The (perceived) quality of agricultural technology and its adoption: Experimental evidence from Uganda

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Abstract

Concerns about the (perceived) quality of agricultural technologies are increasingly recognized as a key constraint to their adoption by smallholder farmers in low-income countries. Focusing on high-yielding maize varieties, we test two hypotheses through a randomized controlled trial involving 350 agro-dealers and 3,500 farmers in Uganda. First, we assess whether limited adoption stems from poor seed quality due to agro-dealers' lack of knowledge, addressed through a seed handling and storage training. Second, we examine whether information asymmetries disincentivize quality provision by introducing a crowd-sourced information clearinghouse similar to review platforms like Yelp. We find that the clearinghouse intervention improves outcomes for both sellers and buyers. Although agro-dealers do not enhance practices that directly affect seed quality, they increase efforts to signal quality and improve customer service, resulting in more business. Farmers do not shift to higher-rated sellers, but the intervention improves perceptions of seed quality, leading to higher adoption and improved harvest and sales outcomes. In contrast, the training yields no measurable impacts on agro-dealers or associated farmers.

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1 Introduction

The adoption of modern agricultural inputs and technologies – such as better-performing seed varieties and inorganic fertilizers – remains low in regions where they have the greatest potential to improve food security, alleviate poverty, and preserve biodiversity (Borlaug, 2007; Gollin, Hansen, and Wingender, 2021; Suri and Udry, 2022). A substantial body of research has examined why small-scale, resource-constrained farmers in low- and middle-income countries often fail to adopt these innovations, despite their promise to raise agricultural productivity. As reviewed by Suri and Udry (2022), key barriers include credit, liquidity, and savings constraints; limited access to insurance; information frictions; high transaction costs and poor infrastructure; and imperfections in labor and land markets.

Recently, concerns about the quality of agricultural inputs have emerged as an important explanation for their limited adoption by smallholders. Bold et al. (2017) argue that farmers are often unable to assess quality at the time of purchase, creating information asymmetries between sellers and buyers. Echoing the dynamics in Akerlof's classic "Market for Lemons" paper (1970), these asymmetries undermine the market for high-yielding maize varieties in Uganda. Using an experimental grow-out test, Bold et al. (2017) conclude that locally sold hybrid seed contains less than 50% authentic seed. Subsequent research, however, raises questions about the source of these quality problems – whether they stem from adulteration or mishandling. Barriga and Fiala (2020) test maize seed samples purchased by mystery shoppers from retailers along the Ugandan supply chain and find evidence of improper handling and storage, rather than adulteration. Very recently, Ilukor et al. (2025) analyzed maize seed samples from across the Ugandan supply chain using DNA fingerprinting and found that at every stage, quality was lower than in samples from seed companies. Additionally, lower quality in samples purchased by mystery shoppers suggests that agro-dealers may strategically provide higher-quality seed to inspectors than to farmers.

Whether due to intentional counterfeiting or unintentional mishandling, the widespread presence of low-quality maize seed in local markets increases the likelihood that farmers unknowingly purchase substandard inputs, reducing the expected returns to adoption. Beyond this direct effect, quality uncertainty distorts complementary input decisions. Bulte et al. (2025) show that when farmers are uncertain about seed quality, they allocate less labor in a field experiment in Tanzania, diminishing the gains from improved varieties. Lower yields, in turn, hinder farmers' ability to learn about the profitability of high-yielding maize, slowing adoption over time. This illustrates a broader challenge: it is difficult to infer input quality from one or two uses. Agricultural production depends on complex, stochastic interactions among inputs, soil, weather, pests, and management practices – making it hard to attribute performance to seed quality. When identifying high-quality sellers is costly and learning from experience is slow and noisy, farmers have little incentive to search. In equilibrium, this leads to low search effort and persistent exposure to poor-quality inputs, reinforcing the learning problem and delaying adoption.

We examine these quality concerns through a randomized controlled trial (RCT) involving agro-dealers and associated farmers in the emerging market for high-yielding maize varieties in eastern Uganda. Agro-dealers are a critical distribution channel for agricultural technologies in contexts where smallholders often live in remote areas with limited infrastructure. While a reasonably dense network of agro-dealers improves access to inputs, these vendors may also constitute weak links in the supply chain. Their small scale and semi-formal operations may imply limited knowledge of appropriate handling and storage practices.

Our first hypothesis is that equipping agro-dealers with information improves their knowledge, practices, and product quality, thereby enhancing farmers' experience and ultimately increasing the adoption of high-yielding maize varieties. We test this by providing a training on seed handling and storage to agro-dealership owners and managers.

However, training alone may be insufficient to resolve the underlying information asymmetry. In the prevailing market equilibrium, agro-dealers may rationally underinvest in seed quality if they believe buyers are unable to credibly assess quality ex ante (at the time of purchase) and struggle to link outcomes such as yield to seed quality ex post (after one or two uses), given the complex nature of agricultural production. As a result, agro-dealers may remain disincentivized to invest in proper handling and storage if they expect that quality improvements will go unnoticed and fail to generate additional demand. In the extreme, profit-maximizing sellers may engage in strategic adulteration – such as blending high-yielding or fresh seed with older seed, local varieties, or even grain – to reduce costs, increase margins, and exploit buyers' limited capacity to detect quality differences.

Our second hypothesis posits that providing a signal of seed quality – accessible to both buyers and sellers – will increase adoption. To test this, we implement a decentralized information clearinghouse based on farmers' ratings of agro-dealers and their products. These ratings are aggregated into scores and rankings and disseminated to farmers. Agro-dealers also receive a certificate displaying their rating, making the information visible beyond the study sample and increasing exposure, much like platforms such as Yelp or TripAdvisor.

This second intervention rests on the assumption that, while individual farmers cannot reliably assess seed quality at the time of purchase and often struggle to do so after one or two uses, groups of farmers can effectively evaluate it after planting and harvesting, consistent with the prevailing consensus in the literature (Michelson et al., 2023). Specifically, we assume that individual ratings are noisy but unbiased signals distributed around the true mean, so that aggregating ratings across many farmers operating under similar conditions (large N) provides a good signal of quality. This reduces the need for individual farmers to learn through repeated use over multiple seasons (large T).

The rating system may help overcome information frictions that hinder technology adoption through several channels. If ratings exceed farmers' prior beliefs, the information clearinghouse improves perceptions of seed quality. If quality varies across sellers, it lowers search costs, enabling farmers to identify and switch to higher-quality providers.

By increasing the likelihood that quality investments are rewarded, the system also creates competitive pressure and incentives, encouraging agro-dealers to improve or credibly signal product quality.

We test the two hypotheses through an RCT involving 350 agro-dealers and 3,500 associated smallholder maize farmers in eastern Uganda over two agricultural seasons. The information clearinghouse improved outcomes for both groups. Agro-dealers adjusted their behavior in response but did not improve seed handling practices that directly affect quality. Instead, they focused on signaling quality and enhancing customer service to boost their ratings. As a result, they attracted more business, though seed quality remained unchanged. On the farmer side, we find no switching to higher-rated sellers, but the intervention improved perceptions of seed quality – likely because ratings exceeded prior beliefs – which increased adoption of high-yielding maize and improved harvest and sales outcomes. In contrast, the agro-dealer training had no meaningful effect: it failed to enhance knowledge, seed handling, or service, and did not impact seed quality, agro-dealer business, or farmer outcomes.

Our study contributes to several strands of the literature. First, it adds to the extensive research on the effectiveness of training programs for small businesses in developing countries. While McKenzie (2021) finds modest positive average effects in a meta-analysis, individual studies yield mixed results (for example, Karlan and Valdivia, 2011; Drexler, Fischer, and Schoar, 2014; Giné and Mansuri, 2021), partly due to methodological limitations such as low statistical power. Others suggest that knowledge alone may be insufficient to change behavior (McKenzie and Woodruff, 2013). More encouraging results have come from programs that emphasize personal initiative – promoting proactive and opportunity-focused behavior among entrepreneurs (Campos et al., 2017). In line with this shift, our findings underscore the role of (external) motivation in enhancing the impact of training.

Second, our paper contributes to the literature on how sellers react to increased market transparency. Several studies show that reducing information frictions can lead to the exit of lower-quality sellers, consistent with a reduction in adverse selection. Jensen and Miller (2018) show that the spread of mobile phones in India enabled consumers to learn about non-local boat-builders, driving market integration, improved product quality, and lower quality-adjusted prices. High-quality firms expanded while low-quality firms exited. Closely related to our context, Hsu and Wambugu (2024) train farmers in rural Kenya to identify quality-verified hybrid maize seeds. While this intervention benefits farmers, local sellers do not respond by upgrading quality or adjusting prices. Instead, many exit the market – likely because better-informed buyers reduce profit margins, and upgrading quality may be too costly.

Other studies show that public quality disclosure and greater market transparency prompt sellers to differentiate on quality and compete over it, consistent with a reduction in moral hazard. Jin and Leslie (2003) find that restaurants in Los Angeles County improve hygiene standards when required to display grade cards. Klein, Lambertz, and Stahl (2016) examine eBay's efforts to reduce strategic bias in buyer ratings by lowering the cost of leaving negative feedback. Sellers respond not by exiting but by improving behavior to boost buyer satisfaction. In a field experiment in Ghana's mobile money markets, Annan (2025) evaluates a anti-misconduct information campaign targeting both customers and vendors. The intervention reduces unethical behavior, increases market activity, raises consumer welfare, and boosts firm revenues – partly by elevating reputational pressure on vendors. In line with these findings, we show that agro-dealers respond to increased transparency by signaling product quality and improving customer service, adding evidence on how sellers adapt to quality disclosure and reduced information frictions in a novel setting.

Relatedly, beyond examining seller (agro-dealer) behavior, our paper contributes to the literature on how buyers respond to increased market transparency, as our information clearinghouse sought to reduce search costs for farmers. Lane, Schonholzer, and Kelley (2022) show that in Kenya, passengers chose safer buses after safety information was publicly disclosed. Cai, Lin, and Szeidl (2024) find that randomized referrals between supplier and client firms in China's writing brush industry lowered search costs, boosting transactions, firm performance, and product quality as firms reallocated to better partners. In our context, however, even with improved ability to screen for quality, farmers did not switch to higher-quality sellers, contributing further evidence on the limits of demand-side adjustment in response to enhanced transparency.

Furthermore, our paper contributes to a growing literature on using crowd-sourced quality information to reduce information asymmetries and increase market transparency. The rise of digital platforms and e-commerce has enabled consumers to widely share feedback, spurring research on the impact of such reviews. Bajari and Hortaçsu (2004) and Dranove and Jin (2010) review the literature on online ratings. On eBay, higher seller ratings are associated with increased sale probabilities and prices (Melnik and Alm, 2002; Lucking-Reiley et al., 2007; Jin and Kato, 2006; Resnick et al., 2006). Anderson and Magruder (2012) show that an extra half-star on Yelp increases the likelihood of a restaurant selling out dramatically. Reimers and Waldfogel (2021) find that crowd-based Amazon star ratings for books generate over ten times the consumer welfare impact of traditional review outlets. In the context of smallholder agriculture, Hasanain, Khan, and Rezaee (2023) implement a crowd-sourced clearinghouse on the quality and pricing of artificial livestock insemination services in Pakistan. Peer signals lead to a 25% increase in insemination success without price changes, driven by veterinarians exerting greater effort in response to enhanced transparency, rather than farmers switching to higher-quality providers.

Lastly, our study deepens the understanding of agricultural technology adoption. Suri and Udry (2022) review key barriers to adoption, while Michelson et al. (2023) emphasize the importance of input quality constraints in particular. Our paper advances this literature by highlighting the role of supply-side quality constraints in limiting the uptake of improved agricultural inputs. It also shows that decentralized institutions – such as peer-based rating systems – can complement formal regulation in low-governance settings, with important implications for both public policy and private sector.

2 Context on seeds and their quality

In this study, the term "high-yielding maize varieties" refers to both open-pollinated varieties (OPVs) and hybrids that have been genetically improved through public or private sector breeding programs. While the difference between these two types of maize is based on their reproductive biology, there are also economic implications (Morris, Rusike, and Smale, 1998; Spielman and Kennedy, 2016). We explain the terminology and our rationale for using this terminology below, recognizing that our explanation is a simplification of much more complex biological phenomena.

Maize hybrids tend to confer a significant advantage in terms of vigor – robust growth, high yields, and uniform yield performance, even under suboptimal conditions. This is due to the expression of heterosis that results from crossing distinct inbred parent lines to produce genetically superior progeny (F1) that is planted by the farmer. However, this vigor declines dramatically if farmers save and plant grain that was set aside from harvest. Instead, the farmer must purchase fresh (F1) seed each season to continue to realize the benefits of heterosis. The combination of vigor and purchase frequency can incentivize public investment in hybrid maize improvement, seed production, and marketing.

OPVs, on the other hand, are typically less vigorous than hybrids. Although they are also less susceptible to genetic degeneration and can be saved and planted across several generations without loss of vigor, their yield performance is typically lower than hybrids. Moreover, OPV seed saving practices – and thus less frequent purchases of fresh seed – tend to reduce these private investment incentives.

Relatedly, we use the term "farmer-saved seed" in this study to refer to seed that is of an unknown progeny or quality. They may be seed saved from the harvest of F1 hybrids or OPVs, and they may be n generations old. They may have been stored under suboptimal conditions between seasons, exposed to moisture, pests, or diseases, and, as a result of both genetic and physical factors, perform poorly relative to fresh hybrid or OPV seed purchased from an agro-input shop.

As highlighted in a recent review by Michelson et al. (2023), seed quality is complex and multi-dimensional due to the living nature of seeds, encompassing three essential dimensions. First, analytical purity measures the proportion of a seed sample that belongs to the intended species. Second, varietal purity ensures the seed is of the expected variety, possessing the claimed genetic characteristics. Third, viability and performance assess the seed's capacity to germinate and grow with sufficient vigor.

This study focuses on the viability and performance dimension of maize seed quality. From a farmer's perspective, this dimension is particularly salient, as it represents both a crucial and observable outcome (Michelson et al., 2023). A key indicator of viability – germination – becomes evident within weeks of planting. Moreover, while some storage and handling practices, such as seed mixing or mislabeling, may affect varietal purity, the practices examined in this study primarily influence seed viability and performance.

Objectively assessing maize seed quality is complex, but measuring the moisture content of a seed sample is the most common and practical test for viability and performance. Moisture is a powerful predictor, as it directly affects germination outcomes. Afzal et al. (2017), for example, report germination rates of approximately 85% for seeds with a moisture content of 12.7%, compared to just 50% for the same seeds at 15.6%. Prolonged exposure to high humidity rapidly degrades seed viability by increasing susceptibility to damage from pathogens, insects, and physical handling (Michelson et al., 2023). The moisture content of a seed sample reflects recent storage conditions – whether the seeds were kept in airtight packages or exposed to open air. Experts consulted during the development of our training emphasized a widely used rule of thumb: each one-percentage-point increase in moisture content halves the seed's shelf life.

While moisture measurement is standard practice among seed companies and crop inspectors and provides a valuable indication of seed quality, it is inherently one-dimensional. Additional quality assessments include germination tests conducted in controlled chambers; vigor tests under the growing conditions that may occur in the field; grow-out tests, which evaluate genetic purity through morphological analysis; seed health testing which measures the presence of pathogens and diseases, and genotyping (DNA fingerprinting), which verifies genetic purity using single nucleotide polymorphism analysis.

3 Experimental design

We designed an experiment with two interventions (detailed in the next section) aimed at improving seed quality or its perception. The interventions are randomized at the agro-dealer catchment area level. These catchment areas consist of clusters of towns, villages, markets, trading centers, and other key hubs where agricultural market activity is concentrated. Catchment areas typically include several agro-dealers, clustered based on geographical proximity.[1]

We randomize at the catchment area level, rather than the more granular agro-dealer level, for three key reasons. First, randomizing at the individual agro-dealer level raises ethical concerns. When two or more agro-dealers operate in close proximity, treating only one could create unfair competitive advantages or disadvantages. Randomizing at the catchment area level mitigates this risk. Second, it reduces the likelihood of spillovers from treated to control agro-dealers. Third, it allows us to measure the interventions' impact on farmers – not just agro-dealers – as all farmers within a catchment area are exposed to agro-dealers receiving the same treatment.

The two interventions are implemented in a field experiment with a 2^2 factorial design. The four possible treatment combinations – neither training nor clearinghouse, training only, clearinghouse only, and both training and clearinghouse – each have an

[1]To define these areas, we used a haversine function to construct an adjacency matrix based on GPS coordinates, assigning agro-dealers less than five kilometers apart to the same catchment area. The five-kilometer threshold was selected based on a visual inspection of the map, the average village size in our sample, and the reported distance between farmers and agro-dealers in survey data from a previous study of the maize value chain, available here.

equal assignment probability of 25%.

We used simulations to determine the sample sizes required to detect treatment effects on selected outcomes at both the farmer and agro-dealer levels. Simulation offers a flexible and intuitive approach to analyzing statistical power. Rather than relying on theoretical distributions that require assumptions and yield analytic solutions, we conducted simulations that (re)sampled from real data collected in previous surveys. Specifically, we used data from 78 agro-dealers and 1,529 smallholder farmers in their catchment areas, gathered from three districts in eastern Uganda in July 2019. These data are publicly accessible here. The simulations indicate that with more than 112 catchment areas, our experiment achieves 80% power to detect effects on a selection of primary outcomes. This corresponds to approximately 318 agro-dealers. Further simulations at the farm-household level guided our decision to sample ten farmers per agro-dealer, resulting in a total sample size of 3,180 households. These figures represent the minimum required sample size; the actual sample size, including the number of agro-dealers and farmers per treatment arm, is detailed in the Sample Subsection 6.1.

As detecting interaction effects requires a substantially larger sample size than detecting main effects, our experiment is underpowered to identify interactions. Consequently, interaction estimates are likely to overstate the true effect magnitude (Muralidharan, Romero, and Wüthrich, 2023). More detailed information about our power simulations, including expected treatment effect sizes, is available in the pre-analysis plan, pre-registered with the AEA RCT registry under RCT ID 0006361.

4 Interventions

4.1 Agro-dealer training

Training content and material

To develop the training content and ensure its relevance to the local context, we engaged experts from several Ugandan organizations through semi-structured interviews and a workshop. These discussions aimed to identify challenges in the seed sector and agro-dealer retail practices, as well as to explore practical solutions for improving seed storage and handling. Insights from these consultations informed the creation of a standardized training manual and a simple, visually engaging poster highlighting key practices.

Participants included representatives from the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF), the National Agricultural Research Organization (NARO), the Uganda Seed Trade Association (USTA), and the Uganda National Agro-Dealers Association (UNADA). The experiment rollout began with the implementation of the first treatment in 2021 (Figure 1).

Training day

In each treated catchment area, all agro-dealers were selected for training, with both the owner and shop manager invited. The owner's invitation was crucial, as several recommended practices required new investments in the agro-dealership, while the shop manager's involvement was key to implementing hands-on practices in daily operations. Of the 166 invited agro-dealers, 140 sent at least one representative, resulting in 84% compliance.[2]

The training took place in May 2021, strategically timed to avoid peak agro-dealer activity and early enough for participants to apply newly learned practices during the second agricultural season. Sessions were held in easily accessible locations and conducted in small groups of 10 to 15 agro-dealers. To ensure COVID-19 safety, participants and trainers maintained proper distance, wore face masks, and regularly disinfected their hands.

All attendees received transport compensation, along with lunch and refreshments. To further encourage engagement, participants were offered a free portable seed moisture meter, initially contingent on passing a short multiple-choice knowledge test at the end of the training. In practice, every agro-dealer who attended received a moisture meter, regardless of test performance. Each agro-dealer also received a copy of the informational poster used in the training to display in their shop as a reminder of best practices.

In each training session, trainers demonstrated proper handling and storage practices for high-yielding maize seed, using the poster and a sample seed bag for illustration. Participants then practiced more complex techniques, such as measuring moisture with a moisture meter. The trainings were organized and conducted in collaboration with UNADA.

4.2 Information clearinghouse

Rating collection and computation

During baseline data collection (April 2021), sampled farmers were asked to rate agro-dealers in their catchment area based on multiple characteristics. Enumerators used a tablet-based application to guide them through the list of agro-dealers, displaying common names, store location descriptions, and storefront pictures obtained during the agro-dealer census (see Subsection 6.1). Farmers could rate an agro-dealer only if they met one of two conditions: either they had personally purchased seed from the agro-dealer or knew someone who had.

Eligible farmers then rated the agro-dealer using the questions listed in Table 1. The selected rating dimensions reflect farmers' priorities and the attributes they are attentive to in their purchases and use of seed, identified through extensive qualitative

[2]Both the owner and manager attended for 80 agro-dealers, only the owner attended for 50, and only the manager attended for ten.

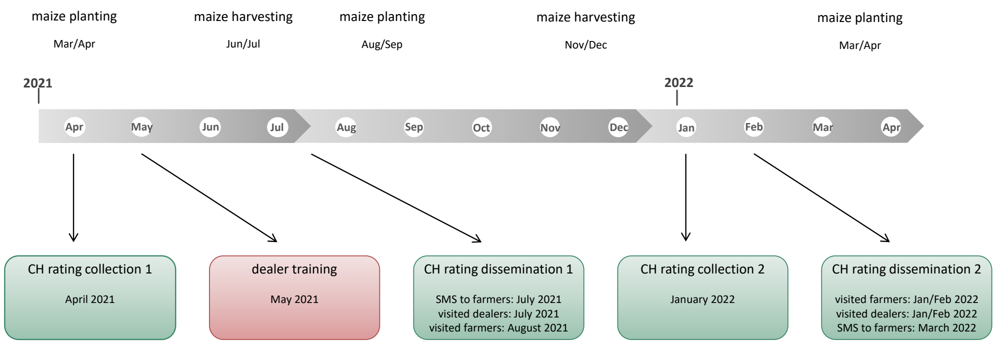

Figure 1: Timeline

work, including workshops with experts from MAAIF, NARO, USTA, UNADA, Naseco Seed Company, and extension specialists. For example, farmers rated "maize seed sold by the agro-dealer" on germination using a one-to-five-star scale.[3]

A potential concern with asking treated farmers to rate agro-dealers is that it could increase their awareness of all agro-dealers in the area, potentially confounding the information clearinghouse effect. To address this, control group farmers were also guided through the list of agro-dealers in their catchment area, ensuring similar exposure. However, they were not asked to provide ratings, as the act of rating could make seed quality more salient – a key aspect of the treatment.

Average ratings for each agro-dealer were computed from all farmer responses in the catchment area. Further details on the rating computations are provided in Appendix A.1.

As shown in Figure 1, the clearinghouse was implemented over two consecutive seasons, with ratings collected again in January 2022. Ratings were always gathered post-harvest, when smallholders could assess seed quality based on germination, yield, drought resilience, pest and disease resistance, and crop maturation speed.

[3]Since agro-dealers stock different seed varieties, assessing overall seed quality may obscure trade-offs. Ideally, ratings would consider variety, manufacturer, and packaging (e.g., "Bazooka" by Naseco in an original two-kilogram bag), but this would have made the process overly complex and time-consuming. Instead, we developed a scalable solution to produce a general signal of seed quality at the agro-dealer level.

Table 1: Questions for farmers to rate agro-dealers

	min	max
Do you know this *shop name* or *dealer name*, sometimes called *nickname*, located in *market name*? The place can be described as *description*.	no	yes
Please rate this agro-dealer on:		
Quality and authenticity of seed	1 star	5 stars
Please rate the maize seed that this agro-dealer sells on:		
General quality	1 star	5 stars
Yield as advertised	1 star	5 stars
Drought tolerance as advertised	1 star	5 stars
Pest/disease tolerance as advertised	1 star	5 stars
Speed of maturing as advertised	1 star	5 stars
Germination	1 star	5 stars

Rating dissemination to farmers

The effectiveness of the information clearinghouse treatment relied on the timely dissemination of agro-dealer ratings. Ratings were shared before farmers began purchasing seed for the next agricultural season, allowing treated farmers to consider this information when deciding whether and where to buy inputs (Figure 1). Dissemination occurred via short message service (SMS) and in person.

Farmers received one SMS per agro-dealer in their catchment area, delivered in one of three local languages – Lusoga, Lugwere, or Samia. For farmers in treatment catchment areas, the message read:

> Hello from AgroAdvisor! Did you know that customers rate the quality of maize seed sold at [*name of the agro-dealer*] as [*okay/good/very good/excellent*]?

To isolate the effect of ratings from the general impact of receiving SMS messages, control farmers received a placebo message that simply highlighted the existence of agro-dealers in their catchment area. This approach also reduced the likelihood of farmers discerning their treatment status, minimizing reactivity effects and experimenter bias.

In addition to the text messages, enumerators revisited farmers in our sample, using a visually engaging tablet-based application to display agro-dealer ratings. The app cycled through all agro-dealers in each farmer's catchment area and generated the following message, accompanied by a corresponding visual of one to five stars , ensuring accessibility and ease of interpretation:

Figure 2: SeedAdvisor certificate

> We wanted to let you know that customers rate the quality of maize seed sold at [*name of the agro-dealer*] as [*okay/good/very good/excellent*]! The maize seed from this agro-dealer received a score of [*score*] out of 5!

For control group farmers, the app similarly cycled through agro-dealers in their catchment area but withheld ratings, controlling for any effects that might arise from simply reminding farmers of these agro-dealers' existence.

Rating dissemination to agro-dealers

Agro-dealers received their ratings as a laminated report delivered directly to their shops. The front showcased an eye-catching certificate with a logo and the agro-dealer's overall rating (Figure 2). We encouraged them to display the certificate prominently, similar to a "Certificate of Excellence" from TripAdvisor or other rating platforms. Six months after delivering the final report, during endline data collection, we asked our field enumerators whether they had seen the SeedAdvisor certificate. This was an independent observation, not a self-reported measure by the agro-dealers. A total of 56% of enumerators confirmed seeing the certificate.

This means the rating information is accessible not only to sampled farmers in the agro-dealer's catchment area and their social networks but also to anyone who sees the certificate if the agro-dealer chooses to display it. Field observations revealed that some agro-dealers placed certificates in highly visible locations – even outside the shop, such as facing the street – making the ratings accessible to potential buyers passing through key market hubs. This increased visibility could amplify the certificate's impact on treated agro-dealers' businesses. Furthermore, the prospect of greater exposure may incentivize agro-dealers to adjust their behavior in response to the treatment.

The back of the report provides further insights, presenting individual ratings for the seed sold by the agro-dealer across key dimensions: overall quality, yield, drought and disease resistance, maturation speed, and germination. It also includes a table showing the average (combined) ratings of other agro-dealers in the same catchment area, visualized with stars. This comparison reveals the agro-dealer's relative standing, potentially encouraging improvements through social comparison and self-image effects.

The ratings collection and dissemination process was carried out twice: first for the second agricultural season of 2021 and again for the first agricultural season of 2022 (see Figure 1). Repeating the treatment was essential to capture the dynamics of different potential impact channels. For instance, if seed quality is high but farmers hold pessimistic beliefs, providing information once may already increase adoption after a single season. However, if agro-dealers engage in counterfeiting, the threat of farmers switching to more honest competitors could incentivize them to improve seed quality – a change that would only be reflected in subsequent ratings. These higher ratings might further boost adoption, but such effects would take time to materialize.

Repetition may also reinforce certain impact pathways. For example, agro-dealers might be more motivated to change their behavior if they expect to be rated again soon. To prevent end-game effects, neither farmers nor agro-dealers were informed of the clearinghouse's duration.

5 Empirical strategy

We use Ordinary Least Squares to estimate the following specification and obtain intention-to-treat effects for agro-dealer-level outcomes:

$$Y_{ij} = \alpha + \beta T_j + \gamma' X_{ij} + \delta Y_{0ij} + \varepsilon_{ij} \tag{1}$$

where Y_{ij} represents the outcome for agro-dealer i in catchment area j at midline or endline, Y_{0ij} denotes the corresponding mean-centered baseline value of the outcome variable (included to increase statistical power), T_j is a binary indicator for the treatment status of catchment area j, X_{ij} is a vector of controls for the orthogonal treatments in the factorial design (demeaned and interacted with the main treatment effect; see Lin, 2013; Muralidharan, Romero, and Wüthrich, 2023), and ε_{ij} is an error term that may be correlated within catchment areas. The coefficient β represents the estimated intention-to-treat effect of being assigned to one treatment, controlling for the orthogonal treatment and its interaction effects with the main treatment.

For farmer-level outcomes, we estimate a similar equation, where Y_{ij} now represents the outcome for farmer i in catchment area j at midline or endline, Y_{0ij} is the corresponding baseline outcome, and all other terms are defined as in the agro-dealer regression above.

Since randomization occurs at the catchment area level, we use cluster-robust variance-covariance matrices that cluster standard errors at this level. For farmer-level outcomes, where we have nearly 3,500 observations across 130 clusters, we apply the original form of the sandwich estimator without small-sample corrections. For agro-dealer-level outcomes, with approximately 350 observations in the same 130 clusters, we use the Bell–McCaffrey adjustment to account for the smaller sample size (Imbens and Kolesár, 2016).

We adhere to several pre-registered principles for variable construction. To mitigate the influence of outliers, we apply trimming to continuous variables – removing the top and bottom 1% of the distribution for agro-dealer-level outcomes and 2.5% for farmer-level outcomes. If a variable is skewed, defined by an adjusted Fisher–Pearson coefficient of skewness exceeding 1.96, we apply an inverse hyperbolic sine transformation. Additionally, outcomes for which 95% of observations share the same value within the relevant sample are excluded from the analysis.

To account for multiple hypothesis testing, we aggregate related outcomes into summary indices, following Anderson (2008). After adjusting the sign of each outcome so that a positive direction indicates a "better" outcome, each summary index is calculated as a weighted mean of several standardized outcomes (i.e., outcomes that are demeaned and divided by the control group standard deviation). The weights in this efficient generalized least squares estimator are determined based on the inverse of the covariance matrix of the transformed outcomes, maximizing the information captured by assigning lower weights to highly correlated outcomes.

As a robustness check, we also compute summary indices following Kling, Liebman, and Katz (2007). Here, each index is constructed as the equally weighted average of the z-scores of its components, where z-scores are calculated by subtracting the control group mean and dividing by the control group standard deviation. The sign of each component is oriented such that higher values reflect "better" outcomes.

While these indices provide a useful measure of the intervention's overall impact on a family of outcomes, interpreting effect sizes is not always straightforward. Examining individual outcomes within each family offers more meaningful effect sizes and identifies the key drivers of the results. Therefore, we also report treatment effects on individual variables, though we caution against over-interpretation.

6 Data

6.1 Sample

The agro-dealer sample was compiled by listing all agro-dealers across eleven districts in southeastern Uganda. *Agro-dealers* are businesses or individuals that distribute and sell agricultural inputs such as high-yielding seed varieties, fertilizers, pesticides, veterinary products, and farming equipment. We started with official records of registered agro-dealers and supplemented this with extensive field visits to identify new and informal

Table 2: Factorial design

		Agro-dealer training	
		1	0
Clearinghouse	1	33 areas 96 agro-dealers 960 farmers	32 areas 97 agro-dealers 970 farmers
	0	33 areas 70 agro-dealers 700 farmers	32 areas 85 agro-dealers 850 farmers

dealers, ensuring a comprehensive listing. This approach allowed us to capture nearly all agro-dealers in the sampled districts, covering a full range of business sizes – small, medium, and large. To account for seasonal variability and market fluctuations, we made an additional effort to include agro-dealers who sell seeds exclusively during the planting season.

Following this census, the 348 eligible agro-dealers were assigned to 130 catchment areas (see Section 3, particularly Footnote 1 for details). This process resulted in an average of three agro-dealers per catchment area, with the number ranging from one to 18.

To link agro-dealers with farmers, we asked agro-dealers to name the villages where most of their customers reside. Enumerators then randomly sampled ten maize-growing households from these villages, resulting in a sample of approximately 3,500 smallholder maize farmers. The allocation of farmers, agro-dealers, and catchment areas to the various treatment cells in the factorial design is summarized in Table 2.

Baseline data were collected from agro-dealers in September and October 2020 and from farmers in April 2021. Midline data for both farmers and agro-dealers were gathered in January and February 2022, while endline data were collected in July and August 2022.

At the agro-dealer level, enumerators were instructed to interview the individual most knowledgeable about the day-to-day operations of the agro-dealership, typically the shop manager. As part of the initial quality assessment, a bag of maize seed was purchased from each agro-dealer.[4] Additionally, enumerators recorded a series of objectively verifiable indicators related to seed storage conditions.

At the farmer level, enumerators were instructed to interview the individual most knowledgeable about maize farming. However, a specific set of questions pertained to the household head, who may or may not have been the respondent. In addition to gen-

[4]Only 232 of the 348 sampled agro-dealers had seed in stock at the time of the baseline interview. While repackaging seed from larger company-supplied bags into smaller, more affordable quantities is common – reported by about half of the agro-dealers in our sample – all seed samples purchased by enumerators came in original, sealed bags.

eral questions on farming and input use, farmers were asked to list all their maize plots, from which one was randomly selected for detailed data collection. This approach was primarily implemented to reduce data collection costs, time, and respondent burden. Since plots were chosen randomly, the resulting averages should be representative at the household level.

6.2 Descriptive statistics

This subsection describes the baseline sample. Table 3 provides information on the average agro-dealer. The typical respondent is 32 years old, 60% are male, and over 90% have completed primary education. In 55% of cases, the respondent is also the owner of the agro-dealership.

There is substantial heterogeneity among agro-dealers. Some operate as small, informal rural stores that sell maize seed and other agricultural inputs alongside consumer goods, catering to a limited customer base and only during the planting season. Others are larger, located in towns, and specialize exclusively in agricultural inputs and equipment, serving a broader clientele. On average, agro-dealerships were established five years before the baseline survey, are situated seven kilometers from the nearest tarmac road, and serve 41 customers per day. Among the sampled agro-dealers, 74% sell only farm inputs and equipment, 60% provide credit, and 46% offer advisory services.

Data were also collected to assess the initial quality of maize seed sold at the sampled agro-dealers, including specific questions on seed storage and handling. With the shop manager's permission, enumerators – who were trained at the outset of the study – inspected seed storage areas and carefully documented the conditions. Baseline data reveal several indicators of suboptimal seed storage and handling, which may impact seed quality, aligning with our first hypothesis. For instance, enumerators reported that 65% of agro-dealers had issues with pests such as rats or insects, while 16% stored maize seed in open containers, exposing it to potential contamination. Unsurprisingly, two-thirds of the sampled agro-dealers had received at least one customer complaint about seed quality during the previous season.[5]

Our measurements of moisture content in sampled seed bags from agro-dealers revealed an average of 13.6%, ranging from 10.3% to 17.4%. On average, moisture levels exceeded the recommended threshold of 13%, increasing the risk of mold growth and storage pests that could compromise seed quality and performance. An even more conservative thresholds indicates that maize seed is at-risk of losing viability from 12% of moisture content on. Regarding quality labeling, 68% of purchased seed bags displayed a printed packaging date, 18% included an expiry date, and only 8% featured a quality

[5]The question asked was: "Since last season, did you receive any complaints from a customer that the seed you sold was not good?" This straightforward binary question enabled us to efficiently assess the prevalence of customer dissatisfaction.

certification label issued by the National Seed Certification Services (NSCS).[6]

From these baseline data, we conclude that this market has an inherent quality problem – it is not merely a matter of perception.

Table 4 presents the summary statistics for the farmer sample. The average household head is 49 years old, with 78% being male and 51% having completed primary education. The typical household consists of nine members, with the homestead located an average of four kilometers from the nearest agro-dealer and nine kilometers from the nearest tarmac road. On average, farmers have 23 years of experience cultivating maize and cultivate crops on three acres of land.

Half of the farmers in our sample planted high-yielding maize seed on at least one plot during the season preceding the baseline survey, with one in three purchasing it from an agro-dealer. The remaining farmers primarily obtained their high-yielding seed from Operation Wealth Creation/National Agricultural Advisory Services or a non-governmental organization. Since OPVs can be both high-yielding and farmer-saved, some farmers retained their own seed or acquired it through farmer-to-farmer exchanges with neighbors, relatives, or other local growers.

Only 25% of farmers applied inorganic fertilizers, such as di-ammonium phosphate (DAP) or nitrogen, phosphorus, and potassium (NPK), to the randomly selected plot. In the preceding season, average yields on these plots were approximately 440 kilograms per acre.

6.3 Randomization balance

We present standard orthogonality tables with pre-registered variables for both agro-dealers and farmers to assess the comparability of treatment and control groups across a set of baseline characteristics (Tables 3 and 4, respectively). Some of these characteristics are unlikely to be influenced by the intervention, while others are part of the outcome variables used to measure its impact and explore the underlying mechanisms in the following sections.

For agro-dealer-level outcomes in Table 3, only one of 34 comparisons is significant at the 5% level, and two at the 10% level. At the farmer level in Table 4, one of 32 comparisons is significant at the 10% level. These results indicate reasonable balance at baseline. Joint orthogonality tests using F-tests further confirm balance between treatment groups.

6.4 Attrition

Table 5 presents attrition rates for the treatment and comparison groups. At midline, data was missing for 12% of agro-dealers and 2% of farmers, while at endline, 14% of

[6]Typically, maize seed is certified by NSCS, a division of the Department of Crop Inspection and Certification within MAAIF. Certified seed is identified by a blue tag or sticker affixed to the package, while quality-declared seed carries a green tag or sticker.

Table 3: Descriptive statistics and orthogonality tests - Agro-dealer

	mean	training	CH
Respondent's age in years†	32.43	0.56	-2.24+
	(11.49)	(1.19)	(1.21)
Respondent is male†	0.59	0.02	-0.01
	(0.49)	(0.06)	(0.06)
Respondent finished primary education†	0.92	0.01	-0.01
	(0.27)	(0.03)	(0.03)
Respondent owns shop	0.55	0.03	0.02
	(0.50)	(0.06)	(0.06)
Respondent received training on maize seed handling†	0.53	0.05	0.12+
	(0.50)	(0.07)	(0.07)
Respondent knows how to store seed after repackaging†	0.27	0.07	0.08
	(0.44)	(0.06)	(0.06)
Agro-dealer's distance to nearest tarmac road in km†	6.56	-0.92	-1.58
	(10.39)	(2.21)	(2.24)
Agro-dealer only sells farm inputs	0.74	-0.09	0.03
	(0.44)	(0.07)	(0.06)
Years since agro-dealer establishment†	5.34	-0.09	0.21
	(6.30)	(0.77)	(0.78)
Number of customers per day†	41.49	11.35	6.43
	(46.49)	(7.16)	(6.72)
Quantity of maize seed sold in kg†	695.50	201.06	176.31
	(1497.18)	(252.97)	(235.92)
Amount of maize seed lost/wasted last season in kg†	3.50	1.99	2.40
	(18.65)	(2.47)	(2.30)
Number of maize varieties in stock	2.83	-0.28	0.19
	(1.59)	(0.22)	(0.21)
Agro-dealer has problem with pests	0.65	-0.01	-0.03
	(0.48)	(0.06)	(0.06)
Agro-dealer stores maize seed in open containers	0.16	0.00	0.08
	(0.36)	(0.05)	(0.05)
Agro-dealer received seed related complaint from customer	0.64	-0.11*	0.07
	(0.48)	(0.05)	(0.05)
Moisture in bag of maize seed in %	13.56	0.25	-0.18
	(1.44)	(0.25)	(0.26)

Note: Column (1) reports sample means at baseline and standard deviations below; columns (2)-(3) report differences between treatment and control groups and standard errors below; they are clustered at the level of randomization; **, *, and + denote significance at the 1%, 5%, and 10% levels. † indicates that the variable was pre-registered to test balance and is included in the F-test.

Table 4: Descriptive statistics and orthogonality tests - Farmer

	mean	training	CH
Household head's age in years†	48.62	-0.08	-0.24
	(13.38)	(0.56)	(0.56)
Household head is male†	0.78	-0.02	0.03
	(0.42)	(0.03)	(0.03)
Household head finished primary education†	0.51	0.00	0.04
	(0.50)	(0.03)	(0.03)
Homestead's distance to nearest tarmac road in km	9.39	0.33	-1.23
	(10.81)	(1.69)	(1.71)
Homestead's distance to nearest agro-dealer in km†	3.78	-0.11	0.11
	(4.79)	(0.37)	(0.37)
Number of people in household (incl. respondent)†	8.70	-0.16	-0.09
	(3.98)	(0.18)	(0.18)
Number of rooms in house	3.49	-0.01	0.02
	(1.45)	(0.09)	(0.09)
Farmer's land for crop production in acres	3.35	0.07	0.00
	(4.32)	(0.21)	(0.22)
Years since farmer started growing maize	23.09	0.61	-0.55
	(13.14)	(0.55)	(0.58)
Yield in kg/acre†	443.01	27.15+	-6.14
	(304.99)	(13.71)	(13.52)
Farmer used high-yielding maize varieties on any plot†	0.49	0.02	0.01
	(0.50)	(0.02)	(0.02)
Farmer bought this seed at agro-dealer†	0.32	-0.01	0.01
	(0.47)	(0.02)	(0.02)
Amount of this seed farmer bought at agro-dealer in kg†	9.52	0.16	-0.34
	(6.92)	(0.53)	(0.53)
Farmer thinks maize seed at agro-dealer is adulterated†	0.68	0.01	0.00
	(0.46)	(0.03)	(0.03)
Farmer used DAP/NPK	0.25	0.04	0.02
	(0.43)	(0.03)	(0.04)
Farmer used organic manure	0.07	-0.01	0.01
	(0.26)	(0.01)	(0.01)

Note: Column (1) reports sample means at baseline and standard deviations below; columns (2)-(3) report differences between treatment and control groups and standard errors below; they are clustered at the level of randomization; **, *, and + denote significance at the 1%, 5%, and 10% levels. † indicates that the variable was pre-registered to test balance and is included in the F-test. Amount of this seed farmer bought at agro-dealer was pre-registered to test balance but is not included in the F-test because the question was only asked if a farmer bought seed at an agro-dealer, leading to 2406 missing observations for this variable.

agro-dealers and 1% of farmers were not surveyed.[7] To assess whether non-response is linked to treatment, we regressed the likelihood of leaving the sample on the treatment indicators, finding that agro-dealers in the information clearinghouse treatment were significantly less likely to drop out.

To examine this differential attrition, we regress the pre-registered balance variables (see Table 3) on a binary variable indicating whether an agro-dealer left the sample, a binary variable indicating whether an agro-dealer belonged to the clearinghouse control group, and their interaction. Results are shown in Appendix A.2. Column (2) reveals that agro-dealers who left the sample at midline operated closer to the nearest tarmac road – the only significant difference between those who left and those who stayed when attrition was most pronounced (see Table 5). By endline, however, those who left were younger, more likely to be female, had less established businesses, were more likely to operate specialized shops, and still tended to be closer to a tarmac road, see column (5). This suggests that agro-dealers who left differed from those who remained, regardless of exposure to the information clearinghouse, possibly indicating greater vulnerability when COVID-19 hit, leading to business closures. Columns (3) and (6) show minimal differences between clearinghouse control and treated agro-dealers, consistent with Subsection 6.3. Examining the interaction between the indicators reveals few differences between agro-dealers who left the sample *and* belonged to the clearinghouse control group and those who did not, suggesting that differential attrition is unlikely to bias our estimates.

As in biomedical RCTs, where differential attrition may result from higher mortality in the control group, those who drop out are likely the ones who would have benefited most from the treatment. Consequently, the unadjusted, selection-contaminated estimates represent lower bounds of the true treatment effect (Angrist, Bettinger, and Kremer, 2006; Duflo, Glennerster, and Kremer, 2007).

6.5 Information clearinghouse ratings

Comparison of rating dimensions

We asked farmers to evaluate maize seed sold by an agro-dealer across six dimensions: General quality, Yield as advertised, Drought tolerance as advertised, Pest/disease tolerance as advertised, Speed of maturing as advertised, and Germination. Figure 4 in Appendix A.3 presents the distribution of farmers' ratings for these attributes along with their mean values.

The figure reveals variation across attributes, with some showing more concentrated distributions and others exhibiting greater dispersion. The attributes most strongly correlated with the *General quality* rating are *Yield as advertised* (0.54) and *Germination* (0.38). These two attributes also have the smallest mean absolute differences (0.47

[7] For agro-dealers lost at endline, the reasons were: eleven shops closed, ten relocated, eight changed their product offerings, three merged with other shops, one refused to be interviewed, and 17 cited other (four) or no specific reasons (13).

Table 5: Attrition

	mean	training	CH
		midline	
Agro-dealer left the sample	0.121	-0.007	-0.108**
	(0.326)	(0.034)	(0.035)
Farmer left the sample	0.018	-0.005	0.001
	(0.134)	(0.005)	(0.005)
		endline	
Agro-dealer left the sample	0.144	0.017	-0.079+
	(0.351)	(0.040)	(0.042)
Farmer left the sample	0.008	-0.003	-0.001
	(0.091)	(0.003)	(0.003)

Note: Column (1) reports sample means at mid- or endline and standard deviations below; columns (2)-(3) report differences between treatment and control groups and standard errors below; they are clustered at the level of randomization; **, *, and + denote significance at the 1%, 5%, and 10% levels.

for *Yield as advertised* and 0.55 for *Germination*), suggesting that farmers primarily consider them when assessing overall quality. This indicates that yield and germination are the key factors farmers prioritize in their evaluations.

Comparison of ratings by purchase channel

Farmers could rate an agro-dealer if they met one of two conditions: either they had purchased seed from the agro-dealer themselves or they knew someone who had. Ideally, only farmers with firsthand experience would provide ratings, but restricting responses in this way risked generating too few observations for a reliable signal. While this decision was made at the experiment's design stage and cannot be revised ex post, we can compare endline ratings between farmers who purchased seed from the agro-dealer and those who did not but knew someone who had.

The vast majority (93%) of ratings came from farmers who had purchased seed, while only 7% were provided by those without direct purchase experience. This alleviates concerns that ratings are primarily driven by reputation or hearsay effects. While the mean ratings differ slightly (3.6 for farmers who bought seed vs. 3.7 for those who did not), the density plots are similar (see Figure 5 in Appendix A.3).

Within and between agro-dealer rating variation

We now analyze the variation in ratings both across farmers for the same agro-dealer (within agro-dealer variation) and across different agro-dealers (between agro-dealer variation). In examining the summary farmer ratings at endline, which range from 1 to 5, we find that the majority of the variation in ratings occurs within agro-dealers, with a variance of 0.23. In contrast, the variation between agro-dealers is relatively small, with a variance of 0.03, resulting in a total variance of 0.26. This indicates that while farmers show considerable disagreement in their ratings of the same agro-dealer, reflecting individual differences in opinion, there is less distinction between agro-dealers, suggesting that farmers perceive them similarly overall.[8]

The within-seller variation highlights the challenges farmers face in assessing seed quality, one of the key motivations of this study. While this variability might initially suggest disagreement among farmers, it is essential to recognize that such variation is typical in consumer ratings, especially in markets characterized by diverse preferences and experiences. Farmers' ratings can be influenced by a range of factors, including personal expectations, environmental conditions, and the specific context in which the seed is used. This inherent variation does not invalidate the rating system; rather, it emphasizes the heterogeneity of farmer experiences with both seeds and agro-dealers.

The large sample of ratings from a diverse group of farmers further strengthens the reliability of the overall ratings by capturing a wide range of perspectives. Although individual ratings vary, aggregating them at the agro-dealer level ensures that the broader patterns remain meaningful. Importantly, the goal of these ratings is not to achieve uniformity but to provide a representative measure of average seed performance across a diverse group of farmers.

The between-farmer variance of 0.10 indicates moderate variability in how different farmers rate the same agro-dealers, while the within-farmer variance of 0.16 reveals substantial variation in how the same farmers assess different agro-dealers, reflecting diverse experiences. The between-catchment area variance of 0.03 suggests minimal spatial differences in ratings across catchment areas, whereas the within-catchment area variance of 0.23 highlights considerable variation in ratings within the catchment areas. This indicates that no catchment area consistently receives very high or very low ratings.

Correlating ratings and quality indicators

The within-seller variation points to the concern that smallholder farmers may base their ratings of agro-input shops on factors such as customer service rather than seed quality or rely on the agro-dealer's reputation or personal relationship with them. To address this, we test whether the ratings – specifically, the index of endline ratings computed following Anderson (2008) – correlate with objective indicators of seller and seed quality, also measured at endline.

We find that specialized agro-input shops, which exclusively sell farm inputs, receive higher ratings, as do dealers with better seed handling practices, objectively observed by our enumerators (Table A2 in Appendix A.3). Additionally, farmers not only rated seeds purchased from agro-input shops but also those used on randomly selected maize

[8] Note that we employ quintiles to ensure that ratings are not disseminated without variation, see Appendix A.1.

fields, using the same questions. These seed ratings are positively correlated with farmers' crop yields (Table A3 in Appendix A.3).

While alternative explanations for these significant correlations exist – for instance, specialized shops may have more capital and appear more "polished," leading to higher ratings regardless of seed quality – the overall pattern supports our claim that farmers are assessing seed quality. Although their perceptions may not be perfectly accurate given the many factors influencing agricultural production, the information clearinghouse ratings provide a valid and reliable signal.

7 Results

We now present the impacts of the two interventions on outcomes at both the agro-dealer and farmer levels. Effects are reported separately after one agricultural season (midline) and after two seasons (endline). To ensure transparency and replicability, all outcome variables were pre-specified in the registered pre-analysis plan, available on the American Economic Association's registry for RCTs. Prior to midline data collection, the full econometric analysis was run using simulated data and documented in a mock report. A mock report is a dynamic document that integrates analytical code, allowing simulated data to be seamlessly replaced with real data as it becomes available (Humphreys, De la Sierra, and Van der Windt, 2013). All documents, code, and data are version-controlled and publicly available in a GitHub repository, which provides time-stamped records of all changes made throughout the project.[9]

Tables 6 to 15 present results in a consistent format. Column (1) reports baseline sample means, with standard deviations in parentheses, to facilitate interpretation of effect sizes. These means are presented in levels, even when treatment effects are estimated using inverse hyperbolic sine-transformed outcomes. Column (2) reports the midline treatment effect of the agro-dealer training, and column (3) presents the corresponding effect of the information clearinghouse. Standard errors are reported in parentheses beneath the coefficient estimates. Column (4) displays the number of observations used in the midline estimations. Columns (5) and (6) report endline treatment effects for the training and clearinghouse interventions, respectively, again with standard errors shown in parentheses. Column (7) indicates the number of observations included in the endline analyses.

As detailed in Section 5, we adjust for multiple hypothesis testing by grouping outcomes into broader families and constructing summary indices, following Anderson

[9]The presentation of results in this paper deviates slightly from the pre-registered and earlier versions (including the mock report, midline report, endline report, and previous manuscript drafts). Specifically, we reorganized the structure to first present impacts on outcomes at the end of the causal chain, followed by intermediate outcomes to examine potential mechanisms. While this reordering modifies the construction of some pre-specified indices, the main conclusions remain unchanged. Analyses adhering to the original pre-analysis plan remain available in the project history on GitHub, for example here.

(2008). As a robustness check, we additionally report indices constructed according to Kling, Liebman, and Katz (2007). Both appear at the bottom of the tables.[10]

7.1 Impact on agro-dealers

We begin by assessing whether the interventions affected the overall business operations of agro-dealers, as reported in Table 6. Sales volume was measured by asking agro-dealers how much of each maize variety they sold in the previous season. We restrict attention to the four most popular high-yielding varieties – two hybrids (Longe 7H and Longe 10H) and two OPVs (Longe 4 and Longe 5). Total sales volume is defined as the sum of quantities sold across these four varieties. Agro-dealers also reported the sales price of each variety at the start of the season, and we use the simple average of these prices. Revenue (expressed in million Ugandan shillings) is calculated by multiplying the quantity sold by the price for each variety and summing across all four. At the time of the study, one US dollar was equivalent to approximately 3,600 Ugandan shillings. Additional outcomes include the average number of customers purchasing maize seed per day at the start of the season and the number of maize varieties the agro-dealer had in stock.

Table 6 shows no evidence that training agro-dealers influenced their business operations. At both midline and endline, the estimated effects on the business volume index are not statistically different from zero. The lack of impact is largely consistent across individual outcome measures, with no clear pattern emerging.

We find that the information clearinghouse intervention positively affected agro-dealer operations. At midline, agro-dealers in the clearinghouse treatment group scored significantly higher on the business operations Anderson (2008) index. Although maize seed sales and prices are not individually significant, their combined effect yields a nearly 20% increase in revenue, significant at the 10% level.[11] By endline, the intervention's effect appears even stronger, with the overall index significantly higher at the 1% level. This result is primarily driven by a 31% increase in the number of customers served – equivalent to approximately six additional customers per day for treated agro-dealers.

Only the endline result is robust to using indices constructed following Kling, Liebman, and Katz (2007), which average standardized outcomes with equal weights. This method treats all components equally, regardless of their relevance or precision, often resulting in less efficient estimates. In contrast, the Anderson (2008) index accounts for the covariance structure among outcomes and assigns optimal weights to maximize statistical power, down-weighting highly correlated components. Using this more efficient approach – also pre-specified in our pre-analysis plan – we find significant and consistent effects at both midline and endline, reinforcing the conclusion that the information

[10] In regressions using these overall indices, we do not control for baseline values, as doing so would limit the sample to agro-dealers and farmers with complete data for all constituent variables at baseline and midline/endline, substantially reducing statistical power.

[11] For sufficiently large values, coefficients from regressions using inverse hyperbolic sine-transformed dependent variables can be interpreted as elasticities (Bellemare and Wichman, 2020).

clearinghouse intervention improved agro-dealer business performance.

The next set of results examines the impact of the interventions on agro-dealer operations related to two specific maize varieties: the most recently released hybrid, Longe 10H (Table 7), and the most recently released OPV, Longe 5 (Table 8). In addition to the general business outcomes described earlier, we include stock management indicators, given that seed quality deteriorates with shelf-life. Agro-dealers were asked how much seed of the respective variety was carried over from the previous season – a measure with generally low baseline means, as many reported carrying no seed over. We also collected estimates of how much seed was procured from suppliers during the season, which slightly exceeded reported sales for both varieties. We expect the interventions to reduce carryover and increase the volume of freshly sourced seed. In addition, agro-dealers reported how much seed was lost or wasted and how often they experienced stock-outs. We expect the interventions to mitigate both outcomes.

At midline, we find no significant effects of either the training or the clearinghouse intervention. By endline, however, all coefficients for the information clearinghouse group move in the expected direction, and the combined Anderson (2008) index shows a positive and statistically significant effect. These results are robust to index construction using the method of Kling, Liebman, and Katz (2007).

7.2 Impact on farmers

We begin by examining harvest-related outcomes for farmers, with results presented in Table 9. Specifically, we analyze maize production, plot size, and yield (i.e., production per unit of land) on a randomly selected maize plot. We also assess market participation – measured by the quantity sold, sales price, and total revenue from maize sales – as well as the amount of grain retained for use as seed in the following season. While we expect positive treatment effects on harvest and sales outcomes, the quantity retained for seed enters the index with a negative sign, as greater retention indicates ongoing reliance on self-saved seed.

The coefficient estimates for the overall index reveal no significant effect of the agro-dealer training and a positive effect of the clearinghouse, though only after two seasons of implementation. At endline, farmers in clearinghouse areas report higher production and productivity than control farmers in non-clearinghouse areas. The yield effect is statistically significant at the 1% level and corresponds to 13% of the baseline mean. Finally, consistent with expectations, clearinghouse-treated farmers retain less maize for seed at midline.

The effect on the Anderson (2008) index at endline is robust to alternative index construction using the method of Kling, Liebman, and Katz (2007). At midline, however, the Kling, Liebman, and Katz (2007) approach produces a significant negative coefficient, underscoring why we rely on the Anderson (2008) index – as pre-registered in our analysis plan – and use Kling, Liebman, and Katz (2007) only as a robustness check. The outcomes included in the index are highly correlated: yield is defined as production divided by area, and revenue as amount sold multiplied by sales price. All

Table 6: Effects on agro-dealer outcomes: Operations

	baseline	*midline*			*endline*		
	mean	training	CH	obs.	training	CH	obs.
Maize seed sales volume in kg§†	695.503	-0.092	0.284	292	-0.499^{+}	0.239	286
	(1497.183)	(0.220)	(0.227)		(0.250)	(0.253)	
Sales price of maize seed in UGX/kg†	4273.897	-192.784^{+}	99.272	275	-33.867	145.861	264
	(955.073)	(114.934)	(113.292)		(143.152)	(138.816)	
Revenue from maize seed in mln UGX§†	2.890	-0.069	0.185^{+}	292	-0.227^{+}	0.143	286
	(6.286)	(0.104)	(0.108)		(0.118)	(0.118)	
Number of maize seed customers per day§†	19.764	-0.056	0.127	294	-0.190	0.310**	288
	(20.689)	(0.098)	(0.101)		(0.116)	(0.112)	
Number of maize varieties in stock†	2.834	0.042	0.245	295	-0.216	0.221	292
	(1.589)	(0.266)	(0.245)		(0.234)	(0.220)	
Overall Anderson index	0.031	-0.130	0.197*	274	-0.131	0.238**	270
	(0.610)	(0.095)	(0.092)		(0.086)	(0.082)	
Overall Kling et al. index	-0.013	-0.059	0.189	306	-0.162	0.247^{+}	297
	(0.725)	(0.131)	(0.125)		(0.141)	(0.132)	
Max. number of obs.				306			297

Note: Column (1) reports baseline means and standard deviations below; columns (2), (3), (5), and (6) report differences between treatment and control groups and standard errors below; they are clustered at the level of randomization; columns (4) and (7) report the number of observations; **, *, and + denote significance at the 1%, 5%, and 10% levels; † indicates that the variable is included in the overall index; larger indices indicate more desirable outcomes.

§Due to the skewness of this variable, the regression was run after an inverse hyperbolic sine transformation. Coefficient estimates can therefore be interpreted as percentage changes. The baseline mean column shows the untransformed variable.

Table 7: Effects on agro-dealer outcomes: Operations - Longe 10H

	baseline	*midline*			*endline*		
	mean	training	CH	obs.	training	CH	obs.
Sales volume in kg§†	288.384	0.050	0.236	256	-0.205	0.352	242
	(727.049)	(0.206)	(0.204)		(0.231)	(0.239)	
Sales price in UGX/kg§†	9.417	-0.025	-0.013	194	-0.019	0.010	187
	(0.145)	(0.026)	(0.026)		(0.030)	(0.029)	
Revenue in mln UGX§†	1.625	0.008	0.130	255	-0.106	0.173	241
	(3.839)	(0.119)	(0.123)		(0.130)	(0.136)	
Amount carried over in kg§†	2.679	-0.186	0.090	262	-0.012	-0.034	250
	(12.137)	(0.212)	(0.215)		(0.138)	(0.134)	
Amount shop bought from provider in kg§†	294.672	0.118	0.206	257	-0.022	0.283	243
	(741.810)	(0.218)	(0.213)		(0.250)	(0.253)	
Amount lost/wasted in kg§†	0.036	-0.001	0.019	257	-0.058	-0.038	243
	(0.405)	(0.093)	(0.097)		(0.037)	(0.041)	
Number of times per month shop ran out§†	1.039	-0.236^{+}	-0.045	192	-0.180	-0.205	185
	(1.575)	(0.129)	(0.133)		(0.128)	(0.136)	
Overall Anderson index	0.080	0.030	0.029	244	0.021	0.217**	233
	(0.437)	(0.067)	(0.070)		(0.052)	(0.057)	
Overall Kling et al. index	0.005	0.036	0.060	268	0.043	0.232**	254
	(0.518)	(0.083)	(0.082)		(0.080)	(0.076)	
Max. number of obs.[1]				268			254

Note: Column (1) reports baseline means and standard deviations below; columns (2), (3), (5), and (6) report differences between treatment and control groups and standard errors below; they are clustered at the level of randomization; columns (4) and (7) report the number of observations; **, *, and + denote significance at the 1%, 5%, and 10% levels; † indicates that the variable is included in the overall index; larger indices indicate more desirable outcomes.

§Due to the skewness of this variable, the regression was run after an inverse hyperbolic sine transformation. Coefficient estimates can therefore be interpreted as percentage changes. The baseline mean column shows the untransformed variable.

[1]The comparisons were only made for agro-dealers that had Longe 10H in stock at mid- or endline.

Table 8: Effects on agro-dealer outcomes: Operations - Longe 5

	baseline	*midline*			*endline*		
	mean	training	CH	obs.	training	CH	obs.
Sales volume in kg§†	389.492	-0.040	0.304	261	-0.215	0.316	259
	(716.556)	(0.222)	(0.216)		(0.234)	(0.230)	
Sales price in UGX/kg§†	8.730	0.017	-0.015	249	-0.002	0.013	241
	(0.110)	(0.016)	(0.016)		(0.022)	(0.022)	
Revenue in mln UGX§†	1.193	0.019	0.111	261	-0.080	0.114	258
	(2.175)	(0.099)	(0.096)		(0.100)	(0.105)	
Amount carried over in kg§†	4.312	0.247	-0.092	270	-0.095	-0.004	263
	(19.088)	(0.324)	(0.306)		(0.148)	(0.155)	
Amount shop bought from provider in kg§†	431.451	-0.005	0.253	262	-0.179	0.289	260
	(803.696)	(0.221)	(0.215)		(0.232)	(0.235)	
Amount lost/wasted in kg§†	1.756	-0.150	0.031	266	-0.055	-0.033	261
	(10.173)	(0.128)	(0.128)		(0.055)	(0.058)	
Number of times per month shop ran out§†	0.839	0.053	0.086	248	0.094	-0.054	237
	(1.509)	(0.100)	(0.101)		(0.120)	(0.126)	
Overall Anderson index	0.039	0.037	0.012	256	-0.038	0.152*	252
	(0.401)	(0.068)	(0.062)		(0.058)	(0.058)	
Overall Kling et al. index	0.002	0.012	0.105	275	-0.037	0.160^{+}	269
	(0.485)	(0.091)	(0.089)		(0.085)	(0.081)	
Max. number of obs.[1]				275			269

Note: Column (1) reports baseline means and standard deviations below; columns (2), (3), (5), and (6) report differences between treatment and control groups and standard errors below; they are clustered at the level of randomization; columns (4) and (7) report the number of observations; **, *, and + denote significance at the 1%, 5%, and 10% levels; † indicates that the variable is included in the overall index; larger indices indicate more desirable outcomes.

§Due to the skewness of this variable, the regression was run after an inverse hyperbolic sine transformation. Coefficient estimates can therefore be interpreted as percentage changes. The baseline mean column shows the untransformed variable.

[1]The comparisons were only made for agro-dealers that had Longe 5 in stock at mid- or endline.

coefficients on these component variables are negative but individually insignificant. The Anderson (2008) index accounts for this correlation structure by assigning lower weights to highly correlated outcomes, thereby reducing the influence of redundant information. In contrast, the Kling, Liebman, and Katz (2007) method assigns equal weights to each component, treating, for example, yield and production as independent outcomes and thus overstating the negative treatment effect.

Moving further up the causal chain, we examine whether the interventions influence the use of high-yielding maize varieties (referred to as "adoption"), a second key outcome category at the smallholder level, see Table 10. We find no significant effect of the agro-dealer training on adoption at either midline or endline, as measured by the Anderson (2008) index. In contrast, the clearinghouse treatment yields a positive and significant effect at the 5% level at both points in time. These results are robust to alternative index construction using the method of Kling, Liebman, and Katz (2007).

Zooming in on individual outcomes, we begin with a subjective measure of adoption by asking farmers whether they "used any high-yielding maize variety (such as an OPV or hybrid seed) on any of their plots." At midline, farmers exposed to the information clearinghouse treatment were 3.5 percentage points more likely to respond affirmatively than control farmers. After two agricultural seasons, this difference grows to 4.2 percentage points. We also ask whether farmers purchased high-yielding maize varieties at an agro-dealer for any of their plots. At midline, clearinghouse treated farmers are about six percentage points more likely to report such purchases than control farmers – an increase of nearly 20% relative to the baseline mean. At endline, the difference is about three percentage points and not statistically significant. We find no effect of the clearinghouse treatment on the quantity of seed purchased from agro-dealers. However, these estimates are based on a relatively small sample (599 observations at midline and 621 at endline), as this question was only asked of farmers who reported buying seed from an agro-dealer.

Next, we examine the use of high-yielding maize varieties on a randomly selected plot. For the use of hybrid maize or OPVs, we find positive but insignificant treatment effects of the information clearinghouse.[12] As with the broader adoption measures, we also asked whether the seed used on the random plot was obtained from an agro-dealer. We estimate an information clearinghouse treatment effect of nearly five percentage points at midline and nearly four percentage points at endline. We further examine the use of farmer-saved seed on the randomly selected plot. As expected, farmers exposed to the clearinghouse treatment were less likely to rely on saved seed, although the reduction is significant only at midline. Finally, we analyze maize seed expenditure on the random plot, defined as the product of quantity and price. In areas where the clearinghouse was implemented, farmers invested significantly more in seed.

To further investigate whether the previously documented large effect of the clear-

[12] Farmers were asked to report the variety they planted in the previous season. If a farmer reported using Longe 10H, Longe 7H, Longe 7R/Kayongo-go, Bazooka, Longe 6H, Longe 5/Nalongo, Longe 4, Panner, Wema, the KH series, or another hybrid/OPV and the seed was newly purchased rather than recycled or farmer-saved it was classified as hybrid maize seed/OPV.

Table 9: Effects on farmer outcomes: Harvest on specific maize plot

	baseline	*midline*			*endline*		
	mean	training	CH	obs.	training	CH	obs.
Production in kg†	463.203	-0.806	-20.372	2884	16.959	43.937*	2898
	(399.595)	(14.050)	(14.529)		(17.957)	(17.922)	
Area in acres	1.094	-0.013	-0.003	3004	0.000	0.006	3066
	(0.655)	(0.029)	(0.029)		(0.032)	(0.038)	
Yield in kg/acre†	443.013	-12.216	-23.006	2878	5.549	55.606**	2891
	(304.991)	(16.234)	(16.964)		(15.573)	(17.283)	
Amount sold in kg§†	195.295	-0.046	-0.201	3063	-0.147	0.173	3137
	(297.545)	(0.126)	(0.124)		(0.159)	(0.173)	
Sales price in UGX/kg	506.954	-7.787	33.027*	610	-47.215	12.614	639
	(139.389)	(14.395)	(14.244)		(30.547)	(41.238)	
Revenue in UGX§†	97.783	-0.141	-0.393	3058	-0.354	0.355	3109
	(156.538)	(0.260)	(0.257)		(0.341)	(0.363)	
Amount kept as seed in kg§	14.506	-0.098	-0.188*	2931	-0.043	0.036	2861
	(18.530)	(0.092)	(0.092)		(0.108)	(0.104)	
Overall Anderson index	-0.020	-0.015	-0.061	2932	0.018	0.097*	2900
	(0.784)	(0.039)	(0.039)		(0.041)	(0.041)	
Overall Kling et al index	0.017	-0.003	-0.092*	3206	0.011	0.082^{+}	3289
	(0.864)	(0.045)	(0.046)		(0.046)	(0.046)	
Max. number of obs.				3407			3441

Note: Column (1) reports baseline means and standard deviations below; columns (2), (3), (5), and (6) report differences between treatment and control groups and standard errors below; they are clustered at the level of randomization; columns (4) and (7) report the number of observations; **, *, and + denote significance at the 1%, 5%, and 10% levels; † indicates that the variable is included in the overall index; larger indices indicate more desirable outcomes.

§Due to the skewness of this variable, the regression was run after an inverse hyperbolic sine transformation. Coefficient estimates can therefore be interpreted as percentage changes. The baseline mean column shows the untransformed variable.

inghouse on yields is primarily driven by increased adoption, we examine yield gains across farmer subgroups. Restricting the analysis to farmers who had not adopted at baseline yields a coefficient of 56.44 with a standard error of 17.38, significant at the 1% level. For farmers who had already adopted at baseline, the estimated effect is 30.79 with a standard error of 20.38, which is not statistically significant. These results suggest that the yield gains are plausibly driven by farmers who were not using high-yielding maize seed at baseline, adopted it as a result of the clearinghouse treatment, and subsequently achieved higher yields.

8 Causal chain and mechanisms

The mechanism underlying the agro-dealer training is relatively straightforward: the intervention seeks to improve agro-dealers' knowledge and behavior through exposure to new and relevant information. In contrast, the information clearinghouse is a multifaceted intervention that simultaneously targets multiple, potentially interconnected information frictions. If the agro-dealer ratings farmers encounter are more favorable than their prior beliefs, the clearinghouse may enhance perceptions of seed quality. If seed quality varies across sellers, the clearinghouse may enable farmers to identify and switch to those offering higher-quality products. Additionally, the rating system may create competitive pressure, motivating agro-dealers to improve actual product quality or to credibly signal superior quality. In this section, we explore the relative importance of these distinct impact channels.

8.1 Agro-dealer knowledge

Learning is the channel through which the training is expected to enhance the knowledge of treated agro-dealers. To assess whether the interventions improved agro-dealer knowledge, we construct two indices capturing distinct dimensions of knowledge. The first index focuses on seed storage and handling and is based on a short multiple-choice quiz consisting of five questions covering seed carryover between agricultural seasons, appropriate storage practices after repackaging, recommended storeroom conditions, and the appropriateness of repackaging seed. The exact questions and answer options are provided in Appendix A.4.

The second knowledge index captures broader seed-related knowledge. Using multiple-choice questions, we assess whether agro-dealers know which seed varieties to recommend in response to common farmer concerns – such as poor soil conditions, insufficient rainfall, or delayed planting – and whether they can accurately explain the yield advantages of hybrid varieties and OPVs. As with the first index, the questions and answer options are provided in Appendix A.4.

These indices are valuable for testing significant knowledge differences between treatment groups. However, they are less suited for assessing agro-dealer knowledge at baseline and may obscure subtle variations in responses to individual questions. To

Table 10: Effects on farmer outcomes: Adoption

	baseline	*midline*			*endline*		
	mean	training	CH	obs.	training	CH	obs.
Farmer used high-yielding seed on any plot†	0.492	-0.021	0.035^{+}	3206	-0.009	0.042^{*}	3282
	(0.500)	(0.020)	(0.020)		(0.020)	(0.020)	
Farmer bought seed at agro-input shop for any plot†	0.325	-0.014	0.059^{**}	3145	0.004	0.031	3225
	(0.468)	(0.021)	(0.021)		(0.019)	(0.020)	
Amount of this seed farmer bought at agro-input shop in kg	9.519	0.512	-0.105	599	0.457	0.378	621
	(6.920)	(0.348)	(0.358)		(0.419)	(0.431)	
Farmer used hybrid seed/OPV on specific plot^{1†}	0.432	-0.019	0.035	2954	0.009	0.030	3047
	(0.495)	(0.023)	(0.023)		(0.023)	(0.023)	
Farmer bought seed at agro-input shop for specific plot†	0.330	-0.010	0.047^{*}	3153	0.012	0.036^{+}	3240
	(0.470)	(0.022)	(0.022)		(0.019)	(0.019)	
Farmer used farmer-saved seed on specific plot	0.579	0.020	-0.042^{+}	3153	-0.009	-0.016	3240
	(0.494)	(0.022)	(0.022)		(0.020)	(0.020)	
Cost of seed used on specific plot in UGX§†	14078.272	-0.181	0.499^{*}	2848	0.283	0.350^{+}	2942
	(24654.685)	(0.235)	(0.235)		(0.208)	(0.209)	
Overall Anderson index	-0.013	-0.030	0.087^{*}	2854	0.015	0.086^{*}	2978
	(0.899)	(0.043)	(0.042)		(0.039)	(0.039)	
Overall Kling et al. index	0.007	-0.037	0.096^{*}	3216	0.015	0.076^{*}	3299
	(0.909)	(0.041)	(0.041)		(0.038)	(0.038)	
Max. number of obs.				3407			3441

Note: Column (1) reports baseline means and standard deviations below; columns (2), (3), (5), and (6) report differences between treatment and control groups and standard errors below; they are clustered at the level of randomization; columns (4) and (7) report the number of observations; **, *, and + denote significance at the 1%, 5%, and 10% levels; † indicates that the variable is included in the overall index; larger indices indicate more desirable outcomes.

[1]For this variable, only non-recycled (newly purchased, not farmer-saved) seed counted as hybrid variety/OPV.

[§]Due to the skewness of this variable, the regression was run after an inverse hyperbolic sine transformation. Coefficient estimates can therefore be interpreted as percentage changes. The baseline mean column shows the untransformed variable.

address this, we present baseline means and the effects on the individual knowledge variables included in the indices in Appendix A.5. Baseline knowledge is generally low, with only 5% of agro-dealers knowing which seed variety to recommend when a farmer complains about insufficient rainfall. The highest level of knowledge is observed when asking about seed repackaging, with 64% of agro-dealers correctly identifying that this practice should be avoided. This low baseline knowledge indicates ample room for improvement.

Table 11 indicates a positive impact of the agro-dealer training on knowledge at midline, although the coefficient falls just short of significance at the 10% level. The (insignificant) effect of the training is most pronounced at midline, which aligns with the fact that the training was conducted only once at the start of the study (see Figure 1). We observe knowledge effects from the clearinghouse, significant at the 10% level. These findings suggest that this treatment motivates agro-dealers to seek information on seed storage. The results remain robust when alternative index construction methods, as proposed by Kling, Liebman, and Katz (2007), are employed.

These results suggest that providing knowledge through training alone is unlikely to improve outcomes when demand-side constraints are binding, in line with the findings of Bold et al. (2022), who show that smallholder maize farmers did not change their practices in response to a supply-side extension intervention, likely because they were unwilling to incur additional costs and effort without a credible market incentive for quality improvements. In our context, additional knowledge at the agro-dealer level is only valuable if market incentives manage quality (Hoffmann et al., 2021).

8.2 Agro-dealer efforts

To test whether agro-dealers adjust their behavior in response to training or exposure to the information clearinghouse, we examine their efforts. Specifically, we analyze seed handling practices (both labor- and capital-intensive), service provision (as reported by agro-dealers and farmers), and quality-signaling practices, as summarized in Table 12.

While the agro-dealer training was designed to equip participants with the knowledge to improve their practices and services, the information clearinghouse aimed to create incentives by motivating dealers to outperform competitors and attract more customers. A potential channel for differentiation is improved seed storage and handling, which enhances seed quality. Effective seed management requires a combination of capital investment and labor-intensive practices. The training also promoted a range of recommendations tailored to agro-dealers with varying resource constraints – some with surplus labor, others with the financial capacity to invest.

To assess changes in these practices, we construct two indices. The first captures labor-intensive seed handling and storage practices, based on six variables assessed through visual inspection by enumerators: whether seed is stored (1) in a dedicated area, (2) under appropriate lighting, (3) on suitable surfaces, (4) not in open containers, (5) whether a pest problem is present, and (6) the overall cleanliness and professionalism of the agro-dealership. The second index reflects capital-intensive practices and includes

Table 11: Effects on agro-dealer outcomes: Knowledge

	baseline	*midline*			*endline*		
	mean	training	CH	obs.	training	CH	obs.
Index of dealer knowledge about seed storage[1†]	0.000	0.091	0.115	306	0.030	0.124*	297
	(0.482)	(0.076)	(0.075)		(0.053)	(0.055)	
Index of dealer knowledge about seed[2†]	0.000	0.102	0.065	306	-0.009	-0.007	297
	(0.533)	(0.072)	(0.070)		(0.080)	(0.078)	
Overall Anderson index	0.000	0.208	0.211^{+}	306	0.038	0.142	297
	(0.729)	(0.125)	(0.119)		(0.107)	(0.102)	
Overall Kling et al. index	0.000	0.208^{+}	0.208^{+}	306	0.043	0.127	297
	(0.759)	(0.124)	(0.118)		(0.106)	(0.104)	
Max. number of obs.				306			297

Note: Column (1) reports baseline means and standard deviations below; columns (2), (3), (5), and (6) report differences between treatment and control groups and standard errors below; they are clustered at the level of randomization; columns (4) and (7) report the number of observations; **, *, and + denote significance at the 1%, 5%, and 10% levels; † indicates that the variable is included in the overall index; larger indices indicate more desirable outcomes.

[1]The index of dealer knowledge about seed storage contains 5 variables: whether dealer knows how long seed can be carried over, how seed should be stored after repackaging, what the min. distance between floor and seed is, how seed should be stored in storeroom, whether seed should be repackaged.

[2]The index of dealer knowledge about seed contains 4 variables: whether dealer knows which seed variety to recommend if farmer complains about poor soil, if farmer complains about little rain, if farmer is late for planting, what to tell clients about yield benefits of hybrid seed.

six variables: whether the roof is (1) leak-proof, (2) insulated, (3) whether the walls are insulated, (4) whether the store is ventilated, (5) whether an official certificate is displayed, and (6) whether expired seed is handled appropriately. All variables were observed or verified by enumerators, except the last, which is self-reported. Table 12 shows that neither the agro-dealer training nor the information clearinghouse had a significant effect on either seed handling practices index.

Instead of changing practices that directly affect seed quality, agro-dealers may respond by offering more or improved services to indirectly influence their ratings. For example, if farmers report low yields, agro-dealers might provide advice or training and recommend complementary inputs to enhance performance. This could lead to higher yields and, in turn, improve farmers' perceptions of seed quality. Alternatively, offering insurance or money-back guarantees may serve as a signal of high quality. To capture such responses, the third index focuses on service provision as reported by agro-dealers. It includes eight variables: whether the agro-dealer (1) explains how to use the seed they sell, (2) recommends complementary inputs to optimize yields, (3) provides advisory services or training, (4) offers discounts for large-quantity purchases, (5) extends credit, (6) received a seed-related complaint since the previous season, (7) accepts mobile money payments, and (8) stocks small, non-repackaged seed packages. While the agro-dealer training does not significantly affect service provision, the impact of the clearinghouse increases over time and is significant at the 5% level at endline.

A fourth index captures farmers' perceptions of agro-dealer services. It is based on seven variables: whether the agro-dealer (1) offers refunds or insurance, (2) provides credit, (3) offers training or advice, (4) delivers to the farm gate, (5) provides after-sales service, (6) accepts multiple payment methods, and (7) sells small quantities. Farmers' responses are aggregated at the agro-dealer level before computing the index. At midline, farmers perceived agro-dealers exposed to the clearinghouse intervention as offering significantly better services, with the effect significant at the 1% level. This effect weakens by endline. Considering both service indices, we conclude that the information clearinghouse improves agro-dealer service provision, while the training has no effect.

In markets with asymmetric information, signaling is often used to mitigate inefficiencies (Spence, 1973). In our setting, where seed quality cannot be reliably assessed through visual inspection, agro-dealers may adopt strategies to signal product quality to customers. Joining professional organizations is one such strategy. Agro-dealers aiming to signal quality may also welcome, or even actively seek out, inspections to publicize favorable results in their shops. The index of signaling practices captures five indicators of such behavior, including whether the shop displays an official certificate, holds memberships in UNADA or other professional associations, possesses a valid trading license, and the number of inspections conducted during the previous season. We find that the clearinghouse intervention significantly increased compliance with or participation in quality signaling practices, with the index significant at the 10% level at endline. The agro-dealer training had no effect.

Overall, Table 12 shows that agro-dealers exposed to the clearinghouse invest more effort than those in the control group. Instead of improving seed handling practices that directly affect quality, they focus on enhancing service provision and signaling product quality. The agro-dealer training has no discernible impact on effort. These results are robust to alternative index construction following Kling, Liebman, and Katz (2007).

Understanding agro-dealers' disregard for seed quality management

Three main rationales may explain why agro-dealers do not prioritize seed handling practices that would directly improve quality. First, returns on investments in quality are likely to materialize only in the longer term, as farmers must purchase, plant, and assess the performance of improved seeds – feedback that would be reflected in ratings only after a delay. Bayesian learning about quality takes time, and opportunities to update beliefs remain limited – even in Uganda, where two agricultural seasons per year offer repeated learning cycles. Amid the uncertainty caused by the COVID-19 pandemic, agro-dealers may have prioritized short-term gains by focusing on enhanced customer service and quality signaling rather than on practices that contribute to building a long-term reputation for seed quality.

Second, information clearinghouse treated agro-dealers may be willing to improve seed handling practices but lack the technical knowledge to do so effectively. Low baseline knowledge supports this possibility. Relatedly, some may believe that they have limited influence over seed quality or consider it to be the responsibility of seed wholesalers or producers. Because a subset of agro-dealers in our factorial design received both the training and the clearinghouse interventions, we can examine the interaction between the two treatments to explore this hypothesis. When exposed to both incentives and information, agro-dealers appear more likely to improve their operations – handling and storing seed more effectively and attracting more business – suggesting that knowledge may indeed be a limiting factor. However, this exploratory finding should be interpreted with caution, as detecting interaction effects typically requires a substantially larger sample size than detecting main effects, and our experiment is underpowered to do so reliably.

Third, agro-dealers may believe that farmers are unable to assess seed quality, even after use, and therefore that improvements in quality through better storage and handling would not lead to higher ratings. The clearinghouse intervention is based on the assumption that, while individual farmers cannot assess seed quality at the time of purchase and struggle to do so after one or two uses due to confounding factors such as inputs, rainfall, soil quality, pest and disease pressure, and management practices, groups of farmers can effectively evaluate quality after planting and harvesting, implying that maize seeds are experience goods. This assumption is consistent with the prevailing consensus in the literature (Michelson et al., 2023). We assume that ratings are distributed around the true mean, so that aggregating the experiences of many farmers operating under similar conditions (many N) provides a reliable signal of quality, reducing the need for individual farmers to learn through repeated trials over multiple seasons (many T). Accordingly, a clearinghouse based on peer ratings

Table 12: Effects on agro-dealer outcomes: Efforts

	baseline	*midline*			*endline*		
	mean	training	CH	obs.	training	CH	obs.
Index of labor-intensive seed handling practices[1†]	0.010	0.058	0.099	285	0.083	0.074	274
	(0.484)	(0.070)	(0.065)		(0.067)	(0.068)	
Index of capital-intensive seed handling practices[2†]	0.000	-0.019	0.000	270	-0.087	0.070	265
	(0.508)	(0.063)	(0.072)		(0.092)	(0.081)	
Index of services (self-reported)[3†]	0.000	-0.063	0.066	243	-0.057	0.110*	247
	(0.382)	(0.062)	(0.060)		(0.055)	(0.052)	
Index of services (reported by farmers)[4†]	-0.027	-0.151*	0.301**	259	0.006	0.086	271
	(0.583)	(0.074)	(0.069)		(0.092)	(0.084)	
Index of quality signaling practices[5†]	0.002	0.013	0.153	267	0.022	0.265+	255
	(0.686)	(0.106)	(0.103)		(0.152)	(0.147)	
Overall Anderson index	0.036	-0.019	0.375**	162	0.004	0.181+	177
	(0.549)	(0.122)	(0.113)		(0.113)	(0.106)	
Overall Kling et al. index	-0.052	-0.074	0.272*	340	-0.007	0.245*	340
	(0.768)	(0.123)	(0.118)		(0.130)	(0.122)	
Max. number of obs. for dealer survey outcomes				306			297

Note: Column (1) reports baseline means and standard deviations below; columns (2), (3), (5), and (6) report differences between treatment and control groups and standard errors below; they are clustered at the level of randomization; columns (4) and (7) report the number of observations; **, *, and + denote significance at the 1%, 5%, and 10% levels; † indicates that the variable is included in the overall index; larger indices indicate more desirable outcomes.

[1]The index of labor-intensive seed handling practices contains 6 variables: whether seed is stored in dedicated area, in correct lighting, on correct surface, not in open containers, whether shop has no pest problem, cleanness and professionality rating by enumerator.

[2]The index of capital-intensive seed handling practices contains 6 variables: whether roof is leak-proof, roof is insulated, walls are insulated, shop is ventilated, shop displays official certificate, expired seed is handled correctly.

[3]The index of services (self-reported) contains 8 variables: whether shop offers explanations, complementary input recommendations, extension/training, discounts for larger quantities, credit, did not receive seed related customer complaint, accepts mobile money, stocks small (not repackaged) seed package.

[4]The index of services (reported by farmers) contains 7 variables: whether shop offers refund/insurance, credit, training/advice, delivery, after-sales service, accepts different payment methods, sells small quantities. The answers are aggregated at dealer level, then the index is computed.

[5]The index of quality signaling practices includes 5 variables: whether shop displays official certificate, is registered with UNADA, is a member of another professional association, holds a trading license issued by local government, number of shop inspections.

was expected to generate valuable information that farmers could use to inform their adoption and purchase decisions.

Contrary to this assumption, agro-dealers may believe that maize seeds are credence goods and that farmers are unable to draw a causal link between seed quality and outcomes such as plant emergence, growth, and harvest, due to numerous confounding factors, the complexity of their interactions, and the stochastic nature of some of them. This belief would align with evidence from other agricultural inputs – not including maize seed – suggesting that farmers' beliefs often poorly reflect actual quality (Michelson et al., 2021; Hoel et al., 2024 for fertilizer; Ashour et al., 2019 for herbicides; Wossen, Abay, and Abdoulaye, 2022 for cassava seed), and may explain why agro-dealers do not improve seed handling practices: if farmers are unlikely to recognize the benefits, such efforts would go unnoticed, making enhancements in service provision and quality signaling seem more effective. This rationale also aligns with the null result for the agro-dealer training – additional knowledge is only valuable if customers can perceive its benefits (Hoffmann et al., 2021; Bold et al., 2022) – suggesting that pessimistic beliefs about farmers' ability to assess quality may underlie the lack of behavioral change.

8.3 Seed quality

We assess the effects of the agro-dealer training and the information clearinghouse on maize seed quality in Table 13. Enumerators were instructed to randomly purchase a seed bag from each agro-dealer and evaluate it based on several quality attributes. Specifically, we measured the seed's moisture content, examined packaging integrity, and checked for key information such as the packaging date and lot number. Because seed quality declines over time, we included the number of days since the packaging date – or, if missing, the number of days since the expiry date minus six months. We find no significant effects of either the training or the clearinghouse on seed quality. This null result is robust to alternative index constructions following Kling, Liebman, and Katz (2007).

Because not all agro-dealers had seed in stock, the realized sample size was smaller than planned: 232 observations at baseline, 179 at midline, and 265 at endline, compared to a target of 348. To assess whether the null result reflects a true absence of effect or insufficient statistical power, we assume that the estimated clearinghouse effect – a 0.22 percentage point reduction in seed moisture content at endline – represents the true effect. Figure 3 presents a power curve plotting sample size on the x-axis and statistical power – the probability of detecting the estimated effect at a 5% significance level, given the observed baseline variability in moisture content – on the y-axis. The curve indicates that the null result is unlikely to be driven by the reduced endline sample size of 265. Even with a larger sample, the observed effect size would not have been detectable with high reliability. We therefore conclude that there is no evidence of an effect of the information clearinghouse on seed quality, as proxied by moisture content.

As a robustness check, we supplement the analysis with additional indicators of

Table 13: Effects on agro-dealer outcomes: Seed quality

	baseline	*midline*			*endline*		
	mean	training	CH	obs.	training	CH	obs.
Moisture in %†	13.564	0.017	-0.122	175	-0.041	-0.220	261
	(1.482)	(0.142)	(0.144)		(0.198)	(0.197)	
Moisture exceeds recommended level (13%)	0.492	-0.046	-0.011	175	-0.062	-0.102	261
	(0.501)	(0.082)	(0.081)		(0.071)	(0.069)	
Bag shows packaging date†	0.689	0.053	0.050	179	-0.091	0.035	265
	(0.464)	(0.069)	(0.072)		(0.063)	(0.064)	
Shelf-life in days[1]†	60.951	-18.930	-8.272	164	13.091	6.352	240
	(40.960)	(22.091)	(20.869)		(8.243)	(8.289)	
Seed is in original undamaged bag†	0.940	0.025	0.002	179	0.006	0.051	265
	(0.238)	(0.044)	(0.046)		(0.053)	(0.055)	
Bag shows lot number†	0.508	0.025	-0.001	179	-0.138*	0.027	265
	(0.501)	(0.106)	(0.107)		(0.062)	(0.064)	
Overall Anderson index	0.065	0.083	0.108	160	-0.067	0.108	236
	(0.364)	(0.103)	(0.103)		(0.094)	(0.090)	
Overall Kling et al. index	0.002	0.089	0.065	179	-0.142	0.064	265
	(0.651)	(0.112)	(0.111)		(0.093)	(0.087)	
Max. number of obs.[2]				179			265

Note: Column (1) reports baseline means and standard deviations below; columns (2), (3), (5), and (6) report differences between treatment and control groups and standard errors below; they are clustered at the level of randomization; columns (4) and (7) report the number of observations; **, *, and + denote significance at the 1%, 5%, and 10% levels; † indicates that the variable is included in the overall index; larger indices indicate more desirable outcomes.

[1] Days since the packaging date or, if the bag does not show the packaging date, days since the expiry date minus 6 months.

[2] The comparisons were only made for agro-dealers where the enumerator was able to buy a bag of maize seed at mid- or endline. Also, we do not control for the baseline values of the outcome variables in the entire table because only 144 of the 179 dealers who had seed at midline also had seed at baseline and only 183 of the 265 dealers who had seed at endline also had seed at baseline, so that controlling for baseline values would reduce the sample sizes drastically.

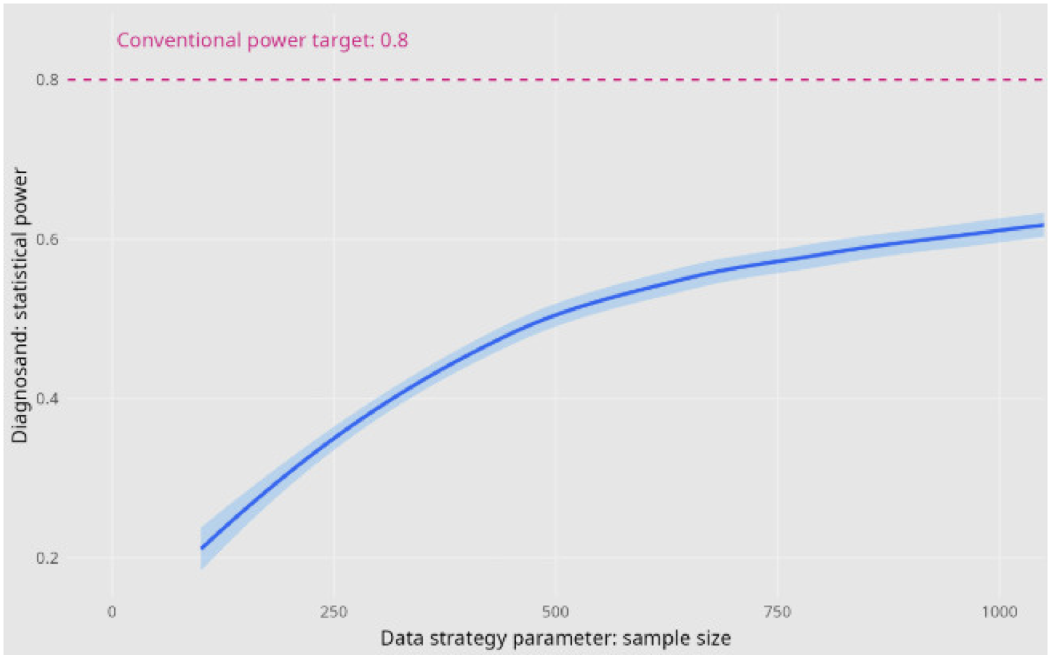

Figure 3: Power curve for seed moisture at endline

seed quality. Specifically, we include binary variables indicating whether an agro-dealer received a seed-related customer complaint, a warning following an inspection, or had products confiscated during an inspection. These outcomes are available for larger samples than seed moisture content. We find no evidence that either the training or the information clearinghouse affected these alternative indicators. This reinforces the conclusion that neither intervention improved seed quality. The results are consistent with the absence of effects on quality-enhancing seed handling practices reported in Table 12.

8.4 Seed quality perception

Although the clearinghouse had no effect on actual seed quality, it may influence farmers' perceptions thereof. In Table 15, we examine an index of maize seed ratings, which combines ratings for general quality, yield, drought tolerance, pest and disease resistance, time to maturity, and germination, based on seed obtained from various agro-dealers. These ratings are aggregated at the farmer level, as each farmer typically rates multiple agro-dealers, and the index is subsequently calculated.[13] Notably, treatment and control groups can only be compared at endline, as at baseline and midline, only clearinghouse-treated farmers rated dealers in their proximity. The act of rating

[13]To compute this index, we restrict the sample to farmers who have rated at least one agro-dealer in their catchment area across all index components. This restriction reduces the sample size, affecting statistical power.

Table 14: Effects on agro-dealer outcomes: Alternative seed quality indicators

	baseline	*midline*			*endline*		
	mean	training	CH	obs.	training	CH	obs.
Shop received seed related complaint from customer†	0.644	0.025	-0.089	306	-0.017	-0.039	297
	(0.480)	(0.057)	(0.057)		(0.048)	(0.048)	
Shop received warning after inspection†	0.317	0.045	0.005	291	0.013	-0.009	284
	(0.466)	(0.072)	(0.073)		(0.062)	(0.063)	
Shop's products were confiscated after inspection†	0.145	0.021	-0.027	293	0.014	-0.025	285
	(0.353)	(0.046)	(0.046)		(0.033)	(0.036)	
Overall Anderson index	-0.007	-0.041	0.066	303	-0.010	0.060	292
	(0.680)	(0.100)	(0.100)		(0.088)	(0.087)	
Overall Kling et al. index	-0.004	-0.050	0.062	306	-0.004	0.059	297
	(0.655)	(0.105)	(0.103)		(0.089)	(0.087)	
Max. number of obs.				306			297

Note: Column (1) reports baseline means and standard deviations below; columns (2), (3), (5), and (6) report differences between treatment and control groups and standard errors below; they are clustered at the level of randomization; columns (4) and (7) report the number of observations; **, *, and + denote significance at the 1%, 5%, and 10% levels; † indicates that the variable is included in the overall index; larger indices indicate more desirable outcomes.

Table 15: Effects of the clearinghouse on farmer outcomes: Seed quality perception

	baseline	*full sample endline*		*sub-sample endline*	
	mean	CH	obs.	CH	obs.
Index of farmer's seed ratings of agro-dealers[1]	0.000	0.092^{+}	1664	0.141^{*}	693
	(0.637)	(0.054)		(0.063)	
Max. number of obs.			3441		1741

Note: Column (1) reports the baseline mean and standard deviation below; column (2) reports the difference between treatment and control group and the standard error below; it is clustered at the level of randomization; column (3) reports the number of observations; columns (4) and (5) mirror this structure for the sub-sample of farmers that did not adopt at baseline, **, *, and + denote significance at the 1%, 5%, and 10% levels; larger indices indicate more desirable outcomes.
[1]The index of farmer's maize seed ratings contains 6 ratings: general quality, yield, drought tolerance, pest/disease tolerance, time of maturity, germination. The ratings are aggregated at farmer level (one farmer rates multiple agro-dealers), then the index is computed.

agro-dealers was an integral part of the clearinghouse treatment.

Column (2) presents the impact of the information clearinghouse on the full sample. The results show that the index is positively and significantly affected by the treatment, with the effect significant at the 10% level. However, we anticipate that the clearinghouse's impact on perceptions will be most pronounced among farmers who did not use high-yielding maize varieties at baseline. To explore this, we repeat the analysis for this subgroup in column (4). The treatment effect on the ratings is significant at the 5% level for the restricted sample.

We conclude that the information clearinghouse affects farmer perceptions of the quality of seed sold by agro-dealers. Two primary explanations account for this result. First, the treatment itself may have altered perceptions: the agro-dealer ratings that farmers encountered – via SMS, in-person visits by enumerators, and the SeedAdvisor certificate – could have been more favorable than farmers' prior beliefs, thereby improving their perceptions of seed quality. Second, as demonstrated in Table 12, treated agro-dealers enhanced service provision and signaled product quality in response to the clearinghouse treatment. These improvements in service and quality signals may also have mediated the effect on farmers' perceptions.

8.5 Switching

A final potential mechanism through which the information clearinghouse may influence outcomes is by encouraging farmers to switch from lower-rated to higher-rated agro-dealers. To examine this, we asked farmers whether they had changed agro-dealers since the previous season. The analysis is restricted to farmers who purchased maize

Table 16: Effects on farmer outcomes: Switching behavior

	midline	*midline*			*endline*		
	mean	training	CH	obs.	training	CH	obs.
Farmer switched to different shop	0.590	-0.008	-0.062^{+}	1270	0.052	-0.031	1410
	(0.492)	(0.033)	(0.033)		(0.034)	(0.033)	
Max. number of obs.[1]				1270			1410

Note: Column (1) reports midline means and standard deviations below (because this variable was not collected at baseline); columns (2), (3), (5), and (6) report differences between treatment and control groups and standard errors below; they are clustered at the level of randomization; columns (4) and (7) report the number of observations; **, *, and + denote significance at the 1%, 5%, and 10% levels.
[1]Comparisons are restricted to farmers who purchased maize seed from an agro-input shop for any plot at mid- or endline and during the season before that (i.e., base- or midline).

seed from an agro-input shop for at least one plot both at either midline or endline and during the reference season (baseline or midline), as meaningful switching is only possible for this group.

Results in Table 16 show that 59% of farmers who purchased maize seed at both baseline and midline reported switching agro-dealers between those two seasons. However, farmers in the clearinghouse treatment group were significantly less likely to report switching at midline, with the difference statistically significant at the 10% level. By endline, there were no significant differences in switching behavior between treatment and control groups. Contrary to expectations, the information clearinghouse did not encourage farmers to change agro-dealers.

One possible explanation for the low switching rate is limited market integration. Farmers often rely on a small set of local agro-dealers due to a lack of nearby competitors and the high costs associated with identifying and transacting with alternative sellers (Jensen and Miller, 2018). Because catchment areas are relatively small – with agro-dealers less than five kilometers apart assigned to the same area – one might argue that the clearinghouse did not sufficiently reduce these frictions to enable reallocation of market share toward higher-quality agro-dealers. However, given the minimal spatial variation in ratings across catchment areas and the substantial variation within them (see Subsection 6.5), we do not believe limited market integration explains the lack of switching.

Instead, the clearinghouse appears to have reinforced farmers' confidence in their previous choices, reducing the likelihood of switching. This interpretation is consistent with the relatively small variation in ratings across agro-dealers (see Subsection 6.5), which suggests limited differentiation and makes switching less attractive. These findings are also in line with Hasanain, Khan, and Rezaee (2023), who implemented a similar crowdsourced information platform in Pakistan's artificial insemination for livestock market and likewise found no evidence that farmers switched to higher-quality providers.

9 Conclusion

This study hypothesizes that seed quality deteriorates either due to agro-dealers' limited knowledge or because asymmetric information increases farmers' search costs and weakens agro-dealers' incentives to maintain quality. To address these challenges, we propose two interventions: a training program to improve agro-dealers' seed handling practices and an information clearinghouse featuring crowd-sourced ratings of seed quality based on farmers' experiences. We evaluate the impact of these interventions on a range of agro-dealer and farmer outcomes using an experimental design that enables causal inference and sheds light on the underlying mechanisms.

We find that training agro-dealers does not result in meaningful learning or improvements in seed handling practices or service provision. Consequently, we observe no effects on the quality of seed sold, agro-dealers' business performance, nor on the adoption of high-yielding maize varieties and harvest outcomes among their customers. These findings suggest that training alone is unlikely to generate improvements in contexts where sellers lack access to markets that reward higher quality. This is consistent with evidence from the maize output market. Hoffmann et al. (2021) show that food safety – a critical but non-observable attribute of maize quality – is not reflected in prices, implying weak incentives for quality management. Similarly, Bold et al. (2022) find that smallholder farmers did not adopt improved practices in response to an extension intervention aimed at raising maize quality, likely because they were unwilling to incur additional efforts and costs without credible market rewards for improved quality.

In contrast, the information clearinghouse proved effective in generating competitive incentives. We find compelling evidence that agro-dealers responded to the intervention by adjusting their behavior to outperform competitors and attract more customers. However, despite a quality problem at baseline, agro-dealers did not prioritize seed handling practices that directly improve quality – either because returns to such investments are delayed, because they lack the necessary knowledge, or because they believe farmers cannot reliably assess seed quality, making these efforts unlikely to pay off. Instead, they prioritized signaling quality and enhancing customer service to influence their ratings indirectly. As a result, we observe no improvements in actual seed quality. Nonetheless, whether through the direct effects of the intervention or through improved service and quality signaling, agro-dealers in the clearinghouse treatment arm attracted more business, even without enhancing the quality of their products.

Turning to farmer outcomes, we find that farmers do not switch to higher-rated agro-dealers, but they appear to trust the information provided by the clearinghouse: the intervention improved their perceptions of seed quality – likely because the ratings exceeded their prior beliefs – and farmers were convinced enough to adjust their adoption behavior and increase their use of high-yielding maize varieties, resulting in positive effects on harvest and sales outcomes.

Notably, the impact on perceptions is strongest among farmers who were not using high-yielding maize varieties at baseline. These same farmers also drive the observed yield effects, as they adopted in response to the clearinghouse intervention and subsequently achieved higher production. These initially non-adopting farmers, who tend to be more disadvantaged and vulnerable, appear to benefit the most from the intervention. While one might argue that the clearinghouse could expose farmers to low-quality agro-dealers, the intervention prompted a shift away from farmer-saved seed toward high-yielding varieties. Even in the presence of seed quality concerns at baseline and without measurable improvements at the agro-dealer level, this behavioral shift led to substantial productivity gains. This suggests that, despite quality issues, the seeds accessed through agro-dealers still outperformed farmer-saved alternatives. The clearinghouse helped pessimistic non-adopters update their beliefs by observing that their adopting peers held more favorable views, thereby reducing perceived risk and lowering the threshold for engaging with the formal seed market.

The significant impact of the information clearinghouse demonstrates that farmers cannot reliably assess maize seed quality at the time of purchase – otherwise, the ratings would have offered little added value. This underscores the need for mechanisms that support farmers in identifying quality. Seed companies try to achieve this by marketing their seed through branding and packaging to signal product quality, but farmers do not rely on packaging innovations to update their beliefs without training on how to purchase seed (Gharib et al., 2021). Another solution is to shift the burden of quality assessment away from farmers through regulation and formal quality assurance. Most low- and middle-income countries regulate seed quality in the formal market using codified standards, inspections, and certification systems. However, in settings where institutional capacity to implement and enforce these systems is limited, their effectiveness is often weak. A decentralized approach that draws on crowd-sourced information, such as the clearinghouse, may provide a more effective alternative.

The strong impact on non-adopting farmers – those not using high-yielding maize varieties at baseline – highlights another key distinction between quality signaling through marketing, formal quality assurance, and the information clearinghouse. Most signals primarily reach farmers who visit agro-dealers and are exposed to these signals at the point of sale. In contrast, the clearinghouse ratings were delivered directly to farmers through enumerator visits and SMS. This kind of direct outreach is especially valuable for non-adopters, and quality signaling mechanisms designed to promote adoption among vulnerable non-adopting farmers should therefore include strategies to reach them directly. The clearinghouse demonstrates that these farmers are generally responsive to credible, accessible signals that support better decision-making.

Furthermore, while formal quality assurance typically emphasizes varietal purity – verifying that seed corresponds to the declared variety and possesses the claimed genetic traits – peer-generated ratings provide signals on other quality dimensions that are highly relevant to smallholders. These include viability and performance, which reflect the seed's ability to germinate and grow vigorously and are particularly salient from farmers' perspectives. In contexts where seed handling and storage are poor, seed may be varietally pure yet lack viability and performance. Moreover, although formal quality assurance relies on objective measures such as DNA fingerprinting and is, if properly implemented, technically more reliable, peer assessments by farmers familiar with the heterogeneous and site-specific conditions on the ground may offer more practically relevant information. A substantial body of research underscores the importance of peer effects in technology adoption (Foster and Rosenzweig, 1995; Bandiera and Rasul, 2006; Conley and Udry, 2010). Drawing on both personal experience and the experiences of others in similar environments is therefore likely to yield especially valuable signals about seed quality. In addition, in settings where trust in government institutions is weak, formal regulation may be perceived as less credible than decentralized, peer-sourced information.

Finally, while the crowd-sourced information clearinghouse tested in this study is scalable, its implementation should be approached thoughtfully. Sustained, positive market impacts are more likely if farmers' aggregated ratings strongly reflect actual seed quality. Although the assumption that farmers can assess seed quality after planting and harvesting aligns with the prevailing view in the literature (Michelson et al., 2023), the position of maize seed along the experience-credence good continuum remains an unresolved empirical question. While our study finds that clearinghouse ratings correlate with objective indicators of seed quality, the experiment was not designed to assess this relationship conclusively. Accurate measurement of both the actual quality of seed used and farmers' beliefs about that quality – as well as the correlation between the two – is critical to understanding the extent to which quality issues, whether real or perceived, hinder adoption.

Additionally, there is ongoing debate about the credibility of rating platforms and the extent to which sellers can strategically manipulate their ratings – by incentivizing customers, using automated bot reviews, or employing other tactics. Practical implementation challenges also arise, such as determining how long ratings should remain valid and addressing the potential for bias in farmer ratings. For instance, evidence suggests that female agro-dealers tend to receive less favorable evaluations (De, Miehe, and Van Campenhout, 2024), raising concerns that rating platforms may reinforce, rather than reduce, existing inequities and discriminatory practices. While this study provides both a proof of concept and an empirical test of theoretical predictions about the role of quality signals in markets with asymmetric information, further large-scale piloting is essential to explore broader market dynamics, including supply and demand responses, and to assess long-term impacts on productivity, welfare, and resilience.

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A Appendix

A.1 Rating computations

What if a treated agro-dealer does not receive a single rating? If a shop in a treated catchment area is not rated by any farmer – for example, because no farmer in our sample is familiar with it – one option would be to assign it the average rating of all agro-dealers in the same catchment area. However, this approach is problematic, as the absence of ratings is unlikely to be random. Lower-quality agro-dealers tend to have fewer customers, making them less likely to be rated. Assigning them the catchment area average would artificially inflate their ratings. Instead, we informed farmers that we had no information about the shop (implicitly signaling its existence). In the first round, 16 out of 193 treated agro-dealers were not rated by any farmer.

Should more ratings lead to better ratings? Some agro-dealers were not rated by any farmer in the first round, while others received up to 22 ratings. If agro-dealer A is rated by ten farmers with an average of 3.5, and agro-dealer B is rated by one farmer with a rating of 3.6, agro-dealer B is treated as having the higher rating. While the number of ratings may correlate with quality (see previous paragraph), there may also be other reasons why some agro-dealers are rated by more or fewer farmers. Moreover, favoring agro-dealers with more ratings could disadvantage new entrants or those subject to discrimination, such as based on gender.

Should ratings reflect catchment area performance? The following examples illustrate why ratings should not depend on catchment area averages. In an area where most agro-dealers are of low quality, an agro-dealer who is slightly better than the rest – but still poor – should not receive a high rating, as this would expose farmers to substandard providers. Conversely, in a high-quality area, an agro-dealer who performs slightly worse than others – but still well overall – should not be rated poorly, as this would be unfair. However, fewer than 9% of agro-dealers received a rating below three out of five, and disseminating only high ratings would result in losing valuable variation.

To address this, ratings are transformed into quintiles based on their distribution. As a result, fewer agro-dealers receive ratings of four or five, and more receive ratings of one or two. This adjustment may increase treatment effects on agro-dealer effort: receiving a lower rating may motivate agro-dealers to improve their performance.

At the same time, the clearinghouse is meant to serve a signaling function, which could be undermined if most agro-dealers appear to be of low quality. That is why the quintile labels were chosen to carry positive connotations. Since most agro-dealers received good or very good initial ratings, even a two-star rating is still communicated to farmers as "good." Specifically, the first quintile is labeled "okay" and assigned one star, the second "good" with two stars, the third "very good" with three stars, and the fourth and fifth quintiles are both labeled "excellent," receiving four and five stars respectively.

By anchoring the labels in the distribution of original ratings, this approach also ensures that the disseminated ratings remain as truthful, fair, and accurate as possible.

Are female agro-dealers rated worse than male agro-dealers? Because significant differences were observed between the ratings of female agro-dealers (41% of the sample) and male agro-dealers (59%), even after controlling for potential confounders such as education and multiple quality indicators, these differences are unlikely to reflect true disparities in performance. Rather, they appear to stem from biased perceptions, likely driven by discrimination (De, Miehe, and Van Campenhout, 2024). To mitigate potential harm from the intervention, the ratings of female agro-dealers were adjusted accordingly. Specifically, each seed quality attribute was regressed on a gender dummy, and the resulting coefficients were added to the initial ratings of female agro-dealers.

A.2 Differential attrition tests

Table A1: Differential attrition tests - Agro-dealer

	baseline		*midline*			*endline*	
	mean	attrited	belongs to CH control	attrited and CH control	attrited	belongs to CH control	attrited and CH control
Respondent's age in years	32.43	-2.50	2.68^{+}	-1.29	-5.59^{**}	1.59	5.45^{+}
	(11.49)	(2.25)	(1.40)	(3.04)	(1.27)	(1.40)	(3.04)
Resp. is male	0.59	-0.17	0.05	-0.12	-0.34^{**}	-0.02	0.28^{+}
	(0.14)	(0.06)	(0.17)	(0.49)	(0.10)	(0.06)	(0.14)
Resp. finished primary education	0.92	0.01	0.01	-0.02	0.04	0.02	-0.04
	(0.27)	(0.08)	(0.04)	(0.10)	(0.05)	(0.04)	(0.08)
Resp. owns shop	0.55	-0.15	-0.01	0.01	-0.05	-0.05	0.14
	(0.50)	(0.17)	(0.06)	(0.20)	(0.16)	(0.07)	(0.20)
Resp. received training on maize seed handling	0.53	0.14	-0.11	-0.18	0.10	-0.09	-0.19
	(0.50)	(0.11)	(0.07)	(0.16)	(0.10)	(0.07)	(0.15)
Resp. knows how to store seed after repackaging	0.27	0.13	-0.08	-0.10	0.03	-0.09	0.03
	(0.44)	(0.17)	(0.06)	(0.19)	(0.12)	(0.06)	(0.15)
Dealer's distance to nearest tarmac road in km	6.56	-5.37^{**}	1.68	2.63	-3.38^{+}	1.67	0.92
	(10.39)	(1.37)	(2.33)	(2.63)	(1.74)	(2.35)	(2.93)
Dealer only sells farm inputs	0.74	0.11	0.00	-0.18	0.23^{**}	0.01	-0.27^{*}
	(0.44)	(0.10)	(0.07)	(0.14)	(0.07)	(0.07)	(0.12)
Years since dealer establishment	5.34	-1.93	0.07	-0.35	-2.99^{*}	-0.08	0.60
	(6.30)	(1.26)	(0.81)	(1.78)	(0.96)	(0.82)	(1.51)
Number of customers per day	41.49	-7.99	-5.02	-5.48	-8.05	-5.35	-4.79
	(46.49)	(8.66)	(7.50)	(10.59)	(7.01)	(7.73)	(9.53)
Quantity of maize seed sold in kg	695.50	234.18	-144.71	-847.11	125.10	-88.44	-551.67
	(1497.18)	(833.31)	(376.10)	(875.12)	(459.81)	(228.49)	(483.08)
Maize seed lost/wasted last season in kg	3.50	2.73	-2.22	-3.06	3.91	-1.68	-5.89
	(18.65)	(8.06)	(2.35)	(8.16)	(9.08)	(2.59)	(9.21)
Dealer has problem with pests	0.65	0.16	0.08	-0.36^{*}	-0.02	0.04	-0.08
	(0.48)	(0.11)	(0.06)	(0.17)	(0.09)	(0.06)	(0.14)
Dealer stores maize seed in open containers	0.16	-0.05	-0.09^{+}	0.09	-0.05	-0.09^{+}	0.09
	(0.36)	(0.10)	(0.05)	(0.12)	(0.10)	(0.05)	(0.12)
Dealer received seed related customer complaint	0.64	-0.03	-0.04	-0.14	-0.11	-0.07	0.05
	(0.48)	(0.12)	(0.05)	(0.17)	(0.12)	(0.06)	(0.16)
Moisture in bag of maize seed in %	13.56	-0.42	0.10	0.27	-0.45	0.10	0.48
	(1.44)	(0.52)	(0.27)	(0.66)	(0.31)	(0.26)	(0.56)

Note: Column (1) reports sample means at baseline and standard deviations below; columns (2) and (5) report differences between agro-dealers who attrited and those who did not, and standard errors below; columns (3) and (6) report differences between clearinghouse control and treatment agro-dealers, and standard errors below; columns (4) and (7) report differences between agro-dealers who attrited *and* belong to the clearinghouse control group and those who do not, and standard errors below; all standard errors are clustered at the level of randomization; **, *, and + denote significance at the 1%, 5%, and 10% levels.

A.3 Information clearinghouse ratings

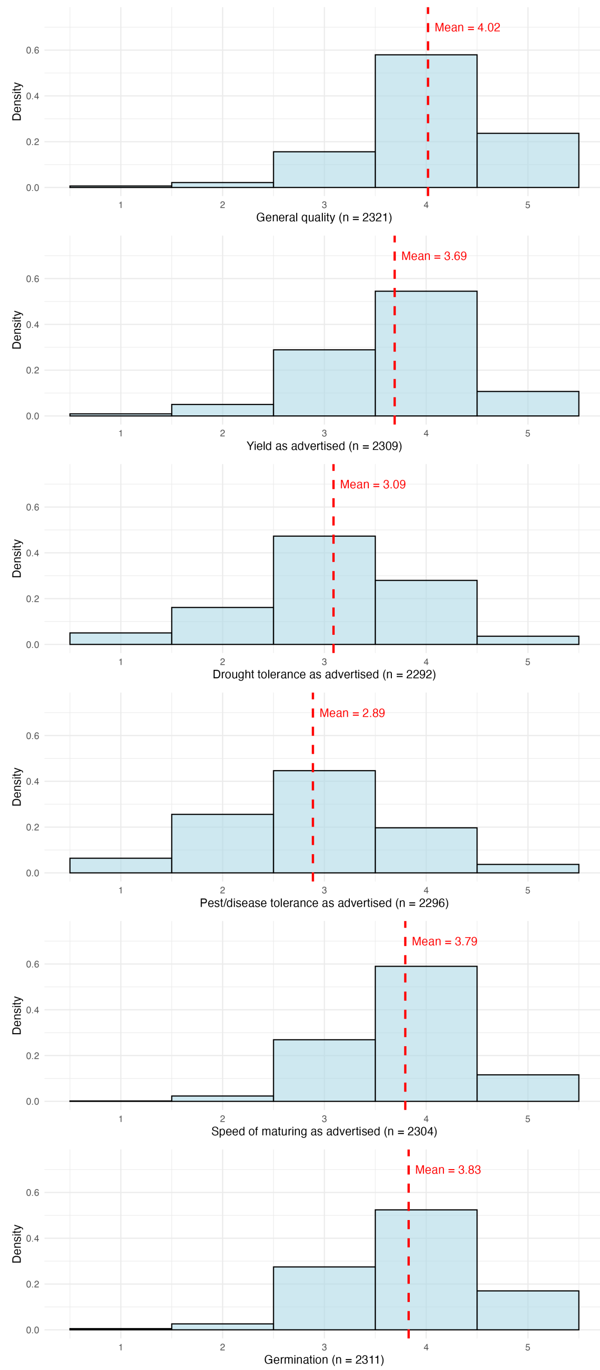

Figure 4: Comparison of rating dimensions at endline

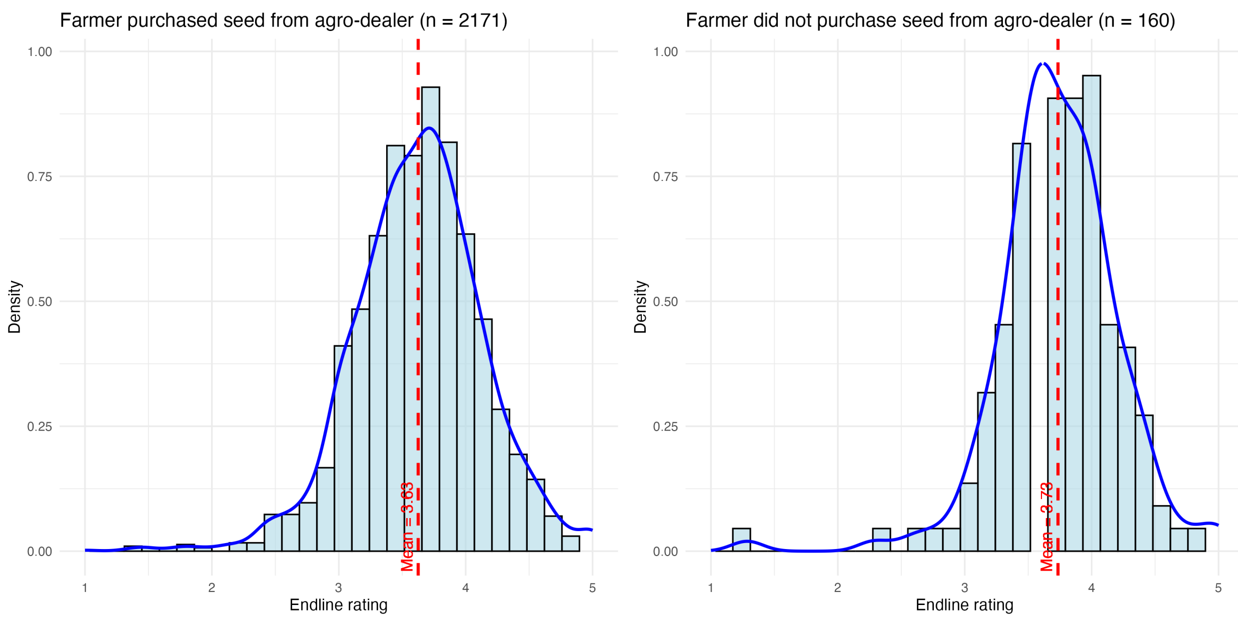

Figure 5: Comparison of ratings by purchase channel

Table A2: Correlating ratings and quality indicators - Agro-dealer level

	Ratings
Agro-dealer only sells farm inputs	0.205**
	(0.078)
Index of labor-intensive seed handling practices[1]	0.164+
	(0.091)
Index of capital-intensive seed handling practices[2]	0.204*
	(0.087)
Index of all seed handling practices[3]	0.225+
	(0.117)
Agro-dealer received seed related complaint from customer	-0.108
	(0.093)
Shop received warning after inspection	-0.034
	(0.086)

Note: [1]The index of labor-intensive seed handling practices contains 6 variables: whether seed is stored in dedicated area, in correct lighting, on correct surface, not in open containers, whether shop has no pest problem, cleanness and professionality rating by enumerator.
[2]The index of capital-intensive seed handling practices contains 6 variables: whether roof is leak-proof, roof is insulated, walls are insulated, shop is ventilated, shop displays official certificate, expired seed is handled correctly.
[3]The index of all seed handling practices contains 12 variables: the ones included in the index of capital-intensive practices and the ones included in the index of labor-intensive practices.

Table A3: Correlating ratings and yield on randomly selected field - Farmer level

	Yield in kg/acre$_{\text{endline}}$
Index of farmer's seed ratings$_{\text{midline}}$[1]	144.971**
	(8.564)
Index of farmer's seed ratings$_{\text{endline}}$[1]	35.225**
	(9.484)

Note: [1]The index of farmer's seed ratings contains 6 ratings: general quality, yield, drought tolerance, pest/disease tolerance, speed of maturing, and germination.

A.4 Questions to measure agro-dealer knowledge

Agro-dealer knowledge about seed storage

1. How long can seed be carried over before losing viability?
   (a) Seed can be carried over into the next seasons as you can store seed for twelve months.
   (b) Seed cannot be carried over into the next seasons as six months is the longest seed can be stored.
   (c) This depends on the seed: hybrids cannot be carried over, OPVs can be carried over for five seasons.
   (d) I don't know.
2. How should seed best be stored after repackaging?
   (a) Airtight in polyethylene bags.
   (b) In paper bags or perforated polyethylene bags.
   (c) In a sealed tin/plastic container.
   (d) I don't know.
3. What is the minimum recommended distance between the floor and where seed is stored?
   (a) 0 inches, seed should be stored directly on the floor for maximum stability.
   (b) Minimum two inches from the floor.
   (c) Minimum six inches from the floor.
   (d) I don't know.
4. How should seed ideally be stored in your store room?
   (a) In sealed cardboard boxes.
   (b) Stacked on pallets.
   (c) Arranged on shelves with sufficient space between packets.
   (d) I don't know.
5. Which statement do you agree most with?
   (a) You should repackage all your seed to visually verify that you are selling high-yielding varieties.
   (b) You should repackages all your seed so you can sell more to small farmers.
   (c) You should avoid repackaging your seed as much as possible.
   (d) I don't know.

Agro-dealer knowledge about seed

1. If a farmer complains about poor soil, which maize variety do you recommend?

   (a) Longe 5.

   (b) Bazooka.

   (c) Longe 10H.

   (d) I don't know.

2. What do you tell clients who inquire about the yield benefits of hybrid seeds?

   (a) Hybrid seeds double maize yields (increasing yield from about 4 to 8 bags/acre).

   (b) Hybrid seeds triple maize yields (increasing yield from about 4 to 12 bags/acre).

   (c) Hybrid seeds increase yields tenfold (increasing yield from about 4 to 40 bags/acre).

   (d) I don't know.

3. If a farmer misses the rains or lives in an area that receives little rain, which maize variety do you recommend?

   (a) Longe 10H.

   (b) Longe 7H.

   (c) Wema.

   (d) I don't know.

4. If a farmer is late for planting in the short season and needs a fast maturing variety, which maize variety do you recommend?

   (a) Bazooka.

   (b) Longe 10H.

   (c) Myezi mitatu (mm3).

   (d) I don't know.

A.5 Effects on agro-dealer knowledge - Individual variables

Table A4: Effects on agro-dealer outcomes: Knowledge (individual variables)

	baseline	*midline*			*endline*		
	mean	training	CH	obs.	training	CH	obs.
Dealer knows...							
...how long seed can be carried over†	0.336	0.085	0.080	306	0.039	0.089	297
	(0.473)	(0.078)	(0.076)		(0.062)	(0.061)	
...how seed should be stored after repackaging†	0.270	0.067	0.055	306	-0.075	-0.018	297
	(0.445)	(0.065)	(0.064)		(0.053)	(0.055)	
...what the min. distance between floor and seed is†	0.526	0.079	0.078	306	0.080	0.056	297
	(0.500)	(0.060)	(0.061)		(0.061)	(0.062)	
...how seed should be stored in storeroom†	0.552	0.007	-0.007	306	0.061	0.071	297
	(0.498)	(0.058)	(0.057)		(0.054)	(0.055)	
...whether seed should be repackaged†	0.638	0.008	0.080	306	0.023	0.119	297
	(0.481)	(0.064)	(0.066)		(0.069)	(0.073)	
Index of dealer knowledge about seed storage	0.000	0.091	0.115	306	0.030	0.124*	297
	(0.482)	(0.076)	(0.075)		(0.053)	(0.055)	
Dealer knows...							
...which variety to recommend if farmer complains about poor soil†	0.193	0.050	0.049	306	0.002	-0.004	297
	(0.395)	(0.048)	(0.049)		(0.054)	(0.054)	
...which variety to recommend if farmer complains about little rain†	0.052	-0.014	-0.004	306	-0.058	0.028	297
	(0.222)	(0.040)	(0.040)		(0.049)	(0.045)	
...which variety to recommend if farmer is late for planting†	0.218	0.132+	0.052	306	0.001	0.038	297
	(0.414)	(0.073)	(0.068)		(0.082)	(0.077)	
...what to tell clients about yield benefits of hybrid seed†	0.445	0.001	0.023	306	0.054	-0.082	297
	(0.498)	(0.062)	(0.061)		(0.059)	(0.060)	
Index of dealer knowledge about seed	0.000	0.102	0.065	306	-0.009	-0.007	297
	(0.533)	(0.072)	(0.070)		(0.080)	(0.078)	
Max. number of obs.				306			297

Note: Column (1) reports baseline means and standard deviations below; columns (2), (3), (5), and (6) report differences between treatment and control groups and standard errors below; they are clustered at the level of randomization; columns (4) and (7) report the number of observations; **, *, and + denote significance at the 1%, 5%, and 10% levels; † indicates that the variable is included in the overall index; larger indices indicate more desirable outcomes.