

Signaling, Screening, and Sunk Costs in Agricultural Technology Adoption

Experimental Evidence from Seed Trial Packs in Ethiopia and
Uganda

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Abstract

Free samples are a widely used strategy to introduce new products or technologies, offering prospective users the opportunity to gain first-hand experience and potentially facilitate diffusion through social networks. However, concerns remain that giving away products for free may reduce their perceived value, increasing the risk that recipients will under-utilize, re-purpose, or resell the product rather than use it for its intended purpose. We examine three mechanisms through which charging a positive price may increase uptake, intended use and subsequent adoption of a new technology: (1) a screening effect, whereby payment deters users who do not value the product and targets those more likely to use it; (2) a sunk cost effect, where paying a positive price induces a psychological commitment to use; and (3) a quality signaling effect, where a positive price conveys higher product quality. We test how these pricing mechanisms shape uptake, use, and subsequent adoption of recently released seed varieties of staple food crops, drawing on a field experiment with smallholder farmers in Uganda and Ethiopia. These findings carry important implications for how pricing strategies can be designed to promote technology adoption in low-income settings.

Keywords: technology diffusion, screening, sunk cost effect, signaling.

JEL: Q12, Q16, O33, D91, C93

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1 Introduction

Prices are ubiquitous in economic transactions. They are central to the efficient allocation of scarce resources within a society and provide important supply-side incentives. But charging the (full) price may not always be optimal. For instance, if a product or technology is new, providing it for free or at a discount for a short period of time may be necessary to encourage potential users to try it and learn from it (Bawa and Shoemaker, 2004). From a social welfare point of view, subsidies may be justified to ensure access to essential goods and services for poor or disadvantaged communities that may benefit most (Duflo and Banerjee, 2011). Additionally, providing an initial bundle of subsidized goods or services can help overcome barriers to adoption by giving a temporary boost that enables reinvestment and sustained use over time, potentially setting off a path to long-term welfare gains, in a process reminiscent of the dynamics described in the poverty trap literature (Balboni et al., 2021). More broadly, from a policy perspective, in the early stages of market development, public subsidies can play a catalytic role by stimulating initial demand for promising technologies or services, helping them reach a critical mass of users that enables economies of scale and attracts sustained private sector engagement. Finally, the presence of positive externalities provides another strong rationale against charging the full price for socially beneficial goods and services (Miguel and Kremer, 2004).

At the same time, there are concerns that free or subsidized provision of goods and services can diminish their perceived value among recipients. When this occurs, such goods may remain unused, be repurposed, or even resold. For instance, free bed nets have sometimes been used for fishing, and subsidized chlorine for water treatment has occasionally been diverted to household cleaning (Cohen and Dupas, 2010; Ashraf, Berry, and Shapiro, 2010).

There are at least three mechanisms through which charging a positive price for a good or service may increase its uptake and use. First, a *screening* effect may arise: individuals who place a higher intrinsic value on the product are more likely to be willing to pay for it, leading to better targeting of actual users. Second, a *sunk cost* effect refers to a psychological commitment whereby individuals are more likely to value and use a product simply because they have incurred a cost to obtain it, regardless of its objective utility (Kahneman and Tversky, 1979; De Bondt and Makhija, 1988). Third, prices can act as *signals* of quality, particularly in contexts of uncertainty and asymmetric information, where consumers may infer higher quality from higher prices, increasing the extent to which they value and use the product (Milgrom and Roberts, 1986).

A key challenge is that these mechanisms are typically conflated in observational data, as each mechanism implies a positive correlation between price and use. Building on Ashraf, Berry, and Shapiro (2010) who employ a two-stage pricing design in which commodities are first offered at randomized prices and then subject to a surprise discount to disentangle screening and sunk cost effects, we extend this design by introducing an additional initial stage that allows us to also isolate signaling effects. Specifically, in the first stage, farmers

receive an initial randomized offer price that provides a potential quality signal. In the second stage, a bargaining game elicits willingness to pay, which allows us to identify screening effects. In the third stage, a surprise discount is introduced, enabling us to measure sunk cost effects. The contribution of each mechanism on a particular outcome can then be estimated through regression analysis: To identify the screening effect, we focus on the marginal effect of willingness to pay while controlling for the initial randomized offer price and whether the farmer ultimately paid or received the good or service for free. To test for sunk cost effects, we focus on the indicator for full payment versus free provision, controlling for willingness to pay and the initial offer price. Finally, to capture signaling effects, we assess the impact of the initial randomized offer price while holding constant both willingness to pay and whether the farmer paid for the good or service.

We apply our experiment in the context of seed trial packs distributed to smallholder farmers in a developing-country setting with the aim of promoting the use of recently introduced improved seed varieties. Studying how pricing may affect adoption and use of such agricultural technologies presents a policy-relevant case for several reasons. First, given the novelty of and limited familiarity with a new variety, trial packs may be necessary to encourage experimentation among risk-averse farmers (Foster and Rosenzweig, 1995; Brick and Visser, 2015). Second, social learning, especially through peer networks, plays a critical role in the large-scale adoption of new agricultural technologies, suggesting the existence of significant positive externalities (Conley and Udry, 2010; Bandiera and Rasul, 2006; Van Campenhout, 2021). Third, seed purchases involve non-trivial upfront costs, making them susceptible to sunk cost effects. Finally, seed markets are often plagued by significant information asymmetries regarding product quality, which adds an additional layer of risk to farmer investment decisions (Bold et al., 2017; Ahmad, 2022). For instance, Bulte et al. (2023) show that uncertainty about seed quality reduces labor investment, and argue that the presence of low-quality (‘lemon’) inputs undermines learning about profitability, while bundling quality seeds with crop insurance to reduce uncertainty, has been found to increase farmer effort and learning (Bulte et al., 2020). Mieke et al. (2023) provide evidence that agro-input dealers actively use signaling to counter these asymmetries and build trust with buyers.

The experiment was implemented for teff and wheat in Ethiopia (with about 650 and 430 smallholder farmers, respectively), and maize in Uganda (with about 760 smallholder farmers). To assess how pricing of improved seed varieties affects outcomes along the adoption pathway, we collected detailed data in two rounds: in the short run (the first season after distribution) we tracked whether the seed trial pack was planted, whether seed and harvest were kept separate, and who in the household used it; in the longer run (the subsequent season) we measured adoption of improved and promoted varieties, plot-level production and productivity, and use of complementary inputs such as fertilizer and chemicals. This dual focus enables us to go beyond the immediate use of the trial pack, which most studies stop at, and examine subsequent adoption and complementary investment decisions that are rarely captured in this literature.

Our study contributes to a growing literature that examines how pricing affects the uptake and adoption of goods and services, particularly in contexts where such goods generate positive externalities. A central question in this literature is whether charging a positive price enhances users’ valuation and proper use of the good or service, or whether providing goods for free or at a subsidy instead leads to underutilization, repurposing, or outright wastage. This tension is especially salient in the design of public health and agricultural interventions, where concerns about cost recovery, wastage, and behavioral responses to subsidies often shape policy.

Seminal studies by [Ashraf, Berry, and Shapiro \(2010\)](#) and [Cohen and Dupas \(2010\)](#) offer contrasting insights. [Ashraf, Berry, and Shapiro \(2010\)](#), in a two-stage pricing experiment of chlorine for water purification in Zambia, find evidence of screening effects---suggesting that willingness to pay reflects private information about future use---but no support for sunk cost effects. Their results imply that pricing may improve targeting efficiency, potentially justifying lower subsidy levels. In contrast, [Cohen and Dupas \(2010\)](#) study demand and usage of insecticide-treated bed nets in Kenya and find that even small prices substantially reduce uptake, with little evidence that pricing improves targeting. They conclude that free distribution may yield greater health benefits by expanding coverage.

More recently, [Mahmoud \(2024\)](#) employs a two-stage pricing design to study improved agricultural technology adoption in Bangladesh, with a distinct objective: to test whether prices can effectively screen farmers based on their expected returns to the technology and thus preventing subsidized inputs from reaching farmers with low potential gains. She finds that buyers do not systematically achieve higher returns than non-buyers, raising concerns about the efficiency of using price as a targeting mechanism for agricultural innovations. Other work has explored whether free distribution leads to misuse or resale. [Hoffmann, Barrett, and Just \(2009\)](#), also studying bed nets in Kenya, find little external leakage and no evidence that poor households resell freely distributed nets. Their findings support the viability of targeted free distribution, challenging the notion that zero prices necessarily erode product value or responsible use.

Our study builds on this body of work but adds a critical innovation by explicitly isolating and testing signaling effects as a third mechanism alongside the more commonly studied screening and sunk cost effects. Existing two-stage pricing designs typically examine whether prices screen for users with higher private valuations or induce sunk cost-driven commitment, typically by estimating one effect while controlling for the other.¹ However, if prices also signal quality in contexts with information asymmetries, then ignoring this channel may confound estimates of both screening and sunk cost effects.² To address

¹Both [Ashraf, Berry, and Shapiro \(2010\)](#) and [Cohen and Dupas \(2010\)](#) discuss signaling as a theoretical possibility, but their design primarily focuses on disentangling screening from sunk cost effects.

²The reason is that signaling shifts willingness to pay; if this is not explicitly controlled for, willingness to pay absorbs part of the signaling effect and becomes endogenous. As a result,

this limitation, we adapt the canonical two-stage design into a three-part pricing experiment, which allows us to separately identify the three effects by randomizing initial offer price (signaling), using a bargaining game to elicit willingness to pay (screening), and assigning a surprise discount to a randomly selected subsample of participants (sunk cost effects).

A second contribution is the multi-country, multi-commodity context, which enables us to assess heterogeneity in price effects across institutional and agronomic settings. Implementing the same experimental design in Uganda and Ethiopia—two countries with distinct agro-ecological conditions, seed market structures, and policy environments—allows us to examine how context shapes the relevance of screening, sunk-cost, and signaling effects, thereby informing the generalizability of our findings. Importantly, these contextual differences also speak to the relative importance of the three mechanisms. For instance, signaling effects may be particularly relevant in Uganda, where persistent concerns about counterfeit and low-quality seed in the supply chain undermine farmers’ trust in new varieties (Barriga and Fiala, 2020). Heterogeneity across crops provides a plausible rationale for the differential importance of screening and sunk cost effects as well. For teff in Ethiopia, a traditional staple characterized by wide variation in farmer familiarity and preferences for local seed, screening mechanisms are likely to be particularly relevant: willingness to pay may effectively sort farmers according to expected returns and willingness to experiment. By contrast, for wheat, which is more commercialized and closely linked to market-oriented production decisions, sunk cost effects may play a larger role, as expenditures on seed are perceived as an investment that reinforces the commitment to plant and manage the crop. By spanning three distinct crops—maize in Uganda, teff and wheat in Ethiopia—we are thus able to explore how the strength of screening, sunk cost, and signaling effects varies with baseline knowledge, perceived quality uncertainty, and crop-specific value propositions. This cross-context approach provides nuanced insights into how pricing strategies should be tailored to different markets and technologies.

The remainder of this article is organized as follows. We first explain the methods used and the experimental design, followed by the estimation strategy. We then turn to sampling and provide descriptive statistics of our study population. The analysis consists of two parts. We first look at the price elasticity of demand for the seed trial packs using willingness-to-pay data. We then provide estimates for screening, sunk cost, and signaling effects. The last section concludes and reflects on implications for policy.

2 Methods and experimental design

The standard approach to disentangle screening and sunk cost effects arising from charging a price is the *two-stage pricing design* pioneered by Ashraf, Berry,

the coefficient on willingness to pay (interpreted as screening) will be biased and, because sunk-cost estimates are identified from payment outcomes conditional on willingness to pay, bias carries over to the sunk-cost effect estimate.

and Shapiro (2010) and Cohen and Dupas (2010). In a two-stage pricing design, the first stage involves randomizing the posted price of a product across participants or sites, generating variation in who initially decides to purchase. This allows researchers to test for screening effects, since willingness to buy at a given posted price may correlate with expected use. In the second stage, among those who agreed to purchase at the posted price, a subset is randomly offered an unanticipated discount or rebate that lowers the actual transaction price. Because all of these individuals revealed a willingness to pay the original posted price, any systematic difference in subsequent usage between those who ultimately pay more versus less can be attributed to sunk cost effects, rather than to differences in underlying demand. Together, this two-stage design cleanly separates selection at the offer stage from psychological responses to the act of paying.

We build on the standard two-stage pricing design by introducing an additional stage at the beginning, yielding a *three-stage pricing design*. In this first stage, farmers are presented with a randomized initial offer price, which can function as a potential signal of product quality. The second and third stages then follow the conventional design: we elicit willingness to pay (WTP) through a structured bargaining game that mirrors real-world seed transactions, providing the basis for identifying screening effects, and finally, we grant a full (100%) surprise discount to a random subset of farmers, allowing us to test for sunk cost effects.

The experiment begins with a scripted bilateral bargaining game involving concessional offers. In particular, farmers are given the opportunity to purchase a bag of seed from a trained enumerator instructed to simulate typical bargaining interactions, closely mirroring how such transactions occur in real-world settings where bargaining is common.³ The enumerator follows a standard script that was implemented in Open Data Kit (ODK) on Android tablets. An initial ask price is randomly drawn from a uniform distribution, and presented to the farmer as the price of one bag of seed for a new improved variety.⁴ The

³In two-stage pricing designs, such as those used by Ashraf, Berry, and Shapiro (2010) and Cohen and Dupas (2010), in the first stage, participants are typically offered a good at randomly assigned price points. A common drawback of this approach is that a substantial share of participants may opt not to purchase the good, which, absent over-subscription, can significantly reduce the effective sample size. Since willingness to pay (WTP) is central to analyzing two-stage pricing designs, alternative elicitation methods like the Becker-DeGroot-Marschak (BDM) mechanism can be employed to mitigate this problem to some extent. In its basic form, BDM asks participants to state a bid, which is then compared to a randomly drawn price. If the bid is lower, participants do not receive the product; if it meets or exceeds the price, participants purchase the product at the drawn price. A key advantage of this method is that it inherently includes a surprise discount for those whose WTP exceeds the random price—mimicking the second stage in two-stage pricing designs—see appendix E in Berry, Fischer, and Guiteras (2020). While we initially planned to elicit WTP using a BDM mechanism, field testing revealed that farmers were confused by the one-shot nature of the transaction. As a result, we opted for a bargaining game that more closely reflected farmers’ real-world experience with price negotiation. This design change led us to update the [pre-analysis plan](#), which is reflected in [commit dated Feb 11, 2023: “changed PAP after field testing - dropped BDM for bargaining experiment”](#) on GitHub.

⁴For maize seed packs (1kg) in Uganda, initial prices ranged from 9,000 to 12,000 Uganda

enumerator explains what kind of variety it is and what the advantages are. The farmer has the option to accept the bag of seed at this initial offer price or not.

If the farmer does not accept the initial offer price, the farmer enters into a bargaining stage where he or she is encouraged to name their first counter bid price. A computer algorithm then determines a counter-offer that the enumerator asks in a second round of negotiation. This new ask price is determined as the farmer's bid price plus 80 percent of the difference between the (initial) ask price and the farmer's bid price (appropriately rounded depending on the crop). This updated (lower) ask price is then compared to the bid price of the farmer. If the price difference between the bid and (updated) ask price is smaller than a (crop specific) threshold, the ODK script instructs the enumerator to sell at the price the farmer bids. If the difference between the updated ask price and the bid price is larger than the threshold, the updated ask price is presented to the farmer, and the farmer gets a second opportunity to accept or reject. If the farmer does not accept, he or she is encouraged to make a second bid and a third ask price is determined as the farmer's last bid price plus 80 percent of the difference between the last ask price and the farmer's last bid price. Bargaining continues until the farmer accepts an ask price, or the price difference between the last bid and last ask price is smaller than a (crop specific) threshold.⁵

After the bargaining experiment, we administered a baseline survey and, near the end of the interaction, offered a randomly selected subgroup of farmers a surprise discount. Unlike most two-stage pricing designs that introduce random or tiered discounts (often to determine optimal subsidy levels), we employ a single, full (100%) discount. This decision is guided by four considerations. First, we anticipate a behavioral discontinuity between paying any positive amount and receiving the good for free, consistent with findings in behavioral economics that zero prices can have a disproportionate impact on uptake and use (eg. [Shampanier, Mazar, and Ariely, 2007](#)). Second, concentrating the sample in two distinct groups (those who pay and those who receive the good for free) increases statistical power relative to designs that distribute observations across multiple price points. Third, by replicating how new agricultural technologies are often introduced in practice, with free sample packs provided to encourage trial and learning, our approach strengthens the external validity of the study.⁶ Fourth, by focusing on a single, full discount rather than multiple rebate tiers, all variation in whether farmers paid or not comes directly from randomized assignment. This design isolates the sunk-cost effect at the extensive margin (pay vs. free) in a straightforward way. By contrast, two-stage rebate designs such as [Ashraf, Berry, and Shapiro \(2010\)](#) estimate sunk-cost effects from con-

shillings (UGX) in increments of UGX 1,000. In Ethiopia, prices ranged from 65 to 110 Ethiopian birr (ETB) for 2 kg of teff (with increments of ETB 5) and from ETB 50 to ETB 80 for a 3 kg wheat seed pack (increments of ETB 10).

⁵To make the bargaining also incentive compatible for the enumerators, we told them in advance that the money that is collected from farmers during this first stage will be distributed equally among all the enumerators.

⁶In [Ashraf, Berry, and Shapiro \(2010\)](#), the possibility of non-linearities around a zero price was also suggested by a practitioner (and tested in Panel B of their Table 4).

tinuous price variation, which combines randomized rebates with households’ self-selection into purchase at different posted prices. While this allows for richer estimands, it requires additional assumptions to separate screening from sunk-cost effects.

Our experimental design generates three variables that will be used to identify distinct price mechanisms. First, the randomized initial offer price may serve as a signal of quality. Second, the WTP price, defined as the final price agreed upon during the bargaining process, captures farmers’ willingness to pay and thus provides the basis for screening. Third, for the main analysis we focus on a simple indicator of whether the farmer paid the agreed price or received the pack for free, which identifies the sunk cost effect. This indicator can also be expressed as a transaction price—equal to zero under the full discount or equal to the WTP price otherwise—which we draw on in supplementary regressions reported in the appendix for robustness. We will examine how these different price dimensions influence trial pack use, subsequent adoption of the promoted variety, and the application of complementary inputs.

Seed trial packs used in this study include 1 to 3 kilograms of seed of an improved variety depending on the crop (1 kg of maize, 2 kg of teff, and 3 kg of wheat). For the Ugandan case, we use a recently introduced hybrid variety popularly known as Bazooka, produced by Naseco Seed Ltd. The seed is high yielding. It promises between 3.5 and 4 metric tons per acre and was partly chosen because it is widely available on the market. The 1 kg bag of maize seed is enough to plant about one-eighth of an acre. For the Ethiopian case, we provide trial packs for three recently released teff varieties (Eba, Bora, and Boset) and one widely available wheat variety (Daka). The seeds were selected based on suitability to the agroecological conditions of our study areas and yield potential compared to standard varieties. A 2 kg bag of teff seed is sufficient to plant about half an acre, while a 3 kg bag of wheat seed covers only about one tenth of an acre. Although wheat is sown more densely than teff, farmers in Ethiopia also devote much smaller areas to wheat compared to teff.

Our study sample constitutes 10 farmers per village from 76 villages in Uganda and 16 farmers per village from 68 villages in Ethiopia. These numbers were chosen to balance logistical feasibility with statistical power considerations. In both countries, assignment to surprise discounts was randomized at the village/kebele level, as we wanted to avoid that a farmer receiving a bag of seed for free would have close interactions with farmers paying a positive price for the same trial pack. However, we did vary the initial offer price in the bargaining experiment at the individual level.

3 Estimation

To separate the three different effects, we estimate models that are similar to the original two-stage design used in for instance [Ashraf, Berry, and Shapiro \(2010\)](#). Recall that in two-stage designs, study participants are given the opportunity to buy a commodity at different price points and in a second stage are given a

surprise discount (leading to a price the farmer is willing to pay and transaction price at which the farmer obtained the seed after the rebate). In such designs, the outcome variable of interest (for example, an indicator for whether the seed was used as intended) is regressed on both the WTP price and the transaction price. A statistically significant and positive coefficient on the WTP price, controlling for the transaction price, provides evidence of a screening effect, since it reflects the positive relationship between the participant’s valuation and the outcome of interest, irrespective of whether the full price was paid or not. A significant and positive coefficient on the transaction price, controlling for the WTP price, indicates a sunk cost effect, where paying a higher price increases commitment to using the product, irrespective of the farmer’s valuation of the product.

In our main analysis, we depart from the canonical specification in two ways. First, we add a signaling effect, identified from the randomized initial offer price, which may convey information about the quality of the seed. Second, we identify the sunk cost effect using a discontinuous treatment indicator that equals one if the farmer paid the bargained price and zero if the farmer received the full surprise discount. This choice stays closest to the experimental design, where sunk costs were introduced through a randomized, sharp contrast between “free” and “paid” packs. By relying on this exogenous discontinuity, we avoid attributing sunk cost effects to within-paid-group variation in transaction prices that was jointly determined by bargaining and may therefore be endogenous. The interpretation is also straightforward: it captures whether paying anything at all changes subsequent use relative to receiving the pack for free.

In our analysis, we thus estimate the following equation:

$$Y_i = \alpha + \beta_I I_i + \beta_P P_i + \beta_D T_i + \varepsilon_i \quad (1)$$

where Y_i is the outcome of interest (e.g., use of seed from trial pack, adoption of promoted variety in subsequent season,...), I_i is the initial offer price, P_i is the WTP price, and T_i is a dummy variable indicating if the full price was paid. A statistically significant positive β_I coefficient in equation 1 provides evidence of a signaling effect. Evidence of a screening effect is provided by a statistically significant and positive coefficient on the WTP price ($\beta_P > 0$ in equation 1). Finally, a statistically significant positive coefficient on the dummy variable indicating if the full price was paid provides evidence of a sunk cost effect ($\beta_D > 0$ in equation 1).⁷

Our design, based on a fully randomized 100% discount, isolates the sunk cost effect at the extensive margin by comparing farmers who pay their reservation price with those who receive the seed for free. This maximizes statistical power and allows a direct test of the behavioral discontinuity at zero price. By contrast, designs that assign fixed discounts across multiple tiers estimate

⁷ Note that, in principle, these three tests can be derived from estimating a single equation (Equation 1). However, in the empirical section below we estimate three separate equations, each focusing on the specific effect of interest, and include the other independent variables demeaned and fully interacted with the variable of interest, following [Lin \(2013\)](#), to enhance robustness and minimize specification concerns.

sunk cost effects along a continuous price gradient, which can be easier to interpret alongside the screening effect—also measured at the margin—and additionally provide insight into how sunk cost effects evolve with payment size rather than only at the free-versus-paid threshold. For completeness, in an online appendix we also present estimates based on the continuous transaction price, which stays closer to the canonical [Ashraf, Berry, and Shapiro \(2010\)](#) two-stage framework. In particular, we estimate equation 1 again, but instead of T_i being a dummy variable, we now include the actual transaction price, which is zero if the discount was obtained, and equal to the WTP price if no discount was obtained. Note though that models using the actual transaction price in the context of an all-or-nothing discount are—after controlling for WTP and the randomized offer—effectively reparameterizations with the continuous coefficient mostly rescaling the paid-vs-free contrast by the conditional mean paid price.

In the analysis, we look at different (potentially correlated) outcomes, leading to the problem of multiple hypothesis testing. To deal with this problem, we follow a method proposed by [Anderson \(2008\)](#) and aggregate different outcome measures within broadly defined families (seed pack use, subsequent adoption of technology, and use of complementary inputs and practices) into single summary indices. Each index is computed as a weighted mean of the standardized values of the outcome variables, with the weights derived from the inverse variance covariance matrix of the components of the index.

4 Sample and Descriptive Statistics

For the Uganda case study, the total sample consists of a representative sample of about 760 maize farming households, drawn from 4 districts in Eastern Uganda (Mayuge, Kamuli, Iganga, and Bugiri). These districts were chosen because maize is an important crop for both food and cash. In these 4 districts, 76 villages were randomly selected from a list of all villages with the likelihood of a village being selected proportional to the number of households that live in the village. Within each village, 10 households were randomly selected. In Ethiopia, we sampled 1,000 farming households from 70 kebeles across 10 districts in the Amhara region: Borena/Debresina, Ebinat, Enbese Sar Midir, Jama, Kelela, Libokemkem, Sayint, Shebel Berenta, Tenta, and Werellu. Within each kebele, 16 households were randomly selected.

In Uganda, in February and March 2023, well before the first agricultural season, trained enumerators visited all sampled households and collected baseline data. At that time, farmers were also provided with the seed trial pack. A few days before enumerators would visit the villages to collect baseline data and implement the bargaining exercise, farmers were notified that we would visit them, and they were told that there may be an opportunity to buy something so they should make sure they had a little bit of money by the time we visited them. Baseline data in Ethiopia was collected in August 2022 by trained enumerators with a minimum of three years of field experience. In May 2023, a subset of

these enumerators received two days of training to implement the experiment, following a standardized protocol consisting of introduction, informed consent, the bargaining exercise, and treatment delivery. In both countries, the baseline survey asked questions about general household characteristics and more specific questions about farming and seed use.

In both countries, after a short introduction and obtaining consent, enumerators started with the bargaining as explained in detail in Section 2. The full sample completed the bargaining game, but in only half of all villages, farmers were asked to pay the price they agreed upon. The remaining half of villages was randomly assigned to received a 100% discount.⁸ Endline surveys were conducted in February 2024 in Uganda and in November 2024 in Ethiopia to capture use of the seed trial pack, seed use, and more general agronomic practices such as use of inputs, in the season following the season when the seed trial pack could be tested.

Table 1 presents baseline characteristics for the three samples (Uganda maize, Ethiopia teff and Ethiopia wheat), revealing some interesting cross-country differences. Ugandan household heads tend to be older, averaging nearly 50 years, compared to about 45 years in the Ethiopian sites. Educational attainment also differs sharply: while nearly half of Ugandan household heads have completed primary school, this is true for only about 20 percent of their Ethiopian counterparts. Households in Ethiopia are more likely to be male-headed than those in Uganda.

Demographic patterns further highlight Uganda’s rapid population growth. The average household in the Ugandan sample is over eight members, compared to just five in Ethiopia. Ugandan farmers report living around 4 kilometers from the nearest agro-dealer, suggesting a relatively dense input supply network. Unfortunately, comparable data on input access were not collected in Ethiopia.

While the first five characteristics are expected to be unaffected by our intervention, we also report five baseline variables that are more likely to change as a result of the study. To begin, we include a broad measure of technology adoption by asking whether farmers had used seed of an improved variety for the relevant crop on any plot during the season prior to the baseline. In Uganda, about 41 percent reported using improved maize varieties, whereas improved seed adoption in Ethiopia was considerably lower, at just 18 to 19 percent.

To capture uptake of the specific varieties promoted in our study, we took a more targeted approach. Farmers were asked to list all plots on which the relevant crop was grown, after which one plot was randomly selected for detailed follow-up questions.⁹ In Uganda, only around 6 percent of farmers had

⁸In Uganda, the baseline survey was implemented after the experiment ended and seed and money changed hands. After the survey, farmers that were in the 100 percent discount groups were told that they were lucky winners of a raffle and got a 100 percent cash-back, to avoid influencing farmers’ responses to the baseline survey.

⁹The decision to only ask detailed questions on one (randomly selected) plot was guided by the fact that outcomes at plot level (such as adoption of improved inputs and technologies and production outcomes) are likely to be correlated such that gains in statistical power from surveying all plots likely do not outweigh costs of longer and more tedious questionnaires. As the plot to be surveyed was selected randomly, outcomes should be unbiased and consistent.

Table 1: Descriptive Statistics

	Uganda maize	Ethiopia teff	Ethiopia wheat
Age household head (years)	48.759 (13.53)	46.17 (13.026)	45.172 (12.7)
Head finished primary education (1=yes)	0.519 (0.5)	0.205 (0.404)	0.238 (0.426)
Head is male (1=yes)	0.784 (0.412)	0.837 (0.37)	0.863 (0.345)
Household size	8.167 (3.818)	5.066 (1.764)	5.172 (1.725)
Distance to agro-dealer (km)	3.812 (4.014)	- -	- -
Used quality seed on at least one plot?	0.415 (0.493)	0.184 (0.388)	0.189 (0.392)
Used promoted seed on randomly selected plot	0.063 (0.244)	0.046 (0.211)	0.057 (0.231)
Seed obtained from trusted source	0.35 (0.477)	0.099 (0.299)	0.096 (0.295)
How often was seed recycled?	0.195 (0.396)	- -	- -
Yield on randomly selected plot	421.851 (359.59)	8.591 (4.811)	9.011 (4.866)

already planted the promoted maize variety, Bazooka, in the preceding season. In Ethiopia, uptake of the promoted teff and wheat variety was similarly low, with less than 6 percent reporting prior use. These figures underscore that the technologies introduced in the study had not yet gained traction at scale.

About 35 percent of farmers in Uganda used maize seed from a formal seed source in the season preceding the baseline (for instance, from an agro-input dealer or the government extension system). This share is substantially lower in the Ethiopian sample. To maintain sufficient vigor, seed should not be recycled too often. In Uganda, fewer than 20 percent of maize farmers used seed that had been recycled fewer than five times, which is generally considered the upper limit for open-pollinated varieties. We did not collect comparable information on seed recycling in Ethiopia. Finally, average maize yields on the randomly selected plot in the season preceding the intervention were around 400 kilograms per acre in Uganda.

5 Analysis

5.1 Price elasticity of demand

A first step in the analysis is to assess whether demand for the seed is responsive to price, as some degree of price sensitivity is needed for screening, sunk cost and signaling effects to manifest in subsequent use of the good or service. From

a policy perspective, price elasticity of demand also affects how an increase in prices might limit seed purchases, even in the absence of mechanisms such as screening, sunk cost, or signaling effects that affect actual use of the seed.¹⁰ In settings where farmers face cash or credit constraints, this may disproportionately exclude those who could potentially benefit most from the technology. In that sense, high price elasticity is often cited as a key justification for providing subsidies.

Figure 1 shows the distribution of prices at which farmers agreed to purchase the seed trial pack during the bargaining experiment for maize, teff, and wheat seed. In all three panels, we observe a clear negative relationship between price and the share of farmers who agree to purchase the seed, consistent with downward-sloping demand curves. For both maize and teff seed, uptake declines steadily as the price increases, indicating relatively high price sensitivity. The pattern is somewhat less smooth for wheat, where demand remains flat between 40 and 50 birr before dropping off at higher price points, but the overall trend is still downward. These patterns confirm that farmers respond to price variation in a way that is consistent with economic theory, and that demand for seed is indeed price-sensitive—a necessary condition for mechanisms like screening, sunk cost, and signaling effects to operate.

5.2 Three-stage pricing analysis

Next, we use regressions to estimate Equation 1 and isolate screening, sunk cost, and signaling effects of prices. We do this for three categories of outcomes measured at different points along the causal impact chain. We present separate regressions for the crops (maize, teff and wheat) but also run models that pool across countries and crops.

5.2.1 Trial pack use

We start by testing if, and how, farmers used the seed trial pack. Indeed, the primary outcome in studies that look at the relative importance of screening and sunk cost effects is whether the product that was subsidized or provided for free was used for its intended purpose and not wasted, diverted or sold. Our first outcome variable is thus whether the seed trial pack was planted in the season that immediately followed the distribution of the seed trial packs.

¹⁰It is important to see the subtle but crucial distinction between price elasticity on the one hand and the three effects—and the screening effect in particular—on the other hand. Price elasticity of demand captures how the number of farmers who purchase the seed changes as its price increases. The screening effect, by contrast, is not about who purchases the seed, but about how the seed is used: it examines whether those who pay higher prices are more likely to actually plant the seed, because they tend to be farmers with higher expected returns or stronger motivation. While screening requires that demand is at least somewhat price-sensitive (so that not everyone buys at every price), the key distinction is that elasticity tells us how many farmers buy the seed, whereas screening tells us how those who buy it differ in how they use it.

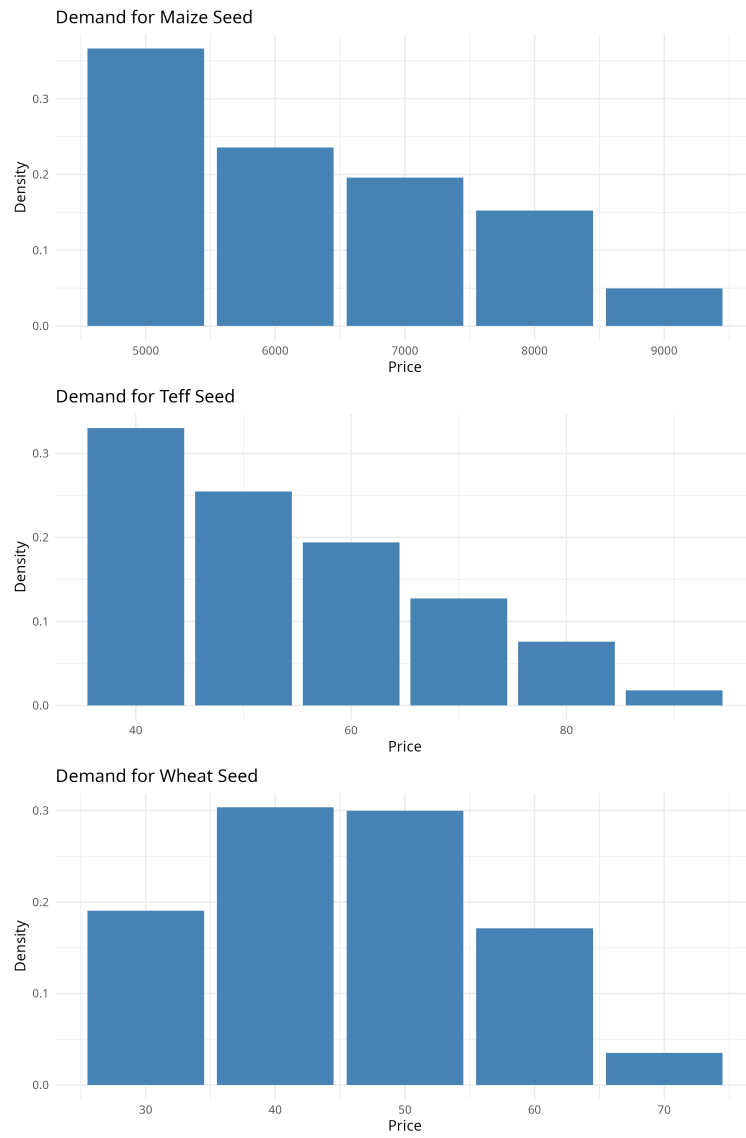


Figure 1: Distribution of WTP prices

The top panel of Table 2 shows results from a regression that pools across countries and crops.¹¹ Doing so, we find evidence of a significant screening effect: farmers with higher valuations of the seed, as proxied by the final price agreed upon during the bargaining game, are also more likely to have planted it. Results further show no evidence of a sunk cost effect on seed trial pack use: farmers who paid a positive price were no more likely to plant the seed than those with a surprise offer who received it for free, suggesting that paying for the technology does not increase farmers' psychological commitment to use it. Finally, a higher starting price at which the seed was initially offered reduces the likelihood that the seed is used for its intended purpose, suggesting a negative signaling effect. A plausible explanation for this unanticipated effect is that farmers who were initially offered a high price saw greater resale potential and chose to sell the seed rather than plant it, suggesting that price signals can divert products from their intended use when resale is feasible.

The next three panels below the pooled results in Table 2 shows results for regressions at the county-crop level. We find important differences between average seed trial pack use. For instance, while average seed trial pack use is close to 100 percent in the Uganda case, less than 70 percent of Ethiopian farmers used the wheat seed trial pack. There are also marked differences in the relative importance of screening, sunk cost and signaling effects between countries and crops. In Uganda, high overall seed trial pack use limits variation in the outcome, potentially attenuating the measured effects. Results from the pooled regression seem to be primarily driven by teff in Ethiopia, for which we also find a significant and negative sunk cost effect, implying that paying actually reduces use (conditional on valuation). This could be due to liquidity constraints: Even among farmers who value the seed similarly, those who had to pay for it may have less cash left over for complementary inputs or other production needs, reducing their ability to plant. Rather than reinforcing commitment, payment appears to create friction---a finding that challenges conventional wisdom on pricing as a behavioral tool.

Results are quite different if we look at wheat in Ethiopia. Here, we do find a sizable and significant sunk cost effect, in addition to a weak negative screening effect. Farmers who paid a positive price for the wheat seed trial pack were more likely to plant it than those who received it for free (keeping their valuation constant). This suggests that paying out-of-pocket for the seed increased their psychological commitment to make use of the technology. This could be because in Ethiopia, wheat is more commercially oriented, with clearer market outlets and government-backed productivity programs, so paying for seed is more likely to translate into planting. Teff markets, while important, are less tied to formal seed systems, and farmers often prefer their own saved seed, so purchasing a trial pack does not necessarily increase the likelihood of use.

Another indicator of appropriate use is whether farmers kept the seed separate during planting. Planting the seed separately (rather than mixing it with local varieties) reflects a deliberate intention to evaluate the promoted variety on

¹¹To do so, all variables were first standardized at the crop level.

its own merits, which may influence adoption decisions in subsequent seasons. While the pooled regression in the top panel of Table 2 shows no strong effects on this outcome, the crop-specific results reveal patterns consistent with those for general seed use: a positive sunk cost effect for wheat, along with negative sunk cost and signaling effects and some evidence of a positive screening effect for teff. For maize in Uganda, none of the coefficients are statistically significant, likely because overall, 94% of farmers kept the seed separate, leaving little room for variation from screening, sunk cost or signaling effects.

Similar to the case of planting, we also examine whether farmers kept the harvest from the seed trial pack separate. Doing so indicates that the variety's identity was maintained throughout the season, enabling an accurate assessment of its yield and other performance characteristics, and thus serves as an additional measure of appropriate use. The pooled regressions reveal a significant screening effect, driven entirely by teff in Ethiopia. For maize in Uganda and teff in Ethiopia, we observe negative sunk cost effects, whereas for wheat the sunk cost effect is positive. As with all use-related outcomes for teff in Ethiopia, we also find a negative signaling effect on this measure.

A final indicator of appropriate use concerns who actually planted the seed trial pack. The premise is that screening, sunk cost, and signaling effects may also influence whether the recipient plants the seed personally rather than passing it to someone else. Paying for the pack, for instance, may strengthen the motivation to plant it oneself instead of delegating it to a household member whose farming skills or practices are less certain. The results align closely with those for overall seed trial pack use, showing a positive screening effect and a negative signaling effect for the pooled regressions---both largely driven by teff in Ethiopia---and a positive sunk cost effect for wheat in Ethiopia.

All of these patterns are summarized in the indices, which reveal a strong and significant screening effect of prices on overall seed trial pack use. As with the individual outcomes, this effect is driven primarily by teff in Ethiopia. However, the index also shows that the individually insignificant but consistently positive coefficients of the WTP price across the various dimensions of maize seed trial pack use in Uganda combine to produce a statistically significant overall screening effect.

Judged by the index, seed trial packs exhibit negative sunk cost effects: after controlling for willingness to pay and signaling effects, farmers who received the pack for free made more appropriate use of it---across the combined dimensions in the index---than those who paid a positive price. The overall negative sunk cost effect is found for both maize in Uganda and teff in Ethiopia. Interestingly, for wheat we find the reverse: here (positive) sunk cost effects do seem at play. The negative sunk cost effects for maize in Uganda and teff in Ethiopia likely reflect liquidity constraints that reduced farmers' ability to invest in complementary inputs after paying for the seed, whereas the positive effect for wheat in Ethiopia suggests that in this more commercially oriented crop, the commitment induced by payment outweighed such constraints.

Finally, the coefficient on the initial offer price on the index is only weakly significant in the pooled model. Only for teff in Ethiopia, a clear negative

Table 2: Effects on Use of Trial Seed

	mean	signaling	screening	sunk cost	nobs
			<i>Pooled</i>		
Used trial pack as seed (1=yes)		-0.042*	0.03*	-0.072	1673
		(0.017)	(0.012)	(0.048)	
Kept seed separate (1=yes)		-0.033 ⁺	0.006	-0.068	1651
		(0.017)	(0.013)	(0.049)	
Kept harvest separate (1=yes)		0.003	0.016	-0.203**	1607
		(0.018)	(0.013)	(0.051)	
Buyer used seed him/herself (1=yes)		-0.041*	0.023 ⁺	-0.105*	1652
		(0.018)	(0.013)	(0.051)	
Index		-0.023	0.023 ⁺	-0.204**	1607
		(0.018)	(0.013)	(0.05)	
			<i>Uganda - maize</i>		
Used trial pack as seed (1=yes)	0.972	-0.004	0.005	-0.014	749
	(0.165)	(0.005)	(0.003)	(0.012)	
Kept seed separate (1=yes)	0.94	-0.005	-0.002	-0.003	727
	(0.238)	(0.007)	(0.004)	(0.018)	
Kept harvest separate (1=yes)	0.713	0.007	0.004	-0.122**	683
	(0.452)	(0.015)	(0.008)	(0.035)	
Buyer used seed him/herself (1=yes)	0.918	-0.011	0.002	-0.044*	728
	(0.275)	(0.009)	(0.005)	(0.021)	
Index	0.12	-0.001	0.006	-0.114**	683
	(0.341)	(0.011)	(0.006)	(0.026)	
			<i>Ethiopia - teff</i>		
Used trial pack as seed (1=yes)	0.818	-0.035**	0.031**	0.132**	554
	(0.386)	(0.012)	(0.011)	(0.045)	
Kept seed separate (1=yes)	0.796	-0.037**	0.026*	0.124*	554
	(0.403)	(0.013)	(0.012)	(0.048)	
Kept harvest separate (1=yes)	0.715	-0.035*	0.04**	0.134*	554
	(0.452)	(0.015)	(0.014)	(0.056)	
Buyer used seed him/herself (1=yes)	0.584	-0.05**	0.056**	0.132*	554
	(0.493)	(0.016)	(0.015)	(0.063)	
Index	0	-0.091**	0.094**	0.289**	554
	(0.844)	(0.027)	(0.025)	(0.103)	
			<i>Ethiopia - wheat</i>		
Used trial pack as seed (1=yes)	0.71	-0.023	0.002	-0.183**	370
	(0.454)	(0.02)	(0.018)	(0.047)	
Kept seed separate (1=yes)	0.695	-0.011	0.001	-0.18**	370
	(0.461)	(0.021)	(0.018)	(0.049)	
Kept harvest separate (1=yes)	0.627	-0.001	0.022	-0.151**	370
	(0.484)	(0.022)	(0.02)	(0.053)	
Buyer used seed him/herself (1=yes)	0.542	-0.009	0.009	-0.103 ⁺	370
	(0.499)	(0.024)	(0.021)	(0.056)	
Index	0	-0.008	0.029	-0.265**	370
	(0.878)	(0.04)	(0.036)	(0.095)	

Note: Variables are standardized for pooled regressions. **, *, and + denote significance at the 1, 5, and 10% levels.

signaling effect is found for the seed trial pack index. The stronger negative signaling effect for teff in Ethiopia may reflect farmers’ preference for their own local seed for this traditional staple crop. When the initial offer price is high, it may also increase the perceived resale value of the trial pack, prompting farmers to sell rather than plant it. In contrast, wheat is more commercially oriented, with stronger market linkages and institutional support, so even at high initial offer prices farmers are more likely to interpret the price as a quality signal and plant the seed rather than sell it.

5.2.2 Adoption and production in subsequent season

Adoption of the promoted technology in the subsequent season is particularly relevant, as seed trial packs are designed not only to encourage initial experimentation but also to foster sustained uptake of the variety. Measuring behavior in the following season therefore reveals whether farmers’ trial experiences translate into repeated use and longer-term impacts. Further down the causal chain, we also examine whether production and productivity of the underlying crop varies with the prices signaled, negotiated, and ultimately paid.

Table 3 again has the top panel showing the pooled regression results, while the three lower panels show results of maize in Uganda, teff in Ethiopia, and wheat in Ethiopia, respectively. The table shows results for 4 different outcomes, which are again aggregated into an index following [Anderson \(2008\)](#). The first two outcomes measure adoption, whilst the remaining two are related to production. All data is derived from a randomly selected plot cultivated by the household.

The first outcome determines if seed of an improved variety was used on the randomly selected plot.¹² The second outcome is more specific, and asks if the promoted variety (ie. the one from the seed trial pack) was planted on the randomly selected plot.

We find that about 22 percent of Ugandan maize farmers used quality seed of improved varieties on the randomly selected plot. Focusing specifically on the variety promoted in the study, roughly 11 percent planted Bazooka. In Ethiopia, these shares are substantially higher: about 60 percent and 70 percent of farmers reported using improved varieties of teff and wheat, respectively. These differences are mirrored in adoption of the promoted variety, with 34 percent for teff and 31 percent for wheat.

Looking at the pooled regressions, we do not find any significant screening, sunk cost, or signaling effects on adopting any improved variety. However, when considering adoption of the promoted variety, we do find that farmers with a higher willingness to pay are also more likely to have adopted it in the

¹²More specifically, we asked a range of questions about the seed planted on the randomly selected plot, including its name, number of times the seed was recycled, and source of the seed, etc. Based on this information, we define a variable indicating “used improved seed”, coded as true if the farmer planted a fresh hybrid or an OPV recycled no more than five times, obtained from a trusted source (generally an agro-input dealer or the government extension system).

subsequent season, an effect driven primarily by teff in Ethiopia. This aligns with the earlier findings on seed trial pack use, where screening effects for teff also played a central role.

Turning to production (measured in kilogram produced on the randomly selected plot) and productivity (production divided by the area of the randomly selected plot), the pooled regression provides suggestive evidence of a screening effect. However, this time the results seem to be driven by maize in Uganda: For each 1000 UGX increase in the valuation of the seed trial pack, production in the subsequent year increased by almost 20 kilograms, which corresponds to about 5 % over the mean. The significant screening effect disappears at the intensive margin (productivity), suggesting that farmers with a higher valuation also expand plot size.

To summarize these results, the index results point to the presence of screening effects in longer-run adoption and production outcomes, with the strongest patterns observed for teff in Ethiopia, particularly for adoption of the promoted variety. Compared to the results for seed trial pack use, these effects are less pronounced and statistically less robust, which is to be expected given that these outcomes are realized further along the impact pathway, where initial price-related mechanisms are likely to weaken as other factors such as seasonal conditions, market dynamics, and farmers' evolving situation and preferences play a greater role.

5.2.3 Complementary input use

Finally, we look at screening, sunk cost and signaling effects with respect to complementary inputs. In particular, we check if farmers used fertilizers (organic or inorganic) on the randomly selected plot. We also inquire about chemicals (pesticides, insecticides, and fungicides). Complementary inputs are very important for yield benefits of improved seed varieties to materialize, a fact that is not always appreciated by farmers, especially if a lot of money has already been invested in acquiring the seed (Miehe et al., 2025).

Examining complements may thus help in clarifying mechanisms: screening may operate because farmers with a higher WTP are those prepared to deploy the necessary inputs; sunk cost may raise or lower complementary investment depending on whether payment increases commitment or tightens liquidity; and price signals may shift expectations about quality and therefore the optimal intensity of complementary use. By tracking complements, we can interpret adoption and yield results more accurately and speak to policy design, for example whether subsidies should be bundled with input vouchers or guidance rather than applied to seed alone.

In the pooled results, reported in the top panel in Table 4, higher willingness to pay is associated with greater use of complementary inputs, with a positive screening coefficient the input index. This effect seems to be mainly driven by fertilizer use. By contrast, sunk cost effects are negative for complementary input use: Paying for the seed appears to tighten cash and crowd out complementary investment. We do not find signaling effects in the pooled model.

Table 3: Effects on Adoption and Production

	mean	signaling	screening	sunk cost	nobs
		<i>Pooled</i>			
Used improved seed on random plot (1=yes)		0.002 (0.019)	0.022 (0.014)	-0.034 (0.054)	1458
Used promoted seed on random plot (1=yes)		-0.026 (0.019)	0.046** (0.014)	-0.036 (0.054)	1458
Production (kg)		-0.034+ (0.019)	0.021 (0.014)	-0.023 (0.055)	1439
Productivity (kg/acre)		-0.024 (0.021)	0.024+ (0.014)	-0.091 (0.059)	1238
Index		-0.025 (0.021)	0.054** (0.014)	-0.038 (0.058)	1238
		<i>Uganda - maize</i>			
Used improved seed on random plot (1=yes)	0.219 (0.414)	0.012 (0.013)	0.006 (0.008)	0.029 (0.032)	703
Used promoted seed on random plot (1=yes)	0.114 (0.318)	0.003 (0.01)	0.005 (0.006)	0.014 (0.024)	703
Production (kg)	381.248 (389.54)	-13.55 (12.593)	19.135** (7.143)	6.31 (29.987)	684
Productivity (kg/acre)	489.523 (374.231)	-14.303 (12.224)	10.022 (6.954)	-55.862+ (29.122)	671
Index	-0.005 (0.71)	-0.01 (0.023)	0.026+ (0.013)	-0.004 (0.055)	671
		<i>Ethiopia - teff</i>			
Used improved seed on random plot (1=yes)	0.695 (0.461)	-0.003 (0.017)	0.012 (0.016)	-0.006 (0.064)	497
Used promoted seed on random plot (1=yes)	0.348 (0.477)	-0.039* (0.017)	0.061** (0.016)	0.112+ (0.065)	497
Production (kg)	456.121 (960.294)	2.567 (36.048)	-41.611 (33.48)	-100.583 (137.706)	497
Productivity (kg/acre)	1352.957 (2150.094)	35.983 (91.192)	71.223 (82.351)	-103.43 (344.397)	384
Index	-0.004 (0.499)	-0.01 (0.02)	0.046* (0.018)	0.047 (0.077)	384
		<i>Ethiopia - wheat</i>			
Used improved seed on random plot (1=yes)	0.622 (0.486)	-0.047+ (0.027)	0.04 (0.024)	-0.096 (0.063)	258
Used promoted seed on random plot (1=yes)	0.325 (0.469)	-0.023 (0.027)	0.037 (0.024)	-0.104 (0.063)	258
Production (kg)	730.742 (1882.932)	-72.491 (112.688)	-99.772 (100.584)	-315.945 (259.928)	258
Productivity (kg/acre)	2625.63 (7156.356)	-865.954 (524.224)	179.709 (478.255)	-387.895 (1244.673)	183
Index	-0.025 (0.479)	-0.082* (0.033)	0.061* (0.031)	-0.069 (0.08)	183

Note: Variables are standardized for pooled regressions. **, *, and + denote significance at the 1, 5, and 10% levels.

Table 4: Effects on Inputs

	<i>Pooled</i>				
	mean	signaling	screening	sunk cost	nobs
Used fertilizer		-0.002 (0.019)	0.018 (0.014)	-0.078 (0.054)	1483
Used chemicals		-0.02 (0.019)	0.001 (0.013)	0.028 (0.053)	1483
Index		-0.014 (0.019)	0.011 (0.014)	-0.029 (0.054)	1483
<i>Uganda - maize</i>					
Used fertilizer	0.546 (0.498)	0.001 (0.015)	0.021* (0.009)	-0.089* (0.037)	728
Used chemicals	0.285 (0.452)	-0.009 (0.014)	0.009 (0.008)	-0.033 (0.034)	728
Index	0 (0.793)	-0.008 (0.025)	0.031* (0.014)	-0.126* (0.059)	728
<i>Ethiopia - teff</i>					
Used fertilizer	0.981 (0.136)	0.002 (0.004)	-0.002 (0.004)	-0.014 (0.016)	497
Used chemicals	0.766 (0.423)	0.008 (0.012)	-0.021+ (0.012)	-0.026 (0.047)	497
Index	0 (0.726)	0.016 (0.021)	-0.03 (0.02)	-0.084 (0.082)	497
<i>Ethiopia - wheat</i>					
Used fertilizer	0.996 (0.059)	-0.001 (0.004)	-0.001 (0.003)	0.006 (0.008)	258
Used chemicals	0.728 (0.446)	-0.056* (0.025)	0.04+ (0.022)	0.148* (0.057)	258
Index	0 (0.741)	-0.068 (0.043)	0.034 (0.038)	0.214* (0.099)	258

Note: Variables are standardized for pooled regressions. **, *, and + denote significance at the 1, 5, and 10% levels.

Turning to crop specific regressions, for the case of maize seed trial packs in Uganda, overall use of inputs is moderate (about 55 percent for fertilizer and 29 percent for chemicals). Screening effects are positive, albeit not significantly so for chemicals. Sunk cost effects are negative: Farmers who value the seed more invest more in fertilizer, but payment reduces their ability to do so, consistent with liquidity constraints.

For both teff and wheat in Ethiopia, complementary input use is already near universal for fertilizer and high for chemicals, reflecting Ethiopia's strong government-led input supply system, coordinated through centralized procurement and distribution via cooperatives and extension agents. Coefficients are small and not statistically significant across mechanisms. Only for chemical use for wheat, screening effects are positive, and sunk cost effects and signaling effects are negative.

Taken together, complementary inputs echo the seed-use story. Where there is room to vary management, we see positive screening effects and negative sunk cost effects, that is, selection on willingness to pay and crowd-out from payment;

where input use is saturated, these effects are muted.

6 Conclusion

In this paper, we examined how pricing influences the introduction of a new technology, using the case of improved seed varieties for teff, wheat and maize distributed to smallholder farmers in Ethiopia and Uganda. While temporary discounts are often justified as a way to encourage trial of an unfamiliar product or service, critics argue that free provision can lead to waste or misuse. We tested whether charging a positive price affects use and adoption through three distinct mechanisms. First, prices may serve as a screening device, ensuring that products are allocated to those who value them most. Second, having paid for a product may foster a sense of commitment, since not using it would mean wasting the money spent, consistent with the sunk cost rationale in behavioral economics. Third, goods obtained for free or at a very low price may be perceived as lower quality, reducing the effort and care invested in their use.

We identified the three mechanisms through a novel field experiment that used a three-stage pricing design. In the first stage, a product (a seed trial pack) was offered at an initial offer price that may serve as a quality signal. In the second stage, farmers participated in a bargaining game, which revealed their willingness to pay price for the product. In the third stage, a randomly selected group of farmers received a surprise discount, resulting in variation between the final offer and actual transaction price. In a regression framework, these three prices allowed us to separately estimate the signaling, screening, and sunk cost effects, while controlling for the other mechanisms.

We test whether each of these three prices affect if and how the seed trial packs were used, how prices affected adoption and production in the next season, and if price affected investment in complementary inputs. Overall, we found that higher willingness to pay is often associated with greater use of seed trial packs, adoption of the promoted variety in the following season, and in some cases higher production, consistent with a screening effect. By contrast, paying for the seed seldom strengthened commitment to use and in some cases reduced appropriate use or complementary investments, potentially due to liquidity constraints. Initial high offer prices did not reliably act as positive quality signals and in some instances discouraged planting. These patterns were not uniform across settings: for wheat in Ethiopia, paying a positive price appeared to increase commitment to use, while for teff, screening effects were more pronounced but high initial prices reduced use, likely due to strong preferences for local seed or resale incentives. This heterogeneity highlights that the influence of price depends on both crop characteristics and the surrounding market and input supply context.

These findings have several implications for the pricing of seed trial packs in efforts to promote improved agricultural technologies. First, the consistent evidence of positive screening effects suggests that charging a low, symbolic price can help target seed packs to farmers most likely to plant and adopt the

promoted varieties. However, even modest prices can reduce diversion or misuse and improve the cost-effectiveness of distribution programs, particularly where resources are limited and follow-up is costly.

Second, the presence of negative sunk cost effects cautions against relying on payment to boost commitment. In our setting, paying for seed generally did not increase use (except maybe for wheat in Ethiopia) and in some cases reduced appropriate use or investment in complementary inputs, likely due to liquidity constraints. This suggests that charging higher prices may inadvertently undermine learning and adoption by reducing farmers' ability to manage the crop effectively. Where targeting is needed, low prices should be coupled with measures that support access to complementary inputs, such as input vouchers or extension advice.

Third, the weakly negative signaling effects indicate that higher initial offer prices are unlikely to serve as reliable indicators of quality and may in some cases discourage planting. This risk is greater in contexts where farmers have strong preferences for local seed or where resale markets exist. Pricing strategies should therefore avoid inflated or misleading reference prices and instead build trust through clear communication, demonstrations, or endorsements from credible sources.

Taken together, the results suggested that the most effective approach was to set a modest price that enabled targeting without creating financial barriers, while using additional targeting mechanisms beyond price (such as limiting distribution to active farmers, using extension agents' local knowledge, or requiring simple expressions of interest) to ensure seed reached those most likely to use it. Our findings also indicated that the effects of pricing may be technology- and context-specific, underscoring the need to tailor strategies to the local market, crop characteristics, and input supply conditions. To avoid the negative effects of payment on input use, programs should have safeguarded farmers' ability to invest in complementary inputs, for instance by bundling fertilizer or chemicals with the seed trial pack, offering small input vouchers, or scheduling input credit alongside seed distribution. Trust in the product could have been strengthened through non-price signals such as field demonstrations, peer testimonials, or endorsements from credible local actors.

7 Ethical clearance

This research received clearance from Makerere’s School of Social Sciences Research Ethics Committee (MAKSSREC 01.23.627/PR1) as well as from IFPRI IRB (DSGD-23-0108). The research was also registered at the Ugandan National Commission for Science and Technology (SS1657ES).

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9 Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used ChatGPT in order to refine phrasing, improve clarity and structure, and prepare materials for publication and dissemination. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article.

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Online Appendix

Table A1: Effects on Use of Trial Seed

	mean	signaling	screening	sunk cost	nobs
			<i>Pooled</i>		
Used trial pack as seed (1=yes)		-0.043*	0.036**	-0.01	1673
		(0.017)	(0.012)	(0.007)	
Kept seed separate (1=yes)		-0.035*	0.011	-0.008	1651
		(0.017)	(0.012)	(0.007)	
Kept harvest separate (1=yes)		0	0.031*	-0.03**	1607
		(0.018)	(0.013)	(0.008)	
Buyer used seed him/herself (1=yes)		-0.043*	0.031*	-0.015*	1652
		(0.018)	(0.013)	(0.008)	
Index		-0.026	0.038**	-0.03**	1607
		(0.017)	(0.012)	(0.007)	
			<i>Uganda - maize</i>		
Used trial pack as seed (1=yes)	0.972	-0.003	0.006+	-0.002	749
	(0.165)	(0.005)	(0.003)	(0.002)	
Kept seed separate (1=yes)	0.94	-0.005	-0.002	0.001	727
	(0.238)	(0.008)	(0.005)	(0.003)	
Kept harvest separate (1=yes)	0.713	0.007	0.013	-0.018**	683
	(0.452)	(0.015)	(0.009)	(0.006)	
Buyer used seed him/herself (1=yes)	0.918	-0.01	0.005	-0.006+	728
	(0.275)	(0.009)	(0.005)	(0.003)	
Index	0.12	0	0.014*	-0.017**	683
	(0.341)	(0.011)	(0.007)	(0.004)	
			<i>Ethiopia - teff</i>		
Used trial pack as seed (1=yes)	0.818	-0.033**	0.027**	0.02**	554
	(0.386)	(0.011)	(0.01)	(0.007)	
Kept seed separate (1=yes)	0.796	-0.035**	0.023*	0.019*	554
	(0.403)	(0.011)	(0.01)	(0.007)	
Kept harvest separate (1=yes)	0.715	-0.03*	0.038**	0.019*	554
	(0.452)	(0.013)	(0.012)	(0.009)	
Buyer used seed him/herself (1=yes)	0.584	-0.05**	0.05**	0.019*	554
	(0.493)	(0.014)	(0.013)	(0.009)	
Index	0	-0.086**	0.085**	0.042**	554
	(0.844)	(0.024)	(0.022)	(0.015)	
			<i>Ethiopia - wheat</i>		
Used trial pack as seed (1=yes)	0.71	-0.019	0.01	-0.05**	370
	(0.454)	(0.02)	(0.017)	(0.01)	
Kept seed separate (1=yes)	0.695	-0.007	0.009	-0.049**	370
	(0.461)	(0.02)	(0.017)	(0.01)	
Kept harvest separate (1=yes)	0.627	0.002	0.028	-0.042**	370
	(0.484)	(0.022)	(0.019)	(0.011)	
Buyer used seed him/herself (1=yes)	0.542	-0.005	0.012	-0.032**	370
	(0.499)	(0.024)	(0.02)	(0.011)	
Index	0	-0.002	0.039	-0.076**	370
	(0.878)	(0.04)	(0.034)	(0.019)	

Note: Variables are standardized for pooled regressions. **, *, and + denote significance at the 1, 5, and 10% levels.

Table A2: Effects on Adoption and Production

	mean	signaling	screening	sunk cost	nobs
<i>Pooled</i>					
Used improved seed on random plot (1=yes)		0.005 (0.019)	0.021 (0.013)	-0.016 (0.013)	1458
Used promoted seed on random plot (1=yes)		-0.028 (0.019)	0.049** (0.013)	0.007 (0.013)	1458
Production (kg)		-0.034+ (0.02)	0.022 (0.014)	-0.006 (0.013)	1439
Productivity (kg/acre)		-0.024 (0.021)	0.028* (0.014)	-0.007 (0.015)	1238
Index		-0.026 (0.021)	0.056** (0.014)	0.005 (0.015)	1238
<i>Uganda - maize</i>					
Used improved seed on random plot (1=yes)	0.219 (0.414)	0.012 (0.013)	0.006 (0.008)	0.029 (0.032)	703
Used promoted seed on random plot (1=yes)	0.114 (0.318)	0.003 (0.01)	0.005 (0.006)	0.014 (0.024)	703
Production (kg)	381.248 (389.54)	-13.55 (12.593)	19.135** (7.143)	6.31 (29.987)	684
Productivity (kg/acre)	489.523 (374.231)	-14.303 (12.224)	10.022 (6.954)	-55.862+ (29.122)	671
Index	-0.005 (0.71)	-0.01 (0.023)	0.026+ (0.013)	-0.004 (0.055)	671
<i>Ethiopia - teff</i>					
Used improved seed on random plot (1=yes)	0.695 (0.461)	-0.001 (0.015)	0.013 (0.014)	-0.004 (0.01)	497
Used promoted seed on random plot (1=yes)	0.348 (0.477)	-0.046** (0.015)	0.056** (0.014)	0.021* (0.01)	497
Production (kg)	456.121 (960.294)	-5.432 (31.637)	-26.135 (29.461)	-14.859 (20.551)	497
Productivity (kg/acre)	1352.957 (2150.094)	5.906 (79.684)	75.376 (72.092)	4.183 (50.273)	384
Index	-0.004 (0.499)	-0.02 (0.018)	0.045** (0.016)	0.012 (0.011)	384
<i>Ethiopia - wheat</i>					
Used improved seed on random plot (1=yes)	0.622 (0.486)	-0.047+ (0.027)	0.046* (0.023)	-0.022+ (0.013)	258
Used promoted seed on random plot (1=yes)	0.325 (0.469)	-0.023 (0.027)	0.046+ (0.023)	-0.019 (0.013)	258
Production (kg)	730.742 (1882.932)	-82.52 (112.886)	-69.003 (96.45)	-33.259 (52.824)	258
Productivity (kg/acre)	2625.63 (7156.356)	-869.189+ (522.082)	216.248 (437.294)	-76.49 (246.896)	183
Index	-0.025 (0.479)	-0.083* (0.033)	0.067* (0.028)	-0.015 (0.016)	183

Note: Variables are standardized for pooled regressions. **, *, and + denote significance at the 1, 5, and 10% levels.

Table A3: Effects on Inputs

	mean	<i>Pooled</i>			nobs
		signaling	screening	sunk cost	
Used fertilizer		-0.002 (0.019)	0.024 ⁺ (0.013)	-0.017* (0.008)	1483
Used chemicals		-0.02 (0.019)	0 (0.013)	0.001 (0.008)	1483
Index		-0.014 (0.019)	0.014 (0.013)	-0.009 (0.008)	1483
<i>Uganda - maize</i>					
Used fertilizer	0.546 (0.498)	0.001 (0.015)	0.029** (0.009)	-0.015** (0.005)	728
Used chemicals	0.285 (0.452)	-0.009 (0.014)	0.011 (0.008)	-0.005 (0.005)	728
Index	0 (0.793)	-0.009 (0.025)	0.042** (0.015)	-0.02* (0.008)	728
<i>Ethiopia - teff</i>					
Used fertilizer	0.981 (0.136)	0.002 (0.004)	-0.001 (0.003)	-0.002 (0.002)	497
Used chemicals	0.766 (0.423)	0.008 (0.012)	-0.019 ⁺ (0.01)	-0.004 (0.007)	497
Index	0 (0.726)	0.016 (0.021)	-0.025 (0.017)	-0.014 (0.012)	497
<i>Ethiopia - wheat</i>					
Used fertilizer	0.996 (0.059)	-0.001 (0.004)	-0.002 (0.003)	0.001 (0.002)	258
Used chemicals	0.728 (0.446)	-0.056* (0.025)	0.029 (0.021)	0.03* (0.012)	258
Index	0 (0.741)	-0.068 (0.043)	0.018 (0.037)	0.044* (0.02)	258

Note: Variables are standardized for pooled regressions. **, *, and + denote significance at the 1, 5, and 10% levels.