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Measuring Agricultural Knowledge and Adoption

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Abstract

Understanding the trade-offs in improving the precision of agricultural measures through survey design is crucial. Yet, standard indicators used to determine program effectiveness may be flawed and at a differential rate for men and women. The authors use a household survey from Mozambique to estimate the measurement error from male and female self-reports of their adoption and knowledge of three practices: intercropping, mulching, and strip tillage. Despite clear differences in human and physical capital, there are no obvious differences in the knowledge, adoption, and error in self-reporting between men and women. Having received training unanimously lowers knowledge misreports and increases adoption misreports. Other determinants of reporting error differ by gender. Misreporting is positively associated with a greater number of plots for men. Recall decay on measures of knowledge appears prominent among men but not women. Findings from regression and cost-effectiveness analyses always favor the collection of objective measures of knowledge. Given the lowest rate of accuracy for adoption was around 80 percent, costlier objective adoption measures are recommended for a subsample in regions with heterogeneous farm sizes.

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Measuring Agricultural Knowledge and Adoption

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1 Introduction

In this paper, we ask: "What drives misreporting in agricultural surveys?" We exploit objective and subjective measures of agricultural knowledge and adoption to study the determinants of misreporting, with a focus on the gender of the respondent. Findings from regression and cost-effectiveness analyses are used to formulate recommendations for extending our applications to standard rural household surveys.

Encouraging the adoption of improved technologies stands front and center of the agricultural policy agenda. The role of women in achieving food security is under investigation and more interventions look to specifically affect women's agricultural outcomes (O'Sullivan et al., 2014). The number of ongoing rigorous impact evaluations on agricultural interventions is booming, aimed to test what works and how to inform policy decisions. Yet, determining what works is largely at the discretion of the methodology and indicators applied to measure effectiveness. The standard indicators used to assess agricultural interventions, such as adoption, are typically based on farmer self-reports which may be subject to various biases. Understanding the trade-offs in improving the precision of agricultural measures through survey design is, therefore, crucial in delivering credible answers.

Recent studies focus on the reliability of agricultural productivity estimates constructed from available developing country surveys. Beegle et al. (2012) randomized interview timing to assess the extent of recall bias on measures of inputs and outputs in Kenya, Malawi, and Rwanda. Consistent with the broader literature on recall bias, they find that salient events, such as the use of hired labor, and factors of importance, such as fertilizer use, were less subject to recall bias. Deininger et al. (2012) examine the reliability of diaries as a tool for improving measurement of agricultural productivity particularly for crops that are harvested continuously throughout the year. They find that the output value for continuously harvested crops is systematically under-estimated in standard agricultural surveys.

Our contribution is threefold. First, we document the extent to which self-reported measures of agricultural knowledge and adoption are subject to measurement error. Second, we investigate the determinants of measurement error. We focus on four culprits: response bias, observed respondent characteristics, exposure to training, and recall decay. Third, we assess the cost-effectiveness of improving survey design in terms of gains in precision.

Self-reported (subjective) and objective measures of knowledge and adoption of sustainable land management (SLM) practices were surveyed to measure the impact of an agricultural extension intervention (Kondylis, Mueller, and Zhu, 2014). Kondylis, Mueller, and Zhu (2014) exploit this special feature of the survey design to formally document the importance of perceptions versus information accuracy in influencing behavior. Other strands of the literature have performed similar analysis. House et al. (2004) and Knight (2005) find that subjective knowledge significantly determines a consumer's willingness to accept a genetically modified product or biotechnology application.

We next investigate gender-specific determinants of misreporting. Building on previous efforts in health (Butler et al., 1987; Baker, Stabile, and Deri, 2004; Johnston, Propper, and Shields, 2009), agriculture (House et al., 2004; Knight, 2005) and development (Beegle et al., 2012; Deininger et al., 2012; de Nicola and Giné, 2013), we document how differences in educational attainment, farm size, training exposure, and the allocation of labor within the household will differentially affect the reporting accuracy of men and women farmers. Response accuracy is shown to be influenced by the respondent's educational attainment (Butler et al., 1987; House et al., 2004; Beegle et al., 2012; Deininger et al., 2012), and farm size (Beegle et al., 2012; Deininger et al., 2012). This is further motivated by the well-documented gender gap in access to inputs and extension services, labor and liquidity constraints, and tenure insecurity (Ragasa, 2012; Croppenstedt, Goldstein, and Rosas, 2013).

Finally, we provide a cost-effectiveness analysis to illustrate the feasibility of incorporating knowledge exams and field measurement of adoption into rural household surveys. The costs of these survey tools are compared to the improvement in precision gained. Final recommendations for future monitoring and evaluation practices are based on these assessments.

We find that, while the incidence of false negative and positive response is similar across men and women, the determinants of misreporting vary with the gender of the respondent. We document that men and women are systematically more likely to underreport their knowledge of agricultural practices and over-report their adoption. Despite clear differences in human and physical capital, there are no obvious gender differences in the precision of knowledge and adoption measures. Having been trained on a given technique is associated with lower knowledge misreports and higher adoption misreports for both men and women. Other determinants of reporting error differ by gender.

Misreporting is positively associated with a greater number of plots for men. Recall decay appears prominent among men but not women for knowledge outcomes. Findings from cost-effectiveness and regression analyses always favor the collection of objective measures of knowledge. Given the lowest rate of accuracy for adoption was around 80 percent, objective adoption measures are recommended for a subsample in regions with heterogeneous farm sizes.

2 Data

2.1 Study Region

The research study was conducted in Mozambique's Zambezi Valley, and covered districts across all but one of its four provinces (Sofala, Tete and Zambezia). The valley spans 5.5 million hectares of arable land, accounting for 15% of Mozambique's overall arable land (FAO, 2007). The tropical climate provides abundant rainfall and the majority of the nation's water reserve. Economic activity stagnated following the end of the civil war in the 1990s. The national government currently targets agricultural investments in this region to encourage growth given its potential (World Bank, 2007).

There are two farming seasons each year in the Zambezi: a rainy season from October to March and a dry season from April to September. Farming is the main source of food and income, and farmers grow maize, cassava, beans, sorghum, and rice as main food crops, and sesame, cotton, cashew nuts, sugar, and tobacco as main cash crops. Agricultural productivity is low in the area, in part attributable to the lack of advanced technologies. Smallholders, who represent 98% of Mozambique's farmers, use low-yield seed varieties and traditional farming methods (Sachs, Toledano, and Maples, 2011). In addition, more than 95% of women are engaged in agricultural activities compared to 66% of men (Farnworth, 2010). Despite the high participation rate and the essential role in growing food crops for families, female farmers are disadvantaged by their lack of accesses to farming inputs, resources, extension services, and land security in Mozambique (Uaiene and Arndt, 2009).

We use data from the 2012 Smallholder's Survey, which were collected in the context of a technology adoption randomized controlled trial (RCT) on a large government-World Bank investment in the agricultural sector (Kondylis, Mueller, and Zhu, 2014).[1] The sample consists of 4,000 households residing in five districts of the Zambezi Valley, Mozambique (Chemba, Maringue, Mopeia, Morrumbala and Mutarara) (Figure 1). The survey is composed of two parts: one Computer Assisted Personal Interviewing (CAPI) questionnaire, filled indoors by different respondents and at various levels (household, individual, and plot); and one paper-based plot survey conducted in the field on household's main plots.

Subjective and objective knowledge and adoption outcomes were asked of two individuals per household, the household head and his/her partner or spouse.[2] Eight sustainable land management (SLM) practices were documented based on the curriculum of the education intervention and prior adoption practices in the region. We focus on the measurement of the three most common techniques: intercropping, mulching, and strip tillage. A fictitious practice was introduced as a placebo, planting in squares, to check for the sensitivity of self-reporting to response bias.

2.2 Knowledge and Adoption Measures

During the interview, enumerators asked the respondent to name any conservation agricultural technique that he knew. When the respondent answered one of the nine SLM techniques, enumerators marked it on the pop-up window as known. The process was repeated until the respondent listed all of the techniques he knew. Our first self-reported measure, "know by memory", reflects the respondent's ability to recall the name of SLM techniques.[3]

After the respondent recollected the techniques he knew, enumerators read the remaining techniques (including the placebo) from the survey list and asked whether the respondent knew each technique. Our second self-reported knowledge measure, "know by name", is based on these responses. Logically, if a respondent knows a technique by memory, he will also know the technique by name. Therefore, for each person, the techniques known by memory are a subset of the techniques known by name, and knowing by memory is a sufficient condition to knowing by name.

[1] This RCT was designed and implemented under the Market-led Smallholders Development in the Zambezi Valley Project, which aims to improve the income of smallholder farmers, soil fertility, and ecosystem resilience to climate change (World Bank, 2007).

[2] In the case of a polygamous household, only the "main" spouse was interviewed. A single response for knowledge and adoption was given when a household head lacked a partner.

[3] Note, in this case, it is improbable that a farmer would state his familiarity with the placebo technique since it does not exist. We therefore treat any response indicating an individual's knowledge of planting in squares as a routing error (enumerator clicked on the technique by mistake).

In order to objectively assess a farmer's knowledge, we administered an agricultural knowledge exam on each technique (see Appendix). The exam contained 23 questions. In some cases, the questions were multiple-choice. Other questions required numerical answers or multiple responses were possible. Sets of questions reflect the knowledge of a particular technique, where approximately 3 questions per technique (with the exception of the placebo) were included on the exam. Our objective measure of knowledge, "know by exam" is created based on the responses to the exam questions: we consider the respondent knows a particular technique objectively if he answered at least one exam question pertaining to the technique correctly.[4]

As with the knowledge measure, we create two sets of binary variables from the adoption information. During the indoor interview, farmers were asked whether they adopted each of the SLM techniques they knew by name in the 2011/2012 rainy season.[5] We use this to build our subjective adoption measure. To collect an objective measure of adoption, enumerators were field-trained to identify SLM techniques in practice. The field interview took place after planting and before harvest, so that enumerators could observe adoption and measure the area on which each SLM technique was practiced.[6] If the area exceeded zero, the objective measure of adoption indicator takes a value of one.

For the adoption analysis, we restrict the sample to respondents who manage only one plot in the household. Self-reported adoption is collected at the individual level, while objective adoption is only measured for the main plot of the respondents. For consistency, we restrict our analysis of both subjective and objective adoption to the sample of households with male and/or female respondents managing no more than one plot. In spite of slight differences between the restricted and omitted samples in terms of demographics and crop choice, [7]the analysis remains informative in the search for methods that improve data collection efforts of agricultural production measures in similar settings in Africa.

[4]Our knowledge exam provides a comprehensive set of questions that describe each technique. For the purpose of our study, it was important to measure how knowledgeable a farmer was about different techniques. However, testing different stringencies in the line of questioning could be of interest, particularly, for deriving the characteristics of an optimal knowledge exam.

[5]This implies that our analysis of adoption measures is conditional on knowing a technique by name.

[6]Respondents were unaware of the field visits until completion of the entire indoor survey.

[7]The sample used for the adoption analysis reflects individuals at earlier stages in their life cycle with smaller households and a greater tendency to complete their primary education (Table A.1). A greater proportion of the restricted sample also produces maize, yet has similar inclinations to grow cash crops (Table A.1).

2.3 Male- and Female- Managed Plots, SLM Knowledge, and Adoption

Table 1 displays descriptive statistics of the individual male and female plot managers. The demographic and human capital characteristics of female plot managers are quite different than those of men. A greater percentage of women are single, divorced, separated, and widowed (18 percent of women compared to 9 percent of men). Women also tend to live in slightly smaller households with fewer children. Perhaps most striking are the differences in literacy and education. Only 10 percent of women are literate compared to 52 percent of men. Moreover, 4 percent of women completed a primary education (grade 6 and above) compared to 24 percent of men.

Men and women also use diverse agricultural practices and inputs (Table 1). The plots managed by women tend to be smaller: the main plot of women (men) averages 0.7 (0.9) hectares. A greater proportion of men use pesticides and chemical fertilizers. Men spend more time farming on their larger main plots where cash crops (e.g., cotton and sesame) are grown in addition to maize, a staple. Women diversify from maize by producing crops typically used as cooking ingredients. Women's plots also suffer less from erosion. One possible explanation is the cultivation practices for staple crops have fewer consequences on erosion than those applied for cash crops (e.g., deep tillage).[8]

Tables 2 and 3 display the average individual knowledge and adoption practices of the pooled sample, men, and women, respectively. Mulching and strip tillage were two of three main techniques propagated as early as 2008 by the Market-led Smallholders Development in the Zambezi Valley Project which explains their widespread use in the region. There are few differences in the knowledge and adoption of techniques by plot manager's gender, despite dissimilarities in human capital characteristics and the conditions of the plots they manage. There is evidence that women are less likely to recall mulching, as a technique they have learned, by memory. Such a difference disappears when using other subjective and objective measures of knowledge.

[8]In Uganda, the production of cotton and its cultivation practices (e.g., deep tillage) have been associated with increased soil erosion (Pender et al., 2009).

2.4 Measurement Error in Knowledge and Adoption Measures

Table 4 displays the shares of accurate, false positive, and false negative knowledge and adoption responses. A false positive (negative) indicates that the respondent reported knowing/adopting (not knowing/adopting) the technique, while the objective measure indicated otherwise.

Across the board, having farmers recall techniques by memory consistently produces more false negatives, except for intercropping. Patterns are remarkably similar across men and women respondents. These results suggest that standard questions used to elicit farmer familiarity with an agricultural practice may mask true knowledge of agricultural practices. Reporting accuracy overall improves when allowing the enumerator to read the names of the techniques. Relying on the memory of farmers to recall agricultural conservation techniques may bias response rates downward. The alternative line of questioning, “know by name”, sufficiently decreases the incidence of false negatives and moderately increases false positives, leading to a sizeable increase in correct responses. Intercropping is especially sensitive to the knowledge outcome used, where accuracy improves 38 percentage points for women and 34 percentage points for men when the enumerator reads the names of all techniques.

We find that self-reported measures of adoption lead to a high incidence of correct responses, with the share of correct answers for mulching and strip tillage on the order of 85-95 percent. The error rate is pronounced for the most widely practiced technique, intercropping, in the study area, on the order of 80 percent. False positives are particularly common at 17-20 percent. Again, the precision in self-reported adoption exhibits similar patterns across gender.

3 Determinants of Misreporting

In what follows, we try to decipher what drives the tendency to on average understate knowledge and overstate adoption. Understanding the factors that drive measurement error may shed light on more cost-effective approaches to improving the precision of agricultural outcomes, particularly with respect to SLM adoption.

3.1 Response Bias

Bias can arise from the respondent's desire to be accepted by the enumerator and his peers. Numerous studies in the social sciences offer methods for reducing its associated measurement error (King and Bruner, 2000). Recent work demonstrates the fallibility of using social desirability indexes as an explanatory variable, a commonly practiced technique to reduce response bias. Norwood and Lusk (2011) conceptually show when the marginal cost of exhibiting social desirable behavior is zero, as in such hypothetical contexts, the behavior of individuals can be similar despite varying social desirability index values. Inference from hypothetical and non-hypothetical choice experiments corroborates their prediction: correlations between the social desirability index and socially desired behavior are greater for non-hypothetical choices.

To gauge the extent of response bias in our subjective knowledge measures, we added a placebo technique to the list of SLM techniques surveyed (planting in squares).[9] Since this technique is fictitious, no farmer should know it by memory. Hence we consider the 0.2 percent of men and women who knew the placebo outcome by memory to be routing errors. Taking these errors out of our "know by name" measure[10] implies that only 0.3 percent of men and 0.2 percent of women assert knowing the placebo technique by name, as prompted by the enumerator. The small magnitude observed suggests that any inference derived from our self-reported, subjective measure of knowledge should be broadly immune to response bias. In addition, the differences in response bias by gender are not statistically different.

Using the same logic as above, response bias is not implicit in our self-reported adoption outcomes. A negligible portion of the sample reported adopting the placebo (6 individuals). Thus, knowledge and adoption responses to the placebo imply misreporting is not driven by a respondent's tendency to over-report to receive peer approval.

[9] Although we did not randomize the placement of the placebo in the list, the placebo technique was listed as the sixth of nine techniques. How the list is read will depend on which techniques the farmer recalled by memory, so technique placement on the list varies for each individual–albeit non-randomly.

[10] Another way to think about misreporting would be to remove these routing errors from the denominator when computing the incidence of misreporting. This does not substantially change the results.

3.2 Respondent-Specific Characteristics and Recall Bias

We estimate separate linear probability models for male and female respondents to identify the determinants of measurement error Y (false negative/positive reporting):

$$\begin{aligned} Y \;=\; & \beta_0 + \beta_1 X + \beta_2 Ever\,learned + \beta_3 Ever\,learned \times Learned\,6-10\,years\,ago \\ & + \beta_4 Ever\,learned \times Learned\,11-20\,years\,ago \\ & + \beta_5 Ever\,learned \times Learned\,over\,20\,years\,ago + \sum_{j=1}^{J} Interviewer_j + \varepsilon. \end{aligned} \tag{1}$$

The dependent variable is equal to one if an individual's subjective outcome does not coincide with the true, objective outcome, and is otherwise zero. Standard errors are always clustered at the community level to allow for within-community correlation of unobserved factors that influence false reporting.[11]

We include several variables in vector X to examine which individual characteristics drive misreporting. Demographic and wealth characteristics[12] are included to evaluate the extent to which socioeconomic characteristics affect false reporting. We also include the number of plots in the household[13] and the number of males of working age (age 15-55) to proxy for farm productivity or capacity constraints. The effect of these factors on misreporting is *a priori* ambiguous. For example, farmer productivity may improve the precision of responses, as high productivity may correlate with sharper knowledge. Alternatively, productivity may correlate with the higher diversification of responsibilities and farming practices within the household and across plots. This may dilute reported knowledge of the techniques by any one respondent.

Building on previous studies, we also account for the role of exposure to training and recall decay in misreporting by including five binary variables which reflect when the interviewer first

[11] For all specifications, the covariates are jointly correlated with the outcomes of interest according to the F test (p-value$\leq$0.001).

[12] Controls include: dummies for age categories (26-40 years, 41-55 years, and greater than 55 years), marital status of the respondent, completion of primary school, the number of children in the household, and the total household landholdings.

[13] Our paper survey instrument allowed for the documentation of the number of plots managed by men and women, which would have provided a total number of plots variable that varied for each male and female respondent in the household. Erroneous skip patterns in the electronic version of our questionnaire prevented female respondents from reporting having managed plots other than their main plot. In the end, we are left with self-reported measures of the number of plots managed by men–not women. We instead use the total number of plots managed by the household, as it is inclusive of all plots owned by the household and is asked prior to the erroneous skip patterns.

learned the technique: Ever learned, Ever learned × Learned this technique 6-10 years ago, Ever learned × Learned this technique 11-20 years ago, and Ever learned × Learned this technique over 20 years ago (the omitted category is Never learned this technique). The effect on misreports associated with having learned a technique less than five years ago is provided by the coefficient on "Ever Learned".[14] The estimated parameters on these variables capture recall bias, as well as the role of experience with a particular technique. We are unable to disentangle these two effects, and the expected sign on the corresponding coefficients is therefore ambiguous. Experience with a technique over time may improve familiarity and, hence, lead to higher precision in self-reporting. The opposite is true for recall decay.

Finally, we control for the duration of the CAPI portion of the household interview to account for survey fatigue, and include enumerator indicators to purge our estimates from any measurement error associated with the transcription process and enumerator idiosyncrasies.[15]

One limitation of the analysis is the ability to identify biases associated with respondent's attitudes. We are unable to capture these dimensions of one's personality with variables available on the survey instrument, and certainly the effects measured on the regression parameters may be influenced by the omission of such variables. The cross-sectional nature of the survey data also precludes the inclusion of individual fixed effects which would greatly reduce the tendency for bias caused by unobserved individual-specific characteristics that influence false reporting. For these reasons, the estimated coefficients should be largely interpreted as correlations rather than causal drivers of false reporting.

We present the estimated marginal effects of variables on the false reporting of knowledge and adoption in Tables 5 and 6.[16] Somewhat surprisingly, autonomy as measured by one's marital

[14] For a farmer who learned the technique 6 years ago, the effect is measures as the sum of the coefficients on "Ever learned" and "Ever learned × Learned this technique 6-10 years ago". Similar computations are made to measure different durations since receipt of training.

[15] As a measure of recall decay, we initially used the difference in the days between the first interview date in the household's district and the actual interview date of each household. The average difference in days (56) was rather low relative to previous work. The estimated parameters on the recall variable were statistically equivalent to zero. Adding a squared term to the model only confirmed a lack of correlation. We also tried to exploit the presence of a randomized intervention in our study areas to create an exogenous measure of exposure to SLM techniques in our sample. Communities that received the treatment had contact farmers who were trained in SLM techniques, fifteen months prior to the survey (Kondylis, Mueller, and Zhu, 2014). The parameters on the treatment variable were also statistically insignificant.

[16] We also estimated linear probability and probit models including district (rather than enumerator) indicators. Factors that affect false reporting are consistent across the two models with the same sign and magnitude. Statistical significance for a few coefficients varies across models, particularly when the statistical significance is marginal in one specification and insignificant in the other (see Tables A.3 and A.4).

status affects mostly the accuracy of male responses and schooling has no effect on the accuracy of knowledge and adoption responses. Regarding the former, single and formerly married men tend to provide more accurate responses for strip tillage outcomes and inaccurate responses for intercropping outcomes. This appears counter-intuitive to the extent that, autonomous individuals are often the decision-makers in their household and may be more motivated to acquaint themselves with available farming practices and their trade-offs. We expected autonomy to be especially relevant for women.

Having ever learned the technique has the strongest association with self-reported accuracy. Having ever learned the technique is significantly associated with lower levels of error in self-reported measures of knowledge. This is intuitive, as, all else being equal, having received a training on a specific technique should increase the farmer's probability of knowing a technique by name. In contrast, having ever learned a technique is associated with higher adoption misreports on the order of 10 percentage points. The magnitude of the effect is remarkably similar across technique. One interpretation of the opposing effects on knowledge and adoption is that trained respondents are prone to social desirability bias. However, we cannot establish causality nor directly test the mechanisms underlying these combined effects.

Recall decay weakens the precision of self-reported knowledge outcomes only among men, while having known the technique longer leads to higher precision in the case of women. The measurement error seems to increase with the timing of learning for the mulching outcomes of men but not women. Rather, women who learned strip tillage and intercropping techniques over 20 years ago appear to have more precise responses. For women, there is only one instance where recall has a marginally significant correlation with the adoption measurement error.

As with schooling, there is no consistent impact of wealth on the reporting of knowledge and adoption outcomes. The estimated parameters on the total landholdings' variable are statistically different from zero in only three cases. Men on larger farms tend to provide more accurate responses of their intercropping knowledge but less accurate responses for their strip tillage adoption. Women on larger farms tend to provide less accurate responses of their intercropping adoption.

The positive impact of the majority of the significant parameters on the total number of plots and the number of male adults' variables suggest two possible influences on false reporting. First, given the opportunity cost of their time, farmers with larger or more productive farms may be less inclined to respond carefully to the survey questions. Such inclinations have been shown in survey work in Uganda, where educated farmers who received a diary were less likely to provide an entry (Deininger et al., 2012). An alternative explanation is that as farming practices are divided across a number of plots and responsibilities shared across individual household members, the response of our household heads and spouses may be less precise.

4 Cost-effectiveness Analysis

We further motivate the use of a knowledge exam to capture farmer awareness of the SLM techniques by comparing the total costs of adding the questions to the survey to the improved precision of the knowledge outcomes. We multiply the number of exam questions for a given technique by the price per survey question. The price per question is derived by dividing the cost of each indoor survey, which equals the total cost of the survey minus the cost of the field survey, by the total number of questions asked on the indoor survey.

Our cost estimates for measuring objective adoption are computed using the additional time spent by the enumerator to collect information in the field and the associated transportation costs (see Table A.2 for details). Since the objective measurement of SLM adoption is done for all techniques at once and the marginal cost of adding a technique to measure in the field visit is minimal, we present a single estimate for the additional costs of adding objective adoption measures, but allow the improvement of the precision to vary by technique. By construction, we tend to underestimate the cost of adoption, as we exclude the additional cost of training the enumerators to identify the technique in the field and cannot account for the exact time spent by the driver. In contrast, we will tend to overestimate the cost of asking additional knowledge questions as we assume that the marginal cost per survey question equals the average cost per survey question.

The cost-effectiveness estimates in Table 7 indicate knowledge exam questions produce substantial benefits. Over the whole survey an additional $1,170 would improve the precision of self-reported strip tillage and mulching knowledge by 23-34 percent, while an additional $2,340 spent on intercropping knowledge questions would improve the precision by only 9 percent. The gains to including the intercropping questions are rather small, since the majority of respondents could identify the technique by name. If costs were divisible, this implies that an additional $100 spent on the use of a knowledge exam can potentially lead to a 0.4-2 percent increase in the accuracy of outcomes.

As shown in Section 2, the descriptive statistics on the measurement error suggest that the self-reported adoption measures are more accurate than the self-reported knowledge outcomes. For example, the self-reported adoption rates for strip tillage are over 90 percent accurate, which may render the additional costs of training enumerators, interview time, and transporting enumerators between plots and households less valuable. In fact, sending the enumerators to the respondents' main plot led to much smaller gains in the precision per dollar spent. Our lower bound estimate of the field visit is about $25,000, with returns to precision ranging from 7 to 27 percent.

5 Conclusion

We compare subjective and objective responses on the knowledge of conservation agricultural practices to gauge the reliability of self-reported measures. Men and women farmers are equally unlikely to recollect these practices without name prompting. Even when farmers are asked if they are familiar with a practice from the list, jargon can interfere with observing the respondent's true knowledge. Farmers' scores on an agricultural knowledge exam suggest self-reported measures may underestimate true knowledge. Interestingly, despite clear differences in demographics and access to inputs, we find no differences in the misreporting of knowledge across gender lines.

A similar exercise was performed for the adoption of conservation agricultural practices. Enumerators visited the main plots of male and female farmers to confirm the practice and measure the area of the plot that the practice was adopted. Comparisons between subjective and objective measures of adoption were reassuring: for many techniques, there were accuracy rates of around 80 percent or above. The most widely practiced technique, intercropping, appeared most susceptible to bias on adoption responses. Given that few farmers admitted to adopting the placebo technique, it is less likely the measurement error stems from response bias.

The land fragmentation and farm size were often associated with the quality of responses in regressions. For example, the misreporting of intercropping adoption, the most error-ridden outcome, was more frequent among male farmers with numerous plots. Land fragmentation dilutes any one household member's knowledge of the techniques practiced on his land. A smaller positive correlation between the misreporting of intercropping adoption and total landholdings was detected for female farmers.

The strongest correlates of misreporting were exposure to training and the recall period. For men and women, exposure to training lowers the incidence of knowledge misreports and increases adoption misreports. Duration of recall periods, however, differentially influences the false reporting of men and women. The inaccuracy of self-reported mulching knowledge increases with the time in which male farmers first learned the technique. In contrast, female farmers gave more precise strip tillage and intercropping knowledge measures when they learned the technique over twenty years ago but not a single year before. This suggests that the negative effects of recall bias dominate for men, while the positive impact of long-term experience is more prominent for women. Duration of recall periods had almost no effect on the accuracy of adoption measures.

Our findings support the use of knowledge exams in surveys, as they are a relatively inexpensive way to improve the collection of farmer knowledge data. Given the additional expense of conducting individual interviews and visiting multiple plots per household to measure adoption, one might focus on the objective measurement for a subsample of individuals particularly in regions where farm size is heterogeneous in acreage or geographic scope. Given the importance of plot size accuracy in constructing key indicators (Kilic et al., 2013), there will be increasing returns to the collection of other important outcomes, like adoption, with the standardization of plot measurement in surveys.

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Figures And Tables

Figure 1: Coverage of Smallholders' Survey 2012

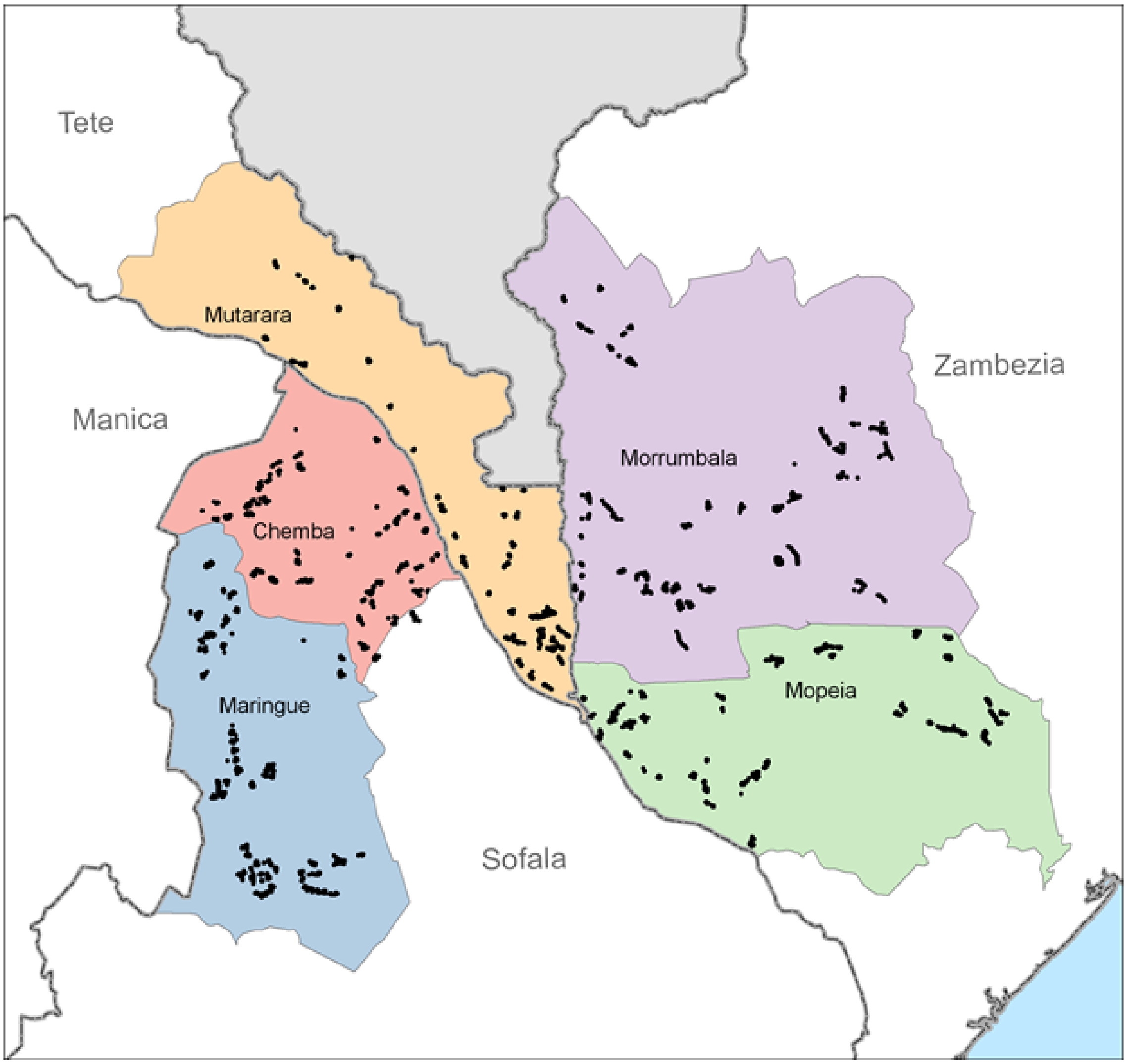

Table 1: Descriptive Statistics of Male and Female Plot Managers and their Main Plots

Variables	N	Pooled	Male	Female	Difference
Plot Manager Characteristics					
Age	6076	37.681	40.308	35.873	4.435 ***
Marital status: single, divorced, separated, or widowed	6076	0.147	0.094	0.184	-0.090 ***
Household head is female	6076	0.209	0.053	0.316	-0.263 ***
Literate	6076	0.267	0.518	0.095	0.422 ***
Have less than primary school education	6076	0.882	0.764	0.962	-0.198 ***
Completed at least primary school education	6076	0.118	0.236	0.038	0.198 ***
Plot Manager - First Exposure to SLM Technique					
Learned mulching in the past 5 years	6076	0.230	0.232	0.228	0.004
Learned mulching in 6-10 years ago	6076	0.067	0.064	0.068	-0.004
Learned mulching in 10-20 years ago	6076	0.083	0.094	0.076	0.018
Learned mulching more than 20 years ago	6076	0.047	0.057	0.040	0.016
Learned strip tillage in the past 5 years	6076	0.062	0.056	0.066	-0.010
Learned strip tillage in 6-10 years ago	6076	0.039	0.041	0.039	0.002
Learned strip tillage in 10-20 years ago	6076	0.062	0.067	0.059	0.008
Learned strip tillage more than 20 years ago	6076	0.054	0.058	0.051	0.006
Learned intercropping in the past 5 years	6076	0.195	0.192	0.197	-0.005
Learned intercropping in 6-10 years ago	6076	0.141	0.132	0.148	-0.016
Learned intercropping in 10-20 years ago	6076	0.307	0.319	0.298	0.021
Learned intercropping more than 20 years ago	6076	0.274	0.306	0.253	0.053 **
Plot Characteristics					
Self-reported plot area (hectares)	5386	0.956	1.065	0.875	0.190 ***
GPS measured plot area (hectares)	5318	0.796	0.906	0.716	0.190 ***
Household owns the main plot	5386	0.984	0.989	0.981	0.008 *
Main plot soil is fertile	5386	0.993	0.992	0.994	-0.003
Main plot is flat	5386	0.643	0.631	0.652	-0.021
Main plot locates in high zone	5386	0.444	0.453	0.437	0.015
Main plot had erosion problem	5012	0.081	0.096	0.069	0.027 *
Used pesticides on the main plot	5012	0.061	0.122	0.012	0.110 ***
Used chemical fertilizer on the main plot	5012	0.009	0.014	0.005	0.009 **
Number of crops grown on the main plot	4642	1.912	1.897	1.924	-0.027 *
Grew maize on the main plot	5012	0.635	0.662	0.614	0.048
Grew sorghum on the main plot	5012	0.243	0.131	0.335	-0.204 ***
Grew cotton on the main plot	5012	0.096	0.187	0.020	0.167 ***
Grew sesame on the main plot	5012	0.161	0.228	0.105	0.123 ***
Grew cassava on the main plot	5012	0.168	0.196	0.146	0.050 *
Grew cowpea on the main plot	5012	0.349	0.303	0.387	-0.084 **
Grew pigeon pea on the main plot	5012	0.189	0.225	0.158	0.067 **
Other Household Characteristics					
Number of household members	6076	5.221	5.513	5.020	0.493 ***
Number of children (age < 15 years)	6076	2.813	2.928	2.733	0.194 **

*Note: Community clustered standard errors used for the t statistics. * p<0.10 ** p<0.05 *** p<0.01.*

Table 2: Knowledge Outcomes by SLM Technique and Plot Manager

	Know by Memory				Know By Name				Know By Exam			
	Pooled	Male	Female		Pooled	Male	Female		Pooled	Male	Female	
	Mean	Mean	Mean		Mean	Mean	Mean		Mean	Mean	Mean	
Techniques	SD	SD	SD	Diff.	SD	SD	SD	Diff.	SD	SD	SD	Diff.
Mulching	0.286	0.321	0.262	0.059 *	0.426	0.447	0.412	0.035	0.603	0.629	0.585	0.044
	(0.452)	(0.467)	(0.440)		(0.495)	(0.497)	(0.492)		(0.489)	(0.483)	(0.493)	
Strip tillage	0.109	0.114	0.106	0.009	0.221	0.221	0.221	0.000	0.459	0.470	0.452	0.018
	(0.312)	(0.318)	(0.307)		(0.415)	(0.415)	(0.415)		(0.498)	(0.499)	(0.498)	
Intercropping	0.520	0.559	0.493	0.066	0.934	0.949	0.924	0.025	0.946	0.944	0.948	-0.004
	(0.500)	(0.497)	(0.500)		(0.248)	(0.221)	(0.265)		(0.225)	(0.229)	(0.223)	
Observation	6,076	2,477	3,599		6,076	2,477	3,599		6,076	2,477	3,599	
		(40.77%)	(59.23%)			(40.77%)	(59.23%)			(40.77%)	(59.23%)	

Note: Community clustered standard errors used for the t statistics. * $p<0.10$ ** $p<0.05$ *** $p<0.01$.

Table 3: Adoption Outcomes by SLM Technique and Plot Manager

	Subjectively Reported Adoption				Objectively Measured Adoption			
	Pooled	Male	Female		Pooled	Male	Female	
	Mean	Mean	Mean		Mean	Mean	Mean	
Techniques	SD	SD	SD	Diff.	SD	SD	SD	Diff.
Mulching	0.228	0.229	0.227	0.003	0.172	0.170	0.173	-0.003
	(0.419)	(0.420)	(0.419)		(0.377)	(0.376)	(0.378)	
Strip tillage	0.132	0.131	0.132	-0.001	0.126	0.120	0.131	-0.011
	(0.338)	(0.337)	(0.339)		(0.332)	(0.325)	(0.337)	
Intercropping	0.774	0.795	0.760	0.035	0.556	0.572	0.544	0.028
	(0.418)	(0.404)	(0.427)		(0.497)	(0.495)	(0.498)	
Observation	6,076	2,477	3,599		5,348	2,267	3,081	
		(40.77%)	(59.23%)			(42.39%)	(57.61%)	

Note: Community clustered standard errors used for the t statistics. * $p<0.10$ ** $p<0.05$ *** $p<0.01$.

Table 4: Knowledge and Adoption False Reporting by SLM Technique and Gender of the Plot Manager

	Mulching		Strip Tillage		Intercropping	
	Male	Female	Male	Female	Male	Female
Knowledge: Memory v.s. Exam						
% Correct (Memory=0 /1 & Exam=0/1)	64.63	64.46	58.82	59.74	57.93	51.76
% False Negative (Memory=0 & Exam=1)	33.10	33.93	38.39	37.43	40.29	46.85
% False Positive (Memory=1 & Exam=0)	2.26	1.61	2.79	2.83	1.78	1.39
# of Observation (ttl: 6076)	2477	3599	2477	3599	2477	3599
Knowledge: Name v.s. Exam						
% Correct (Name=0 /1 & Exam=0/1)	75.17	78.22	65.24	66.74	92.05	90.16
% False Negative (Name=0 & Exam=1)	21.52	19.53	29.83	28.15	3.75	6.11
% False Positive (Name=1 & Exam=0)	3.31	2.25	4.93	5.11	4.20	3.72
# of Observation (ttl: 6076)	2477	3599	2477	3599	2477	3599
Adoption:Subjective v.s. Objective						
% Correct (Sub=0/1 & Obj=0/1)	84.87	86.58	93.43	95.40	80.52	77.57
% False Positive (Sub=1 & Obj=0)	9.37	9.27	3.76	2.81	17.42	19.62
% False Negative (Sub=0 & Obj=1)	5.76	4.15	2.80	1.79	2.07	2.81
# of Observation (ttl: 2920)	1355	1565	1355	1565	1355	1565

Table 5: Probability of False Reporting Knowledge (Linear Probability Model)

	Mulching		Strip Tillage		Intercropping	
	Male	Female	Male	Female	Male	Female
Single, divorced, separated, or widowed	0.045	0.020	-0.105***	0.006	0.056**	0.019*
	(0.032)	(0.019)	(0.031)	(0.020)	(0.026)	(0.011)
Completed primary school education	0.017	-0.034	0.028	0.018	-0.011	0.006
	(0.017)	(0.029)	(0.021)	(0.032)	(0.009)	(0.023)
Total number of plots	0.005	-0.008	0.006	0.005	0.009*	-0.003
	(0.009)	(0.008)	(0.009)	(0.008)	(0.005)	(0.004)
Total landholdings	0.000	0.000	-0.005	-0.008	-0.007*	0.000
	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)	(0.002)
Number of male adults (age 15-55)	-0.001	0.005	0.018	0.008	-0.001	0.011**
	(0.011)	(0.009)	(0.012)	(0.010)	(0.006)	(0.004)
Number of children (age $<$ 15 years)	0.005	-0.002	0.003	0.002	-0.003	-0.002
	(0.005)	(0.003)	(0.004)	(0.003)	(0.002)	(0.002)
Duration of interview (hours)	0.002	0.008**	0.005	0.009**	0.002	-0.001
	(0.004)	(0.003)	(0.004)	(0.004)	(0.002)	(0.002)
Has learned this technique before	-0.353***	-0.358***	-0.250***	-0.202***	-0.608***	-0.703***
	(0.035)	(0.033)	(0.056)	(0.050)	(0.074)	(0.056)
Learned this technique 6-10 years ago	0.051*	0.031	-0.028	-0.039	0.009	0.009
	(0.026)	(0.024)	(0.062)	(0.051)	(0.013)	(0.012)
Learned this technique 11-20 years ago	0.076**	0.013	0.054	-0.056	-0.005	-0.004
	(0.030)	(0.025)	(0.056)	(0.042)	(0.012)	(0.012)
Learned this technique $>$ 20 years ago	0.072**	0.033	-0.027	-0.135**	-0.009	-0.024**
	(0.035)	(0.031)	(0.055)	(0.055)	(0.010)	(0.010)
Constant	0.412***	0.475***	0.344***	0.395***	0.608***	0.722***
	(0.060)	(0.057)	(0.100)	(0.072)	(0.076)	(0.054)
N	2467	3,587	2,467	3,587	2,467	3,587
Adjusted R-sq	0.250	0.255	0.349	0.345	0.427	0.561
F-test p-value, enumerator joint significance	0.000	0.000	0.000	0.000	0.000	0.000

*Standard errors in parentheses. * $p<0.10$ ** $p<0.05$ *** $p<0.01$*

Table 6: Probability of False Reporting Adoption (Linear Probability Model)

	Mulching		Strip Tillage		Intercropping	
	Male	Female	Male	Female	Male	Female
Single, divorced, separated, or widowed	-0.012	-0.007	-0.061**	-0.047***	0.069*	-0.011
	(0.042)	(0.023)	(0.024)	(0.017)	(0.041)	(0.031)
Completed primary school education	0.035	-0.016	0.000	0.001	0.024	0.069
	(0.022)	(0.037)	(0.014)	(0.017)	(0.025)	(0.067)
Total number of plots	-0.030	0.018	-0.005	0.003	0.119***	-0.021
	(0.021)	(0.019)	(0.013)	(0.013)	(0.020)	(0.027)
Total landholdings	-0.005	-0.001	0.008*	-0.005	-0.002	0.015**
	(0.007)	(0.004)	(0.005)	(0.006)	(0.007)	(0.007)
Number of male adults (age 15-55)	0.008	0.003	0.014	-0.015*	0.013	0.005
	(0.014)	(0.013)	(0.009)	(0.008)	(0.018)	(0.017)
Number of children (age $<$ 15 years)	0.002	-0.001	0.000	-0.002	0.004	-0.007
	(0.005)	(0.004)	(0.003)	(0.003)	(0.006)	(0.005)
Duration of interview (hours)	-0.005	-0.004	0.000	0.001	0.007	0.006
	(0.004)	(0.003)	(0.003)	(0.002)	(0.005)	(0.004)
Has learned this technique before	0.107***	0.124***	0.141**	0.068	0.117*	0.105*
	(0.041)	(0.040)	(0.065)	(0.051)	(0.061)	(0.063)
Learned this technique 6-10 years ago	-0.004	0.059	0.046	0.093	0.007	0.012
	(0.044)	(0.039)	(0.072)	(0.058)	(0.035)	(0.031)
Learned this technique 11-20 years ago	0.031	0.083*	-0.058	0.008	-0.004	0.009
	(0.045)	(0.042)	(0.062)	(0.052)	(0.033)	(0.032)
Learned this technique $>$ 20 years ago	0.013	0.046	0.022	0.058	-0.009	-0.014
	(0.052)	(0.040)	(0.080)	(0.054)	(0.038)	(0.036)
Constant	0.254**	0.139	0.013	0.012	-0.156**	-0.111
	(0.111)	(0.121)	(0.082)	(0.047)	(0.076)	(0.072)
N	1353	1,562	1,353	1,562	1,353	1,562
Adjusted R-sq	0.217	0.308	0.271	0.172	0.211	0.265
F-test p-value, enumerator joint significance	0.000	0.000	0.000	0.000	0.000	0.000

*Standard errors in parentheses. * $p<0.10$ ** $p<0.05$ *** $p<0.01$*

Table 7: Cost-effectiveness of the Inclusion of the SLM Knowledge Exam and Measuring SLM Objective Adoption (2012 USD)

Knowledge	Mulching	Strip Tillage	Intercropping
Number of Individual	6076	6076	6076
Additional Number of People that Have Correct Response	1399	2058	551
Additional Percentage of Population that Have Correct Response	23.03%	33.87%	9.07%
Additional Cost	$1,169.78	$1,169.78	$2,339.56
For additional $1 dollar, the additional percentage of population that have correct response	0.02%	0.03%	0.00%
For additional $100 dollar, the additional percentage of population that have correct response	1.97%	2.90%	0.39%
Adoption	Mulching	Strip Tillage	Intercropping
Number of Measures	5348	5348	5348
Additional Number of Correct Measures	722	375	1438
Additional Percentage of Measures that Are Correct	13.50%	7.01%	26.89%
Additional Cost	$24,872.49	$24,872.49	$24,872.49
For additional $1 dollar, the additional percentage of measures that are correct	0.00%	0.00%	0.00%
For additional $100 dollar, the additional percentage of measures that are correct	0.05%	0.03%	0.11%

Appendix

Agricultural Knowledge Exam

During the interview, enumerators read out agricultural knowledge questions to interviewees; interviewees answered them based on their knowledge; and then enumerators marked those responses on questionnaires. Interviewees were not given the set of possible responses to choose from. Agricultural knowledge questions and correct answers are listed below:

1. What materials can be used to cover the soil?

Correct answer (multiple-responses apply [17]): mulch; green cover or plant; black plastic.

2. What are the benefits of mulching?

Correct answer (multiple-responses apply): improve conservation moisture; reduce pests, diseases, and weeds; improve soil fertility; prevent burnings of stubbles; reduce soil erosion.

3. What are the benefits of burning?

Correct answer (multiple-choice question[18]): no benefits.

4. If you decide to intercrop or mix maize together with other crops, what other crops can be grown at the same time?

Correct answer (multiple-responses apply): peanut; pigeon pea; cowpea; soybean; sesame; butter bean.

5. What are the benefits of intercropping or mixing crops at the same time (in the same planting season)?

Correct answer (multiple-responses apply): reduce the risk of losing all yields; reduce the risk of plagues; increase soil fertility; improve the farm space usage.

6. Imagine you are planting maize with sesame, pigeon peas and cowpeas. What distance in cm, should you keep between maize rows?

Correct answer (numerical question): 90 cm.

7. Imagine you are planting maize with pigeon peas on the same plot. Should you plant the two crops at the same time, or should you plant one of these crops first, and then wait before planting the other?

Correct answer (multiple-choice question): wait.

8. Which of these two crops should be sown first?

[17] Multiple-responses apply indicates more than one answer is correct.

[18] Multiple-choice question indicates only one answer is correct.

Correct answer (multiple-choice question): maize.

9. How many weeks after sowing maize, should you sow pigeon peas?

Correct answer (numerical question): 5 or 6 weeks.

10. What crops can be planted with cassava?

Correct answer (multiple-responses apply): peanut; cowpea.

11. Imagine that in the last season, corn crops suffered a plague. In this current planting season, you want to intercrop maize with another crop that helps to ward off pests. Which crops could be used for this purpose?

Correct answer (multiple-responses apply): peanut; onion; pigeon pea; cowpea; soybean; sesame; butter bean; cassava; piri piri.

12. What are the benefits of crop rotation from year to year?

Correct answer (multiple-responses apply): reduce pests, diseases, and weeds; improve soil fertility.

13. Imagine the following two scenarios of crop rotation: 1) first season: corn; second season: sesame; third season: sorghum; fourth season: corn 2) first season: sesame; second season: cowpeas; third season: corn; fourth season: cowpeas Which scenario is the best for soil fertility?

Correct answer (multiple-choice question): the second scenario.

14. What are the benefits of micro-basins?

Correct answer (multiple-responses apply): be able to seed after the first rains; accumulate the moisture and nutrients.

15. Should the catchments be dug before or after the rains?

Correct answer (multiple-choice question): before.

16. Does contour tillage apply to mountainous terrains or to plains?

Correct answer (multiple-choice question): mountainous terrains.

17. Imagine you are applying the technique of contour tillage. Should the row of seedlings be going up and down (vertical), or be in the same level as the slope?

Correct answer (multiple-choice question): the same level.

18. What are the benefits of contour lines?

Correct answer (multiple-responses apply): prevent water goes down and take away soil nutrients; prevent water destroy plants in areas that are steeper.

19. What tools can be used to make direct seeding?

Correct answer (multiple-choice question): jab planter.

20. Does plowing only where you sow worsen the water conservation in the soil?

Correct answer (multiple-choice question): improvement.

21. What are the benefits of direct seeding and tillage?

Correct answer (multiple-responses apply): better water retention in the soil; less soil erosion; less nutrient loss by trawling the lower parts of the land.

22. If a plot is left to fallow for a season, i.e. without growing anything, will the soil be more or less fertile in the following season?

Correct answer (multiple-choice question): more fertile.

23. Imagine the soil of your plot is no longer very fertile and only produces low yields. As a result, you decide to leave the plot to fallow for two years. Your father recommends that during this period, you should not plant anything on that plot. However, your neighbor suggests planting some trees on the plot for these two years. Whose advice is the best?

Correct answer (multiple-choice question): neighbor.

For multiple-responses questions, we define that interviewees receive the full point if at least one correct response was answered. The compositions of questions for the techniques covered in this paper are listed below:

- Mulching: Question 1-3
- Strip tillage: Question 19-21
- Intercropping: Question 4-5, 7-10

Table A.1: Descriptive Statistics of Male and Female Plot Managers and their Main Plots (Unrestricted and Restricted Samples)

Variables	N	All P.	Single P.	Multi. P.	Difference
Plot Manager Characteristics					
Age	5348	38.098	36.866	39.578	-2.712 ***
Marital status: single, divorced, separated, or widowed	5348	0.153	0.134	0.176	-0.042 ***
Household head is female	5348	0.226	0.208	0.248	-0.040 **
Literate	5348	0.268	0.295	0.236	0.059 ***
Have less than primary school education	5348	0.883	0.861	0.910	-0.050 ***
Completed at least primary school education	5348	0.117	0.139	0.090	0.050 ***
Plot Manager - First Exposure to SLM Technique					
Learned mulching in the past 5 years	5348	0.226	0.238	0.213	0.025
Learned mulching in 6-10 years ago	5348	0.065	0.071	0.058	0.014
Learned mulching in 10-20 years ago	5348	0.084	0.089	0.079	0.010
Learned mulching more than 20 years ago	5348	0.049	0.047	0.052	-0.006
Learned strip tillage in the past 5 years	5348	0.062	0.053	0.073	-0.019
Learned strip tillage in 6-10 years ago	5348	0.040	0.040	0.040	0.000
Learned strip tillage in 10-20 years ago	5348	0.062	0.061	0.063	-0.002
Learned strip tillage more than 20 years ago	5348	0.058	0.055	0.060	-0.005
Learned inter-cropping in the past 5 years	5348	0.195	0.176	0.217	-0.042 **
Learned inter-cropping in 6-10 years ago	5348	0.135	0.150	0.117	0.033 **
Learned inter-cropping in 10-20 years ago	5348	0.305	0.323	0.283	0.040 **
Learned inter-cropping more than 20 years ago	5348	0.280	0.270	0.293	-0.023
Plot Characteristics					
Self-reported plot area (hectares)	5348	0.955	0.938	0.976	-0.038
GPS measured plot area (hectares)	5280	0.797	0.761	0.841	-0.080
Household owns the plot	5348	0.984	0.984	0.984	-0.001
Plot soil is fertile	5348	0.993	0.991	0.995	-0.004
Plot is flat	5348	0.642	0.659	0.623	0.036
Plot locates in high zone	5348	0.445	0.475	0.408	0.067 *
Plot had erosion problem	5012	0.081	0.089	0.071	0.018
Used pesticides on the plot	5012	0.061	0.045	0.082	-0.036 **
Used chemical fertilizer on the plot	5012	0.009	0.009	0.009	0.001
Number of crops grown on the plot	4642	1.912	1.904	1.922	-0.018
Grew maize	5012	0.635	0.687	0.572	0.115 ***
Grew sorghum	5012	0.243	0.243	0.243	0.000
Grew cotton	5012	0.096	0.073	0.123	-0.050 ***
Grew sesame	5012	0.161	0.184	0.132	0.051 **
Grew cassava	5012	0.168	0.182	0.152	0.030
Grew cowpea	5012	0.349	0.401	0.284	0.116 ***
Grew pigeon pea	5012	0.189	0.212	0.159	0.053
Other Household Characteristics					
Number of household members	5348	5.249	4.877	5.697	-0.820 ***
Number of children (age $<$ 15 years)	5348	2.849	2.612	3.133	-0.521 ***

*Note: Community clustered standard errors used for the t statistics. * $p<0.10$ ** $p<0.05$ *** $p<0.01$.*

Table A2: Cost of Measuring SLM Objective Adoption (2012 USD)

Transportation costs	\$20,253.16
Car Rental	\$16,703.08
Days needed for measuring SLM adoption	83.52
Rental price per day	\$200.00
Gas	\$794.07
Average distance between plot and house (km)	0.93
Gas costs per km	\$0.16
Number of individuals	5,348
Driver	\$2,756.01
Days needed for measuring SLM adoption	83.52
Driver's wage per day	\$33.00
Interviewer costs	\$4,619.33
Minutes enumerator spent measuring SLM adoption on the first plot of the household	\$10.40
Number of respondents	3,772
Minutes enumerator spent measuring SLM adoption on the second plot of the household	\$0.54
Number or respondents	1,576
Enumerator wage per minute	\$0.12
Total costs	\$24,872.49

Table A.3: Probability of False Reporting of Knowledge by Name Outcome (Comparison of Linear Probability Model and Probit, District Indicators Included)

	Mulching				Strip Tillage				Intercropping			
	LPM		Probit		LPM		Probit		LPM		Probit	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Single, divorced,	0.088**	0.036	0.097**	0.047**	-0.067**	0.029	-0.072**	0.031	0.049*	0.026*	0.036**	0.022**
separated, widowed	(0.042)	(0.024)	(0.038)	(0.024)	(0.030)	(0.022)	(0.033)	(0.022)	(0.029)	(0.014)	(0.017)	(0.011)
Completed primary	0.017	-0.045	0.014	-0.054	0.040*	0.061	0.040*	0.056	-0.009	0.007	-0.009	0.012
school education	(0.018)	(0.033)	(0.018)	(0.038)	(0.023)	(0.042)	(0.022)	(0.039)	(0.010)	(0.033)	(0.010)	(0.026)
Total number of plots	-0.014	-0.018*	-0.011	-0.016*	-0.008	-0.005	-0.009	-0.006	0.005	-0.003	0.004	-0.003
	(0.011)	(0.009)	(0.010)	(0.009)	(0.011)	(0.010)	(0.011)	(0.010)	(0.005)	(0.006)	(0.005)	(0.005)
Total landholdings	0.009	0.006	0.007	0.005	-0.003	-0.004	-0.003	-0.004	-0.006**	0.000	-0.006**	-0.001
	(0.007)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.003)	(0.004)	(0.002)	(0.003)
Number of male adults	-0.003	0.013	-0.004	0.012	0.018	0.013	0.018	0.014	-0.001	0.011**	-0.002	0.011**
(age 15-55)	(0.012)	(0.009)	(0.012)	(0.009)	(0.014)	(0.011)	(0.014)	(0.011)	(0.007)	(0.004)	(0.007)	(0.004)
Number of children	0.002	-0.002	0.003	-0.002	0.002	0.000	0.002	0.000	-0.004	-0.004**	-0.004	-0.005**
(age < 15 years)	(0.005)	(0.003)	(0.005)	(0.003)	(0.005)	(0.004)	(0.005)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)
Duration of interview	-0.001	0.005	-0.002	0.006*	0.016***	0.016***	0.015***	0.015***	0.004	0.002	0.004*	0.002
(hours)	(0.004)	(0.003)	(0.004)	(0.003)	(0.005)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)
Has learned this	-0.351***	-0.308***	-0.372***	-0.341***	-0.165***	-0.106***	-0.180***	-0.111***	-0.685***	-0.758***	-0.229***	-0.243***
technique before	(0.028)	(0.024)	(0.031)	(0.029)	(0.037)	(0.034)	(0.045)	(0.039)	(0.063)	(0.044)	(0.023)	(0.016)
Learned this technique	0.035	0.020	0.072	0.069*	0.021	0.042	0.024	0.044	0.018	0.012	0.019	0.012
6-10 years ago	(0.029)	(0.023)	(0.047)	(0.038)	(0.049)	(0.048)	(0.063)	(0.053)	(0.017)	(0.012)	(0.016)	(0.012)
Learned this technique	0.043	-0.012	0.090**	0.017	0.101**	0.019	0.114**	0.015	0.019	0.012	0.021	0.014
11-20 years ago	(0.029)	(0.022)	(0.045)	(0.046)	(0.048)	(0.039)	(0.056)	(0.046)	(0.015)	(0.013)	(0.015)	(0.012)
Learned this technique	0.007	0.005	0.037	0.043	0.047	-0.015	0.053	-0.019	-0.002	-0.021*	-0.005	-0.026**
> 20 years ago	(0.032)	(0.029)	(0.056)	(0.052)	(0.044)	(0.054)	(0.054)	(0.067)	(0.011)	(0.010)	(0.013)	(0.012)
Constant	0.445***	0.422***			0.178***	0.153***			0.680***	0.755***		
	(0.037)	(0.033)			(0.039)	(0.035)			(0.062)	(0.045)		
N	2,467	3,587	2,467	3,587	2,467	3,587	2,467	3,587	2,467	3,587	2,467	3,587

*Standard errors in parentheses. * p<0.10 ** p<0.05 *** p<0.01*

Table A.4: Probability of False Reporting of Adoption Outcome (Comparison of Probit and Linear Probability Model, District Indicators Included)

	Mulching				Strip Tillage				Intercropping			
	LPM		Probit		LPM		Probit		LPM		Probit	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Single, divorced,	-0.019	-0.041	-0.013	-0.032	-0.082***	-0.053***	-0.080***	-0.053***	0.140***	0.045	0.122***	0.039
separated, widowed	(0.042)	(0.026)	(0.039)	(0.026)	(0.025)	(0.017)	(0.031)	(0.018)	(0.047)	(0.038)	(0.036)	(0.035)
Completed primary	0.043*	-0.039	0.038*	-0.065	-0.002	-0.005	-0.007	-0.009	0.044*	0.078	0.045*	0.074
school education	(0.024)	(0.035)	(0.021)	(0.047)	(0.016)	(0.019)	(0.016)	(0.023)	(0.026)	(0.068)	(0.025)	(0.057)
Total number of plots	-0.031	0.016	-0.032	0.022	-0.002	-0.002	-0.003	-0.001	0.102***	0.003	0.119***	0.003
	(0.023)	(0.022)	(0.022)	(0.023)	(0.015)	(0.014)	(0.014)	(0.013)	(0.020)	(0.030)	(0.024)	(0.030)
Total landholdings	-0.001	-0.002	-0.000	-0.005	0.012	0.001	0.005	-0.002	-0.004	0.020**	-0.007	0.017*
	(0.006)	(0.005)	(0.008)	(0.009)	(0.009)	(0.004)	(0.004)	(0.005)	(0.007)	(0.010)	(0.010)	(0.009)
Number of male adults	0.005	0.005	0.005	0.005	0.013	-0.011	0.014*	-0.012	0.015	0.023	0.013	0.022
(age 15-55)	(0.014)	(0.015)	(0.013)	(0.014)	(0.011)	(0.008)	(0.008)	(0.010)	(0.018)	(0.019)	(0.016)	(0.019)
Number of children	0.001	-0.003	0.001	-0.003	-0.003	-0.003	-0.004	-0.004	0.007	-0.007	0.006	-0.006
(age < 15 years)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.003)	(0.004)	(0.003)	(0.006)	(0.006)	(0.006)	(0.005)
Duration of interview	-0.016***	-0.013***	-0.019***	-0.016***	-0.006*	-0.003	-0.007	-0.003	0.000	-0.007*	0.001	-0.007
(hours)	(0.004)	(0.003)	(0.006)	(0.004)	(0.003)	(0.002)	(0.004)	(0.003)	(0.005)	(0.004)	(0.005)	(0.004)
Has learned this	0.125***	0.164***	0.126***	0.156***	0.166***	0.115***	0.123***	0.081***	0.111**	0.171***	0.099*	0.157**
technique before	(0.035)	(0.032)	(0.029)	(0.026)	(0.050)	(0.038)	(0.025)	(0.017)	(0.052)	(0.055)	(0.057)	(0.064)
Learned this technique	-0.058	-0.019	-0.036	-0.008	0.071	0.085	0.024	0.037*	0.010	-0.014	0.002	-0.018
6-10 years ago	(0.046)	(0.042)	(0.038)	(0.028)	(0.072)	(0.059)	(0.027)	(0.021)	(0.033)	(0.035)	(0.031)	(0.032)
Learned this technique	-0.015	0.006	-0.009	0.004	-0.018	-0.007	-0.014	0.004	0.017	0.015	0.013	0.012
11-20 years ago	(0.048)	(0.050)	(0.035)	(0.031)	(0.061)	(0.050)	(0.027)	(0.021)	(0.032)	(0.034)	(0.031)	(0.031)
Learned this technique	0.053	0.030	0.047	0.024	0.015	0.010	0.003	0.019	0.042	-0.033	0.042	-0.038
> 20 years ago	(0.068)	(0.058)	(0.048)	(0.037)	(0.073)	(0.047)	(0.032)	(0.020)	(0.036)	(0.037)	(0.035)	(0.036)
Constant	0.226***	0.145***			0.021	0.046***			-0.127**	-0.116		
	(0.050)	(0.044)			(0.022)	(0.016)			(0.057)	(0.071)		
N	1,353	1,562	1,353	1,562	1,353	1,562	1,353	1,562	1,353	1,562	1,353	1,562

*Standard errors in parentheses. * p<0.10 ** p<0.05 *** p<0.01*