Evaluating the effect of site-specific soil information on farmer input choices and the relationship between poverty and soil quality

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Narrative

I. Introduction

This is an exciting time for agricultural development in Sub-Saharan Africa. After decades of stasis, in part due to soil nutrient depletion following years of insufficient organic and inorganic fertilizer applications (Sanchez 2002), cereal yields have recently begun to increase in some areas, particularly in countries such as Malawi and Tanzania where governments have instituted programs subsidizing mineral fertilizer and hybrid seed for smallholder farmers (Denning *et al*. 2009, Sanchez *et al*. 2009). Considerable work remains to sustain and improve early yield gains that may result from these programs and to help farmers better manage their soils and use scarce resources more efficiently, especially in a context where more extreme and volatile weather events are expected due to climate change.

Poor soil quality and the associated low crop productivity is linked to the pervasive rates of poverty and malnutrition ensnaring much of Africa (Minten and Barrett 2008, Sanchez and Swaminathan 2005). The link between agricultural growth and poverty reduction has been well-established (Johnston and Mellor 1961). More recently, de Janvry and Sadoulet (2010) find that GDP growth induced by agriculture helps the poorest 40% of the population.

One challenge is that farmers, in particular small-scale farmers, do not know the status of their soils. Despite considerable heterogeneity in soil types and other biophysical conditions across farmers and farm fields, governments generally set a single mineral fertilizer application recommendation for a region or country. While uniform recommendations can succeed up to a point in improving yields, obtaining higher yields will require a targeted approach that addresses specific soil constraints to crop production and makes efficient use of environmental and economic resources. Current resources for soils information provision are lacking in Sub-Saharan Africa. Laboratories that conduct soil tests and make recommendations are few and far between and the costs are beyond the reach of most farmers in the region. Without such soils information it is not possible to make recommendations specific to farmers' soils and growing conditions. Given that soil quality has been shown to have an inverse relationship with farmer wealth (Marenya and Barrett 2009), site-specific diagnoses and recommendations may be of particular use to poorer farmers.

In order to address this problem, a team of researchers and collaborators at Columbia University's Agriculture and Food Security Center has developed a lab-in-a-box, a rapid on-farm soil diagnostic kit. The kit combines in-field measurements of essential soil physical and chemical parameters with information communications technology (ICT) to provide farm-specific management recommendations. The tool, also known as SoilDoc, has been validated and calibrated with standard wet chemistry procedures. It has generated considerable interest and is being field-tested in Tanzania, and in the coming year in Nigeria.

We propose to test the central hypothesis underlying the development of SoilDoc: that farmers will apply productive inputs more effectively and increase yields in response to improved access to information about soil quality. Our approach employs a randomized control trial (RCT). We will evaluate how improved soil information impacts yields, production inputs used by farmers, and welfare of farming households. A team of economists and soil scientists from Columbia University, University of Illinois at

Urbana-Champaign, University of Maryland and Sokoine University will conduct the study in the Morogoro district of Tanzania.

The study addresses reasons why farmers may be unable or unwilling to use information about soil quality to enhance investments in production. Farmers may be unwilling to use the information if they do not trust the source that is providing them information or the way in which the information was developed (Cash 2001). The study will disseminate information about soils through agricultural extension agents. Each of these agents is attached to one village in the district and has established relationships with farmers. Farmers in Morogoro trust the extension agents and farmers have acted on information provided by extension agents in the past.

Farmers may be unable to act on the information about soil quality if they do not have access to needed inputs or if they do not have the resources to purchase those inputs. Supply of fertilizer is well-established in Morogoro although the quality of fertilizer is variable. We will provide all farmers with information on the location of agro dealers in their region that supply fertilizers of reliable, verified quality.

Our RCT will include a component that tests whether available assets constrain farmers' ability to obtain inputs. Some farmers in the RCT will receive a cash grant[1] together with information about their soils, some will receive information about soils only, some will receive a cash grant only, and some will receive neither. In this way we will be able to test whether the cash grant increases the impact of information about soils.

[1] Note that we are exploring whether to disburse cash or vouchers for agricultural inputs of equivalent value. The potential advantage of the voucher option is that the voucher option is more likely to be an approach that can be scaled up through existing institutions in the future than is the cash grant option. The voucher option would be implemented by the research team. We would not provide vouchers through the existing government program since the program has a mixed record. The voucher option would require the same budget as the proposed cash grant option. The team would submit to BASIS the details of the voucher option for review and approval before implementation. Throughout this proposal, we refer to cash transfers only.

The experiment will also enable us to examine whether the impact of soil information on farmer investment decisions and yields depends on the quality of soil. Do poorer farmers, who tend to own lower quality soils, benefit more or less from information than do wealthier farmers? We will also address the related questions of how impacts of information vary across different farming households and why the impacts do or do not occur. The results will help to design large-scale efforts to improve farming productivity through provision of information about soil quality.

II. Background

SoilDoc

SoilDoc is a portable, on–farm soil testing kit coupled with an android system that provides cost-effective, farmer-specific soil and crop management recommendations including inorganic and organic inputs and soil conservation practices. Recommendations are provided in near real time. The soil fertility parameters analyzed with the SoilDoc field kit include soil pH, biologically active soil organic matter, electrical conductivity (indicative of general fertility as well as salinity issues) and extractable macronutrients (nitrate-N, sulfate-S, phosphate-P, and potassium-K). The kit also has the capacity to test nutrients in the sap of growing crops including nitrogen, phosphorus, sulfur and potassium. Furthermore, the kit includes tools to measure soil physical properties such as surface sealing strength, compaction, and aggregate stability (a property that integrates biological, chemical and physical conditions).

Trained extension workers can assess soils in-situ with farmers' participation, they can then make recommendations based on their expertise and can also transmit the field results with an android phone or tablet to a central operating system that will send soil management recommendations based on the combined results. The results are sent via SMS and are communicated to farmers in near real time. This way, farmers are advised on which nutrients to apply on their fields or which other soil management practices can be implemented to address fertility constraints. SoilDoc uses state-of-the-art battery-powered instruments similar to those used in wet-chemistry labs. Current results from SoilDoc correlate highly with laboratory methods. The kit will be the first to put these battery-powered tools to work together with a cloud database to provide on-site, comprehensive soil diagnoses. The spatially explicit database that is developed through this program will also generate useful soil management recommendation domain maps for use by government and non-governmental agencies.

SoilDoc will be implemented in collaboration with Sokoine University and agronomists and government extension workers who will be trained to use SoilDoc in the region of Morogoro, Tanzania. Because the region is a high producer and consumer of maize, we will focus on maize and examining the returns to new soils information specifically on maize production. This is a region characterized by chronically low inputs use. According to the 2007 Tanzania Agricultural Census, 98 percent of households in Morogoro grew maize on at least one plot and less than one percent reported using any fertilizer. Resulting maize yields in Morogoro averaged about 1.4 t/ha between 1994-2001 (Paavola 2008), far below the 6 to 7 t/ha achieved with applications of 70-100 kg N/ha (Folberth *et al*. 2013).

Literature

Several recent studies examining technology adoption have focused on explaining low adoption rates, particularly of fertilizer and/or improved seeds, observed in many countries in Africa (Duflo *et al*. 2011, Sirrine *et al*. 2010, Marenya and Barrett 2009a,b, Suri 2009, Duflo *et al.* 2008, Vissoh *et al*. 2000). Various explanations have been suggested for these low adoption rates despite high expected yields. In some cases, credit market failures impede demand (Gregory and Bumb 2006). In other cases, infrastructural bottlenecks leading to market inefficiencies render fertilizer unaffordable or unavailable to many small farmers (Poulton *et al.* 2006). Based on our previous fieldwork in Morogoro in August, 2013 and our relationships with soil scientists at Sokoine University, we do not expect fertilizer supply to pose a constraint in Morogoro. Our study addresses the possible credit constraint.

Marenya and Barrett (2009a,b) show that fertilizer yield responses vary with soil organic matter content, making fertilizer application less profitable on poorer quality soils. Indeed, recent research shows that some soils, perhaps as much as 20%, do not respond to applications of common fertilizers (containing nitrogen, phosphorus, and potassium), suggesting that the underlying soil constraints to production may be related to pH, micronutrients, or physical or biological factors (Vanlauwe *et al.* 2010, Zingore *et al.* 2007). Duflo *et al*. (2008) find that farmers are given fertilizer application recommendations that do not match the soils they cultivate.

Heterogeneity in soil characteristics (both observed and unobserved), therefore, may affect fertilizer efficiency and profitability, thereby affecting farmers' decision to apply fertilizer (Foltz *et al.* 2011, Zingore *et al.* 2007). Improving farmer information about soils and management strategies through a tool like SoilDoc could improve the efficiency and use of inorganic fertilizer, organic inputs and integrated soil fertility management practices by tailoring fertilizer recommendations at the farmer level, potentially improving household yields and reducing poverty. It is therefore important at this stage to determine the degree to which plot-specific information can affect farmers' input decisions and investments.

We are aware of only a handful of studies examining linkages between soil information, fertilizer, yields and farmers' willingness to pay for such information. Fabregas *et al.* (2014) study how much farmers are willing to pay for results of nearby experimental fertilizer and yield plots. They find a strong correlation between soil qualities located geographically close to each other. Using different elicitation techniques, they examine how much farmers are willing to pay for soil information. They find that farmers are willing to pay between $0.30 - $2.60, depending on the method and level of information presented to the farmer.

III. Objectives

Our research agenda includes four primary objectives:

1. The first objective is to determine how plot-specific soil information affects farmers' agricultural input decisions and yields, relative to information received via traditional extension services. We will also compare how the use of SoilDoc by extension agents affects farmers' evaluation of the quality of information they have received. Additionally, we will measure how information from SoilDoc changes farmers' subjective valuation of the quality of their plots. In order to

assess mechanisms of change, we will study potential impediments to acting upon the new information including the availability of recommended fertilizers on the market and perceived quality of inputs in markets.

2. The second objective of the study is to closely examine the link between soil quality, poverty and input decisions. SoilDoc presents a unique opportunity to empirically test these relationships. How do input decisions change given heterogeneous observed and unobserved soil quality characteristics? How do farmers respond to new information? Does soil information on a poorer quality plot cause farmers to use more or less fertilizer relative to a farmer who receives soil information on a plot with higher soil quality? How do these decisions change with differing initial levels of wealth and soil quality?

3. The third objective is to determine whether farmer input decisions are constrained by access to cash/credit. We will test whether the decision to purchase inputs changes when the cash constraint is relaxed.

4. Finally, because SoilDoc has already captured the interest of several Ministries of Agriculture in Africa, the fourth objective of this study is to disseminate the results of our study to the Ministries of Agriculture in Tanzania, Nigeria, and other interested governments, as well as practitioners and key stakeholders in countries where discussions on the roll-out of SoilDoc have already begun.

IV. Research Methodology

IV.1 Experimental Design

We will address our first three objectives using a randomized control trial, in which we randomize access to each type of treatment among individual farmers within 20 villages. The RCT will consist of three treatment groups:

(i) farmers who receive plot-specific information about the soil based on the SoilDoc lab results

(ii) farmers who receive a cash transfer of similar value to the voucher coupon distributed under Tanzanian's National Agricultural Voucher Scheme (NAIVS) covering approximately 50 percent of the value of fertilizer needed to cultivate one hectare of land

(iii) farmers who receive information based on SoilDoc lab results plus the cash transfer

The control group of farmers will receive advice from extension agents based on a standard extension visit – that is, extension agent observation of fields, crops, and soils without detailed recommendations based on SoilDoc lab results.

Spillovers

Because soil quality within villages is likely to be correlated and because farmers can be expected to share information among themselves, we are concerned about information spillovers. We expect that information received via the SoilDoc testing is likely to spill over to control households within the same village.[2] We will measure the extent and

[2] Increasing the number of villages in the study sufficiently to randomize at the village level would be prohibitively expensive.

magnitude of spillovers by collecting data from households in 30 pure control villages in which all sampled farmers receive only a typical extension visit without information based on SoilDoc.

Village and household selection

We will select 20 villages in Morogoro for the RCT and 30 villages for the pure control villages out of 50 villages that are known to grow maize. In each of the 20 villages selected for the RCT we will randomly select[3]: 10 farmers to receive SoilDoc recommendations, 10 farmers to receive cash and SoilDoc recommendations, 10 farmers to receive a cash transfer only, and 10 farmers to will receive a 'typical' extension visit. As noted, a 'typical' extension visit entails visually assessing a plot's soil quality, texture and moisture. We will randomly select 10 farmers in each of the 30 pure control villages.

Random selection may not ensure a good match between the RCT villages and the pure control villages. Our research design allows us to check the match of the villages before administering the treatment. We will use propensity score matching to improve the match between the pure control villages and the RCT villages.

To conduct the randomization, we will hold meetings with farmers in all study villages prior to beginning the study in order to explain the nature of and the reasons for the experiment and how it may benefit the farmers. We will discuss any concerns that the farmers may have. The discussions should help to allay any conflicts that may arise due to the administration of different treatments in the RCT villages.

[3] 40 maize farmers *who were not recipients of Tanzania's NAIVS input subsidy program program* will be randomly selected. The coverage of the *NAVIS* program in the region was approximately 10%. The Ministry of Agriculture has provided lists of recipients.

Extension agents in Tanzania are assigned by the government to operate within a single village. Because there will be households in the same village who receive SoilDoc recommendations while others will not, there is a strong chance that extension agents could make recommendations to control households based on what they have learned via SoilDoc. To address this concern, the order of training and visits will be as follows: first, all extension agents will receive general training on SoilDoc sampling and interpretation, then an extension agent will visit all control households in his or her village before s/he has specific information about the soils on plots owned by treatment households and before s/he begins visits to the treatment households. This way, extension agents have the same training when they visit the control and the treatment households and we avoid the problem that agents who visit control households and agents who visit treatment households may be of different quality. However, the agents do not yet have any soil-specific information when they visit the control households so they cannot contaminate the control group.

IV. 2 Data collection

During the first round, (*c.f. infra*, Timeline, expected August-September 2014) a group of 25 enumerators will survey all treatment and control households about crops planted per plot owned and rented, yields and inputs during the 2014 season, perceived soil quality, demographic and household characteristics, assets, lending/borrowing, fertilizer availability and quality, and perceived quality of information received from extension agents. We will collect data about availability and quality of fertilizer and perceived quality of interactions with extension agents in order to control for variation in these potential constraints on the response to soil information in the regressions.

Extension agents will collect soil samples on one randomly selected plot for each treatment and each control farmer in all RCT and pure control villages. The plot will be selected from plots on which maize was grown during the 2014 season and on which a farmer also expects to grow maize during the 2015 season. These randomly selected plots will be tested with SoilDoc. SoilDoc results and cash transfers will be shared and distributed to households who were selected to receive soil information in early October 2014 – in time for inputs investments decision in advance of the 2014-15 agricultural season. In the second and final round (August-September 2015), farmers will be asked the same follow up questions as in the 2014 survey. Additionally we will ask them about the perceived quality and usefulness of the information received during the treatment.

Note that we will collect and test soil samples for all control households in RCT and in the pure control villages so that we can estimate how impacts of soil information vary with soil quality. Information about soil quality will be communicated to control households at the end of the study in 2015.

IV. 3 Power Calculations

We will work with a total sample of 1100 farmers. A sample of 800 farmers will be randomly chosen among 20 villages:

Information only – 200 farmers	Cash grant only – 200 farmers
Information + cash grant – 200 farmers	Control – 200 farmers

Another 300 farmers will be randomly chosen as a “pure control” within additional 30 “pure control” villages.

Data from Tanzania's 2008 Agricultural Census restricted to the Morogoro, Dodoma, Manyara, and Ranga regions indicates that maize yields are 464 kilos per hectare without mineral fertilizer and 753 kilos per hectare with mineral fertilizer. This suggests a yield "effect" of fertilizer adoption of 62%. Randomizing at the household level, with a sample size of 400 (200 treatment, 200 control) and a standard deviation of 574 kilos/ha, we can pick up an unconditional effect generated by the treatment that provides soil information only of at least 25%.

The Tanzanian census and our conversations with Morogoro extension agents suggest very low use of fertilizer in the region. Less than one percent reported using any fertilizer. Farmers who did report using mineral fertilizer on maize in the census applied a mean of 40 kg per acre (s.d. 29). The mean per acre application across all farmers (pooling those who use fertilizer and those who do not) was 1.96 kg (s.d. 10.71). Randomizing at the household level, with a sample size of 400 (200 treatment, 200 control), we can pick up an unconditional effect generated by the treatment that provides soil information only of at least 25% (a fertilizer kg/acre change of 2.68 kg/acre). We will have the power to detect much smaller binary changes in the decision whether or not to use fertilizer than the 25% change in the amount of fertilizer used reported here.

In terms of within-village spillovers, we're interested in measuring the degree to which control households in the treatment villages have been "contaminated" by proximity to treatment households who have received information about their soils. Because the pure control villages are matched to the RCT villages, we use a cluster design to calculate power. The within-village maize yield intraclass correlation coefficient from the census is 0.12. Randomizing at the household level across 50 village clusters, we can pick up an unconditional effect on fertilizer use generated by the treatment that provides soil information only of at least 28%. Including household controls will improve this effect size, and we will have the power to detect much smaller changes in the binary decision whether or not to apply fertilizer.

IV.4 Dissemination of results

The fourth objective will be achieved by organizing a conference between interested actors – including actors from the Ministry of Agriculture, the Feed the Future USAID mission, the World Bank and government agents from the department of Morogoro. Policy briefs including preliminary results will be shared at this time. Expected recommendations will include how SoilDoc helps farmers in making soil management decisions, to what degree farmers are most responsive to the information, which farmers respond to the new information, when the information is most beneficial, and describe the links between adoption, yields and poverty, among others.

V. Contributions to host country research capacity

We plan on contributing to Tanzania's research capacity in the following five ways:

1. We will recruit 50 agricultural extension agents from the national system who will participate in a two-day training session on soil sampling and GPS reading. The training session will include three components: a) review the principals of the importance of soil management, and the various soil factors that are especially important for maize production; b) training on methods to obtain representative

soil samples; c) training on communication and dissemination of information to participant farmers. After visiting all control households 20 extension agents in the 20 treatment villages will be trained for 1 day on the interpretation and sharing of information obtained via SoilDoc. These training sessions will be useful in upgrading the technical aspects and skills of extension agents.

2. We will hire and train a group of 25 enumerators through Sokoine University; they will be selected from a pool of recent graduates from the university. These enumerators will participate in two training sessions. The first six-day training session (August 2014) will include an introduction to the project, including the concept and sampling aspects of randomized control trials, review the software used to collect data[4], and review and field-test the survey instruments. The second training session will include the field testing and piloting of the second survey round. All training sessions will take place at Sokoine University so that others from the university community can attend the sessions. We believe that these training modules will expose the university community to recent standards and methods of survey design and implementation.

3. We will hire and train a group of 10 soil scientists through Sokoine University; they will also be selected from a pool of recent graduates from the university. These scientists will be in charge of conducting SoilDoc testing of 1100 samples collected by the extension agents. A ten-day training session will include an introduction to the project and training on soil sampling methods.

[4] Enumerators will be trained to use android tablets to gather the data.

4. We will support the research of a Tanzanian graduate student at Sokoine University. The student and faculty advisor will work with two postdoctoral fellow from Columbia University and an associate professor from the University of Illinois to conduct and implement the surveys and the various activities of the project. The graduate student and faculty advisor will have extensive engagement with the PIs and collaborators on the project, with guidance and mentoring on the topics explored. As with the previous point, these training activities and modules will expose the university community to recent standards and methods of survey design and implementation.

5. The study will partly support the time of Dr. Johnson Semoka, a key professor in the Department of Soil Science. His direct involvement with SoilDoc and his interactions with the faculty and students in the department are important ways of upgrading research methods and tools for assessing soil constraints to increasing crop production in the region. His team will help with the overall design and implementation of the project. Key tasks will include identifying and resolving issues surrounding the theoretical, empirical and logistical methodologies and implementation of this study. They will also identify key people to serve in the agronomy and surveys teams, people that are crucial for the success of the project as well as recruits for the next generation of agronomists and monitoring and evaluation experts in the country.

VI. History of collaboration

The AgCenter and Sokoine University have a long history of collaboration. The director of AgCenter, Dr. Pedro Sanchez, and Dr. Johnson Semoka have collaborated for decades. More recently, that relationship was formalized when Dr. Semoka became involved as the coordinator of SoilDoc project in Tanzania, with the overall responsibility for liaising with the government, overseeing trainings for extension workers, and connecting SoilDoc research and extension to Sokoine University. In addition, Dr. Ray Weil, a collaborator from the University of Maryland, has and is currently mentoring graduate students in soil science at Sokoine University; he also spent a six-month sabbatical at Sokoine in 2012. The two institutions already have intellectual and administrative relationships that will greatly facilitate and support this study.

VII. Policy relevance & contribution to USAID objectives and initiatives

The stated primary goal of USAID Tanzania's Agriculture Productivity Program (TAPP) launched in 2009 is to "increase incomes of smallholder farmers through enhanced productivity, increased investment, and improved market systems" (http://www.tanzania-agric.org/index.aspx, checked 12/19/2013). This objective is to be achieved by raising yields, sales and incomes and training farmers on agricultural productivity. Furthermore, TAPP promotes crops that have high nutritional value and trains households on diversifying diets to include fruits and vegetables to be more nutritious. Finally, TAPP promotes smallholder access to value chains by supporting food safety projects, promoting new crops and value-added products, and disseminating price information. TAPP projects are promoted in Arusha, Kilimanjaro, Lushoto, Morogoro, the Coastal strip, Zanzibar and the Southern Agricultural Corridor of Tanzania (SAGCOT). (http://www.tanzania-agric.org/index.aspx, 2013).

Despite the existence of numerous technologies known to increase yields, their adoption in most parts of Africa has remained low. In Tanzania only about 10% of farming households use mineral fertilizer (from World Bank LSMS panels for 2009 and 2010); yet fertilizers are a key intervention required to redress soil nutrient depletion and low yields. This study most directly contributes to the primary goal of TAPP – to help farmers increase incomes by promoting productivity, promoting investment and reducing input costs. Indeed, it is hypothesized that access to plot-specific information will lead to a more optimal application of inputs. In turn, optimal, plot-level recommendations have the potential to increase yields, reduce costs and therefore increase incomes and household welfare. The project will take place in Morogoro, one of the focus regions of USAID TAPP.

The project will include a conference to share methods and results with stakeholders and policymakers from different levels. The project team will present a series of short policy briefs that distill lessons from the study; this will be followed by discussions focusing on recommendations for scaling the lessons learned, as well as input on the research agenda arising from this project. The Agriculture and Food Security Center at the Earth Institute is starting collaborative efforts on the use of SoilDoc by extension services with the Tanzanian and Nigerian governments. Officials from the Ministries of Agriculture in these countries and others that have expressed interest in SoilDoc will be invited to the final conference to share results on the effects of access to improved technology on input use and productivity. Finally, we will also discuss results on farmers' willingness to pay for soil information and improved technologies and implications for the roll out of SoilDoc in the different countries. The conferences will provide graduate students and faculty to interact with government officials, highlighting the important role of research in agriculture and economic development.

The study collaborators will disseminate findings and policy briefs beyond the conference through international policy and academic forums and will present study results at these forums. In addition, the AgCenter staff and project team will present results with Ministries of Agriculture as they explore further collaborations on SoilDoc.

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Anticipated Outputs

- 50 extension agents or agronomists trained on i) the principles of soil management, ii) methods of collecting representative soil samples, iii) use of GPS, and iv) communication and dissemination of soils information and associated management recommendations to participant farmers.

- 25 enumerators (some of whom will be current and/or recent graduates of Sokoine University) trained on i) experimental methods, ii) use of software and hardware for data collection, iii) field testing of the survey instruments.

- 10 soil scientists (some of whom will be current and/or recent graduates of Sokoine University) trained on testing techniques at the frontiers of soil science.

- Conference with key stakeholders, including members from the Tanzania USAID mission, the Tanzanian Ministry of Agriculture, leaders from the department of Morogoro, Sokoine University and other members of the project, to discuss the results of improved soil information on input decisions, yields, users of information and potential impediments to making use of site-specific soil information.

- Policy briefs highlighting key lessons learned and resulting policy recommendations.

- Expected research journal publications
    - Impacts of improved information about soil characteristics on farming inputs investments, management practices, and yields for farmers with different baseline soil qualities and wealth levels.
    - Dynamics of poverty, soil characteristics and input decisions.

Anticipated Impacts

Target	Indicator
Improved information about the soil quality of a given plot leads to a change in farm management practices on that plot.	• Use of management practices recommended by SoilDoc such as incorporation of organic matter
Improved information about the soil quality of a given plot leads to a change in farm management practices on the farmer's other non-tested plots.	• Use of management practices recommended by SoilDoc such as incorporation of organic matter
Improved information leads to a change in inputs application on the SoilDoc plot.	• Type of inputs applied • Quantity of each type of input including fertilizer/nutrient applied, both total and per hectare • Amount spent on inputs for the SoilDoc plot
Better information leads to a change in fertilizer application on the non-SoilDoc plot.	• Type of fertilizer applied on the non-SoilDoc plot(s) • Quantity of each type of fertilizer/nutrient applied, both total and per hectare on the non-SoilDoc plot(s) • Amount spent on fertilizer across all plots
Better information leads to a change in input expenditure on the non-SoilDoc plot.	• Amount invested in agriculture on SoilDoc plot
Better information leads to a change in input expenditure across all plots.	• Total amount invested in agriculture
Improved information leads to an increase in household welfare.	• Measures of welfare: yields, assets,qualitative assessment of amount of food consumed
Improved information leads to an increase in maize yield on the SoilDoc plot.	• Total maize yields
Extension agents are trained.	• Number of days of training sessions
Project leads to greater awareness about linkages between soil fertility management practices and poverty, and potential policy	• Contacts made with stakeholders • Number of policy briefs disseminated

Timeline

	2014											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Enumerator training								X				
Soil scientist training								X				
Extension agent training								X				
Survey, round 1								X	X			
Randomization									X			
Soil Doc Testing									X			
Soil Information & Cash Provided to Farmers									X			
Data analysis									X	X	X	X
	2015											
Enumerator training								X				
Survey, round 2								X	X			
Stakeholder conference											X	
Policy brief											X	
Data analysis	X	X	X	X	X	X	X	X	X	X	X	X
	2016											
Data analysis	X	X	X	X	X	X	X	X	X	X	X	X
Conferences	X	X	X	X	X	X	X	X	X	X	X	X
	2017											
Data analysis	X	X	X	X								
Conferences	X	X	X	X								