in terms of a set of baseline characteristics, i.e. to test for balance at baseline, we include standard orthogonality tables with pre-registered variables. Some of these characteristics are unlikely to be affected by the intervention, while others are picked from the primary and secondary outcomes. In the second to fourth column of the top panel of Table 1, we test balance at the level of the agro input dealer for selected variables; the full balance table for agro-input dealers as it was pre-registered can be found in the appendix (see Appendix Table A.8). In the second to fourth column of the botom panel of Table 1, we test balance at the level of the farmers for selected variables; the full balance table for farmers as it was pre-registered can be found in the appendix (see Appendix Table A.9). We conclude from these balance tables that there are no structural differences between treatment and control at both agro-input dealer and farmer level.

Table 1: Descriptive and Orthogonality tests

	mean	dealer training	clearing house	farmer video
		Agro-input dealers		
Respondent's age in years	32.427	2.024	-0.039	-2.662
	(11.492)	(3.171)	(2.664)	(2.483)
Respondent is male	0.595	-0.057	0.054	0.080
	(0.492)	(0.142)	(0.132)	(0.107)
Number of customers per day	41.486	8.954	-3.565	-4.755
	(46.489)	(11.999)	(8.797)	(10.085)
Amount of maize seed sold during last season in kg	910.885	562.086	131.991	-24.944
	(2683.235)	(849.800)	(405.968)	(585.445)
Shop has problem with pests	0.649	0.076	-0.042	-0.085
	(0.478)	(0.119)	(0.111)	(0.104)
		Farmers		
Farmer's age in years	48.617	1.744	0.202	0.181
	(13.385)	(1.180)	(1.206)	(1.112)
Farmer is male	0.777	-0.053	-0.013	-0.047
	(0.416)	(0.046)	(0.049)	(0.044)
Farmer used improved maize seed (OPV/hybrid) for any field last season	0.492	-0.020	-0.032	-0.041
	(0.500)	(0.048)	(0.039)	(0.043)
Farmer's rating of maize seed planted on randomly selected maize field on general quality	3.385	-0.063	-0.061	-0.037
	(1.032)	(0.122)	(0.106)	(0.094)
Land productivity in kg/acre (yield/area)	499.517	-60.344	-52.807	-26.771
	(771.173)	(41.873)	(45.528)	(43.390)

Note: First column reports sample means (and standard deviations below); **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). Number of observations for agro-input shops is 348, number of observations for farmers is 3470.

5.3 Orthogonality tests of survey attrition

While random attrition only reduces statistical power, attrition which is correlated with one of our treatments could bias estimates. We focus on limiting attrition during data collection because it is difficult to solve ex post. That is why we recorded the respondents' full names, primary and secondary telephone numbers, and enumerators captured the locations i.e. the GPS coordinates of the interviews. We collected this information for every participant during baseline data collection. We additionally asked the agro-input dealers for other (nick)names that they are known by, enumerators took pictures of their shops and wrote down eye-catching features to later identify it. Based on this information, enumerators will trace missing participants for mid- and endline data collection. Due to these measures and because the surveys are conducted over a reasonably short time period, we expect most baseline respondents to also be available for the mid- and endline survey and hence low attrition rates.

Table 2 shows that despite our efforts to minimize attrition, we failed to collect midline data from 12% of agro-input dealers who were part of the original sample. This is probably due to COVID-19 that led to the closure of many businesses in Uganda. In the sample of farmers, there is hardly any attrition as we were able to track 3407 of the 3470 original farmers. The table also shows if attrition is related to the treatment. There is some indication that attrition is lower in the group of agro-input dealers that were exposed to the clearing house treatment.

6 Results

The remaining tables (Table 3 to A.20) all test differences between treatment and control groups for the three hypotheses. We have separate sections for outcomes at the agro-input dealer level and the farmer level. We also define a set of primary outcomes to test overall impact and various secondary outcomes to explore impact more in detail and look at mechanisms.

6.1 Agro-input dealer

6.1.1 Primary outcomes

Primary outcomes at the dealer level are reported in Table 3. A similar table that corrects p-values for multiple hypothesis testing following Sankoh, Huque, and Dubey (1997) can be found in Appendix Table A.10.

Looking at the effect of the agro-input dealer training in column two, the indices suggest there is no impact. In fact, looking at primary outcomes individually suggests a negative impact on average sales price of improved seed varieties.

The impact of being exposed to the information clearing house on agro-input dealer level primary outcomes in reported in column 3. There is some evidence that the information clearing house had an impact on pre-registered

Table 2: Survey attrition

	mean	dealer training	clearing house	farmer video	number of observations
Agro-input dealer left the sample	0.121	-0.071	-0.152*	-0.028	348
	(0.326)	(0.082)	(0.064)	(0.070)	
Farmer left the sample	0.018	0.003	0.002	0.011	3470
	(0.134)	(0.012)	(0.010)	(0.011)	

Note: First column reports sample means (and standard deviations below); **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop).

Table 3: Differences between treatment and control groups - Agro-input dealer, primary outcome variables

	mean	dealer training	clearing house	farmer video	nobs
Transformed cumulative quantity sold of 4 improved maize varieties last season in kg (IHS)†	6.472	-0.092	0.284	-0.156	292
	(1.851)	(0.220)	(0.227)	(0.187)	
Average sales price of 4 improved maize varieties last season in UGX/ kg	4537.728	-192.784^{+}	99.272	56.732	275
	(871.743)	(114.934)	(113.292)	(100.998)	
Transformed seed revenue in mln UGX: quantities sold * sales prices of 4 maize varieties (IHS)†	1.494	-0.069	0.185^{+}	-0.005	292
	(1.076)	(0.104)	(0.108)	(0.095)	
Transformed number of customers who bought maize seed on average day at last season (IHS)†	3.230	-0.056	0.127	-0.070	294
	(0.824)	(0.098)	(0.101)	(0.089)	
Moisture in random seed bag in percent	12.948	-0.121	-0.145	-0.180	135
	(0.848)	(0.172)	(0.162)	(0.142)	
Index of **capital-intensive** seed handling and storage practices observed by enumerator †	0.021	-0.019	0.000	0.085	270
	(0.493)	(0.063)	(0.072)	(0.055)	
Index of **labor-intensive** seed handling and storage practices observed by enumerator †	0.005	0.058	0.099	-0.098^{+}	285
	(0.457)	(0.070)	(0.065)	(0.053)	
Index of **all** seed handling and storage practices observed by enumerator	0.013	0.042	0.052	-0.023	251
	(0.360)	(0.051)	(0.053)	(0.044)	
Index of dealer's efforts and services †	-0.007	-0.063	0.066	0.034	243
	(0.413)	(0.062)	(0.060)	(0.053)	
Index of shop's maize seed ratings by farmers (no base or midline)					
Overall index controlling for baseline (nobs bc of moisture)	0.031	-0.025	0.133	-0.055	184
	(0.600)	(0.093)	(0.092)	(0.078)	
Overall index not controlling for baseline (nobs bc of moisture)	0.031	-0.004	0.214^{+}	0.034	215
	(0.600)	(0.130)	(0.121)	(0.084)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

outcomes at midline. For instance, we see that the index of the primary outcomes is larger among treated agro-input dealers and the difference becomes significant in the specification that does not control for baseline index value. We see that agro-input dealers in the treatment group sold almost 30 percent more improved seed varieties, and report significantly higher revenues from the sales of improved seed. We also see an increase in the index of labour intensive seed handling and storage practices, which includes whether seed is stored in dedicated area, whether shop has no pest problem, whether seed is stored in correct lighting, whether seed is stored on correct surface, whether seed is not stored in open containers, and cleanness and professionality rating by enumerator. The coefficient is just not significant.

We also look at the impact of the video intervention at the farmer level (column 4), even though we expect most of the effects of this intervention to materialize at the farmer level. Judged by the indices, we do not find an effect of this intervention on agro-input dealer primary outcome levels. In fact, there is some indication that agro-input dealers that are connected to farmers that were exposed to the video treatment score lower in terms of labor intensive seed handling and storage practices.

6.1.2 Secondary

As a first set of secondary outcomes, we construct a series of indices to assess things like motivation, knowledge etc. This is reported in table 4. The outcome variables in 4 are not further adjusted for multiple hypothesis testing by means of an overall index or p-values adjusted according to Sankoh, Huque, and Dubey (1997) because they are all indices.

A first index that proxies dealer's motivation and satisfaction (and is composed of 3 variables: whether dealer sees him-/ herself working as agro-input dealer in future, would recommend working as dealer, how happy dealer feels when he/ she comes to work) remains constant among treatment groups. A second index that reflect self-ratings of agro-input dealers is similarly unaffected by the three treatments.

While the primary index on that measures the dealer's effort and services was based on what dealers reported, we also asked farmers what serviced the dealers offered. In particular, we asked whether the shops offer refund/insurance, credit, training/advice, delivery, after-sales service, accepts different payment methods, and sells small quantities. We find convincing evidence that the information clearing house increases farmers' perceptions about dealers' efforts and services. Somewhat surprising, we find that the agro-input dealer training actually has the opposite effect.

The index of dealer's knowledge about seed storage and handling, an index that is composed of 5 variables (whether dealer knows how long seed can be carried over, how seed should be stored after repackaging, what the minimum distance between floor and seed should be, how seed should be stored in storeroom, and whether seed should be repackaged). While never significant, we do see that the index is somewhat higher for agro-input dealers that were trained

Table 4: Differences between treatment and control groups - Agro-input dealer, secondary outcome variables regarding indices

	mean	dealer training	clearing house	farmer video	nobs
Index of dealer's motivation and satisfaction	0.000	0.033	0.000	0.075	306
	(0.674)	(0.082)	(0.085)	(0.073)	
Index of dealer's self-ratings on location, price, product quality, stock, reputation	0.000	-0.068	-0.002	-0.043	306
	(0.626)	(0.084)	(0.079)	(0.071)	
Index of dealer's efforts and services according to farmers	0.001	-0.151*	0.301**	-0.041	259
	(0.552)	(0.074)	(0.069)	(0.063)	
Index of dealer's knowledge about seed storage	0.000	0.091	0.115	0.065	306
	(0.511)	(0.076)	(0.075)	(0.056)	
Index of dealer's knowledge about seed	0.000	0.102	0.065	0.095	306
	(0.530)	(0.072)	(0.070)	(0.062)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop).

on this and for agro-input dealers that were exposed to the information clearing house. We have a similar index for knowledge related to seed. Here, we see an increase in the group of agro-input dealers that received the training, but again the difference is not significantly different from zero.

We also look at outcomes for particular seed types. As not all agro-input dealers always stock all seed types, sample sizes are smaller when we look at particular seed types. Table 5 looks at farmer level outcomes related to a popular hybrid maize seed, while Appendix Table A.11 gives the same information but adjusted for multiple comparisons. Table 6 looks at similar farmer level outcomes related to a popular OPV maize seed, while Appendix Table A.12 gives the same information but adjusted for multiple comparisons.

The tables reveal that coefficients generally go in the expected direction (higher seed volumes transacted, less losses and stock-outs), but are rarely statistically significant. For Longe10H, the only significant result is found for the agro-input dealer training, that seems to have reduced the cost at which seed is obtained. The training also seemed to have reduced stock-outs of Longe10H by more than 40 percent, albeit not significantly in a statistical sense. For the two other treatments, none of the comparisons are significant.

Results are less consistent for Longe 5. Here, we there is some evidence of a negative impact of the farmer level video on the overall index that also controls for baseline outcomes. This effect seems to be primarily driven by a reduction in the cost at which the agro-input dealer acquires the seed. However, it should be noted that the index is composed of only four variables, though and that the cost of seed is included as a positive outcome in the index, which is debatable.[7]

We now turn to outcomes that are related to registration and quality control. Results are in Table 7 (and corresponding Appendix Table A.13 providing results adjusted for multiple comparisons). We do not find any impact of any of the interventions.

In each shop, we also purchase a random seed bag which is then analyzed. Tables 8 (and Appendix Table A.14) provides comparisons. Unfortunately, we could not obtain a seed bag in many of the agro-input dealers. This was often due to the fact that they did not have seed in stock at the time of the visit.

We see that for the information clearing house treatment, the number of days since packaging (or shelf-life) is lower, but not significant. Agro-input dealers that are located in areas where farmers were shown a video that made it more salient that complementary inputs are also necessary when using improved seed also sell seed that is more likely to have a lot number indicated on the bag.

The final table, Table 9, reports some additional assorted outcomes (with associated Appendix Table A.15 that adjusts for multiple comparisons). We find that agro-input dealers that are located in areas where farmers received the farmer level video treatment had less OPVs in stock. We also find a significant effect on the likelihood of owning a moisture meter for agro-input dealers that were allocated to the agro-input dealer training. This is not surprising since

[7]The reason is that for farmers, we expect that prices may be used to signal quality. However, at the agro-input dealer level, this may be less the case.

Table 5: Differences between treatment and control groups - Agro-input dealer, secondary outcome variables regarding Longe 10H (most common hybrid variety in area) (selection: if shop had Longe 10H in stock last season)

	mean	dealer training	clearing house	farmer video	nobs
Transformed amount of Longe 10H carried into last season from previous season in kg (IHS)†	0.698	-0.186	0.090	0.285	262
	(1.550)	(0.212)	(0.215)	(0.188)	
Transformed amount of Longe 10H bought by shop from provider last season in kg (IHS)†	6.023	0.118	0.206	0.103	257
	(1.357)	(0.218)	(0.213)	(0.154)	
Cost of Longe 10H per kg last season in UGX†	5100.973	-315.538*	-153.756	-73.379	180
	(898.767)	(138.411)	(126.348)	(114.440)	
Transformed quantity of Longe 10H sold last season in kg (IHS)†	5.934	0.050	0.236	0.039	256
	(1.311)	(0.206)	(0.204)	(0.151)	
Transformed sales price of Longe 10H per kg at beginning of last season in UGX (IHS)	9.415	-0.025	-0.013	0.008	194
	(0.156)	(0.026)	(0.026)	(0.023)	
Transformed amount of Longe 10H lost/wasted last season in kg (IHS)	0.169	-0.072	-0.103	-0.085	133
	(0.693)	(0.129)	(0.137)	(0.133)	
Number of times per month shop ran out of Longe 10H last season	1.172	-0.434	-0.057	0.014	192
	(1.678)	(0.265)	(0.276)	(0.244)	
Overall index controlling for baseline	-0.002	-0.017	0.048	-0.018	169
	(0.517)	(0.069)	(0.080)	(0.071)	
Overall index not controlling for baseline	-0.002	0.018	0.016	-0.048	247
	(0.517)	(0.066)	(0.077)	(0.065)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

Table 6: Differences between treatment and control groups - Agro-input dealer, secondary outcome variables regarding Longe 5 (most common open-pollinated variety) (selection: if shop had Longe 5 in stock last season)

	mean	dealer training	clearing house	farmer video	nobs
Transformed amount of Longe 5 carried into last season from previous season in kg (IHS)†	0.895	0.247	-0.092	0.139	270
	(1.807)	(0.324)	(0.306)	(0.225)	
Transformed amount of Longe 5 bought by shop from provider last season in kg (IHS)†	6.116	-0.005	0.253	0.035	262
	(1.438)	(0.221)	(0.215)	(0.158)	
Cost of Longe 5 per kg last season in UGX†	2518.061	-53.321	-79.925^{+}	-57.889^{+}	231
	(318.852)	(39.065)	(42.867)	(31.597)	
Transformed quantity of Longe 5 sold last season in kg (IHS)†	6.015	-0.040	0.304	0.088	261
	(1.446)	(0.222)	(0.216)	(0.157)	
Transformed sales price of Longe 5 per kg at beginning of last season in UGX (IHS)	8.747	0.017	-0.015	0.012	249
	(0.128)	(0.016)	(0.016)	(0.014)	
Transformed amount of Longe 5 lost/wasted last season in kg (IHS)	0.357	-0.224	0.113	-0.307	167
	(1.025)	(0.193)	(0.193)	(0.190)	
Number of times per month shop ran out of Longe 5 last season	0.876	0.093	0.178	0.083	248
	(1.504)	(0.202)	(0.203)	(0.194)	
Overall index controlling for baseline	0.011	-0.124	0.008	-0.108^{+}	218
	(0.481)	(0.087)	(0.085)	(0.062)	
Overall index not controlling for baseline	0.011	-0.088	0.010	-0.046	255
	(0.481)	(0.085)	(0.084)	(0.060)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

Table 7: Differences between treatment and control groups - Agro-input dealer, secondary outcome variables regarding registration/ trading license/ membership/ inspection

	mean	dealer training	clearing house	farmer video	nobs
Shop is registered with UNADA†	0.397	0.040	0.066	0.062	252
	(0.490)	(0.072)	(0.068)	(0.056)	
Shop has a trading license issued by local government†	0.831	-0.042	0.021	0.003	288
	(0.375)	(0.053)	(0.054)	(0.044)	
Shop is a member of other professional association†	0.265	-0.035	0.058	-0.005	268
	(0.442)	(0.051)	(0.052)	(0.055)	
Transformed number of times shop was inspected by DAO/MAAIF/UNADA last year (IHS)	1.347	0.037	-0.097	-0.313	293
	(1.782)	(0.247)	(0.259)	(0.206)	
Shop received a warning after inspection†	0.396	0.045	0.005	-0.033	291
	(0.490)	(0.072)	(0.073)	(0.057)	
Shop's products were confiscated after inspection†	0.129	0.021	-0.027	-0.020	293
	(0.335)	(0.046)	(0.046)	(0.038)	
Overall index controlling for baseline	-0.020	-0.057	0.040	0.022	228
	(0.498)	(0.060)	(0.060)	(0.064)	
Overall index not controlling for baseline	-0.020	-0.023	0.050	0.039	266
	(0.498)	(0.061)	(0.061)	(0.061)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

Table 8: Differences between treatment and control groups - Agro-input dealer, secondary outcome variables regarding seed bag (selection: enumerator was able to buy bag of seed)

	mean	dealer training	clearing house	farmer video	nobs
Random seed bag shows expiry date					
Random seed bag shows packaging date†	0.855	0.055	0.092	-0.015	144
	(0.353)	(0.067)	(0.073)	(0.055)	
Days since packaging date/expiry date minus 6 months†	159.524	-22.883	-32.103	-23.685	102
	(94.440)	(25.330)	(23.273)	(18.236)	
Random seed bag shows lot number†	0.642	-0.028	0.013	0.197*	144
	(0.481)	(0.111)	(0.111)	(0.077)	
Overall index controlling for baseline	-0.002	0.180	0.228	0.310*	102
	(0.652)	(0.172)	(0.178)	(0.121)	
Overall index not controlling for baseline	-0.002	0.143	0.077	0.122	164
	(0.652)	(0.150)	(0.151)	(0.099)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

agro-input dealers that attended the training were given such a device.

6.2 Farmer

We now turn to the impact of the interventions at the farmer level.

6.2.1 Primary outcomes

Just like when we assessed the impact of the intervention at the agro-input dealer level, we define a set of primary outcomes to assess the impact of the different treatments on farmers. These are in Tables 10; Appendix Table A.16 provides a similar table that corrects p-values for multiple hypothesis testing following Sankoh, Huque, and Dubey (1997).

Looking at the primary outcome indices, we do not find any impact at the farmer level. However, it should be noted that sample size reduced substantially due to missing variables in some of the components of the indices. Looking at the primary outcomes individually, we do see some significant impact from the information clearing house intervention. The most striking is a substantial increase in the share of farmers that switched to a different agro-input shop. In areas where the information clearing house was implemented, we record a 4.1 percentage point higher propensity to switch, which corresponds to a 25 percent increase relative to the overall mean.

We also see a 6 percentage point increase in the share of farmers that reported to use quality maize seed bought from an agro-input dealer in the previous year. We also see that farmer use more quality seed from agro-input dealers in the information clearing house treatment group. Finally, farmers indicate that agro-input dealers in areas exposed to the information clearing house provide more services such as training, credit, etc than agro-input dealers in control areas. However, this estimate is based on a very small sample. Some of the other variables are also going in the expected direction for the clearing house treatment. For instance, we find a sizable reduction in the likelihood that farmers think maize seed at agro-input shop is counterfeit or adulterated.

For the video treatment, we find that farmers are more likely to plant local maize seed varieties on a randomly selected field, which may indicate that farmers that become aware of the full cost of improved maize seed varieties switch back to local seed (something we will explore more below). We do not find an effect of the agro-input level training on farmer outcomes.

6.2.2 Secondary outcomes

We start by look at secondary outcomes at plot level. To do so, we selected a random field from all fields cultivated by the farmers and asked detailed questions on the type of seed that was planted (Table 11 and Appendix Tale A.18).

While we do not find any significant impact from the agro-input dealer training, we do find interesting results for the information clearing house treatment

Table 9: Differences between treatment and control groups - Agro-input dealer, secondary outcome variables

	mean	dealer training	clearing house	farmer video	nobs
Number of maize varieties in stock last season (incl. hybrids, OPV, landraces)	3.736	0.042	0.245	0.042	295
	(1.665)	(0.266)	(0.245)	(0.187)	
Number of **hybrid** maize varieties in stock last season†	2.397	-0.187	0.098	0.000	301
	(1.352)	(0.186)	(0.187)	(0.140)	
Number of **open-pollinated** maize varieties in stock last season†	1.374	0.005	-0.060	-0.200*	301
	(0.775)	(0.114)	(0.110)	(0.086)	
Shop has equipment to monitor seed moisture	0.369	0.708**	-0.048	0.034	306
	(0.483)	(0.047)	(0.046)	(0.038)	
Overall index controlling for baseline	-0.008	-0.063	-0.007	-0.131	296
	(0.790)	(0.114)	(0.111)	(0.087)	
Overall index not controlling for baseline	-0.008	-0.027	0.036	-0.081	298
	(0.790)	(0.153)	(0.143)	(0.095)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

Table 10: Differences between treatment and control groups - Farmer, primary outcome variables

	mean	dealer training	clearing house	farmer video	nobs
Farmer used quality maize seed for any plot last season†	0.609	-0.021	0.035	-0.012	3206
	(0.488)	(0.021)	(0.021)	(0.016)	
Farmer used quality maize seed bought at agro-input shop for any plot last season†	0.429	-0.014	0.059**	-0.018	3145
	(0.495)	(0.023)	(0.022)	(0.017)	
Transformed amount of quality maize seed farmer bought at agro-input shop last season in kg (IHS)†	1.025	-0.021	0.147*	-0.045	3025
	(1.284)	(0.060)	(0.060)	(0.044)	
Index of farmer's maize seed ratings for shops nearby (product quality perception) (only endline)					
Index of farmer's general ratings of shops nearby (shop/seller perception) (only endline)					
Index of services of shops nearby according to farmers (perception of services and efforts)	-0.022	-0.138	0.161*	0.081	312
	(0.597)	(0.083)	(0.077)	(0.068)	
Farmer switched to different agro-input shop (no baseline)(†)	0.167	-0.012	0.041**	0.012	3470
	(0.373)	(0.015)	(0.015)	(0.013)	
Index of farmer's practices on randomly selected maize field†	0.008	0.011	-0.026	-0.010	2929
	(0.400)	(0.020)	(0.020)	(0.014)	
Farmer thinks that maize seed at agro-input shops is counterfeit/adulterated†	0.506	-0.033	-0.041	0.025	2113
	(0.500)	(0.029)	(0.029)	(0.022)	
Farmer planted local land race maize seed on this field†	0.390	0.015	-0.013	0.035*	2954
	(0.488)	(0.022)	(0.022)	(0.017)	
Overall index controlling for baseline	0.032	0.041	0.034	-0.031	1686
	(0.598)	(0.035)	(0.035)	(0.028)	
Overall index not controlling for baseline	0.036	0.036	0.024	-0.021	2367
	(0.561)	(0.029)	(0.030)	(0.023)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

Table 11: Differences between treatment and control groups - Farmer, secondary outcome variables: adoption on randomly selected maize field

	mean	dealer training	clearing house	farmer video	nobs
Farmer planted hybrid maize seed on randomly selected maize field†	0.312	0.002	0.009	-0.003	2654
	(0.463)	(0.024)	(0.023)	(0.017)	
Farmer planted open-pollinated maize seed on this field†	0.273	-0.017	0.002	-0.035*	2654
	(0.446)	(0.024)	(0.024)	(0.017)	
Farmer planted farmer saved maize seed on this field (can be hybrid, open-pollinated, local land race)†	0.518	0.020	-0.042^{+}	0.031^{+}	3153
	(0.500)	(0.024)	(0.024)	(0.017)	
Farmer planted maize seed bought at agro-input shop on this field†	0.422	-0.010	0.047^{+}	-0.020	3153
	(0.494)	(0.024)	(0.024)	(0.017)	
Farmer planted hybrid **not farmer saved** seed or an OPV (**not used too often**) on this field	0.544	-0.024	0.033	-0.033^{+}	2954
	(0.498)	(0.023)	(0.023)	(0.017)	
Overall index controlling for baseline	0.005	-0.007	0.003	-0.029	2604
	(0.518)	(0.024)	(0.024)	(0.019)	
Overall index not controlling for baseline	0.005	0.000	0.002	-0.018	2867
	(0.518)	(0.026)	(0.026)	(0.019)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

and for the farm. The impact seems to go in different directions, with the clearing house treatment seemingly increasing adoption of improved seed varieties that were obtained from an agro-input shop and the farmer level treatment reducing adoption of commercial seed, switching back to farmer saved seed. This seems reasonable: Farmers make decisions on adopting commercial varieties by weighing the costs against expected benefits. Our intervention basically tells farmers that they may be underestimating the cost of commercial seed if they consider it to be "miracle seed" that does not need complementary inputs and does need as much effort for weeding etc. As farmers update their cost-benefit comparison in light of this new information, more farmers will decided not to adopt.

We also go more into detail with respect the seed that was used on the randomly selected field (Tables 12 and Appendix Table A.19). Outcomes we include in this family of outcome are related to satisfaction of seed and price. We do not find much impact on these outcomes. The only pattern that appears is one of more expensive seed and higher cost of seed used on plots in areas that were exposed to the clearing house treatment, and less expensive seed and lower cost of seed used on plots for farmers that received the video treatment. This is consistent with the explanation where for the former treatment farmers increase adoption of commercial seed and in the latter treatment farmers revert to own saved seed.

We further look at production related outcomes and disposal of maize (Tables 13 and corresponding Table A.20 in the Appendix). As for all other farmer level outcomes, there is no impact of the agro-input dealer intervention. For the information clearing house treatment, the impact is ambiguous; there are some indications of reduced productivity, but farmers also seem to save less for seed (signaling that they plan to buy improved seed again for the upcoming season). For the intervention at the farmer level, there are some indications that yield actually increased, particularly when judged by the likelihood that farmers harvested what they expected.

We further register a family of secondary outcomes that are somewhat unrelated to each other in Tables 14 (and corresponding Appendix Table A.17).

To avoid priming, some of the questions to test if farmers have picked up on the information that the farmer level treatment aimed to make salient will only be asked during endline data collection. For now, we see no impact on awareness of existing seed varieties among farmers, nor on the likelihood that farmers know shops in their neighborhood.

7 Conclusion

In this report, we provide tables for all pre-registered outcome for a study on "Demand and supply factors constraining the emergence and sustainability of an efficient seed system". This study was started in 2020 and ran for two consecutive agricultural seasons. The study took the form of an RCT with interventions at both farmer and agro-input dealer level. It aims to test three hypotheses. First,

Table 12: Differences between treatment and control groups - Farmer, secondary outcome variables: seed used on randomly selected maize field

	mean	dealer training	clearing house	farmer video	nobs
Index of farmer's ratings of seed used on randomly selected maize field last season†	-0.001	-0.055	0.052	-0.031	3012
	(0.593)	(0.039)	(0.040)	(0.021)	
Farmer was satisfied with quality of seed used on this field last season†	0.707	-0.011	0.010	-0.004	3217
	(0.455)	(0.022)	(0.022)	(0.016)	
Farmer would use the seed used on this field last season again†	0.733	0.007	0.018	-0.017	3217
	(0.443)	(0.021)	(0.020)	(0.016)	
Amount of seed farmer used on this field last season in kg†	6.857	0.055	-0.160	-0.043	2909
	(4.761)	(0.238)	(0.245)	(0.165)	
Price of seed farmer used on this field last season per kg in UGX†	2211.631	-73.500	220.627	-139.280	2982
	(3028.716)	(131.000)	(132.326)	(105.062)	
Transformed cost of seed farmer used on this field last season in UGX (amount*price) (IHS)	4.571	-0.181	0.499^{+}	-0.375^{+}	2848
	(5.312)	(0.251)	(0.251)	(0.192)	
Overall index controlling for baseline	-0.005	-0.024	0.046	-0.035	2546
	(0.584)	(0.031)	(0.031)	(0.023)	
Overall index not controlling for baseline	-0.005	-0.023	0.057	-0.026	2859
	(0.584)	(0.034)	(0.034)	(0.022)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

Table 13: Differences between treatment and control groups - Farmer, secondary outcome variables: yield etc. on randomly selected maize field

	mean	dealer training	clearing house	farmer video	nobs
Production from this field last season in kg (number of harvested maize bags x kg per bag)	300.256	-0.806	-20.372	4.764	2884
	(277.792)	(15.143)	(15.673)	(9.649)	
Yield in kg/acre (production/area)†	335.023	-12.216	-23.006	11.673	2878
	(260.714)	(17.569)	(18.338)	(9.442)	
Farmer harvested as much maize as expected from this field last season (no baseline)$^{(\dagger)}$	0.154	-0.022	-0.041^{+}	0.029*	3200
	(0.361)	(0.022)	(0.023)	(0.013)	
Farmer did not harvest as much maize as expected due to own mismanagement (no baseline)$^{(\dagger)}$	0.102	-0.011	-0.001	-0.013	2981
	(0.303)	(0.019)	(0.020)	(0.011)	
Transformed amount of maize sold from this field in kg (IHS)†	1.612	-0.046	-0.201	0.026	3063
	(2.665)	(0.138)	(0.136)	(0.093)	
Transformed revenue in UGX (number of sold maize bags x price per bag) (IHS)†	3.331	-0.141	-0.393	0.122	3058
	(5.507)	(0.284)	(0.279)	(0.192)	
Transformed amount kept as seed in kg (IHS) (no baseline)$^{(\dagger)}$	1.774	-0.098	-0.188^{+}	0.016	2931
	(1.654)	(0.098)	(0.097)	(0.061)	
Overall index controlling for baseline	-0.015	-0.046	-0.084^{+}	0.022	2742
	(0.806)	(0.048)	(0.047)	(0.030)	
Overall index not controlling for baseline	-0.114	0.027	0.036	0.005	2124
	(0.422)	(0.027)	(0.027)	(0.019)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

Table 14: Differences between treatment and control groups - Farmer, secondary outcome variables

	mean	dealer training	clearing house	farmer video	nobs
Number of improved maize varieties the farmer is are aware of†	2.625	-0.015	0.042	0.017	3217
	(1.577)	(0.126)	(0.121)	(0.053)	
Farmer knows particular shop in neighborhood†	0.652	0.007	-0.006	0.000	3267
	(0.384)	(0.041)	(0.036)	(0.012)	
Farmer bought shop's seed last season (only endline)					
Index of farmer skill questions (only endline)					
Overall index controlling for baseline	-0.001	0.000	0.000	0.005	3185
	(0.766)	(0.070)	(0.064)	(0.025)	
Overall index not controlling for baseline	-0.001	0.033	-0.148^{+}	-0.005	3196
	(0.766)	(0.085)	(0.080)	(0.027)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

it tests if seed is of poor quality due to poor handling and storage at the input dealer level. To test this hypothesis, a random subsample of agro-input dealers was exposed to an intensive training on proper seed handling and storage. A second hypothesis tests for asymmetric information resulting in a mismatch between seed quality delivered by agro-input dealers and seed quality perceived by farmers. To test this hypothesis we set up an information clearing house similar to yelp.com or trustpilot.com. Finally, we test if farmers suffer from learning constraints and inflated expectations about improved seed varieties. Here we convey the message to farmers that use of complementary inputs and effort is particularly important when improved seed is used.

Overall, a picture emerges whereby at midline the information clearing house has positive but weak effects on both agro-input dealers and farmers. For instance, there are some indications that agro-input dealers that are in the treatment areas sold more improved seed varieties. Furthermore, we find that farmers that were exposed to the information clearing house were more likely to have used quality seed obtained from an agro-input shop. We further find that farmers in the treatment group are less likely to use farmer saved maize seed at a randomly selected plot. Interestingly, we also find that farmers in the treatment group seem to be switching agro-input dealers more frequently, which is expected further increase outcome in subsequent season.

For the farmer level video treatment, we find signs of dis-adoption. Apparently, raising awareness about the fact that improved maize seed varieties also needs supplementary inputs and crop management leads farmers to re-evaluate the costs of improved maize seed. As a result, we see a large share of farmers turning towards farmer saved seed.

We do not find that the agro-input dealer has and effect on agro-input dealer nor farmer outcomes.

References

Akerlof, G. 1970. "The market for 'Lemons': Quality uncertainty and the market mechanism." *Quarterly Journal of Economics* 84 (3): 488–500.

Anderson, J. R. and G. Feder. 2004. "Agricultural Extension: Good Intentions and Hard Realities." *The World Bank Research Observer* 19 (1): 41–60.

Ashour, M., D. O. Gilligan, J. B. Hoel, and N. I. Karachiwalla. 2019. "Do Beliefs About Herbicide Quality Correspond with Actual Quality in Local Markets? Evidence from Uganda." *The Journal of Development Studies* 55 (6): 1285–1306.

Ashraf, N., X. Giné, and D. Karlan. 2009. "Finding missing markets (and a disturbing epilogue): Evidence from an export crop adoption and marketing intervention in Kenya." *American Journal of Agricultural Economics* 91 (4): 973–990.

Barham, B. L., J.-P. Chavas, D. Fitz, V. Ríos-Salas, and L. Schechter. 2015. "Risk, learning, and technology adoption." *Agricultural Economics* 46 (1): 11–24.

Barriga, A. and N. Fiala. 2020. "The supply chain for seed in Uganda: Where does it go wrong?" *World Development* 130: 104928.

Bernard, T., S. Dercon, K. Orkin, and A. Seyoum Taffesse. 2015. "Will Video Kill the Radio Star? Assessing the Potential of Targeted Exposure to Role Models through Video." *The World Bank Economic Review* 29 (suppl_1): S226–S237.

Bold, T., K. C. Kaizzi, J. Svensson, and D. Yanagizawa-Drott. 2017. "Lemon technologies and adoption: measurement, theory and evidence from agricultural markets in Uganda." *The Quarterly Journal of Economics* 132 (3): 1055–1100.

Camerer, C. and T. Hua Ho. 1999. "Experience-weighted attraction learning in normal form games." *Econometrica* 67 (4): 827–874.

Conley, T. G. and C. R. Udry. 2010. "Learning about a New Technology: Pineapple in Ghana." *American Economic Review* 100 (1): 35–69.

Duflo, E. and A. Banerjee. 2011. *Poor economics.* PublicAffairs.

Duflo, E., M. Kremer, and J. Robinson. 2011. "Nudging farmers to use fertilizer: Theory and experimental evidence from Kenya." *American economic review* 101 (6): 2350–90.

Fafchamps, M. and B. Minten. 2012. "Impact of SMS-based agricultural information on Indian farmers." *The World Bank Economic Review* 26 (3): 383–414.

Foster, A. D. and M. R. Rosenzweig. 1995. "Learning by doing and learning from others: Human capital and technical change in agriculture." *Journal of political Economy* 103 (6): 1176–1209.

Gars, J. and P. S. Ward. 2019. "Can differences in individual learning explain patterns of technology adoption? Evidence on heterogeneous learning patterns and hybrid rice adoption in Bihar, India." *World development* 115: 178–189.

Gharib, M. H., L. H. Palm-Forster, T. J. Lybbert, and K. D. Messer. 2021. "Fear of fraud and willingness to pay for hybrid maize seed in Kenya." *Food Policy* 102: 102040.

Gollin, D., M. Morris, and D. Byerlee. 2005. "Technology adoption in intensive post-green revolution systems." *American Journal of Agricultural Economics* 87 (5): 1310–1316.

Goyal, A. 2010. "Information, Direct Access to Farmers, and Rural Market Performance in Central India." *American Economic Journal: Applied Economics* 2 (3): 22–45.

Hanna, R., S. Mullainathan, and J. Schwartzstein. 2014. "Learning through noticing: Theory and evidence from a field experiment." *The Quarterly Journal of Economics* 129 (3): 1311–1353.

Hasanain, A., M. Y. Khan, and A. Rezaee. 2019. "No bulls: Experimental evidence on the impact of veterinarian ratings in Pakistan." .

Karlan, D., R. Osei, I. Osei-Akoto, and C. Udry. 2014. "Agricultural decisions after relaxing credit and risk constraints." *The Quarterly Journal of Economics* 129 (2): 597–652.

Magruder, J. R. 2018. "An Assessment of Experimental Evidence on Agricultural Technology Adoption in Developing Countries." *Annual Review of Resource Economics* 10 (1): 299–316.

Michelson, H., A. Fairbairn, B. Ellison, A. Maertens, and V. Manyong. 2021. "Misperceived quality: Fertilizer in Tanzania." *Journal of Development Economics* 148: 102579.

Reimers, I. and J. Waldfogel. 2021. "Digitization and pre-purchase information: the causal and welfare impacts of reviews and crowd ratings." *American Economic Review* 111 (6): 1944–71.

Riley, E. 2019. "Role models in movies: the impact of Queen of Katwe on students' educational attainment." *The Review of Economics and Statistics* 1–48.

Sankoh, A. J., M. F. Huque, and S. D. Dubey. 1997. "Some comments on frequently used multiple endpoint adjustment methods in clinical trials." *Statistics in medicine* 16 (22): 2529–2542.

Suri, T. 2011. "Selection and comparative advantage in technology adoption." *Econometrica* 79 (1): 159–209.

Tripp, R. and D. Rohrbach. 2001. "Policies for African seed enterprise development." *Food Policy* 26 (2): 147–161.

Van Campenhout, B. 2021. "The role of information in agricultural technology adoption: Experimental evidence from rice farmers in Uganda." *Economic Development and Cultural Change* 69 (3): 1239–1272.

Van Campenhout, B., D. J. Spielman, and E. Lecoutere. 2020. "Information and Communication Technologies to Provide Agricultural Advice to Smallholder Farmers: Experimental Evidence from Uganda." *American Journal of Agricultural Economics* n/a (n/a).

Vandevelde, S., B. Van Campenhout, and W. Walukano. 2018. *Spoiler alert! Spillovers in the context of a video intervention to maintain seed quality among Ugandan potato farmers.* Tech. rep., LICOS Discussion Paper.

Wossen, T., K. A. Abay, and T. Abdoulaye. 2022. "Misperceiving and misreporting input quality: Implications for input use and productivity." *Journal of Development Economics* 157: 102869.

A Appendix

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Figure A.1: SeedAdvisor certificate

A.1 Descriptives

Table A.1: Descriptive statistics - Agro-input dealer (baseline)

	mean	min	max	SD	nobs
Respondent's age in years	32.43	15	80	11.49	347
Respondent is male	0.595	0	1	0.492	348
Respondent finished primary education	0.920	0	1	0.271	339
Respondent finished secondary education	0.386	0	1	0.488	339
Respondent owns shop	0.555	0	1	0.498	348
Shop's distance to nearest tarmac road in km	6.556	0	52	10.39	343
Shop's distance to nearest murram road in km	0.190	0	9	0.626	348
Shop only sells farm inputs	0.741	0	1	0.439	348
Number of customers per day	41.49	2	300	46.49	346
Number of customers per day **buying maize seed**	21.27	0	250	26.80	347
Years since shop establishment	5.339	0	33	6.299	348
Shop also sells machinery	0.066	0	1	0.249	348
Shop also sells equipment	0.724	0	1	0.448	348
Shop also sells chemicals	0.945	0	1	0.228	348
Shop also sells fertilizers	0.960	0	1	0.197	348
Respondent received training on maize seed handling/storage	0.526	0	1	0.500	348
Respondent received this training **last year**	0.267	0	1	0.443	348
Respondent received this training last year **by ISSD**	0.106	0	1	0.308	341
Number of maize varieties in stock	2.917	0	10	1.755	348
Number of **hybrid** maize varieties in stock	1.681	0	8	1.330	348
Shop has Longe 10H in stock	0.684	0	1	0.466	348
Shop has Longe 7H in stock	0.161	0	1	0.368	348
Number of **OPV** maize varieties in stock	1.276	0	5	0.686	348
Shop has Longe 5 in stock	0.885	0	1	0.319	348
Shop has Longe 4 in stock	0.264	0	1	0.442	348
Shop stores seed away from other products	0.460	0	1	0.499	348
Shop has problem with pests	0.649	0	1	0.478	348
Shop has leak-proof roof	0.537	0	1	0.499	348
Shop has insulated roof	0.580	0	1	0.494	348
Shop has insulated walls	0.813	0	1	0.390	348
Shop is ventilated	0.793	0	1	0.406	348
Shop has plastered walls	0.920	0	1	0.272	348
Shop's floor is cement/tiles (not mud)	0.974	0	1	0.160	343
Shop's light is ambient (not direct sunlight/dark)	0.825	0	1	0.381	348
Shop stores seed on pallets/shelves (not directly on wood/floor/cardboard)	0.707	0	1	0.456	331
Shop stores maize seed in open containers	0.155	0	1	0.363	348
Shop displays official certificate	0.460	0	1	0.499	348
Shop's cleanness/professionality rating by enumerator	3.451	1	5	1.098	348

Table A.2: Descriptive statistics - Agro-input dealer (baseline)

	mean	min	max	SD	nobs
Shop never had expired seed	0.589	0	1	0.493	348
Shop had expired seed but always handled it correctly	0.759	0	1	0.429	145
Shop always explains to customers how seed should be used	0.457	0	1	0.499	348
Shop always recommends complementary inputs to customers	0.529	0	1	0.500	348
Shop offers extension/training to some/ to everyone	0.483	0	1	0.500	348
Shop offers discounts for large quantities	0.750	0	1	0.434	348
Shop's smallest seed bag is 1 kg (not larger)	0.728	0	1	0.445	335
Shop repackages seed if customers want small quantities	0.523	0	1	0.500	348
Shop charges more if customers buy only 1 kg	0.154	0	1	0.362	182
Shop keeps expiry date when repackaging seed	0.588	0	1	0.494	182
Shop provides seed on credit to some	0.595	0	1	0.492	348
Number of customers who received credit (if shop provides credit)	11.02	1	120	13.80	193
Number of **women** who received credit (if shop provides credit)	3.430	0	35	4.692	200
Shop received seed related complaint from customer	0.644	0	1	0.480	348
Shop accepts mobile money as payment	0.348	0	1	0.477	348
Shop sometimes delivers to customers	0.399	0	1	0.490	348
Dealer's self-rating: location	3.876	1	5	0.878	348
Dealer's self-rating: price	3.922	1	5	0.867	348
Dealer's self-rating: product quality	4.046	1	5	0.844	348
Dealer's self-rating: stock, convenient quantities	3.583	1	5	1.002	348
Dealer's self-rating: reputation	4.319	2	5	0.735	348
Shop is registered with UNADA	0.442	0	1	0.497	319
Shop has trading license by local government	0.749	0	1	0.435	338
Shop is member of other professional association	0.345	0	1	0.476	325
Number of inspections by DAO/MAAIF/UNADA last year	1.866	0	43	3.843	335
Shop received warning after inspection	0.317	0	1	0.466	334
Shop's products were confiscated after inspection	0.145	0	1	0.353	337
Shop was closed after inspection	0.009	0	1	0.093	342
Shop has equipment to monitor seed moisture	0.026	0	1	0.159	348
Shop monitors temperature	0.026	0	1	0.159	348
Shop temperature where seed is stored in degrees Celsius	25.31	19.5	52	2.996	345
Moisture in random seed bag in percent	13.576	10.3	17.4	1.522	232
Random seed bag shows expiry date	0.181	0	1	0.386	232
Random seed bag shows expiry date but seed is expired	0.049	0	1	0.218	41
Random seed bag shows packaging date	0.677	0	1	0.469	232
Packaging date is visible but more than 6 months ago	0.039	0	1	0.194	154
Days since packaging date/expiry date minus 6 months	64.96	9	261	47.41	183
Random seed bag is original and undamaged	0.935	0	1	0.246	232
Random seed bag shows certification sticker	0.082	0	1	0.275	232
Random seed bag shows lot number	0.504	0	1	0.501	232
Random seed bag shows e-verification	0.026	0	1	0.159	232

Table A.3: Descriptive statistics - Agro-input dealer (baseline)

	mean	min	max	SD	nobs
Shop is known by random farmer in village with most clients	0.557	0	1	0.260	347
Shop sold seed to this farmer	0.247	0	1	0.184	342
Years since shop has this farmer as customer (if shop sold seed)	3.729	0	13	2.310	313
Shop sold seed to someone this farmer knows	0.085	0	1	0.137	341
Shop's maize seed rating on quality by farmers (who (know someone who) bought seed there)	3.772	1.5	5	0.527	176
Shop's maize seed rating on yield by farmers	3.537	1.5	5	0.527	175
Shop's maize seed rating on drought tolerance by farmers	2.938	1	5	0.525	169
Shop's maize seed rating on pest/disease tolerance by farmers	2.445	1	4	0.516	173
Shop's maize seed rating on time of maturity by farmers	3.817	2	5	0.403	172
Shop's maize seed rating on germination by farmers	3.669	2	5	0.540	172
Number of shop's maize seed ratings by farmers	NA	NA	NA	NA	NA
Shop refunds if problem, according to farmers (who (know someone who) bought seed there)	0.331	0	1	0.302	316
Shop gives credit, i.e. inputs one can pay later, according to farmers	0.410	0	1	0.313	314
Shop advises during sales, according to farmers	0.757	0	1	0.263	320
Shop delivers seed to clients, according to farmers	0.235	0	1	0.282	315
Shop provides after-sales service, according to farmers	0.241	0	1	0.288	322
Shop accepts different payment methods, according to farmers	0.420	0	1	0.327	314
Shop sells small quantities if necessary, according to farmers	0.898	0	1	0.188	324

Table A.4: Descriptive statistics - Farmer (baseline)

	mean	min	max	SD	nobs
Homestead's distance to nearest tarmac road in km	9.390	0	100	10.81	3302
Homestead's distance to village headquarters in km	0.745	0	15	0.903	3436
Homestead's distance to nearest agro-input shop in km	3.779	0	52	4.789	3339
Number of agro-input shops in farmer's village/neighborhood	2.163	0	25	2.346	3263
Homestead's distance to nearest neighbor in km	0.114	0	2	0.183	3463
Farmer's age in years	48.62	18	97	13.38	3453
Farmer is male	0.777	0	1	0.416	3470
Farmer is married	0.884	0	1	0.320	3470
Farmer had no formal education	0.079	0	1	0.270	3437
Farmer finished primary education	0.507	0	1	0.500	3437
Farmer finished secondary education	0.089	0	1	0.284	3437
Number of people in household (incl. respondent)	8.695	1	25	3.979	3470
Number of rooms in house	3.490	1	10	1.445	3469
Roof is made of iron sheets/tiles (not grass)	0.928	0	1	0.259	3460
Farmer's land for crop production in acres	3.348	0.185	100	4.320	3442
Years since farmer started growing maize	23.09	0	82	13.14	3470
Farmer is member of (maize) farmer group/association/cooperative	0.126	0	1	0.332	3459
Farmer used improved maize seed (OPV/hybrid) for any field last season	0.492	0	1	0.500	3466
Farmer used farmer saved maize seed (if he/she used improved seed)	0.163	0	1	0.370	1664
Farmer bought maize seed at agro-input shop (if he/she used improved seed)	0.668	0	1	0.471	1664
Farmer used maize seed for more than 3rd (not 1st/2nd) time (if he/she used farmer saved seed)	0.529	0	1	0.500	261
Amount of improved maize seed bought from agro-input shop in kg (if farmer bought from shop)	11.07	1	200	13.48	1108
Farmer did not buy seed at agro-input shop because it is too expensive	0.860	0	1	0.347	1813
Farmer did not buy seed at agro-input shop because it is of poor quality	0.088	0	1	0.283	1813
Farmer bought seed at particular agro-input shop because it is of very good quality	0.578	0	1	0.494	948
Farmer says seed at agro-input shop is of poor quality due to disappointing yield	0.252	0	1	0.435	151
Farmer says seed at agro-input shop is of poor quality due to disappointing pest tolerance	0.252	0	1	0.435	151
Farmer says seed at agro-input shop is of poor quality due to disappointing germination	0.318	0	1	0.467	151
Farmers thinks seed at agro-input shop is counterfeit/adulterated	0.685	0	1	0.465	2673
Farmer mentioned Longe 5/Nalongo when asked for improved maize varieties	0.655	0	1	0.475	3470
Farmer mentioned Longe 7R/Kayongo-go when asked for improved maize varieties	0.076	0	1	0.266	3470
Farmer mentioned Wema when asked for improved maize varieties	0.010	0	1	0.099	3470

Table A.5: Descriptive statistics - Farmer (baseline)

	mean	min	max	SD	nobs
Farmer grew maize on only 1 field (stand alone/mixed)	0.653	0	1	0.476	3470
Number of fields farmer grew maize on (stand alone/mixed)	1.463	1	5	0.725	3470
Area of randomly selected maize field in acres	1.181	0.075	20	1.001	3465
This maize field was intercropped	0.702	0	1	0.457	3470
This maize field was intercropped with beans	0.419	0	1	0.493	3470
This maize field was intercropped with soybeans	0.108	0	1	0.311	3470
This maize field was intercropped with groundnuts	0.108	0	1	0.311	3470
This maize field was intercropped with cassava	0.267	0	1	0.443	3470
This maize field was intercropped with millet	0.002	0	1	0.045	3470
This maize field was intercropped with sorghum	0.004	0	1	0.061	3470
Percentage allocated to maize (if this field was intercropped)	56.43	5	99	17.84	2414
Farmer planted hybrid maize seed on this field	0.264	0	1	0.441	3124
Farmer planted open-pollinated maize seed on this field	0.260	0	1	0.439	3124
Farmer planted local land race maize seed on this field	0.448	0	1	0.497	3318
Farmer planted hybrid or open-pollinated maize seed on this field	0.552	0	1	0.497	3318
This maize seed was farmer saved	0.579	0	1	0.494	3429
Farmer bought this maize seed at agro-input shop	0.330	0	1	0.470	3429
This maize seed was hybrid but farmer saved	0.050	0	1	0.217	3103
This maize seed was open-pollinated, farmer saved but used 4 or more times	0.031	0	1	0.173	3108
Farmer's rating of this maize seed on general quality	3.385	1	5	1.032	3461
Farmer's rating of this maize seed on yield	3.040	1	5	1.081	3462
Farmer's rating of this maize seed on drought tolerance	2.806	1	5	1.004	3378
Farmer's rating of this maize seed on pest/disease tolerance	2.189	1	5	1.009	3456
Farmer's rating of this maize seed on early maturity	3.416	1	5	1.025	3457
Farmer's rating of this maize seed on demand/market/output price	2.209	1	5	1.096	3299
Farmer's rating of this maize seed on taste	4.031	1	5	0.929	3448
Farmer's rating of this maize seed on price	3.187	1	5	1.223	3163
Farmer's rating of this maize seed on availability	3.362	1	5	1.025	3387
Farmer's rating of this maize seed on germination	3.570	1	5	0.937	3468
Farmer was satisfied with this maize seed	0.678	0	1	0.467	3470
Farmer told supplier that he/she was not satisfied (if not satisfied with maize seed)	0.275	0	1	0.447	509
Farmer would use this maize seed again	0.764	0	1	0.425	3470
Amount of maize seed used on this field in kg	9.616	0.2	200	9.871	3413
Price of this maize seed per kg in UGX	4308	0	14500	3463	1683
Price of this maize seed per kg in dollars	1.210	0	4.071	0.972	1683
Cost of this maize seed in UGX (amount in kg x price per kg)	38612	0	1e+06	61988	1677
Cost of this maize seed in dollars (amount in kg x price per kg)	10.84	0	280.8	17.40	1677

Table A.6: Descriptive statistics - Farmer (baseline)

	mean	min	max	SD	nobs
Farmer spaced seeds correctly on this maize field (2.5 feet x 1 foot)	0.109	0	1	0.312	3470
Number of seeds per hill on this maize field	3.350	1	8	1.254	3362
Farmer sowed correct number of seeds per hill on this maize field (1)	0.042	0	1	0.201	3362
Farmer applied organic manure on this maize field	0.074	0	1	0.262	3466
Farmer applied DAP/NPK on this maize field	0.249	0	1	0.432	3465
Amount of DAP in kg on this maize field (if farmer applied DAP/NPK)	16.88	0.1	150	20.68	845
Farmer applied Urea on this maize field	0.075	0	1	0.263	3466
Amount of Urea in kg on this maize field (if farmer applied Urea)	15.81	0.5	150	19.89	251
Number of times farmer weeded this maize field	2.560	0	5	0.650	3466
Farmer weeded this maize field 3 or more times	0.529	0	1	0.499	3466
Days after planting farmer first weeded this maize field	17.53	1	60	6.662	3428
Farmer weeded this maize field first at correct time (18-20 days after planting)	0.063	0	1	0.244	3428
Farmer used pesticides/herbicides/fungicides on this maize field	0.409	0	1	0.492	3463
Farmer planted at correct time on this maize field (1-3 days after 1st rains)	0.699	0	1	0.459	3441
Farmer re-sew where seeds did not germinate on this maize field	0.483	0	1	0.500	3464
Number of maize bags harvested from this field last season (incl. consumed)	5.364	0	250	8.520	3460
Kilograms per bag	100.5	40	149	8.978	3469
Yield in kg (number of harvested maize bags x kg per bag)	544.2	0	25000	858.2	3459
Land productivity in kg/acre (yield/area)	499.5	0	28000	771.2	3454
Market value per bag at harvest in UGX	70259	20000	149999	27821	3400
Market value per bag at harvest in dollars	19.73	5.616	42.12	7.812	3400
Yield in UGX (number of harvested maize bags x market value per bag)	391126	0	36250000	835450	3390
Yield in dollars (number of harvested maize bags x market value per bag)	109.8	0	10178	234.6	3390
Land productivity in UGX/acre (yield/area)	351874	0	1.8e+07	534819	3385
Land productivity in dollars/acre (yield/area)	98.80	0	5054	150.2	3385
Farmer sold maize from this field	0.513	0	1	0.500	3470
Number of maize bags sold from this field (if farmer sold maize)	5.007	0.02	250	9.134	1778
Price farmer charged per bag in UGX	53596	1	750000	38713	1774
Price farmer charged per bag in dollars	15.05	0	211	10.87	1774
Revenue in UGX (number of sold maize bags x price per bag)	313	0.001	70000	1734	1772
Revenue in dollars (number of sold maize bags x price per bag)	0.09	0	20	0.5	1772
Amount kept as seed in kg	17.57	0	400	33.37	1710
Number of maize bags farmer expects to harvest from this field next season (incl. consumed)	8.764	0	280	12.01	2574

Table A.7: Descriptive statistics - Farmer (baseline)

	mean	min	max	SD	nobs
Farmer knows particular shop in neighborhood	0.556	0	1	0.380	3449
Farmer bought shop's seed (if he/she knows any shop)	0.258	0	1	0.346	2804
Years since farmer became shop's customer (if he/she bought seed from any shop)	4.104	0	35	3.873	1280
Farmer knows someone who bought shop's seed (if he/she did not buy seed from all shops but knows any)	0.079	0	1	0.235	2462
Farmer bought shop's seed last season	0.448	0	1	0.468	598
Farmer's rating of particular shop on general quality (if he/she (knows someone who) bought seed there)	3.709	1	5	0.946	730
Farmer's rating of particular shop on location	3.874	1	5	1.156	730
Farmer's rating of particular shop on price	3.249	1	5	1.109	730
Farmer's rating of particular shop on product quality	3.780	1	5	1.015	730
Farmer's rating of particular shop on seed stock/availability	3.892	1	5	1.030	730
Farmer's rating of particular shop on reputation/reliability	4.133	1	5	0.910	730
Farmer's rating of particular shop's maize seed on general quality	3.788	1	5	0.841	711
Farmer's rating of particular shop's maize seed on yield	3.542	1	5	0.881	699
Farmer's rating of particular shop's maize seed on drought tolerance	2.997	1	5	0.858	679
Farmer's rating of particular shop's maize seed on pest/disease tolerance	2.446	1	5	0.904	685
Farmer's rating of particular shop's maize seed on timing of maturity	3.845	1	5	0.695	688
Farmer's rating of particular shop's maize seed on germination	3.679	1	5	0.854	699

A.2 Balance tests

Table A.8: Orthogonality tests of randomization balance - Agro-input dealer (baseline)

	mean	dealer training	clearing house	farmer video
Respondent's age in years	32.427	2.024	-0.039	-2.662
	(11.492)	(3.171)	(2.664)	(2.483)
Respondent is male	0.595	-0.057	0.054	0.080
	(0.492)	(0.142)	(0.132)	(0.107)
Respondent finished primary education	0.920	0.018	-0.080	-0.002
	(0.271)	(0.046)	(0.055)	(0.060)
Shop's distance to nearest tarmac road in km	6.556	2.642	0.896	-1.307
	(10.390)	(3.628)	(3.360)	(2.288)
Number of customers per day	41.486	8.954	-3.565	-4.755
	(46.489)	(11.999)	(8.797)	(10.085)
Years since shop establishment	5.339	-0.362	0.208	-0.124
	(6.299)	(1.845)	(1.588)	(1.380)
Respondent received training on maize seed handling/storage	0.526	-0.052	0.006	-0.011
	(0.500)	(0.122)	(0.136)	(0.108)
Number of maize varieties in stock	2.917	-0.357	-0.199	0.118
	(1.755)	(0.338)	(0.371)	(0.377)
Amount of maize seed sold during last season in kg	910.885	562.086	131.991	-24.944
	(2683.235)	(849.800)	(405.968)	(585.445)
Amount of maize seed lost/wasted during last season in kg	3.504	-3.210	-1.869	-3.394
	(18.651)	(3.652)	(3.824)	(4.053)
Shop has problem with pests	0.649	0.076	-0.042	-0.085
	(0.478)	(0.119)	(0.111)	(0.104)
Shop has leak-proof roof	0.537	0.024	-0.006	0.011
	(0.499)	(0.118)	(0.101)	(0.109)
Shop received seed related complaint from customer	0.644	-0.257*	0.077	-0.040
	(0.480)	(0.111)	(0.083)	(0.103)
Respondent knows how seed should be stored after repackaging	0.270	0.048	0.095	-0.099
	(0.445)	(0.129)	(0.131)	(0.096)
Shop has trading license by local government	0.749	0.000	0.125	0.124
	(0.435)	(0.121)	(0.107)	(0.096)
Moisture in random seed bag in percent	13.576	0.393	0.267	0.621
	(1.522)	(0.555)	(0.363)	(0.409)
Random seed bag shows lot number	0.504	-0.006	0.013	-0.036
	(0.501)	(0.195)	(0.166)	(0.136)
Shop refunds if problem, according to farmers (who (know someone who) bought seed there)	0.331	-0.022	-0.083	0.018
	(0.302)	(0.091)	(0.088)	(0.067)
Shop gives credit, i.e. inputs one can pay later, according to farmers	0.410	0.059	0.091	0.050
	(0.313)	(0.076)	(0.085)	(0.070)
Shop provides after-sales service, according to farmers	0.241	0.107	0.086	0.100
	(0.288)	(0.071)	(0.061)	(0.062)
Number of observations	348	348	348	348

Note: First column reports sample means (and standard deviations below); **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop).

Table A.9: Orthogonality tests of randomization balance - Farmer (baseline)

	mean	dealer training	clearing house	farmer video
Homestead's distance to nearest tarmac road in km	9.390	4.178	1.663	0.092
	(10.810)	(3.624)	(2.969)	(2.011)
Homestead's distance to nearest agro-input shop in km	3.779	-0.807	0.294	0.045
	(4.789)	(0.755)	(1.042)	(0.749)
Farmer's age in years	48.617	1.744	0.202	0.181
	(13.385)	(1.180)	(1.206)	(1.112)
Farmer is male	0.777	-0.053	-0.013	-0.047
	(0.416)	(0.046)	(0.049)	(0.044)
Farmer finished primary education	0.507	-0.073	0.003	-0.030
	(0.500)	(0.054)	(0.046)	(0.045)
Number of people in household (incl. respondent)	8.695	-0.123	0.035	0.401
	(3.979)	(0.423)	(0.328)	(0.353)
Number of rooms in house	3.490	-0.076	-0.081	-0.017
	(1.445)	(0.156)	(0.156)	(0.155)
Farmer's land for crop production in acres	3.348	0.342	-0.046	0.026
	(4.320)	(0.434)	(0.369)	(0.432)
Farmer used improved maize seed (OPV/hybrid) for any field last season	0.492	-0.020	-0.032	-0.041
	(0.500)	(0.048)	(0.039)	(0.043)
Farmer used improved maize seed bought at agro-input shop	0.325	0.002	-0.001	0.000
	(0.468)	(0.047)	(0.045)	(0.044)
Amount of improved maize seed bought from agro-input shop in kg (0 if not from shop)	3.533	-0.376	-0.784	-1.235
	(9.198)	(1.114)	(1.065)	(0.863)
Farmers thinks seed at agro-input shop is counterfeit/adulterated	0.685	0.021	-0.044	-0.023
	(0.465)	(0.066)	(0.078)	(0.058)
Randomly selected maize field was intercropped with beans	0.419	-0.042	-0.061	0.074
	(0.493)	(0.066)	(0.067)	(0.047)
Farmer used improved (not too often recyvled) maize seed for randomly selected field last season	0.477	-0.026	-0.053	-0.004
	(0.500)	(0.051)	(0.045)	(0.044)
Farmer's rating of maize seed planted on randomly selected maize field on general quality	3.385	-0.063	-0.061	-0.037
	(1.032)	(0.122)	(0.106)	(0.094)
Farmer applied organic manure on randomly selected maize field	0.074	-0.036	-0.017	-0.020
	(0.262)	(0.026)	(0.022)	(0.019)
Farmer planted at correct time on randomly selected maize field (1-3 days after 1st rains)	0.699	0.055	-0.048	-0.017
	(0.459)	(0.048)	(0.052)	(0.051)
Yield in kg (number of harvested maize bags x kg per bag)	544.188	-127.100	-160.308	-130.885
	(858.238)	(94.066)	(97.963)	(95.228)
Land productivity in kg/acre (yield/area)	499.517	-60.344	-52.807	-26.771
	(771.173)	(41.873)	(45.528)	(43.390)
Farmer sold maize from randomly selected maize field	0.513	0.056	-0.026	0.001
	(0.500)	(0.054)	(0.058)	(0.046)
Number of observations	3470	3470	3470	3470

Note: First column reports sample means (and standard deviations below); **, * and + denote significance at the 1, 5 and 10 percent level. Reported standard errors are clustered at the level of randomization (catchment area or village/shop).

A.3 Results

Table A.10: Differences between treatment and control groups - Agro-input dealer, primary outcome variables: P-values adjusted according to Sankoh, Huque, Dubey (1997)

	mean	dealer training	clearing house	farmer video	nobs
Transformed cumulative quantity sold of 4 improved maize varieties last season in kg (IHS)†	6.472	-0.092	0.284	-0.156	292
	(1.851)	(0.220)	(0.227)	(0.187)	
Average sales price of 4 improved maize varieties last season in UGX/ kg	4537.728	-192.784	99.272	56.732	275
	(871.743)	(114.934)	(113.292)	(100.998)	
Transformed seed revenue in mln UGX: quantities sold * sales prices of 4 maize varieties (IHS)†	1.494	-0.069	0.185	-0.005	292
	(1.076)	(0.104)	(0.108)	(0.095)	
Transformed number of customers who bought maize seed on average day at last season (IHS)†	3.230	-0.056	0.127	-0.070	294
	(0.824)	(0.098)	(0.101)	(0.089)	
Moisture in random seed bag in percent	12.948	-0.121	-0.145	-0.180	135
	(0.848)	(0.172)	(0.162)	(0.142)	
Index of **capital-intensive** seed handling and storage practices observed by enumerator †	0.021	-0.019	0.000	0.085	270
	(0.493)	(0.063)	(0.072)	(0.055)	
Index of **labor-intensive** seed handling and storage practices observed by enumerator †	0.005	0.058	0.099	-0.098	285
	(0.457)	(0.070)	(0.065)	(0.053)	
Index of **all** seed handling and storage practices observed by enumerator	0.013	0.042	0.052	-0.023	251
	(0.360)	(0.051)	(0.053)	(0.044)	
Index of dealer's efforts and services †	-0.007	-0.063	0.066	0.034	243
	(0.413)	(0.062)	(0.060)	(0.053)	
Index of shop's maize seed ratings by farmers (no base or midline)					

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

Table A.11: Differences between treatment and control groups - Agro-input dealer, secondary outcome variables regarding Longe 10H (most common hybrid variety in area): P-values adjusted according to Sankoh, Huque, Dubey (1997) (selection: if shop had Longe 10H in stock last season)

	mean	dealer training	clearing house	farmer video	nobs
Transformed amount of Longe 10H carried into last season from previous season in kg (IHS)†	0.698	-0.186	0.090	0.285	262
	(1.550)	(0.212)	(0.215)	(0.188)	
Transformed amount of Longe 10H bought by shop from provider last season in kg (IHS)†	6.023	0.118	0.206	0.103	257
	(1.357)	(0.218)	(0.213)	(0.154)	
Cost of Longe 10H per kg last season in UGX†	5100.973	-315.538	-153.756	-73.379	180
	(898.767)	(138.411)	(126.348)	(114.440)	
Transformed quantity of Longe 10H sold last season in kg (IHS)†	5.934	0.050	0.236	0.039	256
	(1.311)	(0.206)	(0.204)	(0.151)	
Transformed sales price of Longe 10H per kg at beginning of last season in UGX (IHS)	9.415	-0.025	-0.013	0.008	194
	(0.156)	(0.026)	(0.026)	(0.023)	
Transformed amount of Longe 10H lost/wasted last season in kg (IHS)	0.169	-0.072	-0.103	-0.085	133
	(0.693)	(0.129)	(0.137)	(0.133)	
Number of times per month shop ran out of Longe 10H last season	1.172	-0.434	-0.057	0.014	192
	(1.678)	(0.265)	(0.276)	(0.244)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

Table A.12: Differences between treatment and control groups - Agro-input dealer, secondary outcome variables regarding Longe 5 (most common open-pollinated variety): P-values adjusted according to Sankoh, Huque, Dubey (selection: if shop had Longe 5 in stock last season)

	mean	dealer training	clearing house	farmer video	nobs
Transformed amount of Longe 5 carried into last season from previous season in kg (IHS)†	0.895	0.247	-0.092	0.139	270
	(1.807)	(0.324)	(0.306)	(0.225)	
Transformed amount of Longe 5 bought by shop from provider last season in kg (IHS)†	6.116	-0.005	0.253	0.035	262
	(1.438)	(0.221)	(0.215)	(0.158)	
Cost of Longe 5 per kg last season in UGX†	2518.061	-53.321	-79.925	-57.889	231
	(318.852)	(39.065)	(42.867)	(31.597)	
Transformed quantity of Longe 5 sold last season in kg (IHS)†	6.015	-0.040	0.304	0.088	261
	(1.446)	(0.222)	(0.216)	(0.157)	
Transformed sales price of Longe 5 per kg at beginning of last season in UGX (IHS)	8.747	0.017	-0.015	0.012	249
	(0.128)	(0.016)	(0.016)	(0.014)	
Transformed amount of Longe 5 lost/wasted last season in kg (IHS)	0.357	-0.224	0.113	-0.307	167
	(1.025)	(0.193)	(0.193)	(0.190)	
Number of times shop per month ran out of Longe 5 last season	0.876	0.093	0.178	0.083	248
	(1.504)	(0.202)	(0.203)	(0.194)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

Table A.13: Differences between treatment and control groups - Agro-input dealer, secondary outcome variables regarding registration/ trading license/ membership/ inspection: P-values adjusted according to Sankoh, Huque, Dubey

	mean	dealer training	clearing house	farmer video	nobs
Shop is registered with UNADA†	0.397	0.040	0.066	0.062	252
	(0.490)	(0.072)	(0.068)	(0.056)	
Shop has a trading license issued by local government†	0.831	-0.042	0.021	0.003	288
	(0.375)	(0.053)	(0.054)	(0.044)	
Shop is a member of other professional association†	0.265	-0.035	0.058	-0.005	268
	(0.442)	(0.051)	(0.052)	(0.055)	
Transformed number of times shop was inspected by DAO/MAAIF/UNADA last year (IHS)	1.347	0.037	-0.097	-0.313	293
	(1.782)	(0.247)	(0.259)	(0.206)	
Shop received a warning after inspection†	0.396	0.045	0.005	-0.033	291
	(0.490)	(0.072)	(0.073)	(0.057)	
Shop's products were confiscated after inspection†	0.129	0.021	-0.027	-0.020	293
	(0.335)	(0.046)	(0.046)	(0.038)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

Table A.14: Differences between treatment and control groups - Agro-input dealer, secondary outcome variables regarding seed bag: P-values adjusted according to Sankoh, Huque, Dubey (selection: enumerator was able to buy bag of seed)

	mean	dealer training	clearing house	farmer video	nobs
Random seed bag shows expiry date					
Random seed bag shows packaging date†	0.855	0.055	0.092	-0.015	144
	(0.353)	(0.067)	(0.073)	(0.055)	
Days since packaging date/expiry date minus 6 months†	159.524	-22.883	-32.103	-23.685	102
	(94.440)	(25.330)	(23.273)	(18.236)	
Random seed bag shows lot number†	0.642	-0.028	0.013	0.197*	144
	(0.481)	(0.111)	(0.111)	(0.077)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

Table A.15: Differences between treatment and control groups - Agro-input dealer, secondary outcome variables: P-values adjusted according to Sankoh, Huque, Dubey (1997)

	mean	dealer training	clearing house	farmer video	nobs
Number of maize varieties in stock last season (incl. hybrids, OPV, landraces)	3.736	0.042	0.245	0.042	295
	(1.665)	(0.266)	(0.245)	(0.187)	
Number of **hybrid** maize varieties in stock last season†	2.397	-0.187	0.098	0.000	301
	(1.352)	(0.186)	(0.187)	(0.140)	
Number of **open-pollinated** maize varieties in stock last season†	1.374	0.005	-0.060	-0.200+	301
	(0.775)	(0.114)	(0.110)	(0.086)	
Shop has equipment to monitor seed moisture	0.369	0.708**	-0.048	0.034	306
	(0.483)	(0.047)	(0.046)	(0.038)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

Table A.16: Differences between treatment and control groups - Farmer, primary outcome variables: P-values adjusted according to Sankoh, Huque, Dubey (1997)

	mean	dealer training	clearing house	farmer video	nobs
Farmer used quality maize seed last season for any plot†	0.609	-0.021	0.035	-0.012	3206
	(0.488)	(0.021)	(0.021)	(0.016)	
Farmer used quality maize seed bought at agro-input shop last season for any plot†	0.429	-0.014	0.059^{+}	-0.018	3145
	(0.495)	(0.023)	(0.022)	(0.017)	
Transformed amount of quality maize seed farmer bought at agro-input shop last season in kg (IHS)†	1.025	-0.021	0.147	-0.045	3025
	(1.284)	(0.060)	(0.060)	(0.044)	
Index of farmer's maize seed ratings for shops nearby (product quality perception) (only endline)					
Index of farmer's general ratings of shops nearby (shop/seller perception) (only endline)					
Index of services of shops nearby according to farmers (perception of services and efforts)	-0.022	-0.138	0.161	0.081	312
	(0.597)	(0.083)	(0.077)	(0.068)	
Farmer switched to different agro-input shop (no baseline)$^{(\dagger)}$					
Index of farmer's practices on randomly selected maize field†	0.008	0.011	-0.026	-0.010	2929
	(0.400)	(0.020)	(0.020)	(0.014)	
Farmer thinks that maize seed at agro-input shops is counterfeit/adulterated†	0.506	-0.033	-0.041	0.025	2113
	(0.500)	(0.029)	(0.029)	(0.022)	
Farmer planted local land race maize seed on this field†	0.390	0.015	-0.013	0.035	2954
	(0.488)	(0.022)	(0.022)	(0.017)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

Table A.17: Differences between treatment and control groups - Farmer, secondary outcome variables: P-values adjusted according to Sankoh, Huque, Dubey (1997)

	mean	dealer training	clearing house	farmer video	nobs
Number of improved maize varieties the farmer is are aware of†	2.625	-0.015^{NA}	0.042^{NA}	0.017^{NA}	3217
	(1.577)	(0.126)	(0.121)	(0.053)	
Farmer knows particular shop in neighborhood†	0.652	0.007^{NA}	-0.006^{NA}	0.000^{NA}	3267
	(0.384)	(0.041)	(0.036)	(0.012)	
Farmer bought shop's seed last season (only endline)					
Index of farmer skill questions (only endline)					

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

Table A.18: Differences between treatment and control groups - Farmer, secondary outcome variables: adoption on randomly selected maize field: P-values adjusted according to Sankoh, Huque, Dubey (1997)

	mean	dealer training	clearing house	farmer video	nobs
Farmer planted hybrid maize seed on randomly selected maize field†	0.312	0.002	0.009	-0.003	2654
	(0.463)	(0.024)	(0.023)	(0.017)	
Farmer planted open-pollinated maize seed on this field†	0.273	-0.017	0.002	-0.035	2654
	(0.446)	(0.024)	(0.024)	(0.017)	
Farmer planted farmer saved maize seed on this field (can be hybrid, open-pollinated, local land race)†	0.518	0.020	-0.042	0.031	3153
	(0.500)	(0.024)	(0.024)	(0.017)	
Farmer planted maize seed bought at agro-input shop on this field†	0.422	-0.010	0.047	-0.020	3153
	(0.494)	(0.024)	(0.024)	(0.017)	
Farmer planted hybrid **not farmer saved** seed or an OPV (**not used too often**) on this field	0.544	-0.024	0.033	-0.033	2954
	(0.498)	(0.023)	(0.023)	(0.017)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

Table A.19: Differences between treatment and control groups - Farmer, secondary outcome variables: seed used on randomly selected maize field: P-values adjusted according to Sankoh, Huque, Dubey (1997)

	mean	dealer training	clearing house	farmer video	nobs
Index of farmer's ratings of seed used on randomly selected maize field last season†	-0.001	-0.055	0.052	-0.031	3012
	(0.593)	(0.039)	(0.040)	(0.021)	
Farmer was satisfied with quality of seed used on this field last season†	0.707	-0.011	0.010	-0.004	3217
	(0.455)	(0.022)	(0.022)	(0.016)	
Farmer would use the seed used on this field last season again†	0.733	0.007	0.018	-0.017	3217
	(0.443)	(0.021)	(0.020)	(0.016)	
Amount of seed farmer used on this field last season in kg†	6.857	0.055	-0.160	-0.043	2909
	(4.761)	(0.238)	(0.245)	(0.165)	
Price of seed farmer used on this field last season per kg in UGX†	2211.631	-73.500	220.627	-139.280	2982
	(3028.716)	(131.000)	(132.326)	(105.062)	
Transformed cost of seed farmer used on this field last season in UGX (amount*price) (IHS)	4.571	-0.181	0.499	-0.375	2848
	(5.312)	(0.251)	(0.251)	(0.192)	

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.

Table A.20: Differences between treatment and control groups - Farmer, secondary outcome variables: yield etc. on randomly selected maize field: P-values adjusted according to Sankoh, Huque, Dubey (1997)

	mean	dealer training	clearing house	farmer video	nobs
Production from this field last season in kg (number of harvested maize bags x kg per bag)	300.256	-0.806	-20.372	4.764	2884
	(277.792)	(15.143)	(15.673)	(9.649)	
Yield in kg/acre (production/area)†	335.023	-12.216	-23.006	11.673	2878
	(260.714)	(17.569)	(18.338)	(9.442)	
Farmer harvested as much maize as expected from this field last season (no baseline)$^{(\dagger)}$					
Farmer did not harvest as much maize as expected due to own mismanagement (no baseline)$^{(\dagger)}$					
Transformed amount of maize sold from this field in kg (IHS)†	1.612	-0.046	-0.201	0.026	3063
	(2.665)	(0.138)	(0.136)	(0.093)	
Transformed revenue in UGX (number of sold maize bags x price per bag) (IHS)†	3.331	-0.141	-0.393	0.122	3058
	(5.507)	(0.284)	(0.279)	(0.192)	
Transformed amount kept as seed in kg (IHS) (no baseline)$^{(\dagger)}$					

Note: First column reports means of the entire sample (control and treatment groups: only 12 percent of dealers were not treated, rest was treated somehow) and standard deviations below in brackets; **, * and + denote significance at the 1, 5 and 10 percent levels. Reported standard errors are clustered at the level of randomization (catchment area or village/shop). † indicates that the variable was included in the overall index.