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Incentivizing and nudging farmers to spread information: Experimental evidence from Ethiopia

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Abstract

Information does not flow freely through social networks. We use an experiment to study knowledge diffusion about an innovation (integrated pest management, IPM) in farmer groups in Ethiopia. Group leaders are incentivized to share knowledge with members through the conditional provision of material or social prestige rewards. We combine incentives with loss-framed messaging to leverage loss aversion. Incentives increase diffusion effort, and combining incentives with loss-framed messaging increases effort further. However, the treatments failed to induce follower farmers to experiment with IPM. We also document that reclaiming material rewards is difficult after a long delay, attenuating the effectiveness of the loss frame.

KEYWORDS

agricultural extension, clawback, integrated pest management, reference-dependent utility, social prestige vs material rewards

JEL CLASSIFICATION

O13, O33, Q12

1 | INTRODUCTION

Although widespread adoption of modern inputs and practices by smallholders is a precondition for meeting the Sustainable Development Goals related to food security and poverty in Africa, the

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uptake of such productivity-enhancing inputs remains incomplete (Pamuk et al., 2014). One well-known reason for this is lack of information (e.g., Foster & Rosenzweig, 1995, 2010).[1] If farmers are not informed about new technologies, do not know how to implement them, or are uncertain about their benefits, adoption will fail. Most governments invest in extension systems to promote the diffusion of information. A typical approach to extension involves targeting and training so-called lead (or model) farmers—often recruited from the subset of successful, entrepreneurial, and relatively well-educated farmers. After receiving some training, these lead farmers are supposed to share information with their co-villagers and peers.

This approach has produced disappointing outcomes in sub-Saharan Africa (de Janvry et al., 2016; Pamuk et al., 2014). The main reason is presumably that most extension systems are wildly underfunded. Other possible reasons include the absence of clear incentives for public sector extension workers, resulting in the application of low levels of effort (Dar et al., 2021), or selection of the "wrong" subsample of farmers as lead farmers. Although it is convenient for extension experts to work with advanced farmers, ordinary farmers are more likely to learn from peers similar to them rather than peers who set a shining example for the rest (BenYishay & Mobarak, 2019). Outcomes may also be disappointing because the implicit assumption that knowledge spreads spontaneously among intended beneficiaries, perhaps as a side effect of normal social interaction, is false. The current paper asks whether applying incentives and nudges (applying loss framed messages) promotes the diffusion of information about a specific agricultural innovation.

Several papers analyze social learning and study how information spreads through social networks (e.g., Bandiera & Rasul, 2006; Conley & Udry, 2010; Magnan et al., 2015; Beaman et al., 2021). New information does not always spread spontaneously, and typically the source should invest additional effort––especially when it is difficult or risky for farmers to mimic the behavior of successful adopters (Munshi, 2004). Additional instruction or information may be needed to implement an innovation successfully. However, unless there are strategic complementarities in adoption, lead farmers may not be interested in teaching others, as doing so involves an opportunity cost. Spreading information is a conscious choice that involves an effort cost, so economic reasoning based on incentives is likely relevant when explaining lead farmer behavior.

Shikuku et al. (2018) propose that lead farmers may be motivated by altruism, social prestige, or private gains when deciding to engage in information sharing. Hence, one solution is to promise a material incentive to lead farmers if they share information––compensating them for their effort cost. Recent research suggests that providing private incentives to farmers to spread information increases diffusion effort (BenYishay & Mobarak, 2019).[2] Shikuku et al. (2018) demonstrate that social prestige incentives may work equally well. The social prestige incentive they use is a material gift to the local community rather than the lead farmer herself. Gifts like a weighting scale for the community may be a source of status for individuals who "earned" them.

This paper evaluates the effectiveness of different approaches to incentivizing lead farmers to spread information about a new agricultural technology. We probe the robustness of earlier findings concerning private rewards (BenYishay & Mobarak, 2019) and social prestige (Shikuku et al., 2018) for a new technology (integrated pest management) in a novel context (rural Ethiopia). We extend the literature by (i) considering a new type of social prestige incentive with only symbolic value (rather than a material reward for the community), (ii) leveraging *existing* semiformal local institutions for knowledge diffusion rather than working with artificial institutions created during the experiment, and (iii) combining the private or social prestige incentive with a loss framed incentive (see below) and probing their interaction by leveraging loss aversion (and maybe shame). We are

[1]There are several other well-known reasons for incomplete adoption of modern inputs. For example, farmers must incur costs when trying to access markets and may lack the liquidity to pay for modern inputs (e.g., Duflo et al., 2011; Feder et al., 1985). Heterogeneity in returns to technologies among farmers implies that the adoption of new technologies may not be in the interest of all farmers (Suri, 2011).

[2]The effectiveness of incentives for technology diffusion was also demonstrated in other domains. For example, Sseruyange and Bulte (2018) study incentives and the spread of financial knowledge, and Alem and Dugoua (2022) study incentives and diffusion of knowledge about the benefits of a solar lamp.

among the first to apply loss-framed incentives in a real field experimental setting in a low-income country condition, where leveraging loss aversion is much more complex than in controlled (lab) settings. This implies a final (methodological) contribution: (iv) in addition to evaluating the *impact* of loss-framed incentives, we also examine their *feasibility* in a context characterized by imperfect contracting and long production cycles.

To study the impact of incentives and loss-framed messages in the context of smallholder social learning, we implement a randomized controlled trial (RCT) in northwestern Ethiopia. We introduce a new integrated pest, weed, and soil management system that promises several benefits to adopters––protection from pests and invasive weeds, and providing high-quality feed for livestock. In our study area, the conventional extension system uses a farmer training center (FTC) and the so-called "one-to-five groups" approach to disseminating agricultural information (Agricultural Transformation Agency [ATA] and Ministry of Agriculture [MoA], 2014). Groups of six smallholder farmers have one designated leader who receives training on the new technologies or practices and is expected to share lessons with his group members. We construct a sample frame consisting of 571 farmer groups from the lists of available groups in the villages and randomly allocate these groups to one of five experimental arms: (a) a control group, (b) two arms where group leaders receive a private incentive (a modern sickle) for diffusing information, and (c) two arms where leaders receive a social prestige incentive (a framed certificate of recognition). The sickle is an important farm tool for weeding and harvesting crops. The framed certificate signals the leader's successful participation in the experiment and only has symbolic value. Orthogonal to the incentive treatments, we introduce loss and gain frames so that, in total, we have four treatment groups.

In the gain frame, leaders are promised a reward in case of sufficient performance. In the loss frame, instead, leaders received their reward *up front*, but they have to return it in case of insufficient performance. Although gain and loss-framed incentives are perfectly isomorphic from a conventional economics perspective, the literature in behavioral economics emphasizes that their incentive effects are different if leaders are loss averse—that is, have a utility curve that is "kinked" at the endowment level. If returning a reward involves greater disutility than not winning a same-sized reward, leaders should supply greater effort with loss-framed incentives (Bulte et al., 2020).

From an intervenionist's perspective, it is an open question whether all types of rewards (incentives) can be "clawed back" in practice, as intended in the loss frame regime. Although up-front incentives can be easily reclaimed in lab-style settings, it is not obvious whether this is credible in the setting of a field experiment—especially if complete contracting is impossible and there is a long delay between the timing of the up-front payment and the actual measurement of performance. For example, workers can hide their reward or claim it is stolen or broken. Anticipating that they can hide their reward later, lead farmers may have little incentive to change their behavior now, and the effectiveness of the loss-framed incentive would be attenuated or even nullified.[3]

Our main results are as follows. We find that both private and social prestige incentives increase diffusion effort by lead farmers and promote knowledge diffusion to other farmers. These findings confirm insights from the existing literature. Extending the literature, we find evidence of interaction between incentives and the loss-framed message. Loss-framed incentives increase the effectiveness of social prestige incentives––losing prestige is worse than not obtaining it. This could reflect the power of shame. We also find that loss frames induce little extra effort, on average, when combined with a private reward. As mentioned above and further discussed below, this could reflect a lack of credibility of our threat to reclaim the material reward in case of insufficient performance.

Interestingly, we also find that diffusion effort by group leaders does not translate in additional experimentation and adoption by follower farmers. This suggests farmers face other constraints besides a lack of information or that access to information is a necessary but not a sufficient

[3]Fryer et al. (2018) study clawback incentives for teachers in a real school setting, with a full academic year between up-front payment and performance assessment. However, teachers are employed by the school, and the experimenters wrote a contract specifying outcomes in case of nonperformance. Instead, casual employment is common in low-income countries, and imperfect contracting is the norm. It is not clear that the clawback or loss frame be implemented under such circumstances.

condition for adoption. It is also important to realize that earning the rewards was conditional on information diffusion (instead of contingent on experimentation by follower farmers, as in BenYishay & Mobarak, 2019). In other words, the leaders responded to incentives but accomplished nothing more. Further study is required, but potential adoption barriers in the context of our study region could include labor and skill constraints, and a preference for intercropping with food crops rather than forage crops.

This paper is organized as follows. Section 2 provides additional information about loss-framed nudging. In Section 3 we sketch the experiment and provide testable predictions. In Section 4 we summarize our data and outline our identification strategy. Section 5 provides our regression results and examines how the combination of incentives and loss-framed messages affects diffusion effort and diffusion patterns. The discussion and conclusions ensue.

2 | THEORETICAL BACKGROUND

The experiment involves combinations of incentives and loss-framed messages to promote knowledge diffusion about a particular agricultural innovation. The notion that farmers respond to incentives needs no additional explanation, and neither does the idea that the prospect of earning a private reward can be a powerful stimulus (e.g., Lazear, 2000). The idea that people care about their social position and prestige, and that this affects their behavior, is also rather well-established and has been worked out in theory (e.g., Benabou & Tirole, 2006) and demonstrated in empirical work (e.g., Ashraf et al. 2014; Carpenter & Myers, 2010). However, the hypothesis that the provision of effort can be manipulated by framing rewards as a gain or a loss is more controversial. We will elaborate on that hypothesis in this section.

Focus on the case of material rewards first. An assumption underlying the effectiveness of loss-framed incentives is that a sizable fraction of the population displays reference-dependent preferences or is loss averse (e.g., Kahneman and Tversky, 1979). Kőszegi and Rabin (2006) developed a model of reference-dependent utility where an individual's utility consists of two components: conventional consumption utility and so-called "gain–loss utility." Specifically, utility is assumed to depend on a consumer's k-dimensional consumption vector $\boldsymbol{c}$ and a reference vector $\boldsymbol{r}$, as follows:

$$u(\boldsymbol{c}|\boldsymbol{r}) = \sum_k m_k(c_k) + \sum_k \mu(m_k(c_k) - m_k(r_k)). \tag{1}$$

The first term on the right-hand side captures utility derived from consuming good k. The second term introduces reference dependence and captures gain–loss utility. Value function μ is defined as: $\mu(x) = \eta x$ for $x > 0$ and $\mu(x) = \eta\lambda x$ for $x < 0$, where parameter η is the idiosyncratic weight attached to gain–loss utility, and λ is the consumer's coefficient of loss aversion. Parameter λ is assumed to be greater than unity ($\lambda > 1$), so that utility loss associated with outcomes c_k below reference value r_k are greater than utility gains from equal-sized realizations in excess of r_k.[4] Kahneman and Tversky (1979) speculate that reference points may be based on current *endowments* (agents want to keep what they have), *expectations* (agents want to obtain what they expect to receive), or *aspirations*. Recent experimental work examined the role of endowments and expectations in reference point formation (e.g., Abeler et al., 2011; Ericson & Fuster, 2011; Banerji & Gupta, 2014; Heffetz & List, 2014).

If economic agents maximize (1), then manipulating reference points r_k will provoke a behavioral response. Specifically, if reference points shift in response to varying the timing of rewards, then the framing of incentive designs invites an effort response. The idea is that up-front payment of rewards

[4]The implications of reference-dependent preferences are studied in several domains, including technology adoption (Dupas, 2014), housing demand (Simonsohn & Loewenstein, 2006), and labor supply (Crawford & Meng, 2011).

is akin to providing that agent with an endowment, which shifts reference point r_k. If recipients anchor on owning the reward, Equation (1) says that losing the reward is worse than not earning it (as $\lambda > 1$). The theory of loss-framed incentives exploits this idea. It proposes that up-front bonus payments, which should be returned in case of non-compliance, extract greater effort from agents than the promise of an *ex-post* bonus of the same size (in case of compliance).[5] Because workers have to return their rewards in case of underperformance, loss-framed incentives are also known as "claw-back" incentive regimes.

If information about individual behavior is public, then "image payoffs" may also enter. The idea of using social incentives to motivate desired behavior is to leverage public recognition. This means that information about behavior or performance should be shared with a relevant group of other people. In case a leader meets the norm, this may lead to pride. In contrast, falling short of the norm could cause feelings of shame. Tangney et al. (2007) emphasize that, from a psychological perspective, pride and shame are separate emotions of different valences. In other words, the welfare gain caused by an increase in status (pride) may be smaller than the welfare loss caused by an equal-sized decrease in status (shame). Indeed, Butera et al. (2022) study the welfare effects of positive and negative image payoffs (pride and shame, respectively) and find that the so-called *public recognition utility function* is nonlinear. The public recognition utility function may be "kinked"— akin to the consumption-based utility function that includes gain–loss utility. If so, applying a loss frame when using social incentives would be more effective than applying a gain frame.

3 | EXPERIMENTAL DESIGN AND PREDICTIONS

3.1 | The new technology

The intervention we study is a new agronomic approach in the study area developed to reduce pest infestation and improve soil fertility and fodder production. Push–pull technology (PPT) is a novel cropping system designed for integrated pests (e.g., stemborer, fall armyworm), weed, and soil management in cereal-livestock production systems (Khan et al., 2018; Pickett et al., 2014). It combines the target cereal crop with a pest repellent plant (push) and a trap plant (pull) to control pests. PPT is an intercropping system where maize or sorghum are grown with two other fodder crops: *desmodium* and *brachiaria*.[6] Both companion crops are perennial forage legumes, important to diversify income through enhancing livestock production and selling the fodder (Kassie et al., 2018). The push–pull system's high-quality forage supply is an additional incentive to farmers, given the shortage of grazing land in the study areas.

Stemborer and fall armyworm are the main pests affecting maize production in the study area, reducing maize yields by on average 12.3% and 16.2%, respectively. PPT reduces crop damage by pests (Fetene et al., 2021; Midega et al., 2018). It also increases and diversifies income (Kassie et al., 2018), increases women's nutrition security (Kassie et al., 2018) and farmers' resilience to

[5]Some evidence supports this line of reasoning. Several lab studies indicate that agents work harder in a loss-frame incentive regime. In a lab-style real effort experiment in Uganda, Bulte et al. (2020) found that workers are 30% more productive under a loss-frame than a gain-frame regime. Moreover, recognizing their own productivity response, many "sophisticated" workers self-select in a loss-framed incentive regime when given that option—using it as a commitment device for supplying high effort (see also Brownback & Sadoff, 2020 and Imas et al., 2017). Hossain and List (2012) worked with a Chinese electronics company and found that the threat of clawing back up-front bonuses raised the productivity of teams of workers. Fryer et al. (2018) found that up-front payments raise the productivity of schoolteachers compared to a conditional bonus scheme. Not all evidence supports the effect of loss-framed incentives. Smaller and sometimes insignificant effects are found in experiments on dieting (List & Samek, 2015), educational performance of school children (Levitt et al., 2016), recruitment (de Quidt, 2018), and effort provision during simple online tasks (DellaVigna & Pope, 2016).

[6]*Desmodium* is a fodder legume with repellent chemicals, grown between rows of cereals in the field, that "pushes" stemborers away from the field. Moreover, the root exudates of *desmodium* control the parasitic striga weed, causing abortive germination, and the plant contributes to improved soil fertility by nitrogen fixation, natural mulching, and erosion control. *Brachiaria* is grown at the field's edges and attracts stemborers––"pulling" them from the nearby cereal crop (e.g., Khan et al., 2018; Pickett et al., 2014). *Desmodium* and *brachiaria* seeds can be produced locally to enhance seed availability at a lower price.

climate shocks (Gugissa et al., 2022), and improves soil health (Ndayisaba et al., 2020, 2021). Some evidence suggests PPT reduces labor demand once established (Diiro et al. 2021). However, there are barriers to adoption. First, PPT is a labor-intensive technology during the first season of land preparation, planting, weeding, and trimming and harvesting of forage crops to avoid competition with main crops. Second, the companion (forage) crops compete with the main (food) crops for space. Third, a well-functioning seed system for companion crops does not exist yet. Fourth, adopting the technology requires knowledge––farmers require information and training to apply it on their farms.[7] Any of these constraints may be binding, and we focused on relaxing the third and fourth one. We made seed available that farmers could obtain at zero cost via extension workers and organized an extension intervention to promote the diffusion of information.

In this extension experiment we leverage an existing institution to promote the diffusion of knowledge about PPT. So-called "one-to-five groups" are a key component of the extension system in Ethiopia. Farmers form groups of six and then propose one group member as their "leader." This leader figure is targeted for training by extension officers promoting new technologies or practices and instructed to share new knowledge with other group members (also known as followers). Diffusion of information via one-to-five groups is therefore planned but not supervised or monitored. In our experiment, we try to increase the performance of existing one-to-five groups by incentivizing and loss-framed messaging group leaders to spend more time and effort spreading knowledge about PPT.

3.2 | The treatment arms

We organize our experiment in Jabi Tehnan district (Ethiopia), in 38 kebeles (or villages) and 113 subkebeles. We organized a census of the one-to-five groups in all 113 subkebeles in the district and randomly picked approximately five groups per subkebele for participation in the experiment. The total sample consists of 571 groups (and group leaders). All selected group leaders participated in a two-day theoretical and practical training session in their villages, offered by the International Centre of Insect Physiology and Ecology (*icipe*) and the Jabi Tehnan district agricultural office experts. The training took place in May 2018. Group leaders received training on PPT implementation techniques (correct spacing, row planting, timely weeding and harvesting of companion crops) and learned about its benefits. Group leaders were also offered seeds of the companion crops (*desmodium* and *brachiaria*). We made seeds available via village extension offices to stimulate experimentation, and both leaders and group members could access them at zero cost (in Season 1). They were advised to use vegetative propagation after Season 1 but could also purchase new seeds at cost-recovery prices (in Season 2).

After participating in the training, group leaders were assigned to one out of five experimental arms and learned about the incentive regime in which they would be working. Importantly, farmers heard about incentives *after* participating in the training, so their effort and learning are unaffected by the assignment to treatment arms. We assigned all group leaders from the same subkebele to the same experimental arm to avoid spillover effects.

One-third of the subkebeles were assigned to the control arm (38 subkebeles, 190 group leaders). These group leaders received the PPT training and were asked to share the information with their group members but received no incentives for knowledge diffusion. The remaining leaders were promised an incentive in case of sufficient knowledge diffusion within their own one-to-five group. Specifically, as a threshold for adequate leader performance, we used the rule that leaders should successfully train at least half of their group members (so that these members could pass a simple knowledge test—see below). One-third of the subkebeles were assigned to a private reward incentive, and group leaders were promised a sickle if they trained enough group members (38 subkebeles, 190 group leaders). Finally, one-third of the subkebeles were assigned to the social prestige incentive.

[7]Planting companion crops and separating *desmodium* from weeds during establishment are difficult tasks of implementing the technology. Until farmers have seen *desmodium* seedlings growing, they struggle to distinguish between weeds and the crop.

These leaders receive a "good performance" framed certificate if they trained at least half of their group members (38 subkebeles, 191 leaders).

After being assigned to receive a private or social reward, group leaders were randomly allocated to either a gain or loss frame.[8] Half of the group leaders in the private reward arm were promised the sickle as a *bonus* in case of sufficient performance. In what follows, we refer to this as the "private incentive framed as a gain" (*PIGF*). The other half of the leaders received the sickle as an *up-front* reward but were told they would have to return it if they failed to share knowledge with at least half of their follower farmers. These group leaders were in the "private incentive framed as a loss" group (*PILF*). Leaders in both *PIGF* and *PILF* were informed about the conditions for earning the sickle in an instruction session that was specific to their experimental arms. They received their reward in the privacy of their house. If a leader under-performed in the *PILF* arm, then the sickle would be reclaimed in private during a visit to the leader's house. Information about leader performance, relative to others, was kept private.

Leaders from the social prestige arm were also allocated to two subgroups: a "social incentive framed as a gain" group (*SIGF*) and a "social prestige incentive framed as a loss" group (*SILF*). Certificates of recognition were offered during an official village visit at which the village chief was also invited—either at baseline (*SILF*) or at endline (*SIGF*). The recall of certificates in case of insufficient performance, in the *SILF* arm, was organized as a "semi-public" event. Specifically, leaders who failed to meet the threshold were visited at their houses (to avoid the outright embarrassment of having to return their certificate during a public gathering), but village chiefs were informed about the outcomes during a separate visit. Group leaders were also informed about this sequence of events during separate instruction sessions organized for the leaders from the different experimental arms. Hence, we have four treatment groups and one control group. The experimental design is summarized in Table 1.

3.3 | Hypotheses

Based on the theory in Section 2, our predictions about the experimental outcomes are as follows.

1. The private and social prestige incentive will increase knowledge diffusion from the group leader to group members relative to the control group. We have no clear ex-ante predictions regarding whether the private or social prestige incentive is more powerful in promoting knowledge diffusion––this presumably is context -specific and, therefore, an empirical matter.
2. If group leaders are loss averse, then the loss frame is more successful in promoting knowledge diffusion than the gain frame when combined with the private incentive.
3. If the welfare loss due to shame is greater than the welfare gain due to pride, then the loss frame is more successful in promoting knowledge diffusion than the gain frame when combined with the social incentive.

Also, return to the challenge of implementing the loss frame "in the field" caused by the long delay between the up-front payment and the day of reckoning. An asymmetry exists between the social prestige reward and the material reward. Although claiming back the sickle requires some cooperation by the group leader, cooperation by the leader is not required to destroy the symbolic value of the social prestige reward. If group leaders fear that rumors about unsatisfactory performance may spread regardless of whether they retain or return their certificates, then the symbolic value of retained certificates will be nullified. Clawing back certificates should therefore be easier than clawing back sickles. This results in the final prediction.

[8]This means the number of groups in each of the four treatment arms is about half the number of groups in the control arm (see Table 1). We could have assigned fewer groups to the control arm to increase power for the comparisons that we make across the four incentive regimes. However, we are sufficiently powered to pick up small effects. Moreover, differences in intervention costs between participants from the treatment and control groups suggested an uneven ratio of participants from the four treatment arms to the control participants. The current assignment of groups to treatment is a compromise between these considerations.

TABLE 1 Summary of experimental design

***Sample frame*: 113 subkebelles (*K*), 571 lead farmers (*N*), 1684 follower farmers (*n*)**

Training only: $K = 38$, $N = 190$, $n = 565$

Private incentive: $K = 37$, $N = 190$, $n = 566$

- Private incentive framed as a gain (*PIGF*) $K = 18$, $N = 90$, $n = 271$
- Private incentive framed as a loss (*PILF*) $K = 19$, $N = 100$, $n = 295$

Social prestige incentive: $K = 38$, $N = 191$, $n = 554$

- Social prestige framed as a gain (*SIGF*) $K = 19$, $N = 91$, $n = 265$
- Social prestige framed as a loss (*SILF*) $K = 19$, $N = 100$, $n = 290$

4. In a field setting where material rewards can be hidden so that reclaiming them is difficult, then the "clawback" design is not credible and the loss frame should be less effective than the gain frame. This consideration is unlikely to be relevant for social prestige incentives.

We now explore the extent to which these predictions are supported by our data.

4 | DATA AND IDENTIFICATION STRATEGY

We obtained IRB approval for the experiment, preregistered the experiment,[9] and obtained informed consent from respondents and local officials. Well-trained enumerators and supervisors collected two waves of panel data using tablets. We collected baseline survey data in June–August 2018 before training the group leaders. We visited 113 subkebeles to survey selected group leaders and between three and four follower farmers per group. In total, 571 group leaders and 1684 follower farmers were interviewed. We collected information on household demographics, food security, crop and livestock production, plots owned and managed, exposure to and awareness of maize field pests (including stemborer, fall armyworm, and Striga weed), field pest controlling strategies, sources of agricultural information, and knowledge about farming practices.

Appendix Table S1 summarizes the baseline data for the group leaders and provides t-tests to check pre-existing differences across experimental arms. On average, leaders are 45 years old, have a family of 5.5 persons, and receive some 6 years of education. Nearly all leaders are male, and the main activity is crop farming. Half the leaders own a milking cow. There are few significant differences among leaders in their field pests experiences and knowledge. A sizable minority of the leaders know that stemborer, fall armyworm, and Striga weed constrain maize production. We include baseline controls to increase the precision of our impact estimates and control for any pre-existing differences. Appendix Table S2 summarizes baseline data for follower farmers. Again, assignment to treatment arms resulted in balanced groups. Joint significance tests based on a regression model with all baseline controls also indicate that treatment assignment is unrelated to group member or leader characteristics (not shown).

[9]The experiment was pre-registered at: https://www.socialscienceregistry.org/trials/5642AER.

We undertook the second survey wave in November 2020, after the second post-experimental cropping season, to measure group leader performance. We managed to revisit 558 group leaders and 1644 follower farmers; 53 respondents were missing during the follow up (13 group leaders and 40 follower farmers). These individuals had either moved or were not available. Regressing attrition status on baseline controls and treatment arms suggests that attrition is nearly random and not correlated with treatment status (see Appendix Table S3).

We collected data on PPT knowledge diffusion and experimentation during the follow-up survey. We use five different proxies to measure group leader effort: (i) whether or not the group leader organized at least one training event to share PPT knowledge with follower farmers (binary variable, based on whether follower farmers reported the occurrence of such an event); (ii) the number of group members that the leader reached out to individually (count variable––the number of follower farmers who reported having received PPT information from their leader during a one-on-one conversation); (iii) knowledge of follower farmers (binary variable based on whether farmers met a knowledge threshold about PPT: farmers should be able to mention at least two benefits as well as have a basic understanding of how PPT "works" in the field)[10]; (iv) PPT experimentation by leaders (binary variable indicating whether the group leader experimented with PPT on his plots, based on survey question and verified in the field); and (v) PPT experimentation by followers (binary variable whether any of the group members tried out PPT on their plots, based on survey question and verified in the field).

Outcome variables are summarized in Table 2, split across the five experimental arms. In the top row we summarize outcomes for the group leader performance test. In the control group, 64% of the leaders from the control group trained at least half of their group members about the benefits and implementation of PPT. Leaders in the various treatment arms consistently do better, especially in the *SILF* arm where 89% of the leaders trained enough follower farmers, presumably to avoid the shame of being exposed to a certificate recall.

Next, we turn to the dependent variables used in the regression analysis. In the control group nearly half the group leaders organized a session to discuss PPT, and, on average, leaders discussed PPT with nearly half of their follower farmers. However, only 9% of the follower farmers possessed basic knowledge of PPT. In the control group, about one-third of the leaders adopted PPT on their maize plot, but uptake by their group members was low. Overall, 64% of the group leaders shared knowledge with at least 50% of their group members. The active attitude of group leaders in the control group reflects that the one-to-five group is an existing and functioning institution in our study region. Group leaders have a clear mandate and are experienced in communicating with their peers.

However, it is obvious from descriptive statistics (Table 2) that various incentive and framing regimes outperform the control group. Treated group leaders appear more active and achieve higher knowledge scores among their followers than group leaders from the control group. But we also document that leaders did not manage to convince many follower farmers to adopt PPT on their plots –– neither in the control group nor in the intervention groups. Although adoption rates for leaders are in the 30%–50% range (depending on treatment), the adoption rate among follower farmers hovers around 5% only. Adoption by followers is low and not significantly different across arms. This suggests that some of the barriers to adoption discussed above prevented farmers from taking up the new technology.[11]

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[10]Advantages of PPT include: (i) control of stemborer and fall armyworm, (ii) reduction of soil erosion, (iii) improvement of soil fertility, and (iv) companion crops are an important source of animal feed. Regarding implementation and functioning, PPT involves (i) intercropping a leguminous fodder crop called *desmodium* with maize, (ii) *desmodium* pushes stemborer away from the maize, (iii) *brachiaria* is sown surrounding the maize plot; and (iv) *brachiaria* attracts the stemborer, "pulling" it from the maize field. If farmers are able to mention at least two advantages and two items regarding implementation and functionality, then she is defined to have "basic knowledge" about PPT and received a score of one for the binary variable (else a zero).

[11]In case of heterogeneity among follower farmers, it is conceivable that leader farmers tried to target the subsample of farmers who they expected to gain from their training. However, we do not have data to test this. Anyway, leaders were incentivized to train follower farmers regardless of whether they were likely to adopt. Perhaps outcomes would have been different if we had incentivized leader farmers to promote actual adoption or experimentation by leader farmers (as in BenYishay & Mobarak, 2019). This is left for future research.

TABLE 2 Descriptive statistics of performance measures

	Control	Private incentive framed as a gain (*PIGF*)	Private incentive framed as a loss (*PILF*)	Social prestige framed as a gain (*SIGF*)	Social prestige framed as a loss (*SILF*)
	Performance measure for reward				
Group leader meets threshold (50% follower farmers "knowledgeable")	0.64	0.81	0.75	0.71	0.89
	Dependent variables				
Leaders organized at least one training event to train group members about PPT (1 = yes)	0.46	0.61	0.58	0.55	0.73
Leaders provided PPT information to group members (Number of group members)	2.5	3.6	2.9	2.9	3.7
Leaders experimented with PPT on their maize plots (1 = yes)	0.29	0.51	0.34	0.42	0.44
Group members have knowledge of PPT (1 = have full knowledge)	0.09	0.37	0.38	0.34	0.38
Group members experimented with PPT on their maize plots (1 = yes)	0.04	0.04	0.06	0.04	0.03
Number of group leaders	190	90	100	87	91
Number of follower farmers	557	268	293	240	286

We use the following equations to estimate the impact of incentives and loss-framed messages on knowledge diffusion (effort)[12]:

$$Y_{is} = \alpha + \beta_1 \text{Private reward}_{is} + \beta_2 \text{Social prestige}_{is} + \gamma X_{is} + \delta_v + \varepsilon_{is}, \tag{2}$$

$$Y_{is} = \xi + \psi_1 \text{Gain frame}_{is} + \psi_2 \text{Loss frame}_{is} + \rho X_{is} + \delta_v + \varepsilon_{is}, \tag{3}$$

$$Y_{is} = \pi + \varphi_1 PIGF_{is} + \varphi_2 PILF_{is} + \varphi_3 SIGF_{is} + \varphi_4 SILF_{is} + \upsilon X_{is} + \delta_v + \varepsilon_{is}. \tag{4}$$

In Equation (2), we estimate the effect of private incentive and social prestige incentive on our five performance measures Y, conditional on the *ith* respondent baseline characteristics (X_{is}) in subkebele s, and kebele-level fixed effects, δ_v. The incentive treatment effect estimated in Equation(2) is not conditional on the loss-framed messages. Equation (3) estimates the effect of the loss frame on the same outcome variables. This treatment effect is not conditional on the underlying incentive (private or social prestige reward). Finally, Equation (4) introduces all four experimental groups separately via four dummy variables: *PIGF*, *PILF*, *SIGF*, and *SILF*. This model allows exploring whether incentives and loss-framed messages interact, for example, if group leaders are more sensitive to losing social prestige than the private reward. In Models (2–4), the control group is the omitted category.

[12]In this paper we report the outcomes of linear models. However, we obtain qualitatively similar results when we estimate (nonlinear) probit and Poisson models instead. (Results not shown but available on request.)

Because the unit of randomization was the subkebele level, we also cluster the standard errors at the subkebele level. To control for multiple hypotheses testing and reduce the false discovery rate (4 treatments $\times$ 5 dependent variables) we also report Anderson sharpened q-values, in addition to regular p-values, following Benjamini and Hochberg (1995).

Because we randomly assigned groups to treatment, the identifying assumptions are satisfied unless there are spillover effects from the treated groups to the control group (or from one treated group to another). This would violate the stable unit treatment value assumption, SUTVA. To minimize this risk, treatments are block randomized at the subkebele level––one treatment per subkebele. To further check whether the SUTVA is satisfied, we focus on the behavior of group leaders in the control group. We distinguish between two types of leaders: those living in kebeles without incentivized leaders (52 leaders) and those with leaders from any of the other treatment arms (138 leaders). We compare the diffusion effort of the control group leaders across these two groups to explore whether the nearby presence of incentivized leaders affects behavior.

5 | REGRESSION RESULTS

Table 3 summarizes the regression results of Equation (2) and describes the average effect of private and social prestige incentives on PPT knowledge diffusion. Below the coefficients we report p-values and FDR sharpened q-values (observe that q-values can be smaller or greater than p-values).

Both types of incentives induce group leaders to increase their diffusion effort––the propensity to organize a training event, one-on-one outreach to individual members, and experimentation by the leaders. We also find that both types of incentives promoted learning among group members, though this did not translate into significant uptake of PPT during the time interval of our study. Table 3, therefore, supports prediction 1. Private and social incentives are equally successful in promoting knowledge diffusion when measured at the level of follower farmers (Columns 4–5). However, leaders incentivized by a certificate are significantly more likely to organize a training event for group members (Column 1, $p = 0.04$) and to reach out to individual members (Column 2, $p = 0.07$).

Table 4 presents the average impact of gain- and loss-framed incentives, not controlling for the type of incentive. Both gain- and loss-framed incentives raise diffusion effort and knowledge diffusion, and leaders in a loss-framed regime are more likely to organize a training and information session with group members than their counterparts from the gain frame ($p = 0.09$). The long delay between up-front payment and performance measurement, on average, did not negate the effectiveness of loss-framed messaging. Table 4 supports Hypotheses 2 and 3.

Table 5 contains our main results, summarizes results for all combinations of incentive types and loss-framed messages separately, and compares the various coefficients to each other. The aggregate results in Tables 3,4 conceal quite a bit of heterogeneity. First, consider the impact of incentive- and loss-frame combinations on diffusion effort of group leaders (columns 1–3)––the key variables directly under the leader's control. All coefficients have the expected sign, and all but two are significantly different from zero. Social prestige framed as a loss wins the "horse race" for our two training variables—the propensity to organize a training event and the number of group members informed individually. The probability of organizing a training event increases by >60% (compared to the control group), and the number of group members reached by leaders increases by 44%. The former result is significantly greater than any of the other treatment effects ($p = 0.00$), and the latter is greater than the effect of the private reward framed as a loss ($p = 0.00$) or a gain ($p = 0.09$), and the social reward framed as a gain ($p = 0.00$).

The regression results in Table 5 suggest the following narrative. Leaders do not prefer a framed certificate of recognition over a sickle. If anything, leaders work harder to earn a material reward when a gain frame is used than a symbolic one: *PIGF* coefficients in Columns (1–3) in Table 5 are consistently larger than *SIGF* coefficients but not significantly different. But *losing* social prestige is

TABLE 3 Private and social prestige incentives

	Knowledge diffusion effort by leaders			*Follower outcomes*	
	Leader organized at least one training event	**Number of group members received PPT information from leaders**	**Leaders experiment with PPT**	**Group members have knowledge of PPT**	**Group members experiment with PPT**
Private reward	0.12** (0.03) (0.02)	0.54*** (0.01) (0.01)	0.16*** (0.02) (0.02)	0.24*** (0.00) (0.00)	−0.00 (0.80) (1.00)
Social prestige	0.24*** (0.00) (0.00)	0.94*** (0.00) (0.00)	0.15** (0.02) (0.02)	0.26*** (0.00) (0.00)	−0.01 (0.70) (1.00)
Village fixed effects	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes
Mean of dependent variables	0.56	2.9	0.38	0.27	0.04
R-squared	0.15	0.16	0.22	0.21	0.06
Number observations	558	558	558	1644	1644
Test of coefficients: Private vs. social incentives (*p*-values)	0.04	0.07	0.93	0.53	0.80

Note: All models are estimated with O.L.S., standard errors clustered by subvillage (the unit of randomization). The private reward is a sickle, and the social recognition is a framed certificate of good performance. Controls are *Household members* (number), *Household head age* (years), *Household head literacy* (1 = yes), *Primary activity farming* (1 = yes), *Lived in the village* (years), *Farm size* (hectare), *Grazing land* (hectares), *Knowledge of fall armyworm* (1 = yes), *FAW major constraint in maize production* (1 = yes), *Knowledge of stemborer* (1 = yes), *Stemborer (SB) major constraint in maize production*? (1 = yes), *Knowledge of striga* (1 = yes), *Striga is major constraint in maize production* (1 = yes), *Extension* (*Number of visits last 12 months*), *Credit constrained* (1 = yes), and *Household owns milking cow* (1 = yes). In parentheses, *p*-values and Anderson's sharpened *q*-values.

**$p < 0.05$. ***$p < 0.01$.

considered worse than losing the sickle. Leaders work harder to retain their certificate than their sickle ($p = 0.00$ in columns 1 and 2). Social prestige, therefore, affects leaders' behavior asymmetrically––although leaders invest modest levels of effort to earn it, they work quite hard to prevent losing it. This is consistent with the notion that (avoiding) shame is a powerful stimulus for behavior, or that the social prestige function is highly nonlinear (as in Butera et al., 2022). The coefficients associated with the social prestige incentive framed as a gain (*SIGF*) are relatively small. Weaker patterns emerge for the variable measuring whether the leaders experimented with the technology on one of their plots (column 3). Although the leaders from the *PILF* group cannot be statistically distinguished from the control group, and are less likely to experiment with the new technology than the leaders from the *PIGF* group, the differences across groups are small. Across all groups we find that about half the leaders experimented with PPT on their farm.

Overall, our regression results also suggest that the credibility of the loss frame is imperfect and varies with the nature of the incentive––consistent with Prediction 4 (and therefore in contrast to Prediction 2). To earn the private reward (sickle), leaders invest more effort in a gains frame (*PIGF*) than in a loss frame (*PILF*, column 3, $p = 0.09$). This is consistent with the assumption that some leaders believe that they can keep "their sickle" regardless of performance––for example, they may try to hide it from the experimenter. For none of the other leader coefficients do we find that the loss

TABLE 4 Gain and loss-framed incentives

	Knowledge diffusion effort by leaders			*Follower outcomes*	
	Leader organized at least one training event	**Number of group members received PPT information from leaders**	**Leaders experiment with PPT**	**Group members have knowledge of PPT**	**Group members experiment with PPT**
Gain frame	0.13** (0.02) (0.01)	0.65*** (0.00) (0.00)	0.19*** (0.00) (0.01)	0.28*** (0.00) (0.00)	0.01 (0.77) (1.00)
Loss frame	0.23*** (0.00) (0.00)	0.83*** (0.00) (0.00)	0.12* (0.07) (0.04)	0.24*** (0.00) (0.00)	−0.01 (0.39) (1.00)
Village fixed effects	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes
Mean of dependent variables	0.56	2.91	0.38	0.27	0.04
R-squared	0.15	0.16	0.22	0.21	0.06
Number observations	558	558	558	1644	1644
Test of coefficients: Gain vs. loss frame (*p*-values)	0.09	0.38	0.25	0.36	0.21

Note: All models are estimated with O.L.S., standard errors clustered by subvillage (the unit of randomization). The private reward is a sickle, and the social recognition is a framed certificate of good performance. Controls are *Household members* (number), *Household head age* (years), *Household head literacy* (1 = yes), *Primary activity farming* (1 = yes), *Lived in the village* (years), *Farm size* (hectare), *Grazing land* (hectares), *Knowledge of fall armyworm* (1 = yes), *FAW major constraint in maize production* (1 = yes), *Knowledge of stemborer* (1 = yes), *Stemborer (SB) major constraint in maize production*? (1 = yes), *Knowledge of striga* (1 = yes), *Striga is major constraint in maize production* (1 = yes), *Extension* (*Number of visits last 12 months*), *Credit constrained* (1 = yes), and *Household owns milking cow* (1 = yes). In parentheses, *p*-values and Anderson's sharpened *q*-values.
**$p < 0.05$. ***$p < 0.01$.

frame extracts greater effort than the gain frame. The reverse seems true (even if other differences are not significant). But, consistent with expectations, the same is not true for the social prestige incentive. The gains from prestige are not embodied in the certificate but the opinion of others. If a leader successfully hides the sickle, he can benefit from it in the future. The gains from social prestige are not embodied in the certificate. If knowledge spreads that the leader failed to meet the threshold, social prestige dissipates and shame is the result, regardless of whether the leader owns a certificate.

This intuition is consistent with follow-up data we collected. In our experiment, 25 leaders from the *PILF* group failed to meet the threshold. The same was true for only 10 leaders from the *SILF* treatment. After the end line, we tried to give complying leaders from the gain-frame treatment arms their rewards and tried to "claw back" the rewards from underperforming leaders from the two loss–frame arms. We were able to reach *all* leaders from the gain frame (100%). However, we could only contact 23 leaders from the *PILF* group and eight from the *SILF* group—an attrition rate of >11%. Perhaps some underperforming leaders from loss frame arms avoided us? More importantly, although all leaders from the *SILF* group voluntarily returned their reward, this was not true for leaders from the *PILF* group. Here, 24% of the leaders (or six leaders) refused to return their sickle, using a range of excuses. If some leaders from the *PILF* group anticipated that they would not comply with the experiment's rules, this explains the difference in the effectiveness of the incentive

TABLE 5 Incentives, gain–loss frames, and the diffusion of knowledge

Treatments	*Knowledge diffusion effort by leaders*			*Follower outcomes*	
	Leaders organized at least one training event	**Number group members received PPT information from leaders**	**Leaders experiment with PPT**	**Group members have knowledge of PPT**	**Group members experiment with PPT**
Private incentive framed as gain (*PIGF*)	0.15** (0.03) (0.04)	0.81*** (0.00) (0.00)	0.23*** (0.01) (0.03)	0.20*** (0.00) (0.00)	−0.03 (0.05) (0.25)
Private incentive framed as loss (*PILF*)	0.14** (0.04) (0.04)	0.44* (0.08) (0.04)	0.10 (0.14) (0.12)	0.27*** (0.00) (0.00)	0.01 (0.52) (1.00)
Social prestige framed as a gain (*SIGF*)	0.12 (0.11) (0.05)	0.46** (0.03) (0.03)	0.14* (0.08) (0.10)	0.26*** (0.00) (0.00)	−0.00 (0.96) (1.00)
Social prestige framed as a loss (*SILF*)	0.34*** (0.00) (0.00)	1.29*** (0.00) (0.00)	0.14* (0.09) (0.10)	0.27*** (0.00) (0.00)	−0.01 (0.69) (1.00)
Village fixed effects	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes
Mean of dependent variables	0.56	2.91	0.38	0.27	0.04
R-squared	0.16	0.17	0.22	0.21	0.06
Number observations	558	558	558	1644	1644
Test of coefficients:					
PIGF versus *PILF*	0.89	0.22	0.09	0.21	0.06
PIGF versus *SIGF*	0.77	0.25	0.40	0.28	0.11
PIGF versus *SILF*	0.02	0.10	0.34	0.17	0.20
PILF versus *SIGF*	0.84	0.94	0.68	0.88	0.40
PILF versus *SILF*	0.00	0.00	0.62	0.90	0.18
SIGF versus *SILF*	0.01	0.00	0.97	0.80	0.67

Note: All models are estimated with O.L.S., standard errors clustered by subvillage (the unit of randomization). The private reward is a sickle, and the social recognition is a framed certificate of good performance. Controls are *Household members* (number), *Household head age* (years), *Household head literacy* (1 = yes), *Primary activity farming* (1 = yes), *Lived in the village* (years), *Farm size* (hectare), *Grazing land* (hectares), *Knowledge of fall armyworm* (1 = yes), *FAW major constraint in maize production* (1 = yes), *Knowledge of stemborer* (1 = yes), *Stemborer (SB) major constraint in maize production*? (1 = yes), *Knowledge of striga* (1 = yes), *Striga is major constraint in maize production* (1 = yes), *Extension* (*Number of visits last 12 months*), *Credit constrained* (1 = yes), and *Household owns milking cow* (1 = yes). In parentheses, p-values and Anderson's sharpened q-values.
$^{**}p < 0.05$. $^{***}p < 0.01$.

regimes. An equal proportions test indicates that the share of group leaders refusing to return their reward is significantly greater for private rewards than social prestige rewards ($p < 0.05$).

Our analysis yields an additional result. Although the extra effort by leaders in treatment arms translated into more knowledge by followers (Column 4), it did not invite more experimentation by followers (Column 5). We speculate that this reflects the existence of barriers to adoption, as discussed above (e.g. labor, space, seed). If follower farmers do not want to adopt innovations, the returns to diffusion effort will be negligible. Although group leaders can be incentivized to work harder, reaching out to more farmers, the social return of these efforts is small if the context within which adoption should occur does not match the requirements of the innovation. Of course we should also consider that we incentivized leaders to promote knowledge diffusion among group members—not to promote experimentation by group members. Lead farmers did what was necessary to obtain (or keep) their reward and not much more. Using an experimental design with rewards contingent on experimentation by others would plausible produce different impacts (e.g., BenYishay & Mobarak, 2019) and would be a useful extension in future research.

Finally, we checked the existence of spillover effects. Appendix Table S4 reveals that the presence or absence of incentivized group leaders in the kebele does not change leaders' diffusion effort from the control group. We interpret this as weak evidence that inter-subkebele spillover effects are relatively unimportant. As mentioned, intra-subkebele spillover effects are ruled out by our design in which we assign all leaders from the same subkebele to the same experimental arm.

6 | DISCUSSION AND CONCLUSIONS

Many development experts believe that African smallholder farmers should adopt a greater range of productivity-enhancing inputs and practices if Africa is to reach the Sustainable Development Goals with respect to poverty, food security, and sustainable resource management. However, adoption levels are lagging behind expectations in many countries. Imperfect information flows may explain part of this––farmers may be unaware of innovations or be uncertain about how to implement them. But one lesson from our study is that adoption of push–pull technology is not just limited by a lack of information––other constraints impede uptake as well. Information is a necessary but not a sufficient condition for adoption.

We use an experimental design to analyze the effectiveness of two types of incentives—a private material reward and a social prestige reward—and examine how incentives interact with gain–loss framed messaging. We consider an existing institution for farmer extension in rural Ethiopia. In these so-called one-to-five group system, a group leader is responsible for sharing information with his five follower farmers. The loss-framed messaging we apply provides leaders with an up-front private or social reward that is "clawed back" in case of underperformance. This should make leaders work harder. In the case of a private reward, the loss frame leverages loss aversion, as leaders want to avoid losing their material endowment (if the threat of losing the up-front reward is perceived as credible). In the case of social prestige, leaders work harder because they want to avoid shame caused by losing social prestige.

Our main results are consistent with predictions. Group leaders who receive an incentive work harder than their peers from the control group to share information. Introducing a loss frame combined with a social incentive causes leaders to work even harder. This points to the salience of shame as a motivational emotion. The loss frame did little to improve the performance when combined with a material reward. This is consistent with the idea that several leaders did not believe that they would lose their up-front reward in case of underperformance. If clawing back material rewards after a long delay is difficult, the loss frame loses its credibility. Because hiding and keeping a material reward is "relatively easy," as proven by some of our respondents, we indeed find that the effectiveness of standard loss-framed messaging combined with material rewards is compromised in the field.[13]

This implies an important lesson for policy makers. Although loss-framed messaging can be used to increase effort, the "space" for applying them in a welfare-enhancing fashion may be narrower than heretofore expected. Clawing back private rewards may be difficult in real-life settings in low-income settings where incomplete contracting is the rule (rather than the exception). Although clawing back social prestige may be easier to accomplish, it is not obvious that designing and

[13]Not all leaders in a loss-frame regime anticipate refusing to return their rewards. But if some leaders believe they can hide their reward, then *average* performance of the incentive regime is compromised. This is what we find.

implementing such incentive systems will improve welfare (Butera et al., 2022). The prospect of shame associated with losing prestige may more than offset potential welfare gains due to improved efficiency and productivity. For example, workers may be reluctant to work for firms that leverage shame to make people work harder as part of their incentive regime. Much more work on the welfare effects of loss-framed social rewards is needed.

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REFERENCES

Abeler, J., A. Falk, L. Götte, and D. Huffman. 2011. "Reference Points and Effort Provision." *American Economic Review* 101(2): 470–92.

Agricultural Transformation Agency (ATA) and Ministry of Agriculture (MoA). 2014. *National Strategy for Ethiopia's Agricultural Extension System: Vision, Systemic Bottlenecks and Priority Interventions*. http://extwprlegs1.fao.org/docs/pdf/eth190334.pdf.

Alem, Y., and E. Dugoua. 2022. "Passive Learning and Incentivized Communication: A Randomized Controlled Trial in India." In *Economic Development and Cultural Change*. Chicago, IL: Chicago University Press.

Ashraf, N., O. Bandiera, and B. K. Jack. 2014. "No Margin, No Mission? A Field Experimenton Incentives for Public Service Delivery." *Journal of Public Economics* 120: 1–17.

Bandiera, O., and I. Rasul. 2006. "Social Networks and Technology Adoption in Northern Mozambique." *Economic Journal* 116: 869–902.

Banerji, A., and N. Gupta. 2014. "Detection, Identification and Estimation of Loss Aversion: Evidence from an Auction Experiment." *American Economic Journal: Microeconomics* 6(1): 91–133.

Beaman, L., A. BenYishay, M. Mobarak, and J. Magruder. 2021. "Can Network Theory-Based Targeting Increase Technology Adoption?" *American Economic Review* 111(6): 1918–43.

Benabou, R., and J. Tirole. 2006. "Incentives and Prosocial Behavior." *American Economic Review* 95(5): 1652–78.

Benjamini, Y., and Y. Hochberg. 1995. "Controlling the False Discovery Rate: A Practical and Powerfiul Approach to Multiple Testing." *Journal of the Royal Statistical Society: Series B* 57(1): 289–300.

BenYishay, A., and M. Mobarak. 2019. "Social Learning and Incentives for Experimentation and Communication." *Review of Economic Studies* 86(3): 976–1009.

Brownback, A., and S. Sadoff. 2020. "Improving College Instruction through Incentives." *Journal of Political Economy* 128(8): 2925–72.

Bulte, E. J. List, and D. van Soest. 2020. "Toward an Understanding of the Welfare Effects of Nudges: Evidence from a Field Experiment in Uganda." *Economic Journal* 130(632): 2329–53.

Butera, L., R. Metcalfe, W. Morrison, and D. Taubinsky. 2022. "Measuring the Welfare Effects of Shame and Pride." *American Economic Review* 112(1): 122–68.

Carpenter, J., and C. Myers. 2010. "Why Volunteer? Evidence of the Role of Altruism, Image, and Incentives." *Journal of Public Economics* 94: 911–20.

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

Crawford, V., and J. Meng. 2011. "New York City Cabdrivers' Labor Supply Revisited: Reference-Dependence Preferences with Rational Expectations Targets for Hours and Income." *American Economic Review* 101(5): 1912–32.

Dar, M., A. de Janvry, K. Emerick, E. Sadoulet, and E. Wiseman. 2021. Private Input Suppliers as Information Agents for Technology Adoption in Agriculture. Unpublished manuscript. University of California at Berkeley.

de Janvry, A., E. Sadoulet, and M. Rao. 2016. "Adjusting Extension Models to the Way Farmers Learn." In *Learning for Adoption: Technology Adoption in Developing Country Agriculture*. Clermont-Ferrand: FERDI Discussion Paper.

de Quidt, J. 2018. "Your Loss Is my Gain: A Recruitment Experiment with Framed Incentives." *Journal of the European Economic Association* 16(2): 522–59.

DellaVigna, S., and D. Pope. 2016. "What Motivates Effort? Evidence and Expert Forecasts." *Review of Economic Studies* 85(2): 1029–69.

Diiro, G., M. Fisher, M. Kassie, B. Muriithi, and G. Muricho. 2021. "How Does Adoption of Labor Saving Technologies Affect Intrahousehold Resource Allocations: The Case of Push-Pull Technology in Western Kenya." *Food Policy* 102: 102114.

Duflo, E., M. Kremer, and J. Robinson. 2011. "Nudging Farmers to Use Fertilizer: Theory and Experimental Evidence from Kenya." *American Economic Review* 101(6): 2350–90.

Dupas, P. 2014. "Short-Run Subsidies and Long-Run Adoption of New Health Products: Evidence from a Field Experiment." *Econometrica* 82(1): 197–228.

Ericson, K., and A. Fuster. 2011. "Expectations as Endowments: Evidence on Reference-Dependent Preferences from Exchange and Valuation Experiments." *Quarterly Journal of Economics* 126(4): 1879–907.

Feder, G., R. Just, and D. Zilberman. 1985. "Adoption of Agricultural Innovations in Developing Countries: A Review." *Economic Development and Cultural Change* 33(2): 255–98.

Fetene, G., S. Balew, Z. Abro, M. Kassie, and T. Tefera.(2021. Push-Pull Technology as a Climate-Smart Integrated Pest Management Strategy in Southern Ethiopia. 2021 Conference, August 17–31, Virtual 315246, International Association of Agricultural Economists.

Foster, A., and M. Rosenzweig. 1995. "Learning by Doing and Learning from Others: Human Capital and Technical Change in Agriculture." *Journal of Political Economy* 103(6): 1176–209.

Foster, A. D., and M. Rosenzweig. 2010. "Microeconomics of Technology Adoption." *Annual Review of Economics* 2: 395–424.

Fryer, R., S. Levitt, J. List, and S. Sadoff. 2018. *Enhancing the Efficacy of Teacher Incentives through Framing: A Field Experiment*. Cambridge MA: NBER Working Paper 18237.

Gugissa, D., Z. Abro, and T. Tefera. 2022. "Achieving a Climate-Change Resilient Farming System through Push–Pull Technology: Evidence from Maize Farming Systems in Ethiopia." *Sustainability* 14: 2648. https://doi.org/10.3390/su14052648.

Heffetz, O., and J. List. 2014. "Is the Endowment Effect an Expectations Effect?" *Journal of the European Economic Association* 12(5): 1396–422.

Hossain, T., and J. List. 2012. "The Behavioralist Visits the Factory: Increasing Productivity Using Simple Framing Manipulations." *Management Science* 58(12): 2151–67.

Imas, A., S. Sadoff, and A. Samek. 2017. "Do People Anticipate Loss Aversion?" *Management Science* 63(5): 1271–84.

Kahneman, D., and A. Tversky. 1979. "Prospect Theory: An Analysis of Decision Under Risk." *Econometrica* 47(2): 263–92.

Kassie, M., J. Stage, G. Diiro, B. Muriithi, G. Muricho, S. Ledermann, J. Pittchar, C. Midega, and Z. Khan. 2018. "Push–Pull Farming System in Kenya: Implications for Economic and Social Welfare." *Land Use Policy* 77: 186–98.

Khan, Z., J. Pittchar, C. Midega, and J. Pickett. 2018. "Push-Pull Farming System Controls Fall Armyworm: Lessons from Africa." *Outlooks on Pest Management* 29: 220–4.

Kőszegi, B., and M. Rabin. 2006. "A Model of Reference-Dependent Preferences." *Quarterly Journal of Economics* 121(4): 1133–65.

Lazear, E. 2000. "Performance Pay and Productivity." *American Economic Review* 90(5): 1346–61.

Levitt, S., J. List, S. Neckermann, and S. Sadoff. 2016. "The Behavioralist Goes to School: Leveraging Behavioral Economics to Improve Educational Performance." *American Economic Journal: Economic Policy* 8(4): 183–219.

List, J., and A. Samek. 2015. "The Behavioralist as Nutritionist: Leveraging Behavioral Economics to Improve Child Food Choice and Consumption." *Journal of Health Economics* 39: 133–46.

Magnan, N., D. Spielman, T. Lybbert, and K. Gulati. 2015. "Leveling with Friends: Social Networks and Indian Farmers' Demand for Technology with Heterogeneous Benefits." *Journal of Development Economics* 116: 223–51.

Midega, C., J. Pittchar, J. Pickett, G. Hailu, and Z. Khan. 2018. "A Climate-Adapted Push-Pull System Effectively Controls Fall Armyworm, Spodoptera Frugiperda (J E Smith) in Maize in East Africa." *Crop Protection* 105: 10–5.

Munshi, K. 2004. "Social Learning in a Heterogeneous Population: Technology Diffusion in the India Green Revolution." *Journal of Development Economics* 73(1): 185–213.

Ndayisaba, P. S., C. Kuyah, P. Mwangi Midega, and Z. Khan. 2020. "Push-Pull Technology Improves Maize Grain Yield and Total Aboveground Biomass in Maize-Based Systems in Western Kenya." *Field Crops Research* 256: 107911.

Ndayisaba, P., S. Kuyah, C. Midega, P. Mwangi, and Z. Khan. 2021. "Intercropping *Desmodium* and Maize Improves Nitrogen and Phosphorus Availability and Performance of Maize in Kenya." *Field Crops Research* 26: 108067.

Pamuk, H., E. Bulte, and A. Adekunle. 2014. "Do Decentralized Innovation Systems Promote Agricultural Technology Adoption? Experimental Evidence from Africa." *Food Policy* 44: 227–36.

Pickett, J., C. Woodcock, C. Midega, and Z. Khan. 2014. "Push-Pull Farming Systems." *Current Opinions in Biotechnology* 26: 125–32.

Shikuku, K., J. Pieters, E. Bulte, and P. Laderach. 2018. "Incentives and the Diffusion of Agricultural Knowledge: Experimental Evidence from Northern Uganda." *American Journal of Agricultural Economics* 101: 1164–80.

Simonsohn, U., and G. Loewenstein. 2006. "Mistake #37: The Effect of Previously Encountered Prices on Current Housing Demand." *Economic Journal* 116(508): 175–99.

Sseruyange, J., and E. Bulte. 2018. "Do Incentives Matter for the Diffusionof Financial Knowledge? Experimental Evidence from Uganda." *Journal of African Economies* 1–20.

Suri, T. 2011. "Selection and Comparative Advantage in Technology Adoption." *Econometrica* 79(1): 159–209.

Tangney, J., J. Stuewig, and D. Mashek. 2007. "Moral Emotions and Moral Behavior." *Annual Review of Psychology* 58: 345–72.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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