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# Increasing the Adoption of Conservation Agriculture

## A Framed Field Experiment in Northern Ghana

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## INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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**Abstract:** Conservation agriculture techniques can increase agricultural production while decreasing $CO_2$ emissions, yet adoption in the developing world remains low—in part because many years of continuous adoption may be required to realize gains in production. We conduct a framed field experiment in northern Ghana to study how randomly assigned incentives and peer information may affect adoption. Incentives increase adoption, both while they are available and after withdrawal. There is no overall effect of peer information, but we do find evidence that information about long-term adoption increased adoption, particularly when that information shows that production gains have been achieved.

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## 1. Introduction

Climate change is a serious threat to the livelihoods of millions of smallholder farmers in developing countries. In sub-Saharan Africa, where smallholders are largely dependent on rainfed agriculture, they are uniquely vulnerable to droughts, flooding, and disruption of seasonal rainfall patterns (UNDP 2017). Their productivity is further threatened by increasing soil degradation, which reduces land productivity over time (UNCCD 2017). A package of practices called Conservation Agriculture (CA) has been proposed as one solution to the consequences of climate change and soil degradation. Proponents argue that CA combines private benefits to adopters– by increasing yields and reducing vulnerability to rainfall shocks– and public good characteristics, via carbon sequestration in soil and reduced soil runoff into water catchment systems (Hobbs 2007; Bell et al. 2018a).

Despite claims about CA, adoption of its practices in developing countries remains low (Giller et al. 2009; Michler et al. 2018). Production gains from improved soil health can take up to ten years to be realized, but adopting CA requires immediate additional investments in the form of labor and/or herbicide application for weeding (Giller et al. 2009). Farmers in developing countries may be unwilling to bear these up-front costs for an uncertain future gain. In this paper we conduct a framed field experiment with farmers in northern Ghana to test whether two potential strategies to mitigate these issues– providing short-term incentives and information about peers– affect farmers' adoption decisions.

If the returns to CA practices are negative in the short term but positive in the long term, one way to increase adoption would be to offer temporary incentives conditional on implementing CA practices. In theory, such payments should help induce adoption if they are large enough to compensate for farmers' uncertainty around production, and should only be necessary until benefits are realized. A related concept has been tested in different settings, by paying people to preserve land endowments that provide ecological benefits (e.g. Jayachandaran et al. 2017; Alix-Garcia et al. 2018). However, in part because a long time horizon is required, rigorous evaluations of incentives for adopting CA are rare. The framed field experiment allows us to simulate the time horizon needed for CA practices to become profitable and provide initial evidence regarding strategies that governments and other policymakers might find useful.

An alternative approach to incentives is to reduce the uncertainty around adoption by providing information about the experience of peers to farmers. The role of individual learning is particularly important in the adoption of agricultural technologies, as observing peers can reveal information both about the profitability of a technology as well as information on management practices (Foster and Rosenzweig 2010). Conley and Udry (2010) find evidence of both processes in studying the adoption of pineapple among farmers in Ghana: farmers adjust their own input use after observing unexpected profits (or losses) from a neighbor's previous input allocation. Recent evidence suggests that peers can be just as, if not more, influential than community leaders and extension workers (BenYishay and Mobarak 2019; Ambler, Godlonton and Recalde 2019). Of particular relevance to the technology we consider, Crane-Droesch (2018) conducts an experiment on the diffusion of information on a soil amendment technology in Kenya, and finds that observed variability in peer outcomes has a strong negative effect on adoption.

The field experiment presented in this paper is designed to answer two primary research questions. First, we examine whether providing incentives to implement CA practices increases adoption both in the "short-run" (while conditional incentives are available) and the "long-run" (after incentives have been withdrawn). Second, we study whether farmers who receive information on the returns achieved by others in their community who have (or have not) adopted CA practices are as likely to adopt as those who do not receive information. We randomized farmers into an incentive treatment (where they received a payment for choosing to adopt CA in the initial rounds of the experiment) and a cross-randomized peer information treatment (in which farmers received randomly-determined information about others in their community before making their adoption decision). For both groups we test the null hypothesis that the proportion adopting CA practices is the same as in a control group.

Our results provide support for the potential of time-limited incentive payments to cause farmers to adopt CA practices in the long run. Across specifications we find a positive and statistically significant effect of assignment to the incentive treatment on the extent of CA adoption across a range of specifications. Treated participants are more likely to adopt the CA practice, maintain adoption until they achieve the private returns to choosing CA, and are less likely to return to conventional practices after choosing CA. For the information treatment, we find learning that a peer has successfully adopted CA over several years increases adoption, but do not find effects for other types of information, or for receiving information in general.

The primary contribution of this paper is to provide rigorous evidence on the potential for incentives to increase adoption of CA. Despite significant interest in the adoption of CA practices, the literature to date has not sought to exploit exogenous variation to test its determinants. Reviews of the adoption literature have found it to be very context specific (Knowler and Bradshaw 2007) and methodologically weak, often relying on observational data from projects aimed at promoting CA (Andersson and D'Souza 2014). While several studies have used discrete choice experiments to explore farmers' stated preferences for both financial and non-financial incentives to adopt (e.g. Marenya, Smith and Nkonya 2014; Ward et al. 2016; Schaafasma, Ferrini and Turner 2019), there is limited evidence which exploits exogenous variation to test how farmers respond to actual incentives. One exception is ongoing work by Bell et al. (2018b) which uses randomized assignment to test the effects of incentives on CA adoption in Malawi and finds an initial increase in adoption after the first season of the project. Also related, Oliva et al. (forthcoming) study incentives for adoption of a technology with delayed payout under uncertainty. They find (among other things) that offering incentives leads to increased adoption by people who are less likely to follow through. In our study we offer incentives that persist until the technology is close to paying off, though we do not document increased dis-adoption among those who must wait longer after the incentives cease for that payoff to materialize.

We also contribute to the literature on how peer effects can influence the adoption of agricultural technologies. By randomizing information in the context of our framed field experiment we are able to study how different types of information affect behavior, and how information might be useful in the context of a technology that requires a long time horizon to be profitable. Interestingly, in a paper related to the project testing incentives for adoption in Malawi, Bell et al. (2018a) find an association between peer effects and adoption, but they do not disentangle the differences between different types of information.

The paper proceeds as follows. Section 2 provides background, Section 3 describes the experimental design, and Section 4 presents the data and empirical strategy. Section 5 describes the results and Section 6 concludes.

## 2. Background

Before describing the design of the experiment, we provide a brief description of CA and its current status in our context of northern Ghana. CA is defined by three principles: minimal soil disturbance, permanent soil cover, and crop rotation (FAO, 2007). Minimal soil disturbance is the replacement of traditional ploughing with direct seeding, to reduce effects of planting on the soil structure. Permanent soil cover involves leaving residues from the previous crop on plots, combined with the planting of cover crops during fallow periods. Crop rotation is the practice of planting different crops in sequential seasons to diversify nutrients available to micro-organisms and create variation in the soil depth in which roots are established.

The purpose of these practices is to increase soil organic matter to improve water and nutrient retention, which in turn allows farmers to sustainably intensify production while mitigating negative environmental impacts. CA practices have been widely adopted in some developed economies, particularly in the US where reduced tillage currently accounts for more than half of all acreage for corn, wheat, and soybeans (USDA, 2019).

A variety of projects have promoted some or all aspects of CA in northern Ghana.[1] However, there appears to have been a general lack of evaluation of the extent to which these programs successfully increased adoption among farmers. As a result, we rely upon a household survey which we implemented immediately prior to the experiment to provide data on the extent of sensitization and adoption of CA practices in our population.

## 3. Design

### *3.1 Experimental procedure*

The framed field experiment was designed to represent key features of CA practices over a medium to long time horizon.[2] Participants are asked to decide whether to adopt a single CA

[1] To the authors' knowledge, the first such project was Sasakawa Global 2000 (Ito et al., 2007) which was active from 1986-2003 and promoted no-till farming and not burning crop residues. Other notable activities include: the Savannah Resources Management Project implemented by the Ministry of Lands and Forestry (Boahen et al., 2007); ongoing work by the Center for No-Till Agriculture which is sponsored by the Howard Buffett Foundation and provides training to farmers on CA techniques; and the World Bank's Sustainable Land and Water Management Practice Project (SLWMP) which is active around the Kulpawn-Sissili and Red Volta watersheds.

[2] The scripts used in the experiment are included in Online Appendix A.

practice: minimal soil disturbance (MSD). The features of the MSD decision model CA generally, but we focus on a single practice for experimental simplicity. MSD was chosen because focus groups in the area suggested it was the CA practice for which participants had the least experience. Participants are asked to make an adoption decision in each of ten rounds, with each round modeled as an agricultural season.[3] Prior to the first round, the participant receives a monetary endowment for use in the activity. Each round then proceeds as follows:

1) The participant chooses one of two technologies to adopt for that round, either MSD or conventional practices (CP).
2) They pay a fixed price associated with that choice from their current endowment.[4] In the experiment this represents the cost of weeding associated with the chosen technology, and these costs are higher with MSD than with CP.
3) The enumerator reveals the rainfall for that season. Rainfall is determined randomly and is poor with 1/3 probability or normal with 2/3 probability.[5]
4) The participant receives a payment based on their choice of technology and the rainfall realization. This payment represents the value of their harvest for that season. Payments are always higher with normal rainfall than with poor rainfall.

Before the beginning of each round, the participant was shown a choice sheet, which showed the two available choices, the price associated with each choice, and the two potential payoffs associated with each choice (four total). The choice options and associated prices were

[3] Ten years was chosen as this is argued to be an high bound on the number of years of continuous adoption required for conservation agriculture to provide production gains to farmers (GIller, et al. 2009).
[4] The experiment was structured such that the participant always had sufficient funds to choose either practice, irrespective of the outcome of prior rounds.
[5] To ensure consistency all randomization was conducted in Stata prior to fieldwork and loaded into the software used for implementation. Enumerators were not able to change any randomized parameters since they were associated with a unique subject identifier.

fixed throughout. The probability of each rainfall outcome was fixed and independent across rounds. The payments associated with each outcome could vary by round if participants were assigned to the incentive treatment (described below) and based on their adoption choices in the current and preceding rounds. The choice sheets are shown in Online Appendix B.

For participants who chose MSD, if the choice was made continuously over multiple rounds the available payments associated with that technology would increase once and remain at that higher level so long as they continued to adopt. This was intended to reflect the property that private benefits from CA adoption are realized over a medium to long timeframe. Participants were randomly assigned with equal probability to receive the production increase with 5, 6, or 7 rounds of continuous adoption. Participants were told in the script that the increase would occur in the fifth, sixth or seventh round of continuous adoption, but the exact round was unknown to them (and the enumerator) prior to realization.

Both prices and costs were represented in pesewas, which are the sub-unit of the Ghanaian cedi. Images of coins and notes were used on visual aids showing payoffs, so participants could easily recognize the amounts involved. To prevent potential adverse issues during the experiment, play money with the same appearance as local currency was used and exchanged for real money following the conclusion of the final round.

*3.2 Incentive treatment*

The incentives treatment was designed to represent a subsidy payment to farmers adopting MSD. Participants were randomized into a group receiving incentives and a control group. Randomization was done at the individual level, stratified by farmer group.[6] The probability of

[6] Since groups were not of uniform size, individuals did not always evenly divide into treatment groups within a stratum (i.e. a farmer group of twenty people cannot be divided into thirds). For the additional 'misfit' observations we randomly allocate individuals independently across strata, using the procedure and associated *randtreat* command described in Carril (2017).

being assigned to the incentives treatment was 2/3, with 1/3 assigned to the control. The reason for treating a larger portion was to ensure sufficient variation among treated individuals in the number of consecutive rounds required to achieve increased production.

If assigned to receive incentives, the participant was eligible to receive an additional payment conditional on choosing MSD in any of the first four rounds of the experiment, which they received immediately after making their choice in a given round. The amount of the incentive was fixed, and no incentives were available after the fourth round. The incentive was not conditional on decisions in any previous round, so a treated individual choosing CP in Rounds 1-3 would still be able to receive a payment if they chose MSD in Round 4.

*3.3 Peer information treatment*

Participants were also cross-randomized with equal probability into either a group assigned to receive information about a generic peer farmer or a control group.[7] Participants assigned to the information treatment were read a short prompt about an unnamed neighbor before making their decision during the first four rounds of the experiment. The prompts consisted of four possible vignettes about a neighboring farmer:

- Last year they used conventional practices on their plots, they have always used conventional practices.
- Last year they used minimal soil disturbance on their plots. They had not used this technique before.
- Last year they used minimal soil disturbance on their plots. They have been using minimal soil disturbance for the last ten years.

[7] Assignment followed the same procedure as for the incentives treatment, but the treatment and control groups were of equal size.

- Last year they used conventional practices on their plots. They had used minimal soil disturbance before but decided to go back to conventional practices.

Along with each vignette, they received information on the peer farmer earnings, which were calculated in the same way as for the participant, based on the realization of the rainfall variable in the previous round.[8] As a result there were eight possible variations of the information provided. The vignettes are representative of all possible payoffs and adoption histories (i.e. never adopted, early adoption, achieved production gain, dis-adoption). For a given prior rainfall outcome, each variation was chosen via an independent random draw. An individual could receive the same vignette in different rounds, and the assignment for a given round did not affect the probability of assignment in other rounds.

*3.4 Payoffs*

The payoff amounts were calibrated to model the features of CA technologies, scaled to a reasonable budget for the project. Participants were paid a fixed fee of 5 cedis (0.93 USD) which was approximately the wage for a day of agricultural labor at the time of the experiment, and could earn 3-10 cedis over the course of the experiment.[9] Therefore, the total payout ranged from 8-15 cedis (1.49-2.80 USD). The mean payout for the experiment was 12.6 cedis (2.36 USD). Table 1 presents the available payouts in the experiment for CP and MSD.

Since the values for CP are fixed, there are three possible comparisons: CP vs. MSD without incentives; CP vs. MSD with incentives; and CP vs. MSD without incentives but with a production gain realized.[10] Weeding costs are held constant throughout the experiment, and cost

[8] For Round 1, participants in the information treatment were randomly assigned a rainfall outcome for the hypothetical preceding season.
[9] An initial endowment of 1 cedi, plus 0.2-0.9 cedis per round.
[10] Note that since the incentives were only available in Rounds 1-4, and the production gain took at least 5 rounds to be realized, there is no scenario in which the participant could receive the incentives and the gain in the same round.

10 pesewas for CP and 30 for MSD. The incentive payment is 20 pesewas in the rounds in which it is offered, covering the difference between the cost of implementing CP and MSD. Production payments vary by rainfall and whether the production gain has been achieved. Initially, in normal years, CP and MSD both pay 100 pesewa (not considering the weeding costs or incentives). After the production gain has been achieved, the payment for MSD increases to 120 pesewas in normal years. In poor years, MSD always pays more. Prior to the production gain, in poor rainfall years CP pays 30 pesewa and MSD pays 50. After the production gain, MSD pays 60 pesewa in poor years.

Comparing these three scenarios we can observe some straightforward features of the experiment: for a given round without incentives a participant will strictly prefer CP, since the payouts are higher than MSD under a normal rainfall outcome and equal to MSD under poor rainfall. With incentives, the reverse is true: MSD has equal returns under normal rainfall and better returns under poor rainfall.

Combining payouts across rounds, the expected value of choosing CP across all rounds is 66.7 x 10 = 667 pesewas. Without incentives, the earliest stage at which the production gain could be achieved is Round 5. For this case, the highest possible expected value of always choosing MSD is therefore the expected value of MSD from scenario (A) for four rounds, plus the expected value of MSD from scenario (B) for six rounds. Hence: 53.3 x 4 + 70 x 6 = 633.2 pesewas. As a result, a risk neutral participant always chooses CP over MSD without incentives.

With incentives, the situation is reversed. For a participant always choosing MSD, the latest round in which the production gain can be realized is in Round 7. Therefore, the lowest expected payoff from choosing MSD with incentives will be the total of the expected value from scenario (B) (Rounds 1-4), plus the expected value from scenario (A) (Rounds 5-6), plus the expected value from scenario (C) (Rounds 7-10): 73.3 x 4+53.3 x 2+70 x 4 = 679.8. Hence the lowest possible expected payoff for continuous MSD adoption in the incentive scenario exceeds the expected payoff for continuously choosing CP.

This parameterization implies that for risk neutral individuals, it is preferable for individuals to choose CP when in the control group. However, if individuals are risk averse, preferences depend upon their degree of risk aversion, in other words for some individuals it becomes preferable to select MSD over CP during all ten rounds. If we consider the constant relative risk aversion utility function, a risk averse individual who expected the MSD bonus to occur in round 6 would be neutral between choosing CP and MSD for a risk aversion coefficient of approximately 0.687.[11] If individuals were also discounting values in future rounds, then a larger range of risk aversion parameters would favor MSD over CP.

*3.5 Limitations*

The goal of the framed field experiment is to model real-life adoption decisions over the long time-horizon needed for the benefits of CA to be fully realized. There are three principal ways in which our experiment must necessarily deviate from the parameters of real-life CA adoption decisions. The first is the role of time discounting. When considering payoffs from land preparation decisions that may materialize over ten years, farmers will discount that income differently than payouts to be made over the course of a ninety-minute experiment. Specifically, we may expect farmers to be more present-biased in their actual decisions. Second, although not trivial for participants, the stakes in the experiment are much lower than those around actual planting decisions for a primary crop. This may affect their decisions, in particular their

[11] Assuming a constant relative risk aversion function of the form $U(C) = C^{1-\theta} / (1 - \theta)$, when $\theta \neq 1$ and $U(C) = \ln(C)$ if $\theta = 1$. MSD is preferable under this utility function for individuals with values of $\theta$ between 0.687 and 1.

willingness to take risks. Finally, the income earned in the experiment is a windfall, whereas real-life planting decisions are made with regular income, and evidence has shown that windfall and regular income are often spent in different ways (Arkes et al. 1994; Milkman and Beshears 2009).

## 4. Data and estimation

### *4.1 Sample*

This project was conducted in partnership with the Ghana Agricultural Sector Investment Programme (GASIP), a national initiative which aims to support the development of agricultural value chains within Ghana. As part of its activities, GASIP is promoting CA principles as well as increased access to improved inputs such as certified seed and machinery. We obtained a list of 66 farmer-based organizations (FBOs) created by GASIP for their activities in four northern regions of Ghana.[12] Field staff visited each group in the second quarter of 2019 and obtained a listing of all current members. The FBOs entered into GASIP in waves, with some groups joining in 2018 and others in 2019. The 2018 FBOs had exposure to one year of GASIP extension information (including CA and other techniques) at the time of the experiment, while implementation had not yet begun for the 2019 FBOs.

The sample comprised current FBO members: 1,328 individuals across 66 FBOs.[13] Each member was visited to conduct a household survey, with a separate team of enumerators returning a few days later to conduct the experiment. If the listed individual was not available within one week of the scheduled household interview a replacement was used. Replacements were required to be adults within the same household who were also involved in farming. Overall 1,324

[12] These are Northern, Upper East, Upper West, and Brong Ahafo. Farmer groups are located in twelve districts within these regions.

[13] There are 30 2018 FBOs and 36 2019 FBOs. The average group size was 20 members. One FBO was substantially larger than the others, with 37 members. For this group we randomly sampled 20 members.

individuals were interviewed, of whom 38 were replacements.[14] Field work was conducted from April to June 2019.

Table 2 provides some descriptive statistics about the GASIP members in our sample (Panel A) and the households in which they live (Panel B). The sample is 53 percent female, with an average age of 41. Farmer group members have a low level of formal education, as 65 percent have no education at all and only 9 percent have completed secondary school. 90 percent are involved in household farm work as their primary activity, but approximately half report an additional activity. The average household size is 9 members, with a large range: in some study areas there are very large households, with a maximum of 45 members.

Table 3 presents the share of respondents reporting knowledge and use of CA practices (MSD, cover-cropping, applying crop residues, not burning, and crop rotation). In general, most farmers are familiar with CA techniques, with the share somewhat higher in farmer groups which were targeted by GASIP in 2018, compared to 2019 FBOs.[15] For most practices, fewer than half of participants report practicing in the most recent agricultural season. The exception to this are the related practices of using residues for soil cover, and not burning (though social desirability bias may play a role). Overall, individuals in the sample can be said to be somewhat sensitized to CA techniques, though very few people have adopted all of them.

*4.2 Empirical strategy*

To evaluate the impacts of the respective treatments on adoption of MSD in the experiment, we estimate four primary specifications using ordinary least squares at the participant level,

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[14] There were cases where participants were members of the same household, so the total household survey sample is 1,117. For some cases, the field team was unable to match household data to individuals, as a result there are 25 experiment participants for whom we do not have a full set of controls for regression specifications. We retain these individuals and include indicator variables for the relevant missing data.

[15] The main results do not vary by 2018 and 2019 FBOs.

following our pre-analysis plan.[16] To address multiple hypothesis testing, we also control for the false discovery rate (FDR) by calculating sharpened q-values (Benjamini, Krieger and Yekutieli 2006; Anderson 2008).[17] Our first specification is as follows:

$$Y_i = \alpha + \beta_1 Incentive_i + \beta_2 Information_i + \beta_3 6s_i + \beta_4 7s_i + X_i + \delta_i + \varepsilon \qquad (1)$$

*Incentive* and *Information* are indicator variables for the respective treatments, and *6s* and *7s* are indicators for being in the groups that could realize the production gain after choosing MSD for 6 and 7 consecutive seasons respectively (with 5 seasons as the omitted category).[18] $X$ is a vector of control variables, $\delta$ are stratification cell fixed effects (farmer group dummies), and $\varepsilon$ is a robust error term.[19] This specification differs from that listed in the pre-analysis plan only in that we initially indicated that we would show treatments in separate specifications; however, because they are randomized, there is no reason not to include them in the same regression. This specification shows the main effects of each of the treatments.

In the next specification, we study the interaction of the incentive treatment with the randomized gain round. This specification allows us to understand whether adoption behavior and the effectiveness of the incentive is affected when the production gain does not occur immediately after the incentives expire:

$$Y_i = \alpha + \beta_1 Incentive_i + \beta_2 Information_i + \beta_3 6s_i + \beta_4 7s_i + \beta_5 Incentive_i X 6s_i +$$

[16] https://www.socialscienceregistry.org/trials/3973

[17] The FDR accounts for the percentage of false positives among rejected null hypotheses. The sharpened q-value is the expected proportion of false positive within a family of outcomes if the coefficient in question is assumed to be significant. All main results are robust to the calculation of the sharpened q-value.

[18] Due to some enumerator errors (as a result of conducting an experiment using an incorrect ID on the tablet computer) there are a small number of cases (2 observations for the information treatment, 3 for the incentive & gain round assignments) where the implemented treatment did not match the assignment for the sample. We use the assigned status throughout, but the results of the analysis are not meaningfully altered by using actual assignment.

[19] Control variables include: household size, gender, age, risk and time preferences, value of assets owned, number of CA techniques used last season, value of crop production, number of GASIP crops grown, household has electric light, household has toilet access, household has cement walls, household has cement floors, household has metal roof, household grew tubers, the rainfall assigned in the practice round, and indicators for missing data.

$$\beta_6 Incentive_i X7s_i + X_i + \delta_i + \varepsilon \tag{2}$$

Third, we study the impact of receiving incentives or information only versus receiving both:

$$Y_i = \alpha + \beta_1 IncentiveOnly_i + \beta_2 InformationOnly_i + \beta_3 Incentive\&Information_i + \beta_4 6s_i + \beta_5 7s_i + X_i + \delta_i + \varepsilon \tag{3}$$

Finally, in order to analyze the impact of the type of information received in the information treatment, we conduct an analysis, among only those who received the information treatment, at the participant-round level, for the decisions made in the first four rounds:

$$Y_{ir} = \alpha + \beta_1 InfoB_{ir} + \beta_2 InfoC_{ir} + \beta_3 InfoD_{ir} + \beta_4 PoorRainfall_{ir} + X_{ir} + \delta_i + r_i + \varepsilon \tag{4}$$

Here we include a round fixed effect $r$, and indicator variables representing the information received for a given round:

*InfoA*: Neighbor used CP (which is the omitted category);

*InfoB*: Neighbor used MSD for the first time;

*InfoC*: Neighbor used MSD for the last ten years; and

*InfoD*: Neighbor abandoned MSD (used CP after having used MSD).

*PoorRainfall* is equal to one if the rainfall in the previous season (i.e. the rainfall experienced by the neighbor/peer in the reported information) was poor.

We additionally estimate a specification in which we interact information types with the previous season's rainfall, as the information conveyed depends on the rainfall. This will help to understand whether certain types of information are effective only in conjunction with observing a positive or negative peer outcome. These specifications were not specified in the pre-analysis plan.

## 5. Results

Before turning to regression analysis, it is useful to examine behavior in the experiment descriptively. Table 4 displays the mean of each of the three main participant-level outcomes for each of the two randomized treatments as well as the randomized production gain round. Overall, the share choosing MSD is high with treated individuals choosing it between 7.8 to 8.4 times out of ten, and individuals realizing the production gain in 68 to 78 percent of all sessions. However, dis-adoption is also common. These averages suggest that the incentives increase adoption of MSD and decrease dis-adoption. There is no evidence of a difference in behavior by information treatment. The means by gain round group do suggest that the earlier the gain is achieved, the more likely it is the participant reaches that point.

We also examine how behavior may have changed over the course of the experiment. Figure 1 shows adoption by round and incentive treatment status. Across rounds, adoption rates for the incentive groups are always higher than those in the no incentives group, and this difference is consistent over time. In both groups, adoption is steady across the first four rounds, and then begins to decline slightly. Note that the level of adoption in the control group is substantially higher than among the actual level reported by farmers in FBOs which had been previously sensitized to MSD (33%). This finding likely reflects local constraints (lack of access to seed drills) which are not accounted for in our experiment, as well as easier implementation in the experimental setting versus likely technical knowledge gaps in real life. We also cannot rule out that experimenter demand effects may also play a role. However, these factors should all be equal across treatment groups and thus do not threaten the internal validity of the experiment.

Figure 2 shows the same information separately by information treatment. The same time trend is visible, but there is little to no difference in average choices between the two treatment groups. Figure 3 shows adoption by round separately by gain round group assignment. We do not observe a noticeable divergence among adoption rates by gain round assignment, though there is some variation in the initial share of participants choosing MSD.

We next turn to the main regression analysis, beginning with the participant-level analysis. Table 5 shows the results of estimating equation (1), including all three treatment randomizations. The incentive treatment results in an economically and statistically significant impact on adoption. Participants in the incentive group choose MSD on average in 0.6 more rounds, an increase of 7.6 percent relative to the control group. They were 8.3 percentage points more likely to achieve the production gain (12 percent increase) and were 7.4 percentage points less likely to abandon MSD once they had chosen it (22 percent decrease).

There is some evidence that those who received the gain after rounds 6 or 7 adopt MSD less overall, but the estimates are not statistically significant for the most part. The one significant outcome is that participants who receive the gain round in round 7 are 9 percentage points less likely to achieve the gain than those who receive it in round 5. The estimates of the impact of the information treatment are close to zero in this specification.[20]

Table 6 presents the results of regression specification (2), examining whether the impact of the incentive treatment is differential by gain round group. The impact of the incentive treatment when the gain round is round 5 (incentive treatment main effect) remains positive and statistically significant. The interaction of the round 6 and round 7 gain round indicators with the incentive

[20] In Appendix Table 1 we present our main specifications in long form (with one observation per participant-round and round-level fixed effects), as indicated in the pre-analysis plan. We report our results separately by rounds 1-4 and rounds 5-10 in columns (3)-(6) to examine whether treatments impact the choice of MSD in each round. The results are similar, and there is no evidence that the impact of the incentives falls off after the incentive is removed.

treatment are both of opposite sign from the main effects, and for round 6, large and statistically significant. The interaction term in round 6 is large enough that it cancels out the incentive effect completely for that group. The round 7 coefficients are smaller, and not statistically different from the main effect. The total incentive effect for gain round 7 is still statistically different from zero.

To further examine this result, we plot the impact of the incentive treatment for each incentive-gain round combination, separately by round (Figure 4). Across rounds, this effect is similar for gain rounds 5 and 7, and lower for gain round 6. Note that the effect for gain round 6 is stable across rounds, including rounds 1-4 at which point none of the participants had discovered which gain round value they had been assigned. This suggests that the group of individuals assigned to gain round 6 within the incentives treatment were somewhat less likely to pick MSD *ex ante* than others individuals in the sample. These individuals appear similar in terms of observable characteristics (Appendix Table 2), so this finding appears likely to be a statistical artefact.

Table 7 reports the estimation of regression specification (3) and examines the impact of receiving each treatment alone or receiving both together. The results remain suggestive that the information treatment did not have an impact, and are not indicative of any complementary effects between the two. The coefficients in the incentives only and incentives plus information treatments are similar in magnitude, statistically different from zero, and not statistically distinguishable from each other. The information only coefficients are small and not statistically different from zero. However, we cannot reject that the coefficients in the incentives and information group are equal to the information only treatment in two of three cases.

Finally, recall that the information presented varied by round and in content. Next, we more carefully examine this feature of the information treatment, by studying the different types of information that were offered, using the subset of individuals who received an information treatment (equation 5). This analysis takes place only over the first four rounds, since information was not provided after the fourth round, and the dependent variable is whether MSD was chosen in that round or not (Table 8).

Without interactions between rainfall and information (column 1), we find evidence of an effect of being told the neighbor had used MSD for at least 10 seasons. The coefficient is 3.7 percentage points, corresponding to a 4.6 percent increase relative to being told your neighbor had used CP. The coefficient estimates on the other forms of information are not statistically significant, and we can reject that the effect of being told a neighbor used MSD for the last 10 years is equal to being told that the neighbor abandoned MSD. We cannot however reject that this effect is equal to being told the neighbor used MSD for the first time.

In column 2, we interact the information with the rainfall from the previous season, because the rainfall outcome in the previous season affects what the participant was told about how much the neighbor earned. Recall that a payoff differential under poor rainfall is evident for all those choosing MSD (information groups B and C), but the payoff differential for choosing MSD in normal years is only evident for information group C (neighbor used MSD for 10 years). Because the information treatment occurred in the first four rounds of the experiment, this outcome is the only one participants could not have experienced for themselves, and as such, information group C in normal years may be the mostly likely to affect behavior.

When the rainfall is normal, the effect of being told your neighbor had used MSD for 10 seasons (and therefore received the production bonus) is now 5 percentage points, and statistically significant at the 5 percent level. The corresponding interaction term for poor rainfall is -4.2 percentage points, though not statistically different from zero. Regardless, it implies the total effect of group C information is near zero when rainfall is poor. This pattern is not repeated for those receiving the information that the neighbor used MSD for the first time (group B). These results are in line with the discussion above, that those who received information about the MSD production gain in normal years were receiving new information and updating their behavior accordingly. Overall this evidence suggests that when promoting a technology like CA where there are deferred benefits, observing peers who have actually experienced those benefits can be useful for promoting adoption.

## 6. Conclusion

Agronomists have long argued that CA makes for more efficient use of natural resources than traditional farming methods in developing countries (e.g. Hobbs 2007). However, the long time frame associated with private gains to adoption, combined with information gaps regarding these gains, contribute to adoption rates well below what would be socially optimal. Using a framed field experiment, this study finds that incentives for adoption might be an effective tool for increasing adoption of CA techniques prior to the point when they become privately profitable. Though there is no overall effect of information, we do find some evidence that being given positive information about neighbors experiencing the deferred benefits of CA increases adoption. While our results are limited to the experimental environment, they suggest that investing in pilot tests of these policy solutions would be worthwhile.

These findings point to both incentives and information campaigns that emphasize outcomes from early adopters as policy options for governments and other actors that want to increase the adoption of CA techniques, and also speak more generally to the promotion of technologies with deferred benefits. In considering how to design incentive and information programs, there are several points to consider. The form of incentives is important. In focus groups conducted in formative research farmers suggested that fertilizers or herbicides would be preferred to cash; such in-kind incentives could not be reflected in an experiment such as this one. It is also important to consider the way that farmers conceive of CA. Ward et al. (2018) find that in Malawi farmers think of choices about adopting CA as distinct decisions for each technique. However, the agronomic evidence that exists on yields concerns adoption of the entire package, rather than just pieces of it. Therefore, effective policy would either need to consider ways to ensure that farmers were using the entire suite of CA techniques, or would need to also build evidence on the impacts of partial adoption of CA techniques.

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## Tables

**Table 1 - Payoff amounts per round, by practice choice & scenario**

| Technology | | CP | MSD | MSD | MSD |
|---|---|---|---|---|---|
| Incentive treatment? | | - | No | Yes | No |
| Production increase | | - | No | No | Yes |
| Scenario (Choice Sheet) | | A/B/C | A | B | C |
| Possible rounds | | 1-10 | 1-10 | 1-4 | 5-10 |
| Normal rainfall | A. Price of choice | 10 | 30 | 30 | 30 |
| | B. Incentive payment | 0 | 0 | 20 | 0 |
| | C. Production payment | 100 | 100 | 100 | 120 |
| | Net payoff (C+B-A) | 90 | 70 | 90 | 90 |
| Poor rainfall | A. Price of choice | 10 | 30 | 30 | 30 |
| | B. Incentive payment | 0 | 0 | 20 | 0 |
| | C. Production payment | 30 | 50 | 50 | 60 |
| | Net payoff (C+B-A) | 20 | 20 | 40 | 30 |
| Expected value | | 66.7 | 53.3 | 70 | 73.3 |

Note: Amounts shown are in pesewas, which are a division of the Ghanaian cedi. 100 pesewas = 1 cedi (approximately $0.19 USD at current market rates).

**Table 2- Summary statistics of sample GASIP FBO members and households**

| Panel A: FBO Member Characteristics | Mean | SD | Min | Max | Obs. |
|---|---|---|---|---|---|
| Age | 41.20 | 12.38 | 13 | 98 | 1303 |
| Is female | 0.53 | 0.50 | 0 | 1 | 1303 |
| Received no schooling | 0.65 | 0.48 | 0 | 1 | 1303 |
| Received some primary education | 0.11 | 0.31 | 0 | 1 | 1303 |
| Completed primary school | 0.03 | 0.17 | 0 | 1 | 1303 |
| Received some secondary education | 0.12 | 0.32 | 0 | 1 | 1303 |
| Completed secondary school or higher | 0.09 | 0.28 | 0 | 1 | 1303 |
| Primary activity: Household farm work | 0.89 | 0.31 | 0 | 1 | 1302 |
| Reports secondary activity | 0.50 | 0.50 | 0 | 1 | 1302 |
| Reports any work off-farm | 0.29 | 0.46 | 0 | 1 | 1302 |

| Panel B: Household Characteristics | Mean | SD | Min | Max | Obs. |
|---|---|---|---|---|---|
| Region: Northern | 0.44 | 0.50 | 0 | 1 | 1117 |
| Region: Upper East | 0.30 | 0.46 | 0 | 1 | 1117 |
| Region: Upper West | 0.16 | 0.37 | 0 | 1 | 1117 |
| Region: Brong Ahafo | 0.09 | 0.29 | 0 | 1 | 1117 |
| Household size | 9.40 | 5.26 | 1 | 45 | 1117 |
| Members currently present | 8.71 | 5.01 | 1 | 41 | 1117 |
| Number of adults (14+) | 5.38 | 2.91 | 1 | 22 | 1114 |
| Number of children (<14) | 3.93 | 2.90 | 0 | 21 | 1114 |
| Household reports polygamy | 0.27 | 0.45 | 0 | 1 | 1117 |
| Religion: Catholic | 0.18 | 0.38 | 0 | 1 | 1117 |
| Religion: Other christian | 0.34 | 0.47 | 0 | 1 | 1117 |
| Religion: Muslim | 0.30 | 0.46 | 0 | 1 | 1117 |
| Religion: Traditional/animist | 0.18 | 0.38 | 0 | 1 | 1117 |
| Language: Buli | 0.10 | 0.31 | 0 | 1 | 1117 |
| Language: Dagbani | 0.15 | 0.36 | 0 | 1 | 1117 |
| Language: Frafra/Gruni | 0.20 | 0.40 | 0 | 1 | 1117 |
| Language: Likpakpa | 0.21 | 0.41 | 0 | 1 | 1117 |
| Language: Other | 0.25 | 0.44 | 0 | 1 | 1117 |

**Table 3 – Adoption and knowledge of CA techniques, by timing of FBO entry to GASIP**

| | Old FBOs | New FBOs |
|---|---|---|
| *Heard of…* | | |
| Conservation agriculture | 0.95 | 0.79 |
| Minimal soil disturbance | 0.78 | 0.55 |
| Cover cropping | 0.79 | 0.54 |
| Using residues | 0.93 | 0.81 |
| No burning | 0.97 | 0.84 |
| Crop rotation | 0.84 | 0.73 |
| *Adopted last season…* | | |
| Conservation agriculture | 0.89 | 0.83 |
| Minimal soil disturbance | 0.33 | 0.20 |
| Cover cropping | 0.36 | 0.27 |
| Using residues | 0.70 | 0.61 |
| No burning | 0.81 | 0.70 |
| Crop rotation | 0.48 | 0.41 |

Note: Columns show mean proportion of baseline survey respondents responding "Yes" for each category. For "Heard of" the overall "Conservation Agriculture" category was asked separately from the sub-categories. For "Adopted" the overall CA proportion is an indicator for responding "Yes" to one or more sub-categories.

**Table 4 – Average Outcomes in the Experiment, by Treatment and Gain Round**

| | Incentive treatment | | Information treatment | | Gain round | | |
|---|---|---|---|---|---|---|---|
| | No incentives | Incentives | No | Yes | Round 5 | Round 6 | Round 7 |
| No. rounds MSD | | | | | | | |
| Chosen | 7.83 | 8.41 | 8.25 | 8.18 | 8.42 | 8.09 | 8.14 |
| Achieved gain | 0.68 | 0.75 | 0.73 | 0.73 | 0.78 | 0.72 | 0.69 |
| Abandoned MSD | 0.34 | 0.27 | 0.29 | 0.29 | 0.26 | 0.30 | 0.31 |

Note: Columns represent the mean for each group.

**Table 5 – Impact of Incentive and Information Treatments on MSD adoption**

| | (1)<br>Number rounds MSD | (2)<br>Achieved gain | (3)<br>Abandoned MSD |
|---|---|---|---|
| Incentive treatment | 0.598*** | 0.083*** | -0.074*** |
| *Standard error* | (0.176) | (0.026) | (0.026) |
| *p-value* | 0.001 | 0.001 | 0.005 |
| *Sharpened q-value* | 0.002 | 0.002 | 0.002 |
| Information treatment | -0.049 | 0.004 | -0.009 |
| *Standard error* | (0.157) | (0.023) | (0.024) |
| *p-value* | 0.755 | 0.851 | 0.703 |
| *Sharpened q-value* | 1.000 | 1.000 | 1.000 |
| Gain round: 6 | -0.222 | -0.038 | 0.022 |
| *Standard error* | (0.192) | (0.028) | (0.029) |
| *p-value* | 0.249 | 0.176 | 0.461 |
| *Sharpened q-value* | 0.595 | 0.595 | 0.595 |
| Gain round: 7 | -0.275 | -0.090*** | 0.044 |
| *Standard error* | (0.186) | (0.028) | (0.029) |
| *p-value* | 0.139 | 0.001 | 0.134 |
| *Sharpened q-value* | 0.103 | 0.004 | 0.103 |
| | | | |
| Mean: No incentives | 7.829 | 0.677 | 0.337 |
| Mean: No information | 8.253 | 0.727 | 0.293 |
| Mean: Gain Round = 5 | 8.417 | 0.777 | 0.261 |
| Adjusted R-squared | 0.119 | 0.114 | 0.083 |
| Observations | 1324 | 1324 | 1324 |

Note: Ordinary least squares regression, with stratification-cell (FBO) fixed effects. Control variables are included in the specification, but not reported. *,**,*** indicate significance at the 10%, 5% and 1% level respectively.

**Table 6 – Impact of incentives and gain round on MSD adoption**

| | (1)<br>Number rounds MSD | (2)<br>Achieved gain | (3)<br>Abandoned MSD |
|---|---|---|---|
| Assigned: Incentives | 0.948*** | 0.139*** | -0.100** |
| *Standard error* | (0.293) | (0.043) | (0.046) |
| *p-value* | 0.001 | 0.001 | 0.031 |
| *Sharpened q-value* | 0.002 | 0.002 | 0.011 |
| Assigned: Information | -0.034 | 0.006 | -0.010 |
| *Standard error* | (0.156) | (0.023) | (0.024) |
| *p-value* | 0.827 | 0.782 | 0.679 |
| *Sharpened q-value* | 1.000 | 1.000 | 1.000 |
| Gain round = 6 | 0.367 | 0.049 | -0.016 |
| *Standard error* | (0.352) | (0.051) | (0.054) |
| *p-value* | 0.297 | 0.34 | 0.769 |
| *Sharpened q-value* | 1.000 | 1.000 | 1.000 |
| Gain round = 7 | -0.205 | -0.070 | 0.031 |
| *Standard error* | (0.372) | (0.054) | (0.055) |
| *p-value* | 0.582 | 0.194 | 0.568 |
| *Sharpened q-value* | 1.000 | 1.000 | 1.000 |
| Incentives x Gain Round 6 | -0.903** | -0.134** | 0.057 |
| *Standard error* | (0.423) | (0.063) | (0.066) |
| *p-value* | 0.033 | 0.033 | 0.381 |
| *Sharpened q-value* | 0.052 | 0.052 | 0.146 |
| Incentives x Gain Round 7 | -0.113 | -0.030 | 0.019 |
| *Standard error* | (0.431) | (0.064) | (0.066) |
| *p-value* | 0.793 | 0.638 | 0.772 |
| *Sharpened q-value* | 1.000 | 1.000 | 1.000 |
| | | | |
| Incentives + Incentives x Round 6 | 0.882 | 0.909 | 0.351 |
| Incentives + Incentives x Round 7 | 0.009 | 0.022 | 0.086 |
| Mean: No incentives | 7.829 | 0.677 | 0.337 |
| Mean: No information | 8.253 | 0.727 | 0.293 |
| Mean: Gain Round = 5 | 8.417 | 0.777 | 0.261 |
| Adjusted R-squared | 0.122 | 0.116 | 0.082 |
| Observations | 1324 | 1324 | 1324 |

Note: Ordinary least squares regression, with stratification-cell (FBO) fixed effects. Control variables are included in the specification, but not reported. *,**,*** indicate significance at the 10%, 5% and 1% level respectively.

**Table 7 – Impact of treatments on MSD adoption, interacted treatments**

| | (1)<br>Number rounds MSD | (2)<br>Achieved gain | (3)<br>Abandoned MSD |
|---|---|---|---|
| Assigned incentives only | 0.871*** | 0.123*** | -0.084** |
| *Standard error* | (0.251) | (0.037) | (0.038) |
| *p-value* | 0.001 | 0.001 | 0.028 |
| *Sharpened q-value* | 0.002 | 0.002 | 0.010 |
| Assigned information only | 0.310 | 0.057 | -0.022 |
| *Standard error* | (0.295) | (0.043) | (0.045) |
| *p-value* | 0.293 | 0.189 | 0.624 |
| *Sharpened q-value* | 0.783 | 0.783 | 0.783 |
| Assigned incentives and information | 0.645** | 0.101*** | -0.086** |
| *Standard error* | (0.256) | (0.037) | (0.037) |
| *p-value* | 0.012 | 0.006 | 0.020 |
| *Sharpened q-value* | 0.018 | 0.018 | 0.018 |
| Gain round = 6 | -0.209 | -0.036 | 0.021 |
| *Standard error* | (0.191) | (0.028) | (0.030) |
| *p-value* | 0.274 | 0.197 | 0.472 |
| *Sharpened q-value* | 0.699 | 0.699 | 0.699 |
| Gain round = 7 | -0.276 | -0.090*** | 0.044 |
| *Standard error* | (0.186) | (0.028) | (0.029) |
| *p-value* | 0.138 | 0.001 | 0.134 |
| *Sharpened q-value* | 0.102 | 0.004 | 0.102 |
| | | | |
| *p-value*: Incentives = Information | 0.018 | 0.065 | 0.099 |
| *p-value*: Incentives = Both | 0.219 | 0.436 | 0.925 |
| *p-value*: Information = Both | 0.169 | 0.223 | 0.086 |
| Mean: No treatments | 7.685 | 0.653 | 0.338 |
| Mean: Gain Round = 5 | 8.417 | 0.777 | 0.261 |
| Adjusted R-squared | 0.120 | 0.115 | 0.082 |
| Observations | 1324 | 1324 | 1324 |

Note: Ordinary least squares regression, with stratification-cell (FBO) fixed effects. Standard errors in parentheses Control variables are included in the specification, but not reported. *,**,*** indicate significance at the 10%, 5% and 1% level respectively.

## Table 8 – Impact of different information types on MSD adoption

| | (1) | (2) |
|---|---|---|
| | Dependent variable: Chose MSD | |
| Info B: Used MSD (first time) | 0.030 | 0.024 |
| *Standard error* | (0.020) | (0.024) |
| *p-value* | 0.135 | 0.326 |
| Info C: Used MSD (last 10 years) | 0.037* | 0.051** |
| *Standard error* | (0.020) | (0.024) |
| *p-value* | 0.064 | 0.032 |
| Info D: Abandoned MSD | -0.001 | 0.004 |
| *Standard error* | (0.020) | (0.025) |
| *p-value* | 0.951 | 0.884 |
| Poor rainfall last round | -0.012 | -0.002 |
| *Standard error* | (0.015) | (0.031) |
| *p-value* | 0.416 | 0.941 |
| Info B x Poor rainfall | | 0.018 |
| *Standard error* | | (0.041) |
| *p-value* | | 0.651 |
| Info C x Poor rainfall | | -0.042 |
| *Standard error* | | (0.043) |
| *p-value* | | 0.327 |
| Info D x Poor rainfall | | -0.015 |
| *Standard error* | | (0.044) |
| *p-value* | | 0.738 |
| | | |
| *p-value*: Info B = Info C | 0.683 | 0.226 |
| *p-value*: Info B = Info D | 0.113 | 0.393 |
| *p-value*: Info C = Info D | 0.050 | 0.039 |
| *p-value*: Info B + Info B x Prev Rainfall | | 0.209 |
| *p-value*: Info C + Info C x Prev Rainfall | | 0.082 |
| *p-value*: Info D + Info D x Prev Rainfall | | 0.587 |
| Mean: No information, previous normal | 0.837 | 0.837 |
| Adjusted R-squared | 0.106 | 0.105 |
| Observations | 2644 | 2644 |

Note: Sample restricted to information treatment group. Observations are at the participant-round level, rounds 1-4. Ordinary least squares regression, with stratification-cell (FBO) and round fixed effects. Control variables are included in the specification, but not reported. *,**,*** indicate significance at the 10%, 5% and 1% level respectively.

**Figure 1 – Share choosing MSD, by incentive treatment status**

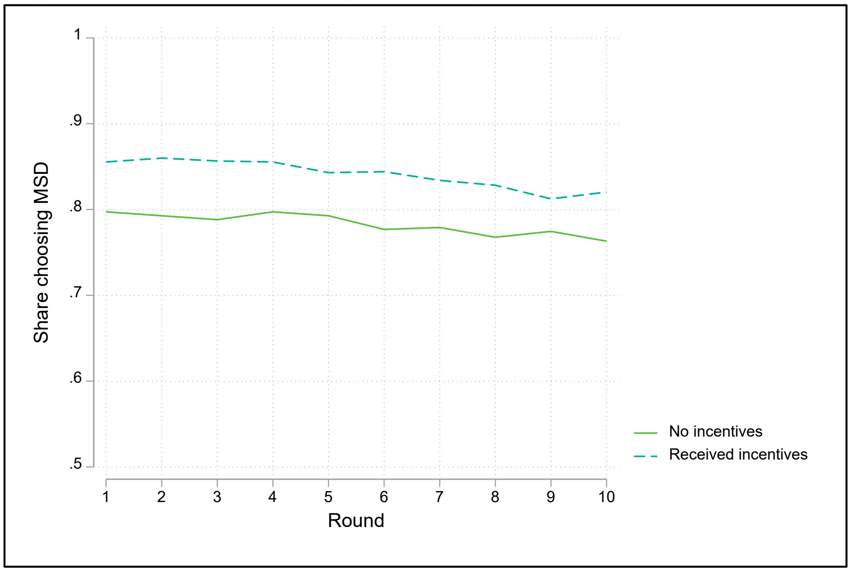



**Figure 2 – Share choosing MSD, by information treatment status**

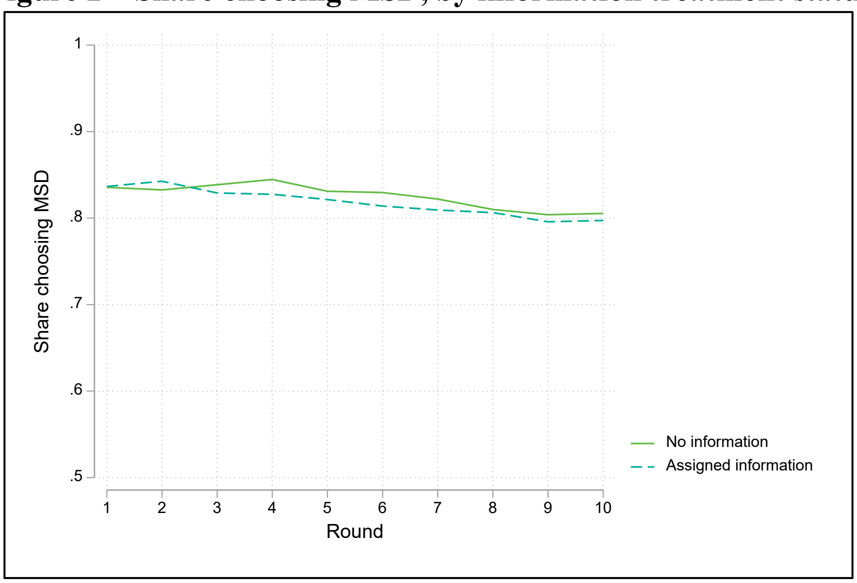


**Figure 3 – Share of Participants choosing MSD, by gain round**

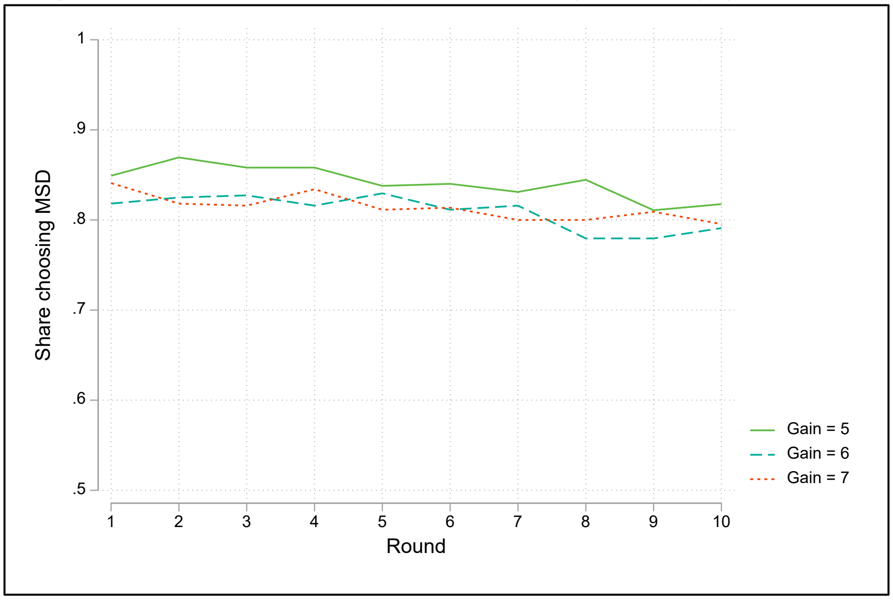
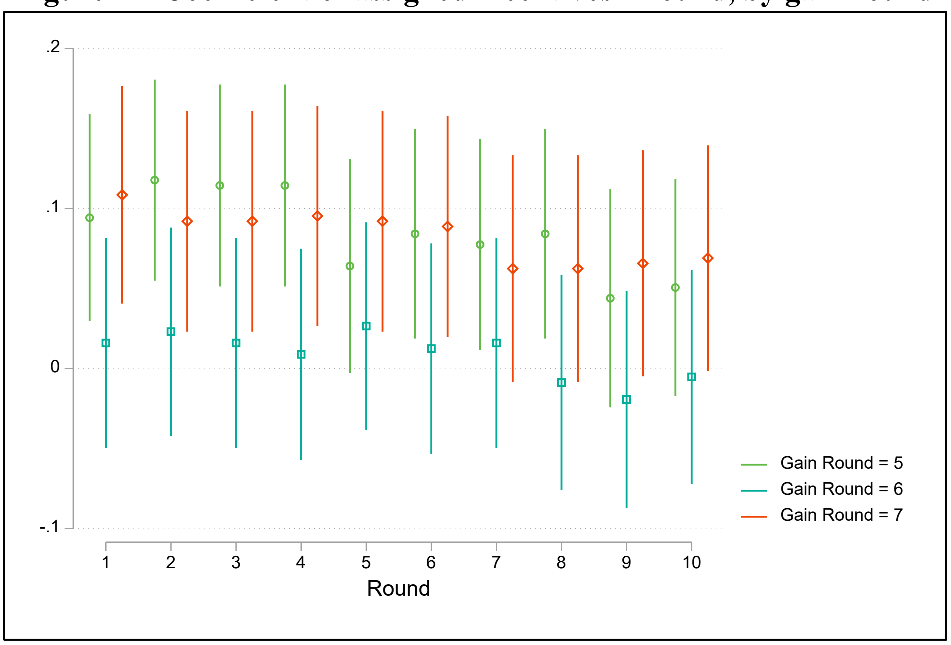



**Figure 4 – Coefficient of assigned incentives x round, by gain round**



## Appendix Tables

**Appendix Table 1– Impact of treatments on MSD adoption, by participant-round**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Dependent variable: Chose MSD | | | | | |
| | All rounds | | Rounds 1-4 | | Rounds 5-10 | |
| Assigned: Incentives | 0.060*** | 0.095*** | 0.064*** | 0.119*** | 0.057*** | 0.078** |
| | (0.017) | (0.028) | (0.017) | (0.029) | (0.018) | (0.030) |
| | 0.000 | 0.001 | 0.000 | 0.000 | 0.002 | 0.010 |
| Assigned: Information | -0.005 | -0.003 | -0.001 | 0.001 | -0.007 | -0.006 |
| | (0.015) | (0.015) | (0.016) | (0.015) | (0.016) | (0.016) |
| | 0.748 | 0.822 | 0.948 | 0.955 | 0.645 | 0.699 |
| Gain round = 6 | -0.022 | 0.037 | -0.029 | 0.055 | -0.018 | 0.024 |
| | (0.019) | (0.034) | (0.019) | (0.035) | (0.020) | (0.037) |
| | 0.234 | 0.282 | 0.133 | 0.114 | 0.368 | 0.506 |
| Gain round = 7 | -0.028 | -0.020 | -0.032* | -0.009 | -0.025 | -0.028 |
| | (0.018) | (0.036) | (0.018) | (0.038) | (0.019) | (0.038) |
| | 0.127 | 0.570 | 0.085 | 0.803 | 0.203 | 0.460 |
| Incentives x Gain Round 6 | | -0.090** | | -0.128*** | | -0.065 |
| | | (0.041) | | (0.042) | | (0.044) |
| | | 0.028 | | 0.002 | | 0.138 |
| Incentives x Gain Round 7 | | -0.011 | | -0.034 | | 0.004 |
| | | (0.042) | | (0.043) | | (0.044) |
| | | 0.787 | | 0.428 | | 0.930 |
| Incentives + Incentives x Round 6 | | 0.878 | | 0.777 | | 0.679 |
| Incentives + Incentives x Round 7 | | 0.007 | | 0.007 | | 0.011 |
| Mean: No incentives | 0.783 | 0.783 | 0.783 | 0.783 | 0.783 | 0.783 |
| Mean: No information | 0.825 | 0.825 | 0.825 | 0.825 | 0.825 | 0.825 |
| Mean: Gain Round = 5 | 0.842 | 0.842 | 0.842 | 0.842 | 0.842 | 0.842 |
| Adjusted R-squared | 0.104 | 0.106 | 0.100 | 0.104 | 0.103 | 0.104 |
| Observations | 13240 | 13240 | 5296 | 5296 | 7944 | 7944 |

Note: Ordinary least squares regression, with round and stratification-cell (FBO) fixed effects. Standard errors in parentheses Control variables are included in the specification, but not reported. *,**,*** indicate significance at the 10%, 5% and 1% level respectively.

**Appendix Table 2– Balance comparison for participants assigned incentives and gain round = 6**

| | Incentives only | | | Full sample | | |
|---|---|---|---|---|---|---|
| | Gain != 6 | Gain = 6 | p-value | Gain != 6 or control | Gain = 6 and incentives | p-value |
| Household size | 10.29 | 9.51 | 0.027 | 10.16 | 9.51 | 0.044 |
| Is female | 0.54 | 0.57 | 0.516 | 0.52 | 0.57 | 0.182 |
| Age | 41.16 | 39.87 | 0.147 | 41.26 | 39.87 | 0.094 |
| Risk preference (1-10) | 6.50 | 6.11 | 0.524 | 6.80 | 6.11 | 0.108 |
| Time preference (1-10) | 4.84 | 4.76 | 0.649 | 5.06 | 4.76 | 0.22 |
| Household assets (USD) | 8273 | 7961 | 0.778 | 8494 | 7961 | 0.649 |
| # CA practices last season | 2.39 | 2.49 | 0.45 | 2.36 | 2.49 | 0.303 |
| Crop value (USD, estimated) | 2309 | 2021 | 0.53 | 2444 | 2021 | 0.252 |
| Has electric light | 0.58 | 0.60 | 0.149 | 0.58 | 0.60 | 0.157 |
| Has toilet access | 0.56 | 0.52 | 0.079 | 0.54 | 0.52 | 0.31 |
| Dwelling: Cement walls | 0.17 | 0.17 | 0.858 | 0.17 | 0.17 | 0.978 |
| Dwelling: Cement floor | 0.75 | 0.74 | 0.994 | 0.75 | 0.74 | 0.987 |
| Dwelling: Metal roof | 0.81 | 0.81 | 0.769 | 0.80 | 0.81 | 0.684 |
| Poor rainfall (practice round) | 0.5 | 0.537 | 0.236 | 0.488 | 0.537 | 0.148 |

**Online Appendix A – Experiment Script**

# Framed Field Experiment Script:

# Incentives to Adopt Conservation Agriculture

## Before You Start

The lab-in-the-field script should be read exactly as written. The document is split into numbered sections to reflect the screens which will be shown as individual pages on the tablet used by the enumerator. The text written **in bold** indicates an instruction to the enumerator and should not be read aloud. Questions requiring a response are followed by answer options in *italics*.

## Outline

Section 1: Informed consent

Section 2: Introduction

Section 3: Instructions for the activity

Section 4: Practice

Section 5: Main activity

Section 6: Closing

The text also includes variables which are highlighted in yellow and indicated by a dollar sign followed by braces, ie. ${example_variable}. These indicate variables used in the survey program which will be populated with text or number values in the tablet program. The main part of the activity is repeated ten times, the text is repeated with different variable values depending on the stage of the activity, the treatment status of the respondent, and the respondent's previous decisions. There is some text that will only display if the respondent is on a certain stage and has made certain choices. This text is highlighted in pink. The beginning and end of the iterated section of the text is highlighted in red.

Each respondent may be assigned to one (or both) of two treatments: an incentive treatment and an information treatment. Some portions of the texts are only shown to respondents who are assigned to a treatment. Text shown only to respondents in the incentive treatment is highlighted in green while text shown only to respondents in the information treatment is highlighted in blue.

## Script Start

### Section 0 – Household Identification

*Screen 0.1*

Enter the unique household ID

Re-enter the unique household ID to confirm

*Screen 0.2*

**Community:** ${pl_community}

**Farmer group:** ${pl_farmgroup}

Compound Name: ${pl_compound}

Respondent name: ${pl_name}

Respondent gender: ${pl_gender}

Confirm that the person listed is the person who will complete the activity.

If the person you are talking to is NOT the listed respondent, go back to check that the household ID has been entered correctly. If the household ID is correct, but the person is NOT the listed respondent, do not proceed.

Contact your Team Leader or Field Manager to resolve the issue.

**Section 1 – Informed Consent**

*Screen 1.1*

Good morning/afternoon. I am ________ from Innovations for Poverty Action (IPA) a research institute dedicated to discovering and promoting solutions to global poverty problems. We are working with the International Food Policy Research Institute (IFPRI) which is an international research organization focused on sustainable solutions to hunger and poverty. We are doing a study with farmers in Northern Ghana to understand how farmers make decisions about which agricultural practices to use. You recently participated in a household survey for this research, and we would now like to invite you to participate in an additional activity.

*Screen 1.2*

In the activity, you will be asked to make decisions about which farming practice to use. Researchers will study these choices. They will do this to learn how farmers make decisions about what to do on their farm. The goal of the activity is to provide the government with better information, so that they can improve conditions for farmers.

Provide respondent with the informed consent form

*Screen 1.3*

If you agree to participate, we will ask you to take part in an activity in which we ask you to make choices about which agricultural practices to use. In the activity we will ask you to make a decision on which practice to adopt. These are not real choices that you will make for your field, just decisions that you make in the activity.

You will receive 5 cedis today, and you will also have the opportunity to receive additional money based on the decisions you make in the activity. Whatever money you earn will be yours to keep and you will not have to pay this money back at any time.

*Screen 1.4*

The decisions you will make are not difficult. All you need to think about is making the decisions that seem right to you. It is important to think seriously about your decisions because they will affect how much money you will keep at the end of the activity. The activity will take approximately one hour for you to complete.

*Screen 1.5*

You will make all of your decisions in private, and receive the money in private, so no one will know how much you earn today, unless you choose to tell them. We will not share any information about the decisions you personally make or the amount of money that you may keep at the end of the activity. Your name and address will not be stored with other information we collect about you. The list connecting your name with your number will be kept safe and will only be accessible to the research team.

Any personal information we obtain during the research will be kept strictly confidential. There will be no risk as a result of your participating in the study. Your participation is completely voluntary. You are free to refuse to participate or end participation at any time during the activity.

*Screen 1.6*

If you agree to consent, you are agreeing to the following:

The researcher read to me orally the consent form and explained to me its meaning. I agree to take part in this study. I understand that I am free to discontinue participation at any time if I so choose, and that the enumerator will gladly answer any question that arise during the course of the study. I will receive a copy of the signed and dated consent form.

Do you have any questions?

Answer any questions and ensure the participant understands the consent form before proceeding

*Screen 1.7*

Are you willing to provide your consent to participate in the activity today?

- Yes

If the respondent is willing to provide their consent, ask them to sign the copy of the informed consent document. Give an unsigned copy of the consent form to the respondent. Retain the signed copy and give it to your supervisor at the end of the day.

- No

If the respondent is unwilling to provide consent, thank them for their time and issue them a voucher for 5 cedis, and direct them to see your team leader to redeem the voucher for cash. If they do not provide consent, the activity ends here.

**Section 2 – Introduction**

*Screen 2.1*

Before we start, I am going to tell you about two farming practices. Then we will explain the activity, so you understand what you will be doing. After that, we will do some examples so that you can practice. Then we will do the main activity. Once the activity is completed, we will find out how much you earned. Then you will receive the payment, and we will be finished.

*Screen 2.2*

I want to tell you about the 2 different farming practices during the land preparation phase. During the activity, you will choose between these two practices.

The first choice is conventional tillage.

Using conventional tillage, farmers prepare the land by tilling the soil. This can be done with hand tools, or it can be done with animals or by using mechanized tools such as a tractor. This prepares the land to grow the seeds and reduces weeds, but this also makes the soil loose so it does not keep as much water and can make the soil less fertile.

Because it does not hold as much water, if the rains are poor the harvest is lower. And when the living material in the soil is reduced, over several seasons the harvest will not be as high.

*Screen 2.3*

The second choice is called minimal soil disturbance.

You may have heard about this practice before. Minimal soil disturbance is a different way to prepare the land. Using this practice, the soil is not disturbed with hand tools or a tractor before planting.

Instead, 'residue' is chopped off from last season's crop and left on top of the soil. During planting season, holes are made in the residue to plant the seeds. This keeps the soil firmer, so it can hold more water than using conventional tillage.

So, if the rains are poor, you can harvest more from a plot compared to using conventional tillage. Also, because the soil is not disturbed, over several seasons the soil will produce more. However, because the soil is not tilled, there may me more weeding required when using minimal soil disturbance versus conventional tillage.

*Screen 2.4*

So, now I have told you about the two practices. I would like to ask a few questions before we start the main activity.

Can you tell me, which choice will have a greater harvest if the rains are poor, conventional tillage, or minimal soil disturbance?

Record participant's <u>first</u> answer

- Conventional tillage
- Minimal soil disturbance

*Screen 2.5 [2.4 = Conventional tillage]*

That is not correct, please review the information with the respondent before proceeding.

*Screen 2.6*

Which choice requires less weeding?

Record participant's <u>first</u> answer

- Conventional tillage

- Minimal soil disturbance

*Screen 2.7 [2.6 = MSD]*

That is not correct, please review the information with the respondent before proceeding.

*Screen 2.8*

Which choice has better harvests after many seasons?

Record participant's <u>first</u> answer

- Conventional tillage
- Minimal soil disturbance

*Screen 2.9 [2.8 = CP]*

That is not correct, please review the information with the respondent before proceeding.

*Screen 2.10*

Review the information if necessary and answer any questions. Do not provide additional information on minimal soil disturbance other than what is written above.

**Section 3: Instructions for the main activity**

*Screen 3.1*

Now, I will explain how to complete the activity. I will give you paper money to use during the activity. At the end of the activity, I will give you a receipt for the amount of paper money you have, which you can take to my team leader to exchange for real money.

*Screen 3.2*

During the activity, you will be asked to choose between 2 farming practices. We will ask you to imagine that you have a one-acre plot on which you grow crops. This is not a real plot, it is just for the activity.

The main activity will be completed in 10 rounds. You can think of each round of the activity as one farming season. Therefore, at the end of the activity, you will have completed 10 choices for 10 agricultural seasons. Each round will have three stages.

*Screen 3.3*

For each season, the first stage is land preparation. You will decide how to prepare the land. You will decide to use conventional tillage or minimal soil disturbance.

*Screen 3.4*

The second stage is weeding. Depending on the practice you choose for land preparation, you will pay a weeding cost during this stage using the paper money. The cost is lower for conventional tillage, and higher for minimal soil disturbance.

*Screen 3.5*

The last stage is harvest. We will find out if the rainfall was normal or poor for the season. This will be done randomly using my computer. You or I will not know what the rains will be for that round until the harvest stage. Depending on the rainfall and the practice you chose at the start of the round, I will give you some paper money for the harvest.

*Screen 3.6*

After I give you the paper money for the harvest, we will begin a new round. Before we begin the main activity, we will practice the activity with a few examples.

*Screen 3.7*

Because minimal soil disturbance preserves more living matter in the soil, over time the production will be better. This is the same in the activity. After some time the production will increase. But when it happens is not certain. The reason we do not know when the increase will occur for sure is because everyone's fields are different, so the process of improving the soil may take more or less time.

So, if you always choose MSD, the production will increase in the fifth, the sixth or the seventh season. But only if you always choose MSD. If you choose CP for any season, you will again have to wait until between five and seven seasons for the production to increase.

*Screen 3.8*

So, if you always choose MSD, what is the first season when you might receive the gain?

Record participant's <u>first</u> answer

*Screen 3.9 [3.8 != 5]*

That is not correct. Repeat the information as required to ensure they understand the answer is 5.

*Screen 3.10*

So, if you keep choosing MSD, you might receive the gain in production in Round 5. But it is not certain.

What is the latest season when you would receive the gain?

Record participant's <u>first</u> answer

*Screen 3.11 [3.10 != 7]*

That is not correct. Repeat the information as required to ensure they understand the answer is 7.

*Screen 3.12*

That's right. If you choose MSD for seven seasons, it is certain that in the seventh season your production will increase with MSD. But what if you then choose conventional tillage, after that will the production amount for minimal soil disturbance still be increased in the next round?

Record participant's <u>first</u> answer

- Yes
- No

*Screen 3.13 [3.12 = 1]*

That is not correct. Repeat the information as required to ensure they understand they understand.

*Screen 3.14*

Remember, if you keep choosing MSD, between the fifth and seventh season of use your production will increase. You will find out that if your production has increased when you receive money at the end of the round for the harvest. After that you will continue to receive the increased amount if you continue to choose MSD.

*Screen 3.15*

Ok, so as we have seen there are three important characteristics of the practices that affect the activity. The first is that minimal soil disturbance is better for production if the rainfall is poor.

The second is that minimal soil disturbance requires more weeding, so the cost of weeding is higher for minimal soil disturbance.

The third is that minimal soil disturbance benefits production over time, if you choose minimal soil disturbance the production payout will increase between the fifth and seventh round.

*Screen 3.16*

Next, now that we know about the activity I am going to explain how we will complete it, and we will practice it together. Do you have any questions before I do that?

ANSWER ANY QUESTIONS AND REFER BACK TO PREVIOUS EXPLANATIONS IF REQUIRED BEFORE PROCEEDING TO PART 4

**Section 4: Practice**

*Screen 4.1*

We will practice the activity before the main activity begins. I am going to give you 1 cedi's worth of pesewa coins – this is for practice only.

GIVE THE PARTICIPANT:

- 1 FIFTY PESEWA COIN
- 5 TEN PESEWA COINS

*Screen 4.2*

Ok, so now that you have the money to use for the practice, I want to show you the choice sheet that we will use.

SHOW PARTICIPANT CHOICE SHEET A

*Screen 4.3*

At the beginning of each round I will show you a choice sheet like this one. First, we have land preparation **[POINT].** This is the part of the round where you make a choice about which practice you want to use.

*Screen 4.4*

Second, we have weeding **[POINT]**. Just like on a real plot, someone must work to remove the weeds after planting. So, in the activity, you must pay a cost to remove weeds in each round. This cost depends on which choice you make for land preparation. If you choose conventional tillage the cost is ${cp_cost}. If you choose minimal soil disturbance, the cost will be ${msd_cost}.

So, you can see that the cost for MSD is higher for weeding. This is because minimal soil disturbance requires more weeding. After you make your choice, you must pay me ${cp_cost} if you chose conventional tillage or ${msd_cost} if you chose minimal soil disturbance.

*Screen 4.5*

Third, we have harvest **[POINT]**. This is when we find out how much your harvest was for this round. Just like a real season, at the end is the harvest when we find out how much crop was produced on your plot. This depends on the rain. The rain can be normal or it can be poor. On average, the rain will be normal 2 out of every 3 rounds, and poor 1 out of every 3 rounds. But we do not know what the rain will be like for each round until this third stage of the round. When you choose which practice to use for the round, you will not know if the rain will be normal or poor. Here we can see what the production will be for each practice if the rain is normal **[POINT]** and if it is poor **[POINT]**. So, in the harvest stage, my computer will randomly determine what the rainfall was for that round. Then you will receive the amount for that type of rainfall, based on what practice you used.

*Screen 4.6*

At the bottom here **[POINT]** you can see there is an additional amount below for MSD. This is an additional amount that you could receive for your harvest if you have practiced MSD for at least five seasons in a row. So, for the first four seasons it will not be possible to receive this. But if you choose MSD for at least five seasons, you may receive this additional amount either in the fifth, sixth or seventh season if you continue to choose MSD.

*Screen 4.7*

After you receive it in one round, it will be available to you for certain in the next round if you choose MSD. Then I will show you this sheet.

SHOW PARTICIPANT CHOICE SHEET B

Here you can see the same amounts have been added to the total. This indicates that you will receive the additional amount for sure if you choose MSD. But only if you continue to choose MSD. If you decide to choose CP, then you will have to wait again for another five seasons before you could receive the increase again.

*Screen 4.8*

Ok, so now we have explained the choice sheet, we are going to do a round to practice. This is just to know how to complete the activity, you will not receive any money for this round.

SHOW CHOICE SHEET A. Use this sheet for the practice round

This is the sheet we will use for the practice round. We will use the same sheet at the start of the activity.

*Screen 4.9*

Are you ready to begin?

CONFIRM PARTICIPANT IS READY AND ANSWER ANY QUESTIONS BEFORE PROCEEDING

*Screen 4.10*

We are now going to begin the practice round. The first stage is land preparation. Your choice is either to use conventional tillage or minimal soil disturbance. Which choice would you like to make for this practice round?

RECORD ANSWER

- Conventional tillage
- Minimal soil disturbance

*Screen 4.11*

Thank you, you have chosen ${practice_choice} for this round. This means that you will pay ${practice_cost} for this round for weeding. And you will receive either ${pratice_normal} if the rainfall is normal or ${practice_poor} if the rainfall is poor.

Please provide me with ${practice_cost} from the money I have given you to pay for the cost of weeding for this round.

HAVE PARTICIPANT PROVIDE ${practice_cost}. VERIFY THAT THE AMOUNT GIVEN IS CORRECT BEFORE PROCEEDING.

*Screen 4.12*

Thank you. Now we have made the choice and paid the cost for weeding, we will find out the rainfall amount for this round and calculate your payout for this practice round.

*Screen 4.13*

The computer has determined that the rainfall for this season was ${pl_rainfall_example}. So, because you chose ${practice_choice}, you will receive ${practice_payout}.

GIVE TOKENS CORRESPONDING TO ${practice_payout} TO THE PARTICIPANT. VERIFY THE AMOUNT IS CORRECT BEFORE PROCEEDING

*Screen 4.14*

FOR THE FOLLOWING EXPLANATION DEMONSTRATE USING PAPER MONEY

This concludes our practice round. Because you chose ${practice_choice} you paid ${practice_cost} for weeding. Because the rainfall was ${pl_rainfall_example} you received ${practice_payout}**.** So overall, you received ${practice_net} for this round.

If you had chosen ${practice_alt_choice}, you would have paid ${practice_alt_cost} for weeding, and received ${practice_alt_payout} for your production. So overall, the payoff would have been ${practice_alt_net} for this round.

*Screen 4.15*

Ok, that concludes our practice. Do you have any questions for me?

ANSWER ANY QUESTIONS AND MAKE SURE THE RESPONDENT HAS A GOOD UNDERSTANDING BEFORE PROCEEDING

*Screen 4.16*

Now we are going to begin the main activity. Before we start I want to remind you of three things:

- If you choose MSD the cost for weeding will be higher
- If the rainfall is normal, you will receive the same production from CP as for MSD. But if the rainfall is poor, you will receive more production from MSD.
- If you choose MSD continuously, your harvest will increase sometime between Round 5 and Round 7. If your harvest is increased, you will receive more from production if you choose MSD.

Do you have any questions before we begin the main activity?

ANSWER ANY QUESTIONS, THEN COLLECT ALL TOKENS FROM THE PARTICIPANT BEFORE BEGINNING.

**Section 5: Main activity**

*Screen 5.1*

Now we will begin the main activity. I am going to provide you with 1 cedi worth of play money to use. At the end of the activity, you will redeem the play money for real money.

GIVE THE PARTICIPANT:

- 1 FIFTY PESEWA COIN
- 5 TEN PESEWA COINS

Any money you do not spend you can keep until the next round.

*Screen 5.2*

Before we begin, I would like to inform you that you have been selected to receive an additional bonus payment of ${pl_bonus} each round. However, to receive the bonus payment, you must choose MSD in at least one of the first 4 rounds.

This bonus will be provided to you after the weeding stage of each round if you choose MSD. Once Round 5 begins, you will not be eligible to receive any bonus.

BEGIN LOOP

*Screen 5.3.1-10*

PROVIDE PARTICIPANT WITH CHOICE SHEET ${choice_sheet}

We are now going to begin Round ${round_number}. Here is the choice sheet.

The first stage is land preparation. Your choice is either to use conventional tillage or minimal soil disturbance. Before you make your choice, I would like to remind you that you are eligible to receive a bonus payment of ${pl_bonus} if you choose MSD for this round. Before you make this choice, I would like to give you some information about your neighbor. ${info_treatment}. The weather was ${info_weather}, so they received ${info_net} overall for the season.

Which choice would you like to make for this round?

- Conventional tillage
- Minimal soil disturbance

**RECORD ANSWER**

*Screen 5.4.1-10*

Thank you, you have chosen ${choice} for this round. This means that you will pay ${choice_cost} for this round for weeding. And you will receive either ${display_normal} if the rainfall is normal or ${display_poor} if the rainfall is poor. Please provide me with ${choice_cost} to pay for the cost of weeding for this round.

VERIFY THAT THE CHOICE AND AMOUNT GIVEN IS CORRECT BEFORE PROCEEDING. IF THE CHOICE IS INCORRECT, GO BACK TO PREVIOUS SCREEN

*Screen 5.5.1-4*

[IF BEFORE ROUND 5 & MSD CHOSEN]

Because you chose MSD for this round you are eligible to receive a bonus of ${pl_bonus}. I will now provide you with that amount.

PROVIDE PARTICIPANT WITH ${pl_bonus}

*Screen 5.6.1-10*

Now we have made the choice and paid the cost for weeding, and paid your bonus, we will find out the rainfall amount for this round and calculate your payout for this season.

*Screen 5.7.5-10 [If production increase triggered this round]*

Because you have chosen MSD for at least five seasons in a row, your production has now increased. You will receive an additional amount from harvest for this round and in future rounds if you continue to choose MSD. In the next round I will show you a different choice sheet with the additional amount included.

*Screen 5.8.1-10*

The computer has determined that the rainfall for this season was **${rainfall_outcome}**. So, because you chose ${choice}, you will receive ${payout}.

GIVE TOKENS CORRESPONDING TO ${payout} TO THE PARTICIPANT. VERIFY THE AMOUNT IS CORRECT BEFORE PROCEEDING

*Screen 5.9.1-9*

Thank you, we will now begin the next round.

END LOOP

**Section 6 – Closing**

*Screen 6.1*

Ok, we have now completed Season 10 and this concludes the activity. Overall, you have earned ${total_payout}. I will now write a voucher for the ${total_payout}, for you to exchange for real money.

LAY THE TOKENS FROM THE ACTIVITY IN FRONT OF THE PARTICIPANT, AND RECORD THE TOTAL AMOUNT ON THE RECEIPT

Thank you for your participation today.

ANSWER ANY QUESTIONS, THEN INSTRUCT THE PARTICIPANT TO TAKE THE voucher TO YOUR SUPERVISOR TO RECEIVE THEIR PAYMENT.

*Screen 6.2*

ENUMERATOR: ON A SCALE OF 1-10 where 10= Very good understanding and 1=Very poor understanding, how would you rate the participant's understanding of the activity? (Note that this is not about how much money they received, but how well you think they understood the explanation of the activity).

*Screen 6.3*

Did you experience any problems implementing the activity?

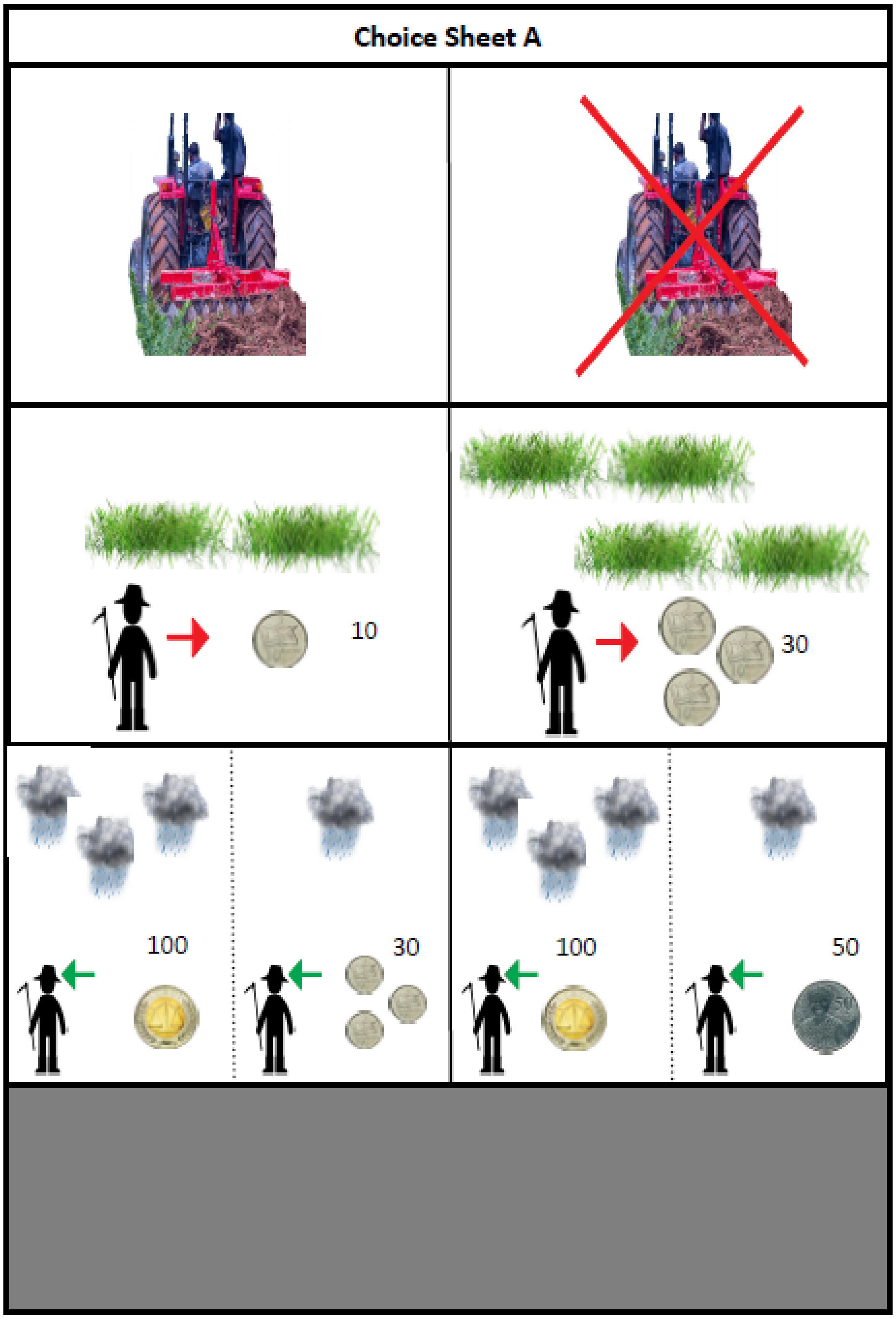
- Yes, the participant did not have a good understanding
- Yes, the participant did not agree with my explanation
- Yes, the activity was interrupted for some time
- Yes, other problem (specify)
- No, no problem

*Screen 6.4*

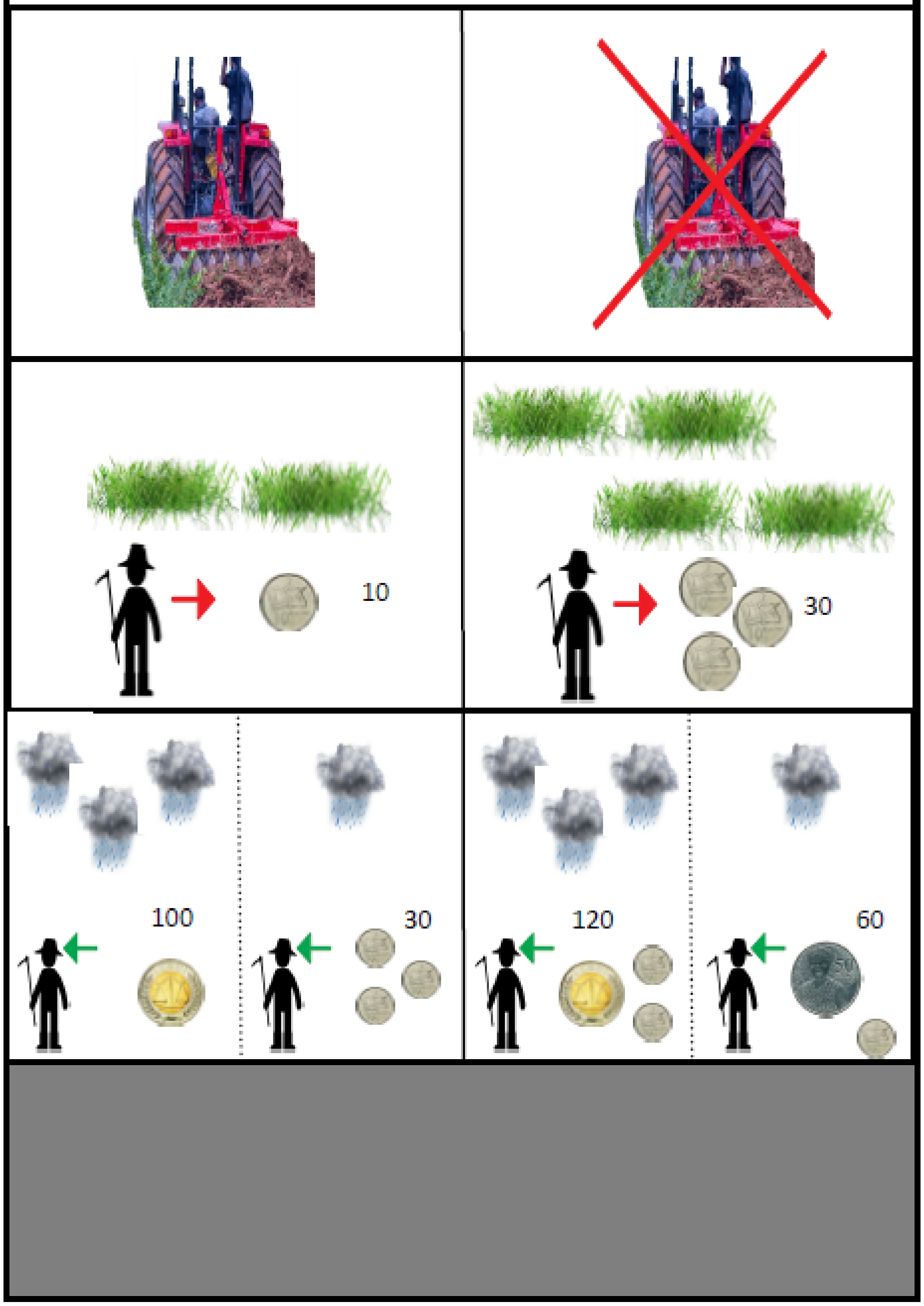
ENUMERATOR: PLEASE RECORD ANY COMMENTS ABOUT YOUR IMPRESSION OF THE SESSION, OR ANY ADDITIONAL DESCRIPTION OF PROBLEMS YOU ENCOUNTERED

## End of Script

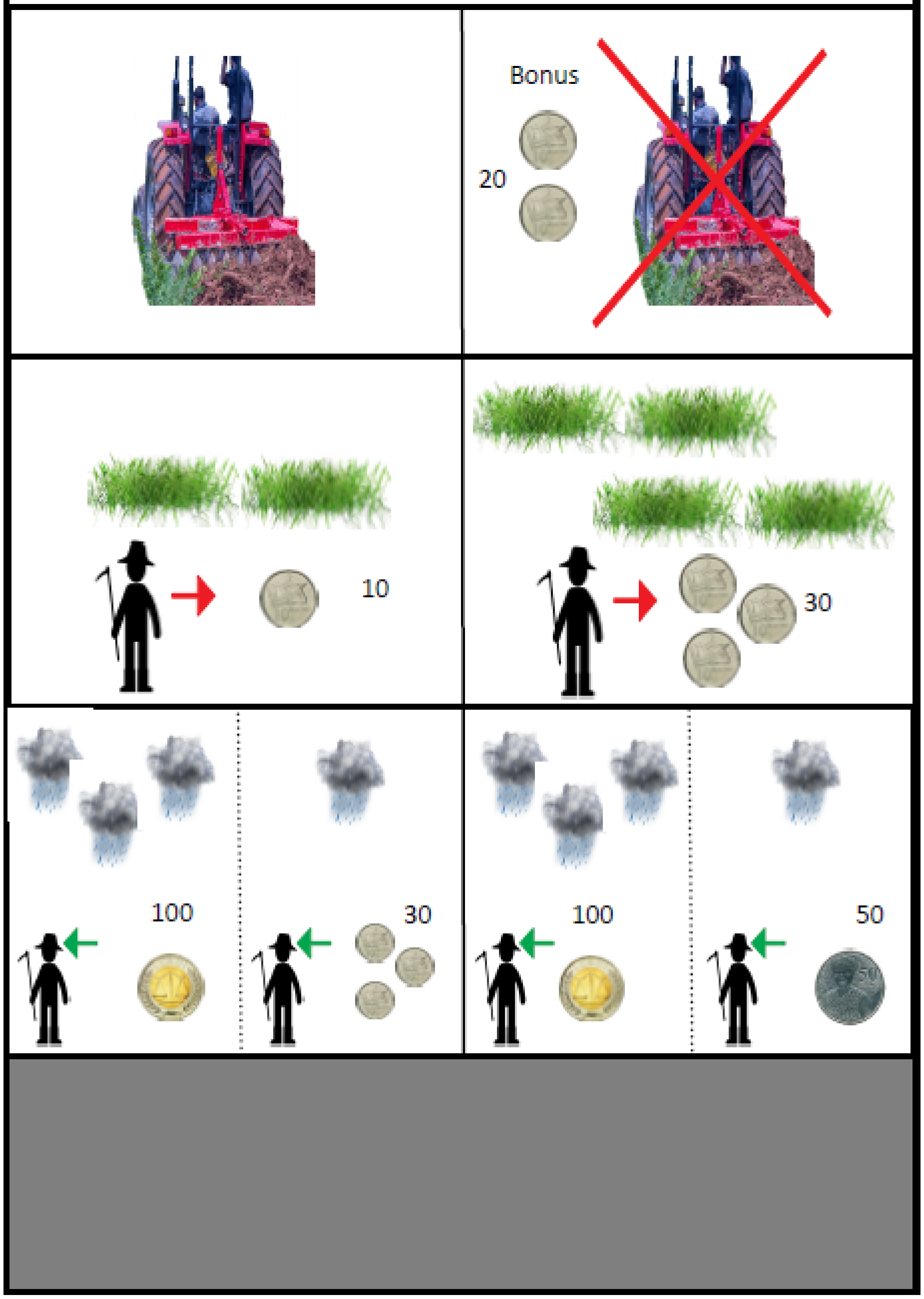
## Online Appendix B – Visual Aids



**Choice Sheet B**



**Choice Sheet C**



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