The Value of Local Agricultural Information: Evidence from Willingness-to-Pay Trials in Kenya*

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Abstract

A social planner would invest in knowledge generation if the costs are less than the aggregate benefits to all agents. However, decentralized markets may not achieve a socially optimal outcome due to the non-rivalry of knowledge and other distortions in information markets. This paper examines the value of knowledge from local soil chemistry and experimental test plots for smallholder farmers in Kenya. If soil characteristics are spatially correlated, local information, as opposed to individual information, may hold significant value and could be shared among many farmers. We conduct four trials to estimate farmers' willingness to pay (WTP) for area-level agricultural information. Our findings indicate that the mean WTP for local soil test results ranges from \$0.20 to \$4.80, while the WTP for results from local experimental plots is \$2.30. Under conservative assumptions, the aggregate WTP for soil information in a given area exceeds the costs of generating and disseminating such information.

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1 Introduction

Economic theory suggests that the creation of information is likely subject to market failures (Arrow, 1962; Romer, 1986). However, if the cost of generating information is greater than its value to any one individual but less than the value to the community as a whole, it will be socially efficient to generate such information (Samuelson, 1954). Nevertheless, when information can be easily shared, it may be difficult for producers of information to recover their costs and limited incentives will exist for its creation.

Lack of generation and dissemination of science-based local agricultural knowledge is apparent in Western Kenya, the area of study. Soil tests to determine suitable fertilizer types for a given area are rarely used, and most small-scale farmers have never experimented with inputs using on-farm trials with appropriate comparison plots. While the private benefits of such experimentation might be lower than the costs of creating this information, the social benefits could be sufficiently large to justify the costs if the information is spatially correlated and can be shared among neighbors. Therefore, while it might be too expensive and impractical to implement soil tests and experimental plots on every farm, testing soils for some farmers in the area and sharing these results with neighboring farmers could be socially valuable.

This paper provides empirical evidence on smallholder farmers' valuation of neighboring agricultural information. First, we characterize agricultural information derived from soil tests and experimental plots. Second, we investigate farmers' valuation of this local agricultural information through four different willingness to pay (WTP) trials, using various elicitation methods and farmer samples. Each elicitation round addressed specific concerns to better capture farmers' valuation of this information. We then average the WTP for this information across different areas to estimate how much farmers would collectively be willing to pay to obtain this area-level information. Finally, we compare these estimates to the costs of generating the information to determine whether

it would be socially optimal to produce such local information.

Overall, we find that the mean WTP for local soil test results is between \$0.2 and \$4.8. For results from local experimental plots this amounts to \$2.3. Under certain conservative assumptions we discuss, the aggregate WTP for soil information in an area exceeds the costs of generating and delivering such information.

This work complements existing empirical evidence estimating farmers' willingness to pay for agricultural information and suggests that there are likely market failures in the generation of this knowledge. Closely related, Cole and Fernando (2016) elicit willingness to pay for an Interactive Voice Response (IVR) system among cotton farmers in Gujarat, India. The authors find that while the cost of the service was \$7 for nine months, farmers valued the service at only \$2 for the same period. Interestingly, their impact estimates suggest that the benefits of receiving the information were much higher than the costs. Similarly, Palloni et al. (2018) find that farmers in Ghana have a high willingness to pay for a phone-based information service at low prices, but their willingness to pay decreases rapidly as the price increases. Complementary work has examined the impacts of receiving agricultural information on farmers' willingness to pay for inputs or their decision to use them (Murphy et al., 2017; Tjernström et al., 2019; Fabregas, 2019; Casaburi et al., 2014; Van Campenhout et al., 2018).

The paper proceeds as follows. Section 2 discusses the context where this project takes place. Section 3 presents the characteristics of the information. Details about the WTP trials are found in section 4 and results are discussed in section 5. Section 6 concludes.

2 Context

This project took place in Western Kenya between 2012 and 2015. In this region, maize is the primary staple crop and the main crop for all the farmers in this study. Few farmers

in this region have ever gotten their soil analyzed, and experimenting with new fertilizer is rare. For instance, in a survey conducted in 2015 only 9% of farmers report having had a soil test ever conducted in their farm.

Chemical fertilizers used in the area include diammonium phosphate (DAP), a source of phosphorus and nitrogen which is applied at planting, calcium ammonium nitrate (CAN), a nitrogen-based fertilizer, which is typically applied at top-dressing, and NPKs, a nitrogen-phosphorous-potassium compound also applied during planting. While DAP and CAN have been widely available in the study area, NPK has not.

Several authors have document limited use of productive agricultural inputs despite high average returns. For instance, Duflo et al. (2008) and Duflo et al. (2011) find that returns to top dressing fertilizer (CAN) are high on average, with annualized returns between 52 and 85 percent. In addition, these authors find that many farmers switch back and forth between using and not using fertilizer from season to season. There is also evidence that returns to agricultural inputs vary across farmers. For example, Suri (2011) documents heterogeneity in costs and benefits of hybrid seeds, and Marenya and Barrett (2009) find that heterogeneity in returns to nitrogen fertilizer is associated with variation in soil carbon content.

3 Agricultural Information

The potential value of local information depends crucially on the spatial correlation of soil characteristics and test plot results. Information from a neighbor's plot is only helpful for a farmer if this information is somewhat predictive of his or her own soil characteristics and, hence, indicative of own expected distribution of rates of return. This section will, hence, consider several measures to determine whether the information collected and distributed by the project is spatially correlated.

3.1 Soil Chemistry: Soil Tests

We conducted two rounds of soil analyses. In the first round we conducted soil tests in 1,615 farms during Fall 2011. These soil tests were part of the endline survey of a previous research project, where a sample of farmers in the area were offered the opportunity to participate in a soil test lottery, with a 50% probability of winning a soil test.[1]

A second round of soil tests took place in 2014. At that time, the research team visited a random sample of 576 farmers, residing in one of 37 catchment areas.[2] During this round, to understand the precision of the soil analyses for a given farm plot, two samples from each farm were sent separately for blind testing. In total, 1,152 soil tests were analyzed.

In both cases, soil samples were collected by a team of trained enumerators, following standard soil sampling protocols.[3] Soil samples were sent for testing at the National Agricultural Research Laboratories (NARL), managed by the Kenya Agricultural and Livestock Research Organization (KARLO). The analysis determined levels of pH, organic carbon content, nitrogen, phosphorus, potassium, calcium, magnesium, manganese, iron, copper, zinc, and sodium. Based on these soil characteristics, KALRO generated recommendations for types and quantities of locally available fertilizers (CAN, DAP, and NPK) as well as agricultural lime and manure. Summary statistics of the recommendations produced by NARL are shown in Table 1.

Figure 1 shows the distribution of selected soil characteristics across the entire 80 km by 60 km study area for the first round and second round of soil tests. The red lines show

[1]See Duflo et al. (2013) for additional details on this sample. In that project farmers were recruited through school meetings. The original sample consisted of over 20,000 farmers in the region, from which 5,000 were randomly sampled to complete an in-person household survey. From that group, a randomly selected two thirds of farmers were offered the opportunity to participate in a soil test lottery.

[2]We define a catchment area as the area around a primary school. Villages are not well-defined in this region, but primary schools are well-known landmarks that people use as a geographical reference

[3]Soil samples are taken in a zig-zag pattern from at least 20 parts of the land and then combined to generate a final soil sample, that is less likely to be vulnerable to within plot noise

the adequate nutrient levels according to NARL. These graphs show high heterogeneity in soil characteristics. In addition, much of the distribution for key nutrients such as nitrogen and phosphorus lies to the left of the adequate level, suggesting soil nutrient deficiencies.

Figure 2 maps the spatial distribution of soil pH, nitrogen, carbon and phosphorus by tercile. Figure 3 maps recommendations for the type of NPK (or neither) as produced by NARL. Visual inspection of these maps suggests that the values of these variables are spatially correlated.

These visual impressions are confirmed by additional measures of spatial correlation. Columns 1 and 2 of Table 2 show that the measured intra-cluster correlation (ICC) using the 2011 sample of farmers (with several plots) as clusters is between 0.23 (zinc) and 0.74 (copper).[4]

We note, however, that some of this variation might come from measurement error. For instance, in the 2014 sample, where two soil samples from the same farm were sent for blind testing, the ICC ranges between 0.04 (copper) and 0.80 (nitrogen). For soil pH, the ICC is 0.74.[5]

Columns 3 and 4 show the measured ICC of soil characteristics using the primary school as the cluster variable. We use primary schools as our main way to denote a community, as they are local landmarks and there is often no other consistent name to refer to villages. In this case, for the 2011 sample, the ICC ranges between 0.06 (zinc) and 0.47 (copper), and in 2014, it ranges between 0.02 (iron) and 0.19 (carbon).[6]

Neighbors' results are predictive of soil characteristics and recommendations. In-

[4]Note that for this year this is not a measure of the test-retest correlation since for most farmers with more than one soil test, one test was taken from the fertilized parts of their land and the other one from unfertilized parts. The measured ICC increases (to between 0.45 (zinc) and 0.79 (copper) when the variables are (log-) transformed to alleviate the influence of outliers.

[5]Similarly, we estimate a test-retest correlation of 0.74 for soil pH using the sample of 563 soil test pairs that do not have missing data for pH.

[6]The ICC is calculated using one observation per farmer. For farmers with several soil tests, we calculated the mean of these tests.

cluding neighbors' characteristics reduces the mean square error (MSE) of the prediction compared to using overall means of the corresponding variables using data from all soil tests in the sample. Column 3 of Table 2 shows that using the mean of the soil characteristics of farmers that live in the same school area can reduces the MSE of prediction compared to using the overall mean for most characteristics.[7] For instance, using school (area) means reduces the MSE of prediction for soil pH by between 12 and 28%, for carbon (15-19%), copper (10-39%), and nitrogen (10-16%). However, for iron and zinc the MSE of the prediction in fact increases.

Finally, Figure 4 shows the predictiveness of the information for different distances (which also implies varying the number of observations) using the data for 2011. Moving further away greatly increases the number of observations (the number of observations are shown next to the black dots) but it makes prediction worse. The variables are normalized such that by construction the MSE converges to 1 when using the entire sample.

3.2 Rates of Return to Fertilizer: Experimental Plots

In addition to the soil tests, we invited farmers to set up experimental test plots in their land, so as to produce information on the rates of returns to different types of fertilizers.

In 2014, we randomly sampled 432 individuals in 10 market centers to participate in demonstration plot trials. Approximately 7% of this sample declined to participate, resulting in test plots being set up with a total of 378 individuals. Test plots for different types of fertilizers were established on each respondent's farm. Each test plot was further divided into two subplots; whether a subplot would be the treatment or control was randomized to receive either NPK, CAN, or DAP.

Participants were asked to use their normal fertilizer application method on the first

[7] The own result is, of course, excluded when calculating school means.

plot and to apply half a teaspoon of fertilizer on the treated plots. Farmers were instructed to farm as they usually would, and members of the research team supervised the application of fertilizers. Finally, at the end of the season field officers returned to harvest with respondents and weigh their maize for each subplot. The rate of return was calculated using data on inputs, prices and harvest weights.

Based on these calculations we prepared information sheets with recommendations based on profitability. Information was provided on rates of return for 3 types of fertilizers, yield with and without fertilizer, amounts of fertilizer provided, and local maize and fertilizer prices.

4 Study Design

We conducted four trials to elicit farmers' willingness to pay for the agricultural information from neighboring soil analysis and experimental test plots. Trials one and two were smaller in scale and were conducted as part of the activities of a separate research project. Trials 3 and 4 incorporated many of the lessons learned during the first two trials. We describe each trial in turn.

4.1 Trial I

The first WTP trial took place in February and March 2012. A sample of 1,319 farmers who were part of the original research sample, and therefore lived in the same areas, but had not gotten their own soil tested, were offered the soil test results from their neighbors. Farmers were visited at their homes and their WTP for soil test information was elicited through a RLIS (Random Lottery Incentive System) where they were given a series of choices between monetary payments (ranging from Ksh 20 to Ksh 200, increasing in steps of Ksh 20) and receiving the neighboring farmers' soil test results. We define

willingness to pay (WTP) as the highest amount, at which the respondent preferred information over money. For example, if a respondent preferred to receive the information over Ksh 140 (and all lower amounts), but preferred Ksh 160 (and all higher amounts) over receiving the information, her WTP is Ksh 140). Appendix A1 shows an example of this method. To ensure incentive compatibility, we randomly selected one of these choices, and then implemented the option that the farmer had selected for this choice.[8]

4.2 Trial II

The second WTP trial took place in June and July 2012. For this trial, a new sample of individuals whom had been visited in Fall 2011 as part of the previous research project was selected.[9] This trial took place during school meetings, to which farmers where previously invited. WTP elicitation was done in private with farmers. However, since this trial was in a public place, in principle, it would have been possible for farmers to share the information they had acquired with others as they walked out of the meeting.

Farmers were randomly divided into two categories: a first group was given Ksh 100 and later on were offered the soil test results of one randomly selected farmer from the area at a price of Ksh 100. A second group was given Ksh 100 and had a choice of purchasing the soil test results of another farmer at a Ksh 50 price.

4.3 Trial III

In June 2013, we conducted a farmer census and randomly sampled farmers from areas in which we had previously set up experimental plots.[10]A total of 866 farmers were

[8]Additionally, the research team return the soil test results to the 370 farmers who had their own land tested.

[9]Just like in the first trial, approximately one third of these individuals had gotten their soil tested, and another third of individuals had been explicitly informed about these tests. We worked with farmers who had not received the information

[10]Since villages are not well defined in this area, farmers were drawn through a random walk method in which a starting point is first selected and households from that point onwards are randomly selected

surveyed in 34 different areas.[11]

Enumerators collected information on demographics, farming experiences and input use, and beliefs about the effectiveness of different types of chemical fertilizers. At the end of the survey the enumerator conducted the WTP experiments. Enumerators carefully explained how the experimental plots were set up in other farmers' land. For instance, they informed subjects that farmers themselves managed these plots and that they applied the amounts of fertilizer they had deemed appropriate. They were also told that there were subplots that received fertilizer and subplots that did not and comparing them could help assess the effects of fertilizers on yield increases, but that the difference in yields were not enough to assess profitability of fertilizer use. Instead needed to account for the costs of inputs and the price at which one could sell the maize.[12] Enumerators had drawings of experimental plots which helped explain this message.

The enumerator would then offer an information sheet to the respondent which contained information on rates of returns for different types of chemical fertilizer for nearby plots. Each sheet contained a table with information on the increase in yields from DAP, CAN and NPK, the amount of fertilizer used, differences in costs from using and not using fertilizers and a calculation for the rates of return for each type of fertilizer. The information sheet also explained how rates of returns were calculated and what did they mean. Before eliciting WTP for the local sheet the enumerator would show a template piece of paper to respondents (that contained the table but not the actual information), to

through a set of rules (e.g. every fifth or sixth household). We completed a short questionnaire at each household, in which we collected GPS information for the farm, information on household structure and who the person responsible for farming was. From July to September 2013, 899 farmers were visited at their homes to invite them to complete WTP elicitation surveys for information on experimental plots.

[11]Primary schools are a good landmark in this setting, since they are ubiquitous and most people know what their closest primary school to their home is. In the sample, over 90% of farmers live within 2 km of their closest school. In total, we worked in the surrounding area of 34 landmarks. Therefore in order to convey where the experimental plots were located and in order to keep a given area fixed we calculated the distance of the experimental plot to each local landmark. We then explained within what radius of the landmark were the experimental plots located. Enumerators were aided by a diagram which would show the landmark, the different radius and the test plots. Distances were also explained in walking time.

[12]The protocols also clarified that yields can be affected by other factors and that information from these experimental plots were only one source of information they should consider but that it could be noisy.

reduce information asymmetries and ensure that respondent was clear on exactly what type of information they could receive. In addition, a sample of farmers were randomized into a module that elicited WTP for soil test results. Figures A3 and A2 in the appendix depict examples of information sheets for test plots and soil tests respectively.

Each farmer completed several WTP elicitation modules in which different versions of information sheets were offered to them. The order of the modules was randomized and WTP was elicited through RLIS in which farmers were offered a series of choices between different monetary amounts and the information. For each agricultural information product, the respondent was presented with both choices and she could choose between information or money, where the money offers initially ranged from 20 to 500 Kenyan Shillings (approximately between 0.2 and 5 US dollars).[13] Farmers were randomly assigned to the following modules:

Distance from Test Plots. A fixed number of 3 test plots at varying distances from the closest landmark (0-5 km, 0-10 km, 10-20 km).

Number of Test Plots. The average of a varying number of test plots within a fixed distance to the closest landmark (1, 2 or 3).

Information on Soil Tests. A randomly selected group of farmers was also offered result from a soil tests within 10 km of the landmark.

Placebo. To measure a lower bound of willingness to pay we elicited WTP for a sheet with low information content (the sheet contained a single number, the total yields in kg from a plot at least 20 km of closest school).

To ensure that farmers had an incentive to truthfully reveal their willingness to pay, participants were informed that one of their choices would be randomly chosen at the end of the visit to be implemented. The implementation of the module and question within the module depended on a series of numbers revealed on a phone scratch card that the

[13]Initially, for the first couple of days the maximum amount was 200 Ksh. However, we increased this ceiling since many farmers were choosing Ksh 200 over the information.The offers were for 20, 50, 100, 150, 200, 300, 400 and 500 Ksh.

respondents would scratch at the end of the survey. [14] On average, we collected WTP data for five different information sheets for each farmer.

The experimental design in trial III attempted to address potential concerns regarding the results found in trials I and II. In particular, we actively addressed the concern that individuals might have had wrong expectations regarding the information they were offered (i.e. they may have expected more detailed or different information), by clearly explained to farmers the information they were offered to purchase before choices were made. Second, to address the concern that individuals were not taking the choices seriously, were instructed ennumerators to put the money on the table at the beginning of the WTP survey. In order to address any potential anchoring, whether the range of prices increased or decreased was randomly assigned to respondents, with half of them facing increasing prices and half decreasing prices.[15]

4.4 Trial IV

In 2015, we conducted a final round of WTP elicitation with a new sample of farmers drawn from areas were soil tests had been conducted in 2014. We elicited WTP from two groups of farmers. First, from a random sample of 207 farmers that lived around the landmarks closest to where the soil samples were taken. Second, from a sample of 185 farmers that were listed as the networks of people who had agreed to have a soil test in their land.[16]

Farmers were visited at home, where they would first complete a suervey and then

[14] In order to ensure that respondents understood these protocols, before any WTP for information was elicited, respondents played a practice round of this game, where we offered them another product (a box of matches) and one of their choices was implemented. At that point, respondents were given the opportunity to clarify questions.

[15] All choices were read to respondent, regardless of whether they had preferred money at a higher price.

[16] When soil samples were taken, a baseline survey was completed with those faramers. This survey contained questions on their demographic profiles, their farming experience and input use. In addition, during the baseline we collected information on the identity of 3 farmers who they regularly spoke to.

they would be offered the information products. Enumerators explained that the information sheets contained information on input recommendations made by NARL based of local wet chemistry soil analyses. Farmers were shown a template of what the information sheet looked like (Appendix A2), which contained the chemical measurements of soil characteristics, and recommendations on types and quantities of agricultural inputs (fertilizer and soil additives) that were most appropriate given the soil deficiencies in the area. All farmers completed several WTP modules in which they were presented with different variations of the information. Farmers were randomized into the following modules:

Distance from Soil tests.A fixed number of soil tests at varying distances from the closest landmark (0-5 km, 0-10 km, 10-20 km).

Number of Soil Tests. The average of a varying number of soil tests within a fixed distance to the closest landmark (1, 2 or 3).

Placebo. To measure a lower bound of willingness to pay we elicited WTP for a sheet with low information content (the sheet contained a single number, the total yields in kg from a plot at least 20 km of closest school).

During this trial farmers were randomly assigned to either one of two different elicitation methods. The first method was the variant of RLIS, previousl described. Choices were offered in descending or ascending order (randomly assigned) and ranged from 0 Ksh to 800 Ksh.[17] The second method was to elicit WTP using a Becker-DeGroot-Marshack (BDM) elicitation method in which farmers were asked to use their own money to acquire the information (Becker et al., 1964).[18] In this scenario, respondents were told that they would be first asked to state their WTP for the information before a random price p was drawn.[19] If their stated WTP was greater than p, the respondent committed to pur-

[17]The prices offered were 20, 50, 100, 150, 200, 300, 400, 500, 600, 700 and 800 Ksh.

[18]Other studies have successfully implemented this method in developing-country contexts (Berry et al., 2015).

[19]This price was also between 0 and 800 Ksh

chase the good at price p. However, if their stated WTP was less than p, the respondent was not allowed to purchase the information sheet. Under this system, farmers were incentivized to reveal their true WTP.[20]

5 Results

5.1 WTP Results

Table 3 presents the overview of the different trials and the mean WTP for a standard (soil or test plot) information sheet. For soil tests, the average WTP in trial I was Ksh 156 ($1.8), in trial II Ksh 27 ($0.3) and in trial III 217 ($2.6). In trial IV mean WTP was Ksh 489 ($4.9) when elicited through RLIS and Ksh 20 ($0.2) when elicited through BDM. For the test plot information, the average WTP in Trial III was 190 Ksh ($2.3). Figure 9 shows an inverse demand function comparing BDM and RLIS results. The point estimates are statistically significantly different from each other.

Figure 6 shows WTP in trial III as a function of distance and number of test plots. The figure shows that farmers have a higher WTP for information that is more precise. WTP is higher the closer the information is to their farms and for a higher number of test plot results. For trial IV, Figure 7 and 8 show WTP as a function of distance and number of soil tests using the RLIS and BDM methods respectively. Farmers have a higher WTP for soil test results that are closer to their land (the sample size is smaller than in trial III, so the point estimates are noisier). However, there is no clear pattern for the number of soil test results.

[20]One issue with this approach is that many farmers would state that they would want to purchase the information but since they were liquidity constrained, they would need time to gather the money to acquire it. During piloting, it became clear that it was difficult to distinguish between those who needed additional time to arrange for money for the information vs. those who might have thought this was a polite way to refuse the purchase. Therefore, we elicited WTP with the amount of money that farmers had in hand when the survey was conducted. Liquidity was confirmed by asking the farmers to show the enumerator the amount of money they were willing to pay before their final bid . This also helped ensure that farmers were in fact committing to pay that amount.

5.2 Addressing Threats to the Interpretation of WTP

The results above show some variation depending on the method with which WTP was elicited and the trial. For instance, in trial IV, where respondents where randomly assigned to either BDM or RLIS we see that mean WTP is \$0.2 vs. \$4.8. In addition, the distribution of WTP tends to be bimodal (see for instance 5 for trial III).

There are a few reasons as to why the result could be different across BDM and RLIS trials. First, one possibility is that WTP elicited through RLIS was too high relative to true valuation due to social desirability bias. Second, BDM elicitation was done during a surprise visit to farmers, and because of the logistical constraints WTP was elicited with cash they had on hand. If farmers are credit constrained, this might underestimate their true valuation for the information. Therefore, the BDM estimates could be a lower bound.

To better understand a potential overestimation of WTP using RLIS , during trials III and IV the research team elicited WTP for a placebo information sheet. The placebo information was likely of very little value to the farmer, since it only contained information on the yields (in kg) of a plot 20 km away. Between, 20% and 30% of farmers were willing to pay for this information. We can use WTP for placebo information in two ways (assuming that the placebo information is valueless). First, we could exclude the farmers with a positive WTP from the analysis. Under this scenario, average WTP falls from \$2.6 to \$2.02 in trial III and from \$4.68 to \$2.70 in trial IV. A second approach is to substract the WTP for the placebo information. Using this approach the average WTP changes from \$2.6 to \$1.44 in trial II and from \$4.68 to \$2.73 in trial IV.

Finally, we also ask whether WTP might be higher than real valuation because farmers' themselves thought they could sell or share this information with others. To address this question, we compare WTP of farmers who were in the social network of those who had previously received information and those who were not part of that network. Fig-

ure 10 shows the results. We do not find evidence to suggest that WTP of the peers of those who had information was lower than that from a random sample of farmers in the area. If anything the point estimates are slightly higher (but statistically insignificant). Overall, we did not find any evidence of resale of information among farmers.

5.3 Aggregate WTP vs. Cost

An key policy question is whether the aggregate WTP in an area is higher than the costs of generating and distributing this information for that area. We conduct back of the envelope calculations to provide some evidence on this question. We consider two scenarios. First, the generation and delivery of this information with the same technologies used during the trials to generate the information but where dissemination is implemented at scale rather than through farmers' home visits (and without additional costs related to research activities). Second, delivery and dissemination of this information, under lowest costs for technologies (e.g. mobile phone for delivery, and cheaper costs for soil test analysis).

Figure 11 suggests that under current technologies, aggregate WTP for experimental plots is unlikely to cover the costs of implementing and managing them, though this might be done at scale, assuming lower costs for delivery of information (done through cheaper labor and reaching additional farmers at a lower marginal cost, either through larger meetings or through cellphones).

The results are most promising for soil tests. We estimate that the overall costs of conducting one soil test was $21 which includes the soil analysis, but also local wages for labor and transporting soil samples. Since returning this information at farmers' homes would be extremely costly, we consider other approaches such as through meetings or through other mass difussion events. We estimate that this can be done for as low as $0.34 per person (excluding other fixed costs). Figure 12 represents the cost of collecting

and disseminating the information from soil tests under different number of farmers served (costs mainly depend on number of tests per catchment area and on number of farmers info is disseminated to). The green line represents a scenario on minimum costs. For instance, one could more cheaply deliver this information through cellphones and there might be other testing technologies (e.g. spectroscopy ($1.6), piloting mobile kits ($3), India's large-scale testing program ($3)). We estimate that at scale soil information could be generated and delivered at less than $0.15 per farmer (for 150 farmers per test), which is less than the $0.2 WTP per farmer in the conservative BDM scenario.

6 Conclusion

Creating individualized agricultural information is costly. This paper contributes to our understanding of whether local information could be shared by many, and whether farmers' would value that information. First, we show that soil information is spatially correlated but noisy. Second, we present average WTP estimates for this information from four different trials. We show that the estimates are sensitive to the way in which they are collected. However, under conservative assumptions, we still find that aggregate WTP for soil information could be higher than its generation and dissemination at scale.

References

Arrow, K. (1962). The economic implications of learning by doing. *Review of Economic Studies 29*, 155–173.

Becker, G., M. DeGroot, and J. Marschak (1964). Measuring utility by a single-response sequential method. *Behavioral Science 9*, 226–232.

Berry, J., G. Fischer, and R. P. Guiteras (2015). Eliciting and utilizing willingness to pay: Evidence from field trials in northern ghana. *Working paper*.

Casaburi, L., M. Kremer, S. Mullainathan, and R. Ramrattan (2014). Harnessing ict to increase agricultural production: Evidence from kenya. Technical report, Technical report.

Cole, S. A. and A. Fernando (2016). 'mobile'izing agricultural advice: Technology adoption, diffusion and sustainability. *Harvard Business School Finance Working Paper* (13-047).

Duflo, E., M. Kremer, and J. Robinson (2008). How high are the returns to fertilizer use? *American Economic Review Papers and Proceedings 98*, 482–488.

Duflo, E., M. Kremer, and J. Robinson (2011). Nudging farmers to use fertilizer: Theory and experimental evidence from kenya. *American Economic Review 101*, 2350–2390.

Duflo, E., M. Kremer, J. Robinson, and F. Schilbach (2013). [title]. *mimeo*.

Fabregas, Raissa; Kremer, M. L. M. O. R. Z. G. (2019). Sms-extension and farmer behavior: Lessons from six rcts in east africa. *Working Paper*.

Marenya, P. and C. Barrett (2009). State-conditional fertilizer yield response on western kenyan farms. *American Journal of Agricultural Economics 91*, 991–1006.

Murphy, D. M., D. Roobroeck, D. R. Lee, and J. Thies (2017). Underground knowledge: Estimating the impacts of soil information transfers through experimental auctions.

Palloni, G., J. Aker, D. Gilligan, M. Hidrobo, and N. Ledlie (2018). Paying for digital information: Assessing farmers willingness to pay for a digital agriculture and nutrition service in ghana.

Romer, P. (1986). Increasing returns and long-run growth. *Journal of Political Economy 94*, 1000–1037.

Samuelson, P. (1954). The pure theory of public expenditure. *Review of Economics and Statistics 36*, 387–389.

Suri, T. (2011). Selection and comparative advantage in technology adoption. *Econometrica 79*, 159–209.

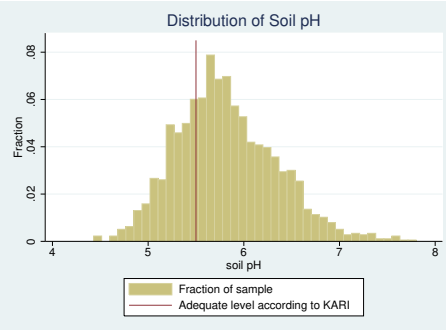
Tjernström, E., T. Lybbert, R. Frattarola Hernández, and J. Correa (2019). Learning by (virtually) doing: Experimentation and belief updating in smallholder agriculture. university of wisconsin. Technical report, mimeo.

Van Campenhout, B., D. J. Spielman, and E. Lecoutere (2018). Information and communication technologies (icts) to provide agricultural advice to smallholder farmers: Experimental evidence from uganda. *1778*.

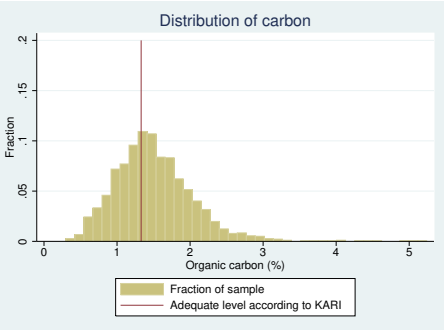
7 Figures

Figure 1: Distribution of soil characteristics in 2011 and 2014

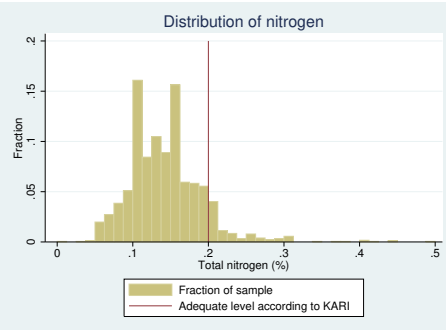
(a) Soil pH 2011



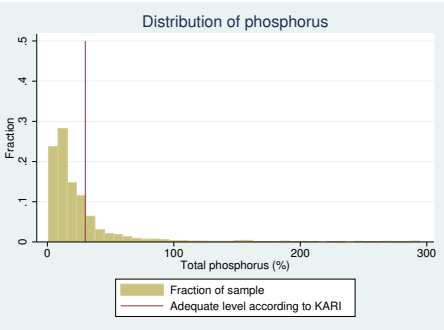
(b) Carbon 2011



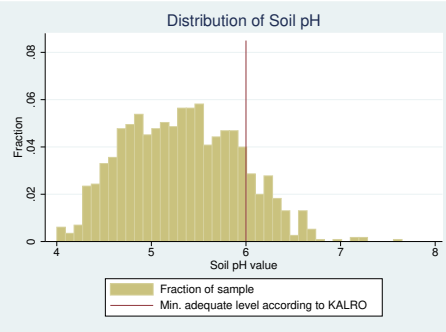
(c) Nitrogen 2011



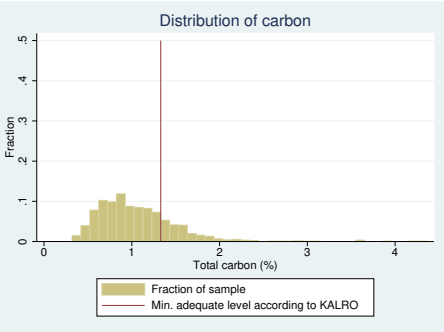
(d) Phosporus 2011



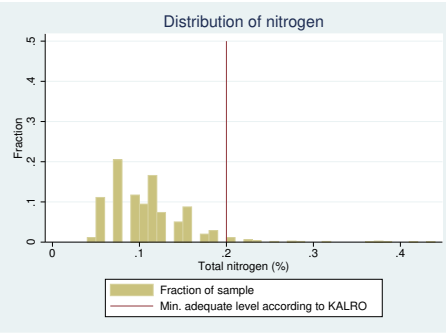
(e) Soil pH 2014



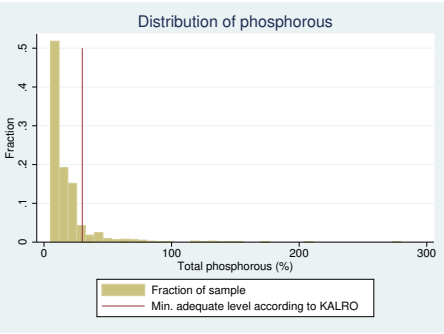
(f) Carbon 2014



(g) Nitrogen 2014

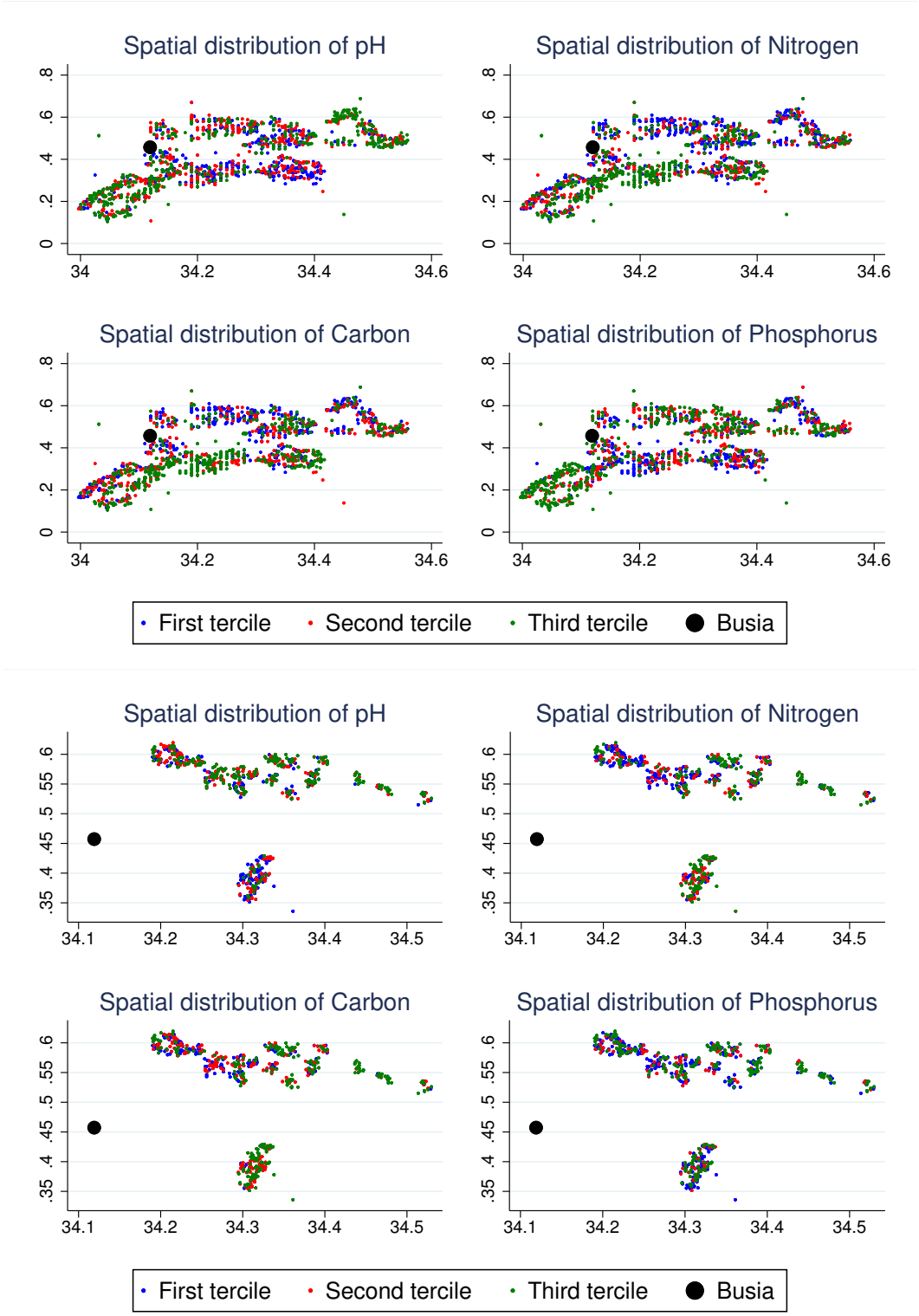


(h) Phosphorus 2014



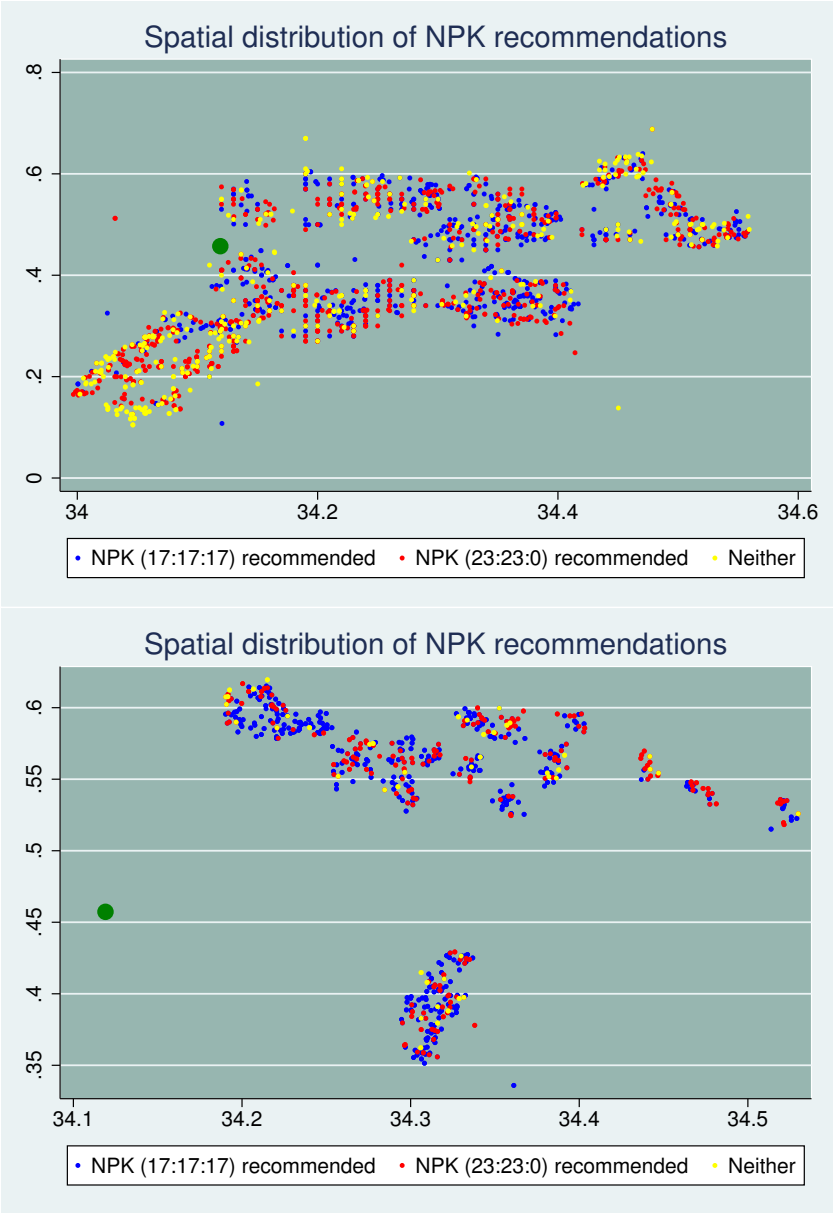
Notes: This graph shows the distribution of soil characteristics in Kenya from soil samples taken in 2011 and 2014.

Figure 2: Maps of Spatial Characteristics 2011 (above) and 2014 (below)



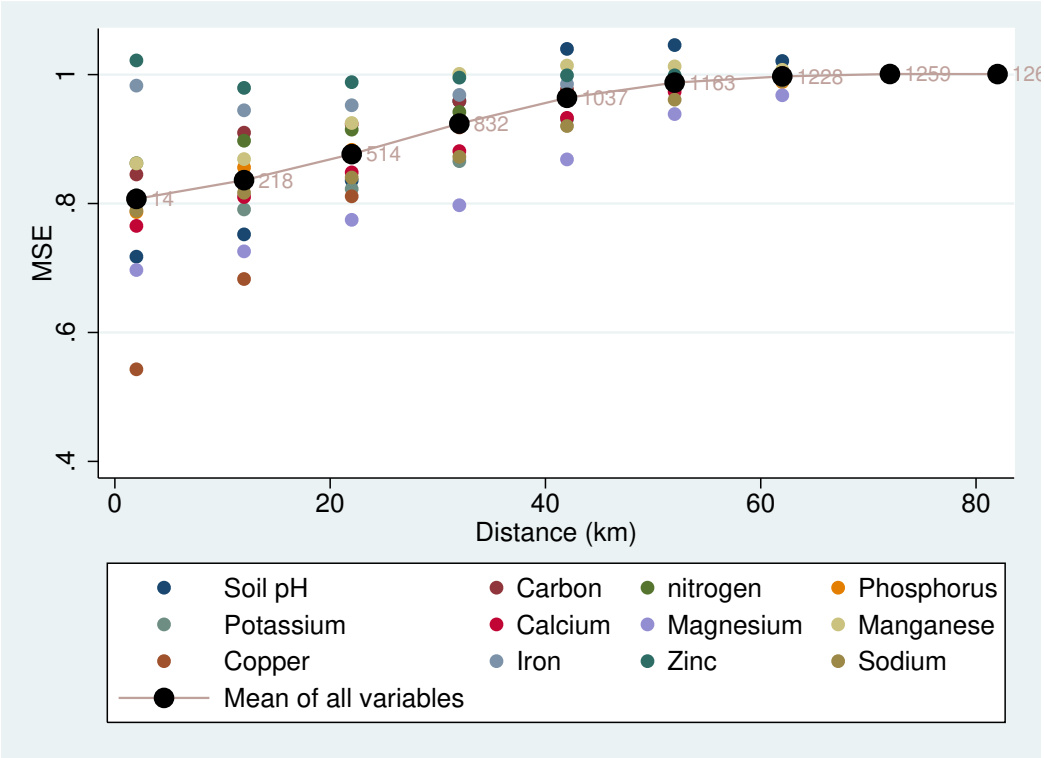
Notes: This graph shows maps of soil samples taken in Western Kenya in 2011 and 2014. The black dots marks the location of Busia town, where the research team was based. The plots show x-axis longitude and y-axis latitude. The study area is of around 80 km by 60 km.

Figure 3: Spatial Correlation of Fertilizer Recommendations



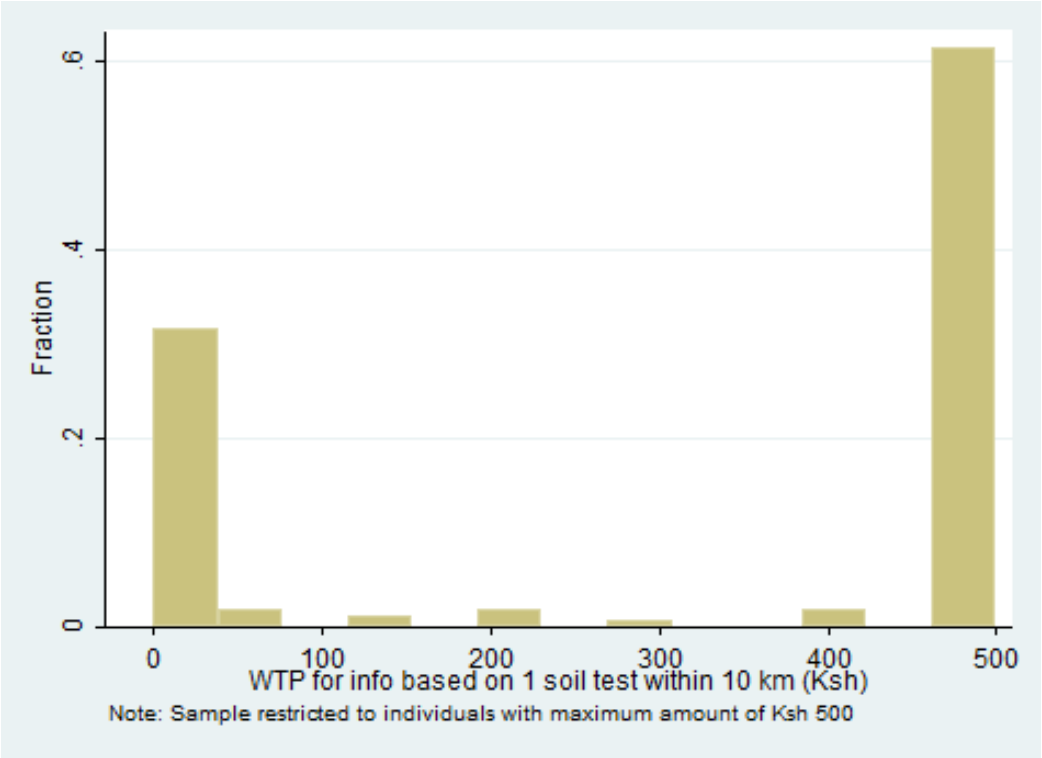
Notes: This figure shows maps of type of NPK recommended by NARL in 2011 (above) and 2014 (below).

Figure 4: MSE for information for different distances



Notes: This figure shows the MSE using the mean of all other observations within different distances.

Figure 5: Bimodal Distribution of WTP



Notes: This figure shows WTP for soil test result for trial III. This only includes the subsample for whom the possible maximum amount was Ksh 500.

Figure 6: WTP as a function of distance and number of tests (Trial III)

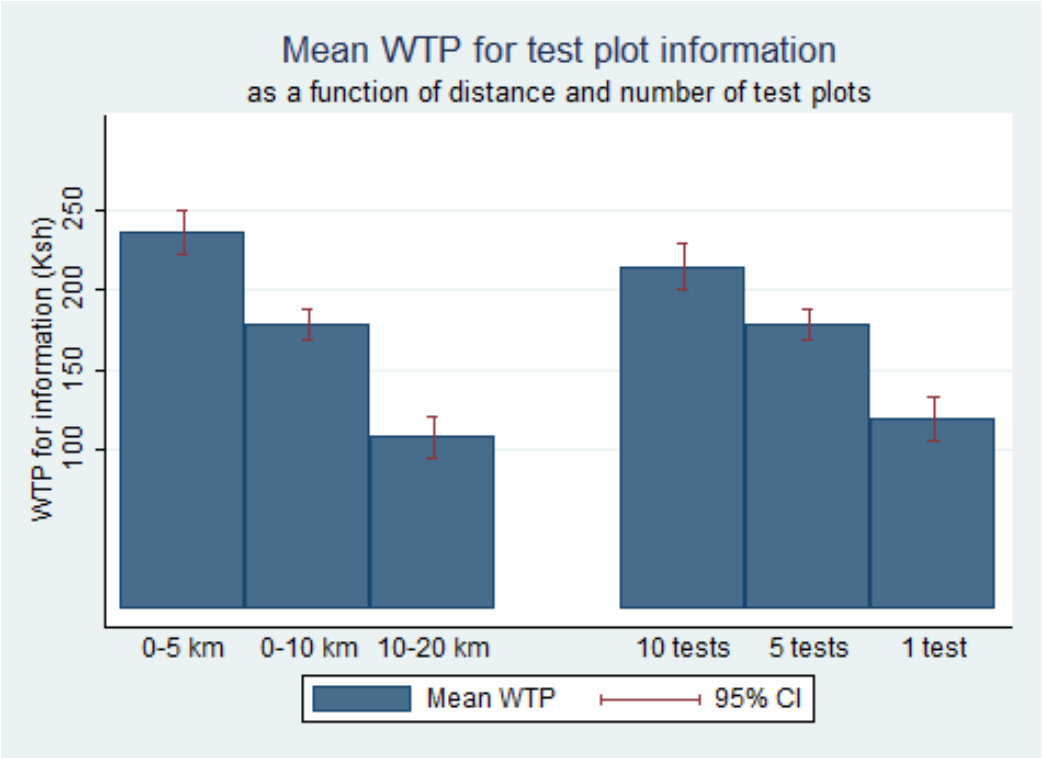


Figure 7: WTP (RLIS) as a function of distance and number of tests (Trial IV)

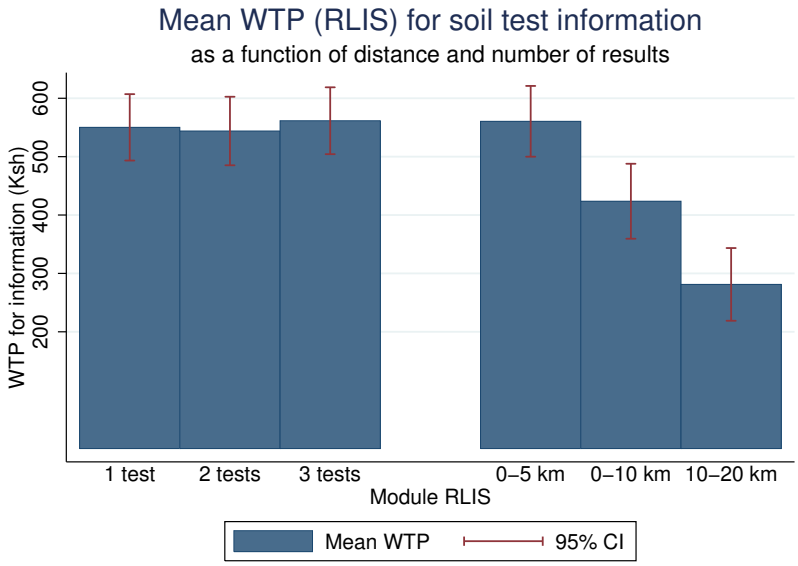


Figure 8: WTP (BDM) as a function of distance and number of tests (Trial IV)

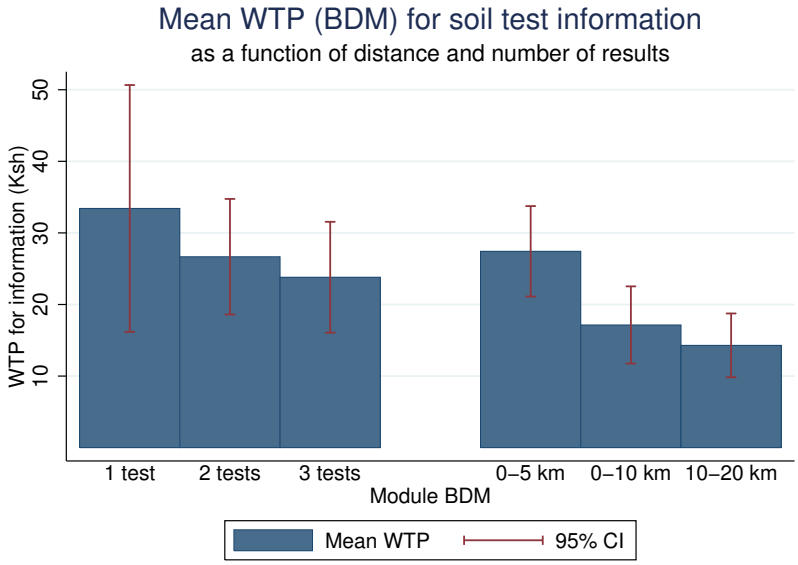
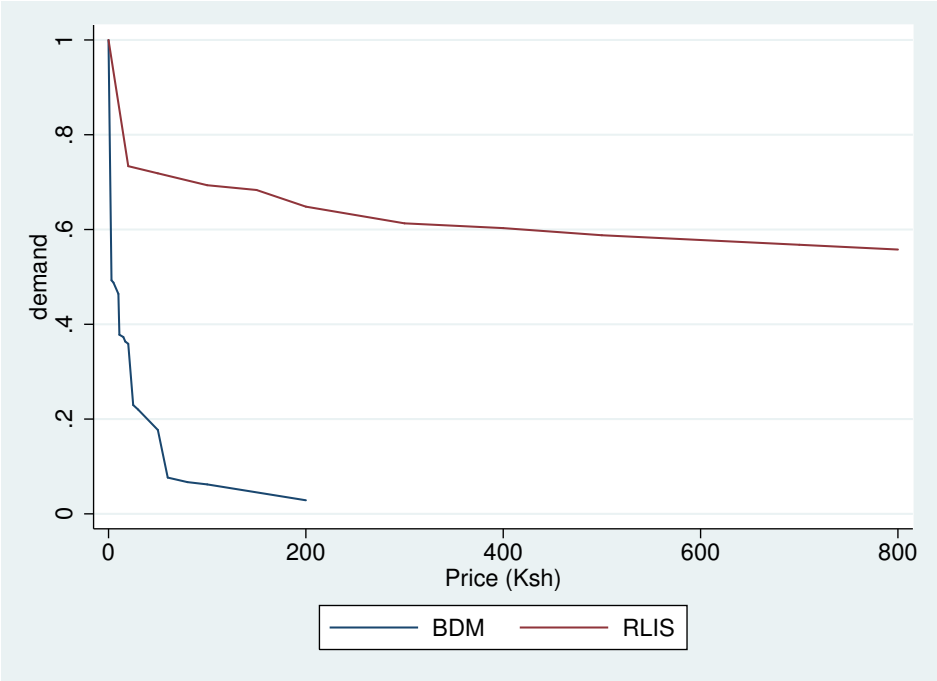
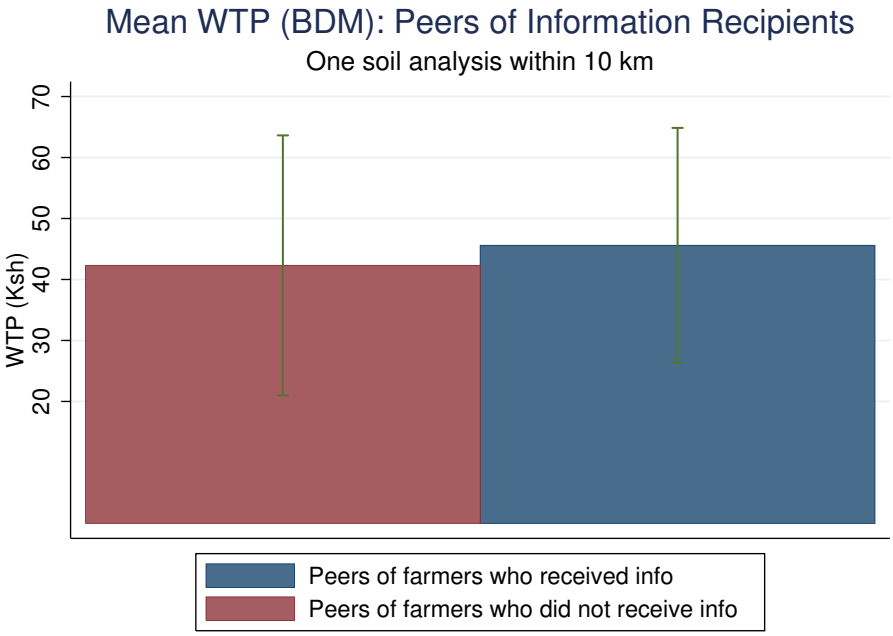


Figure 9: Inverse Demand Curve, Trial IV, BDM vs. RLIS



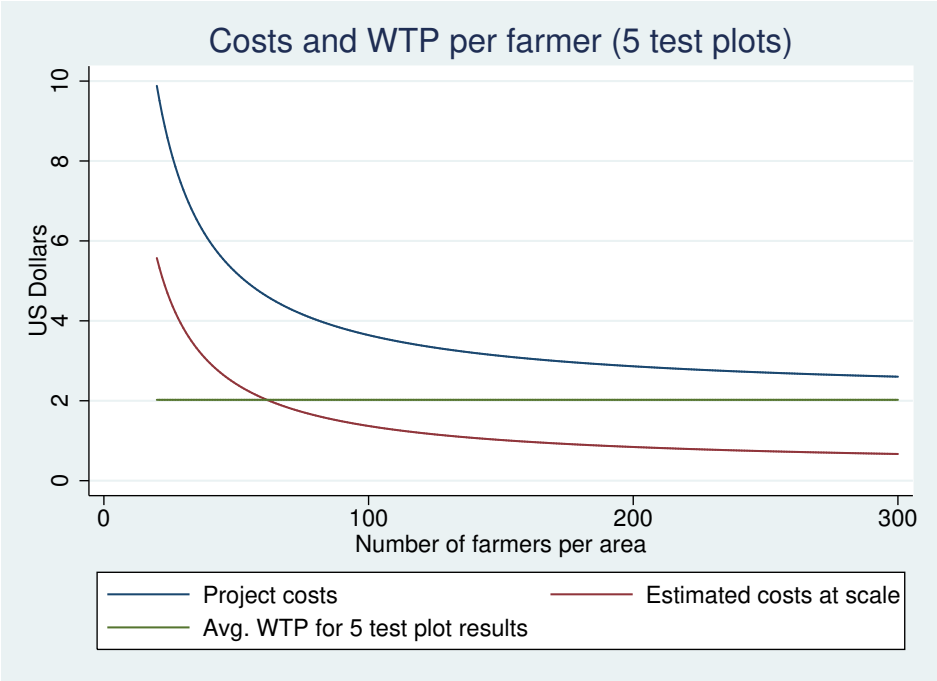
Notes: This graph shows the inverse demand curve for soil test results using a RLIS and a BDM elicitation method.

Figure 10: Peers' WTP



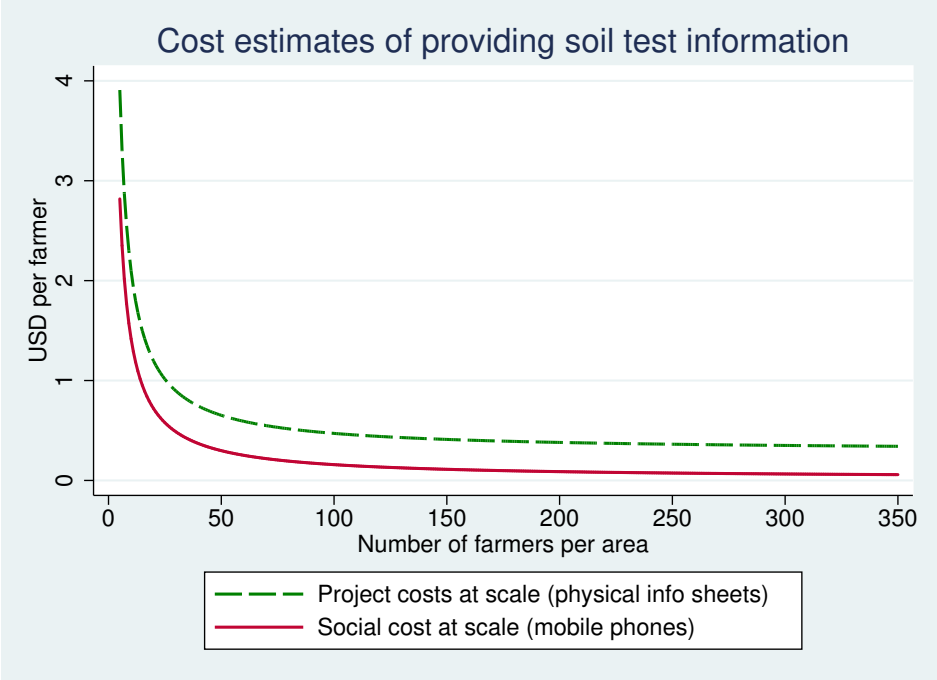
Notes: This graph shows WTP comparing farmers who were listed as peers/networks of those who had received a soil test in their own farm and those who were not listed as such.

Figure 11: Costs of generating and disseminating test plot information



Notes: The cost graphs show two types of costs. First, the blue line shows costs using same technology as during trials but returning sheets using local prices for transport, salary (rather than IPA prices) and returning info through a mass event (i.e. not tracking down respondents). Therefore, it replicates a cheaper version of the research project but assumes same technology and similar set up. Second, the red line shows projections of costs at scale or social costs with delivery through mobile phones.

Figure 12: Costs of generating and disseminating soil test information



Notes: The cost graphs show two types of costs. First, the green line shows costs of returning sheets using local prices for transport, salary (rather than IPA prices) and returning info through a mass event (i.e. not tracking down respondents). Therefore, it replicates a cheaper version of the research project but assumes same technology and similar set up. Second, the red line shows projections of costs at scale or social costs with delivery through mobile phones. These use wet soil technology but collected at scale ($13 per sample, including collection and transport) and the costs of SMS. Therefore this is a calculation of how things might look like in a number of years, without (or lower) markups in soil testing and SMS.

8 Tables

Table 1: Summary Statistics of KARLO recommendations 2011 and 2014

Analysis for 2011

Type of fertilizer or soil additive	**Fraction recommended**	**Mean amount recommended**
Planting fertilizer (NPK rating)		
NPK (any type)	0.80	107.9 kg (10.4)
NPK (17:17:17)	0.40	108.8 kg (10.6)
NPK (23:23:00)	0.40	106.9 kg (10.1)
CAN (26:00:00)	0.13	100.6 kg (16.0)
DAP (18:46:00)	0.02	105.4 kg (9.0)
Urea (46:00:00)	0.02	48.7 kg (5.7)
SSP (00:17:00)	0.02	100.0 kg (0.0)
Topdressing fertilizer (NPK rating)		
CAN (15:00:00)	0.93	50.0 kg (0.5)
Urea (46:00:00)	0.05	25.0 kg (0.0)
SSP (00:17:00)	0.01	34.3 kg (12.1)
Other		
Manure	0.99	2.8 tons (1.0)
Lime	0.03	262.7 kg (52.8)
Muriate of Potash	0.01	50.0 kg (0.0)

Analysis for 2014

Type of fertilizer or soil additive	**Fraction recommended**	**Mean amount recommended**
Planting fertilizer (NPK rating)		
NPK (any type)	0.95	114.0 kg (9.8)
NPK (17:17:17)	0.68	117.1 kg (7.2)
NPK (23:23:00)	0.26	106.1 kg (11.1)
CAN (15:00:00)	0.03	50.0 kg (0.0)
DAP (18:46:00)	0.01	100.0 kg (0.0)
SSP (00:17:00)	0.01	100.0 kg (0.0)
Topdressing fertilizer (NPK rating)		
CAN (15:00:00)	1.00	77.2 kg (8.2)
Other		
Manure	1.00	3.56 tons (0.8)
Lime	0.49	308.0 kg (97.2)

Notes: Mean amounts conditional on positive recommendations

Table 2: Spatial Correlation of soil characteristics in 2011 and 2014

Variable	Farmer-level ICC	School-level ICC	MSE Change
2011 Soil Samples			
Soil acidity			
Soil pH	.656 (.033)	.366 (.032)	− 28%
Macronutrients			
Organic carbon (%)	.692 (.029)	.256 (.029)	− 15%
Total nitrogen (%)	.675 (.031)	.216 (.028)	− 10%
Phosphorus (ppm)	.289 (.064)	.288 (.030)	− 18%
Potassium (me %)	.491 (.047)	.267 (.030)	− 17%
Calcium (me %)	.691 (.029)	.346 (.032)	− 26%
Magnesium (me %)	.730 (.026)	.353 (.032)	− 27%
Micronutrients			
Manganese (me %)	.631 (.035)	.332 (.031)	− 24%
Copper (ppm)	.736 (.025)	.470 (.032)	− 39%
Iron (ppm)	.371 (.057)	.092 (.021)	+ 2%
Zinc (ppm)	.225 (.069)	.058 (.018)	+ 5%
Sodium (me %)	.525 (.044)	.271 (.030)	− 18%
2014 Soil Samples			
Soil acidity			
Soil pH	.737 (.019)	.132 (.042)	− 12%
Macronutrients			
Organic carbon (%)	.796 (.015)	.187 (.051)	− 19%
Total nitrogen (%)	.800 (.015)	.187 (.051)	− 16%
Phosphorus (ppm)	.629 (.025)	.042 (.024)	− 2%
Potassium (me %)	.705 (.021)	.098 (.036)	− 5%
Calcium (me %)	.559 (.029)	.048 (.026)	− 2%
Magnesium (me %)	.763 (.018)	.064 (.029)	− 1%
Micronutrients			
Manganese (me %)	.547 (.029)	.101 (.036)	− 9%
Copper (ppm)	.041 (.042)	.121 (.041)	− 10%
Iron (ppm)	.648 (.024)	.017 (.018)	+ 2%
Zinc (ppm)	.699 (.022)	.128 (.041)	− 8%
Sodium (me %)	.537 (.030)	.058 (.028)	0%

Notes: Standard errors in parentheses.

Table 3: Overview of WTP in different trials

	Trial I (Feb '12)	**Trial II (Jul '12)**	**Trial III (Jul '13)**	**Trial IV (Mar'15)(Group A)**	**Trial IV (Jun'15)(Group B**
Number of farmers	569	153	893	193,273	204,395
Method	RLIS	Direct	RLIS	RLIS,BDM	RLIS,BDM
Own money used?	No	No	No	No, Yes	No, Yes
Setting	Home	Public	Home	Home	Home
Explanation of info	Limited	Detailed	Detailed	Detailed	
Maximum amount	Ksh 200	Ksh 100	Ksh 200/500	Ksh 800	Ksh 800, Ksh 1000
Soil test info	2 nearest plots in sample	1 randomly chosen result from area	1 randomly chosen result from area	1 randomly chosen result from area	1 randomly chosen result from area
Mean WTP	Ksh 146 ($1.7)	Ksh 28 ($0.3)	Ksh 168 ($2.0)	RLIS: Ksh 464 ($4.7) BDM: Ksh 45 ($0.4)	RLIS: Ksh 485($4.8) BDM: Ksh 28 ($0.3)
Test plot info	—	—	5 randomly chosen within 10 km	—	
Mean WTP	—	—	Ksh 190 ($2.3)	Ksh 35 ($0.3)(BDM)	Ksh 25 ($0.2)(BDM)

Appendix

Figure A1: Example of Soil Test information sheet for rounds 1 and 2

Planting

--- Farmer A was recommended to use 100 kg of NPK per acre.
--- This is the same as 1 teaspoons or 2 bluespoons per planting hole.

--- Farmer B was recommended to use 100 kg of NPK per acre.
--- This is the same as 1 teaspoons or 2 bluespoons per planting hole.

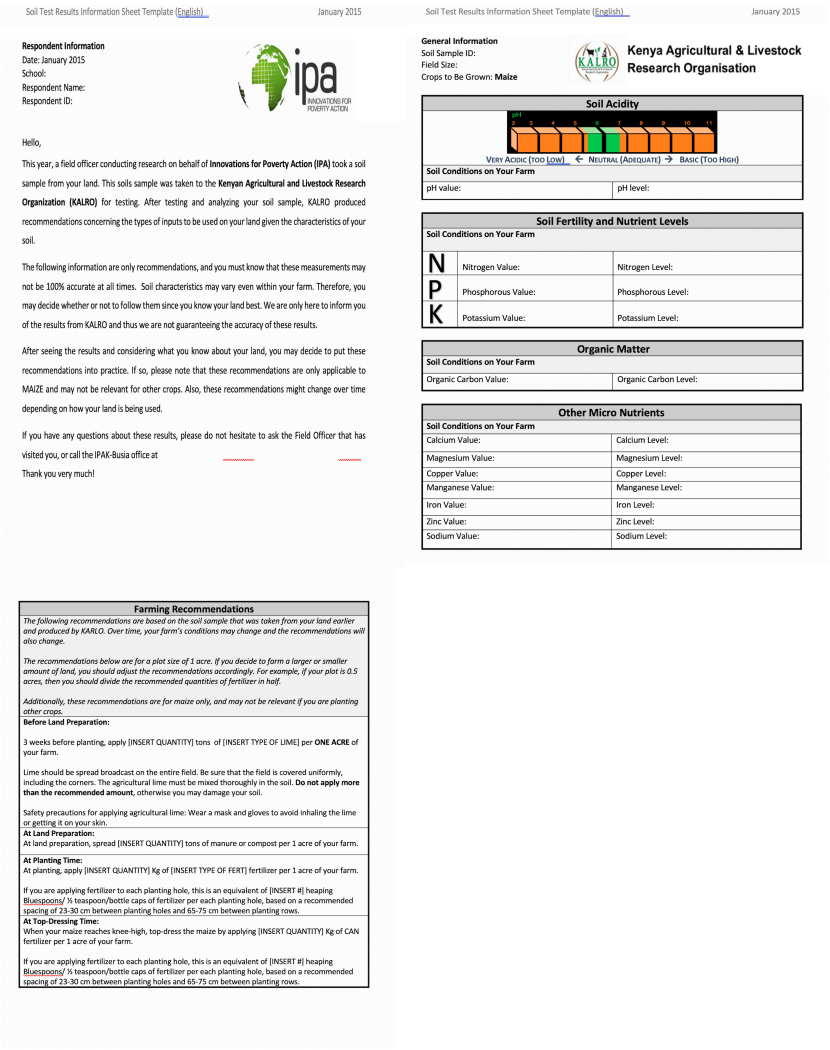
Top Dressing

--- Farmer A was recommended to use 50 kg of CAN per acre.
--- This is the same as ½ teaspoon or 1 bluespoons per planting hole.

--- Farmer B was recommended to use 50 kg of CAN per acre.
--- This is the same as ½ teaspoon or 1 bluespoons per planting hole.

The above recommendations have been drawn from the chemical analysis of the soil samples collected from your plot(s). You know your plot better than anyone, so please keep in mind these are only suggestions for other people with children in the nearby school. They may not be best for everyone, but we thought you might want to try them on a small piece of land and see what the resulting yields are.

Figure A2: Example of Soil Test information sheet for rounds 3 and 4



Soil Test Results Information Sheet Template (English) January 2015

Respondent Information
Date: January 2015
School:
Respondent Name:
Respondent ID:

Hello,

This year, a field officer conducting research on behalf of **Innovations for Poverty Action (IPA)** took a soil sample from your land. This soils sample was taken to the **Kenyan Agricultural and Livestock Research Organization (KALRO)** for testing. After testing and analyzing your soil sample, KALRO produced recommendations concerning the types of inputs to be used on your land given the characteristics of your soil.

The following information are only recommendations, and you must know that these measurements may not be 100% accurate at all times. Soil characteristics may vary even within your farm. Therefore, you may decide whether or not to follow them since you know your land best. We are only here to inform you of the results from KALRO and thus we are not guaranteeing the accuracy of these results.

After seeing the results and considering what you know about your land, you may decide to put these recommendations into practice. If so, please note that these recommendations are only applicable to MAIZE and may not be relevant for other crops. Also, these recommendations might change over time depending on how your land is being used.

If you have any questions about these results, please do not hesitate to ask the Field Officer that has visited you, or call the IPAK-Busia office at

Thank you very much!

Soil Test Results Information Sheet Template (English) January 2015

General Information
Soil Sample ID:
Field Size:
Crops to Be Grown: **Maize**

Kenya Agricultural & Livestock Research Organisation

Soil Acidity	
pH 2 3 4 5 6 7 8 9 10 11	
Very Acidic (Too Low) ← Neutral (Adequate) → Basic (Too High)	
Soil Conditions on Your Farm	
pH value:	pH level:

Soil Fertility and Nutrient Levels		
Soil Conditions on Your Farm		
N	Nitrogen Value:	Nitrogen Level:
P	Phosphorous Value:	Phosphorous Level:
K	Potassium Value:	Potassium Level:

Organic Matter	
Soil Conditions on Your Farm	
Organic Carbon Value:	Organic Carbon Level:

Other Micro Nutrients	
Soil Conditions on Your Farm	
Calcium Value:	Calcium Level:
Magnesium Value:	Magnesium Level:
Copper Value:	Copper Level:
Manganese Value:	Manganese Level:
Iron Value:	Iron Level:
Zinc Value:	Zinc Level:
Sodium Value:	Sodium Level:

Farming Recommendations

The following recommendations are based on the soil sample that was taken from your land earlier and produced by KARLO. Over time, your farm's conditions may change and the recommendations will also change.

The recommendations below are for a plot size of 1 acre. If you decide to farm a larger or smaller amount of land, you should adjust the recommendations accordingly. For example, if your plot is 0.5 acres, then you should divide the recommended quantities of fertilizer in half.

Additionally, these recommendations are for maize only, and may not be relevant if you are planting other crops.

Before Land Preparation:

3 weeks before planting, apply [INSERT QUANTITY] tons of [INSERT TYPE OF LIME] per **ONE ACRE** of your farm.

Lime should be spread broadcast on the entire field. Be sure that the field is covered uniformly, including the corners. The agricultural lime must be mixed thoroughly in the soil. **Do not apply more than the recommended amount**, otherwise you may damage your soil.

Safety precautions for applying agricultural lime: Wear a mask and gloves to avoid inhaling the lime or getting it on your skin.

At Land Preparation:
At land preparation, spread [INSERT QUANTITY] tons of manure or compost per 1 acre of your farm.

At Planting Time:
At planting, apply [INSERT QUANTITY] Kg of [INSERT TYPE OF FERT] fertilizer per 1 acre of your farm.

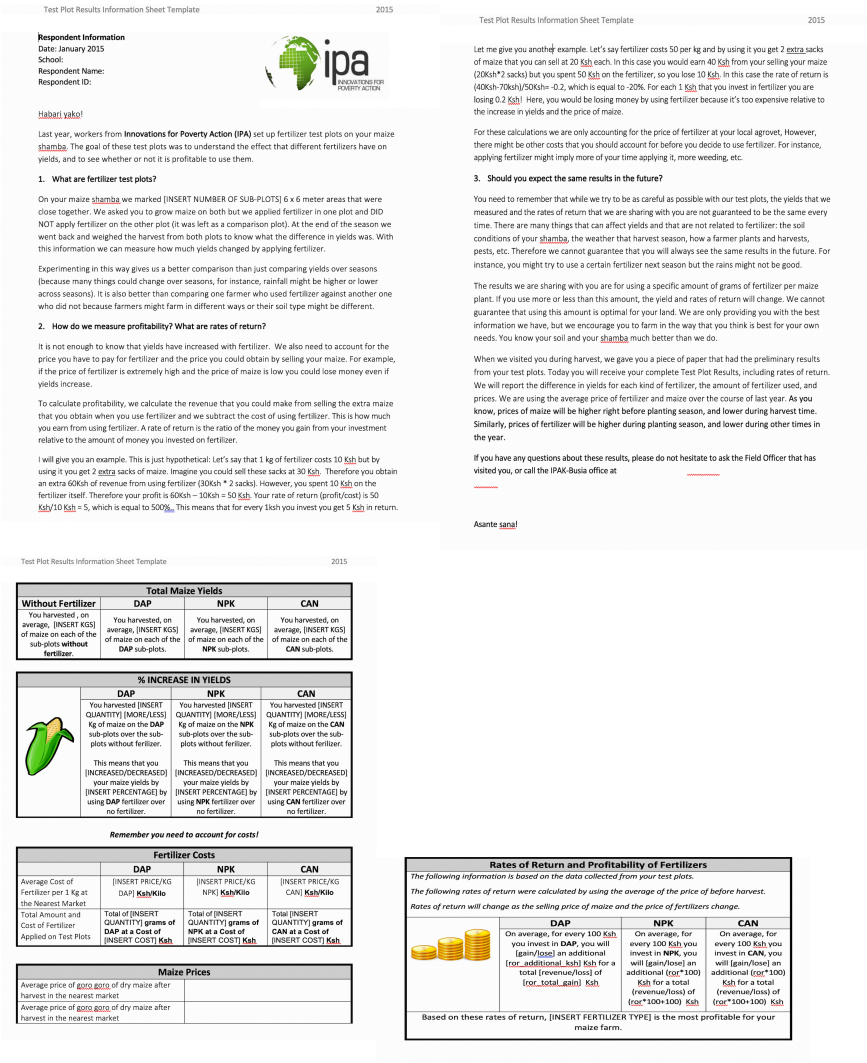
If you are applying fertilizer to each planting hole, this is an equivalent of [INSERT #] heaping Bluespoons/ ½ teaspoon/bottle caps of fertilizer per each planting hole, based on a recommended spacing of 23-30 cm between planting holes and 65-75 cm between planting rows.

At Top-Dressing Time:
When your maize reaches knee-high, top-dress the maize by applying [INSERT QUANTITY] Kg of CAN fertilizer per 1 acre of your farm.

If you are applying fertilizer to each planting hole, this is an equivalent of [INSERT #] heaping Bluespoons/ ½ teaspoon/bottle caps of fertilizer per each planting hole, based on a recommended spacing of 23-30 cm between planting holes and 65-75 cm between planting rows.

Notes: The sheets showed where in Swahili and showed the actual numbers.

Figure A3: Example of Test Plot information sheet (round 3)



Test Plot Results Information Sheet Template 2015

Respondent Information
Date: January 2015
School:
Respondent Name:
Respondent ID:

Habari yako!

Last year, workers from **Innovations for Poverty Action (IPA)** set up fertilizer test plots on your maize shamba. The goal of these test plots was to understand the effect that different fertilizers have on yields, and to see whether or not it is profitable to use them.

1. What are fertilizer test plots?

On your maize shamba we marked [INSERT NUMBER OF SUB-PLOTS] 6 x 6 meter areas that were close together. We asked you to grow maize on both but we applied fertilizer in one plot and DID NOT apply fertilizer on the other plot (it was left as a comparison plot). At the end of the season we went back and weighed the harvest from both plots to know what the difference in yields was. With this information we can measure how much yields changed by applying fertilizer.

Experimenting in this way gives us a better comparison than just comparing yields over seasons (because many things could change over seasons, for instance, rainfall might be higher or lower across seasons). It is also better than comparing one farmer who used fertilizer against another one who did not because farmers might farm in different ways or their soil type might be different.

2. How do we measure profitability? What are rates of return?

It is not enough to know that yields have increased with fertilizer. We also need to account for the price you have to pay for fertilizer and the price you could obtain by selling your maize. For example, if the price of fertilizer is extremely high and the price of maize is low you could lose money even if yields increase.

To calculate profitability, we calculate the revenue that you could make from selling the extra maize that you obtain when you use fertilizer and we subtract the cost of using fertilizer. This is how much you earn from using fertilizer. A rate of return is the ratio of the money you gain from your investment relative to the amount of money you invested on fertilizer.

I will give you an example. This is just hypothetical: Let's say that 1 kg of fertilizer costs 10 Ksh but by using it you get 2 extra sacks of maize. Imagine you could sell these sacks at 30 Ksh. Therefore you obtain an extra 60Ksh of revenue from using fertilizer (30Ksh * 2 sacks). However, you spent 10 Ksh on the fertilizer itself. Therefore your profit is 60Ksh – 10Ksh = 50 Ksh. Your rate of return (profit/cost) is 50 Ksh/10 Ksh = 5, which is equal to 500%. This means that for every 1ksh you invest you get 5 Ksh in return.

Test Plot Results Information Sheet Template 2015

Let me give you another example. Let's say fertilizer costs 50 per kg and by using it you get 2 extra sacks of maize that you can sell at 20 Ksh each. In this case you would earn 40 Ksh from your selling your maize (20Ksh*2 sacks) but you spent 50 Ksh on the fertilizer, so you lose 10 Ksh. In this case the rate of return is (40Ksh-70kshl)/50Ksh= -0.2, which is equal to -20%. For each 1 Ksh that you invest in fertilizer you are losing 0.2 Ksh! Here, you would be losing money by using fertilizer because it's too expensive relative to the increase in yields and the price of maize.

For these calculations we are only accounting for the price of fertilizer at your local agrovet, However, there might be other costs that you should account for before you decide to use fertilizer. For instance, applying fertilizer might imply more of your time applying it, more weeding, etc.

3. Should you expect the same results in the future?

You need to remember that while we try to be as careful as possible with our test plots, the yields that we measured and the rates of return that we are sharing with you are not guaranteed to be the same every time. There are many things that can affect yields and that are not related to fertilizer: the soil conditions of your shamba, the weather that harvest season, how a farmer plants and harvests, pests, etc. Therefore we cannot guarantee that you will always see the same results in the future. For instance, you might try to use a certain fertilizer next season but the rains might not be good.

The results we are sharing with you are for using a specific amount of grams of fertilizer per maize plant. If you use more or less than this amount, the yield and rates of return will change. We cannot guarantee that using this amount is optimal for your land. We are only providing you with the best information we have, but we encourage you to farm in the way that you think is best for your own needs. You know your soil and your shamba much better than we do.

When we visited you during harvest, we gave you a piece of paper that had the preliminary results from your test plots. Today you will receive your complete Test Plot Results, including rates of return. We will report the difference in yields for each kind of fertilizer, the amount of fertilizer used, and prices. We are using the average price of fertilizer and maize over the course of last year. **As you know, prices of maize will be higher right before planting season, and lower during harvest time. Similarly, prices of fertilizer will be higher during planting season, and lower during other times in the year.**

If you have any questions about these results, please do not hesitate to ask the Field Officer that has visited you, or call the IPAK-Busia office at .....

Asante sana!

Test Plot Results Information Sheet Template 2015

Total Maize Yields			
Without Fertilizer	**DAP**	**NPK**	**CAN**
You harvested , on average, [INSERT KGS] of maize on each of the sub-plots **without fertilizer**.	You harvested, on average, [INSERT KGS] of maize on each of the **DAP** sub-plots.	You harvested, on average, [INSERT KGS] of maize on each of the **NPK** sub-plots.	You harvested, on average, [INSERT KGS] of maize on each of the **CAN** sub-plots.

% INCREASE IN YIELDS			
	DAP	**NPK**	**CAN**
	You harvested [INSERT QUANTITY] [MORE/LESS] Kg of maize on the **DAP** sub-plots over the sub-plots without fertilizer. This means that you [INCREASED/DECREASED] your maize yields by [INSERT PERCENTAGE] by using **DAP** fertilizer over no fertilizer.	You harvested [INSERT QUANTITY] [MORE/LESS] Kg of maize on the **NPK** sub-plots over the sub-plots without fertilizer. This means that you [INCREASED/DECREASED] your maize yields by [INSERT PERCENTAGE] by using **NPK** fertilizer over no fertilizer.	You harvested [INSERT QUANTITY] [MORE/LESS] Kg of maize on the **CAN** sub-plots over the sub-plots without fertilizer. This means that you [INCREASED/DECREASED] your maize yields by [INSERT PERCENTAGE] by using **CAN** fertilizer over no fertilizer.

Remember you need to account for costs!

Fertilizer Costs			
	DAP	**NPK**	**CAN**
Average Cost of Fertilizer per 1 Kg at the Nearest Market	[INSERT PRICE/KG DAP] **Ksh/Kilo**	[INSERT PRICE/KG NPK] **Ksh/Kilo**	[INSERT PRICE/KG CAN] **Ksh/Kilo**
Total Amount and Cost of Fertilizer Applied on Test Plots	Total of [INSERT QUANTITY] **grams of DAP at a Cost of** [INSERT COST] **Ksh**	Total of [INSERT QUANTITY] **grams of NPK at a Cost of** [INSERT COST] **Ksh**	Total [INSERT QUANTITY] **grams of CAN at a Cost of** [INSERT COST] **Ksh**

Maize Prices	
Average price of goro goro of dry maize after harvest in the nearest market	
Average price of goro goro of dry maize after harvest in the nearest market	

Rates of Return and Profitability of Fertilizers			
The following information is based on the data collected from your test plots. *The following rates of return were calculated by using the average of the price of before harvest.* *Rates of return will change as the selling price of maize and the price of fertilizers change.*			
	DAP	**NPK**	**CAN**
	On average, for every 100 Ksh you invest in **DAP**, you will [gain/lose] an additional [ror_additional_ksh] Ksh for a total [revenue/loss] of [ror_total_gain] Ksh	On average, for every 100 Ksh you invest in **NPK**, you will [gain/lose] an additional (ror*100) Ksh for a total (revenue/loss) of (ror*100+100) Ksh	On average, for every 100 Ksh you invest in **CAN**, you will [gain/lose] an additional (ror*100) Ksh for a total (revenue/loss) of (ror*100+100) Ksh
Based on these rates of return, [INSERT FERTILIZER TYPE] is the most profitable for your maize farm.			

Notes: The sheets showed where in Swahili and showed the actual numbers.

Table A1: Example of the Random Lottery Incentivized System

[W5a.] Which would you prefer: information based on 1 soil test within 10 km or 20 Ksh?	[X] information	[ ] 20 Ksh
[W5b.] Information or 50 Ksh?	[X] Information	[ ] 50 Ksh
[W5c.] Information or 100 Ksh?	[X] Information	[ ] 100 Ksh
[W5d.] Information or 150 Ksh?	[X] Information	[ ] 150 Ksh
[W5e.] Information or 200 Ksh?	[ ] Information	[X] 200 Ksh
[W5f.] Information or 300 Ksh?	[ ] Information	[X] 300 Ksh
[W5g.] Information or 400 Ksh?	[ ] Information	[X] 400 Ksh
[W5h.] Information or 500 Ksh?	[ ] Information	[X] 500 Ksh