

# Using Mobile Phones to Conduct Research in Developing Countries

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**Abstract.** The rapid spread of mobile telephony throughout the developing world offers researchers a new and exciting means of data collection. This paper describes and analyzes the ongoing experience of a research project that uses mobile phones to collect high frequency economic data from households in rural Tanzania. In summer 2009, researchers distributed mobile phones to 200 farmers in 15 villages, while simultaneously conducting a short baseline survey with these households. From September 2009 to July 2010, survey participants are interviewed over the phone, once every three weeks, on a prearranged day. I discuss the research design, highlight some of the mistakes made and lessons learnt, and speculate on the applicability of this method in other settings.

## I. Introduction

The globe-wide spread of mobile telephony has been described as the most rapid and ubiquitous instance of technology transfer in modern human history (*Economist*, 2009). The effect has been particularly profound in rural areas of low income countries. Villagers that for centuries were cut off from regular communication with the outside world, or limited to passive receipt of information via radio broadcast, are now linked to each other and to the wider world through instantaneous, low cost mobile technology. The effect of this transformation on the lives and livelihoods of rural communities is a subject of intense interest to social scientists and development practitioners, as reflected in the rapidly growing literature on mobile phones in the anthropology, sociology and economics literatures, and in the recent proliferation of mobile-based NGO services in low income countries. In addition to serving as a subject of research interest, mobile telephony also presents researchers with a new and exciting method of data collection. Under the right circumstances, the time and monetary costs of data collection can be substantially reduced if mobile phone enumeration is used in place of the face-to-interview that has been the best practice in development microeconomics for decades. Depending on the subject matter, this cost reduction can be accomplished without reducing data quality. In fact, I argue below that under some circumstances, data gathered via phone may be of higher quality than data gathered in the traditional manner.

This paper describes the experience of a study entitled Research on Expectations in Agricultural Production (REAP), an ongoing economic research project in Tanzania. The REAP team is using mobile phones to collect detailed demographic, agricultural and economic data from rural households on a high frequency basis. The primary intention of this paper is to describe the project – its pitfalls, successes, costs and benefits, both foreseen and unforeseen – so that other researchers who are considering using mobile phones to collect data can better prepare for project implementation. Insights presented here can hardly be called “best practices”, as they are drawn from the experience of only one project. Nevertheless, it is my hope that this paper will help others avoid some of the mistakes that the REAP team has encountered through trial-and-error during the planning and execution of our survey.

My concern in this paper is strictly with methodology. I will not discuss the recent literature on the impact of mobile phones on economic outcomes (such as the price transmission literature, see Aker 2008 and Jensen 2007). I also do not draw on the experiences of researchers who have used phones for data collection in developed countries, such as those working for polling services or census projects. While there are likely to be some useful insights for development economists from phone-based data collection in wealthy countries, the overall research challenges differ substantially. Two of the most significant problems facing phone surveys in developed countries are selection bias in phone ownership and registration, which map directly into selection bias in sampling, and non-response. Selection bias can be a problem in developing countries as well, but not for the same reasons, as mobile phone registries in the majority of countries are non-existent, very incomplete, and/or likely to be unavailable to researchers, making them for the time being useless as sampling frames. Non-response is also problematic in developing country phone surveys, but perhaps less so than in wealthy nations. I discuss both of these issues below, without further reference to developed country phone surveys.

Most field economists with whom I’ve discussed REAP – people who spend countless hours writing grant applications, tracking field expenses and reworking budgets – are quick to identify cost reduction as one of the primary advantages of a phone survey. Traditional face-to-face survey enumeration is expensive.

Each round requires vehicles, gasoline, salaries for drivers, supervisors and enumerators, lodging and food for the teams, and a host of other expenses. If the questionnaires are on paper, then printing, data entry staff, computers and a data entry office are required. If hand-held computers (UMPCs) are employed for data collection, a method that is increasing in popularity but still rare in developing country settings, then data entry costs are avoided but equipment and training costs are substantially greater. The primary expenses of phone-based enumeration are only phones, enumerators, phone credit (calling expenses), and an office from which the team can work. Other costs may be incurred, depending on the structure of a particular survey. But in many instances – for example, in a high frequency panel setting that requires numerous visits to each household – the costs of phone-based enumeration can be only a fraction of those of a face-to-face survey.

The cost savings from a phone survey will be most substantial if the project involves multiple rounds of data collection from the same respondents, without long stretches of time between interviews. If a researcher begins a phone survey by drawing a random sample of households or individuals, perhaps stratifying on one or two characteristics of interest, from a number of geographically distinct villages, districts, regions or provinces, an initial visit to each enumeration area is required, to identify the sampling frame, conduct baseline interviews with sample households, distribute phones and conduct any phone-related training. Although such an exercise involves many of the same budget items as a traditional survey, with the addition of phone-related costs, it will still be much less expensive if sections of the questionnaire that are not time sensitive are enumerated at a later time, over the phone, rather than during the initial visit. Such an arrangement can reduce field time by days, weeks or even months for very large surveys. More importantly, in a panel framework, in which the same households are to be visited again during the ensuing months or years, the marginal cost of collecting additional data by phone is only a small fraction of the costs of a traditional face-to-face survey. Phone-based enumeration has the potential not only to reduce the costs of traditional surveys, but also to make high frequency data collection feasible in a much wider variety of settings, without requiring numerous substantial grants.

For research questions that require data at levels of aggregation above the household or individual – such as market price data, quantities available at trading lots or auctions, road or weather conditions – a phone survey is extremely cost effective. A short visit to identify partners that are already on the ground, observing the data of interest, is the primary field expense. In most settings, it is likely that respondents who already own phones can be located. Automated software is available which can collect and organize incoming data, if it is sent via SMS. Alternatively, a single enumerator working from an office can call and collect data from all sources, in a short period of time, without incurring any transport costs. Remuneration of field participants can easily be accomplished via credit transfer over the phone network, something that is possible in most if not all countries with mobile phone service.

The remainder of this paper describes and analyzes the ongoing REAP experience. In Section II I describe the project, focusing on methodological issues related to the phone survey. In Section III I discuss strengths and weaknesses of the research design, strokes of good fortune, mistakes made and lessons learnt. Though I know of no other phone surveys to compare and contrast with the REAP experience, throughout Section III I speculate on features of the research design that I believe have been especially helpful for ensuring the success of REAP. The final section concludes.

## **II. REAP Project Description**

The primary aim of REAP is to gather data on the formation, evolution and importance of the subjective distributions that farmers hold over uncertain future outcomes, such as weather, pest intensity and crop yields. These primary questions call for high frequency data collection. Without the funding needed to place an enumerator in each village for an extended period of time, I elected instead to distribute mobile phones to each sample farmer. This method allows for high frequency communication with sample farmers, without paying the maintenance costs of embedding enumerators in villages for a long period of time. Also, information gathered via phone is available to the research team in real time, making it very easy to monitor data quality. This was a particular concern of the REAP project, since the questions related to expectations and forward-thinking behavior are not straightforward for all respondents, and require substantial understanding on the part of both respondents and enumerators. The ability to closely monitor the data as it comes in has been critical for correcting misunderstandings on the part of enumerators and respondents.

Prior to beginning the REAP survey, my greatest concern was that patchy mobile network coverage across rural Tanzania would introduce bias into the selection of research villages. I was relieved to find that this was not the case. During piloting we carried phones from each of the major mobile networks in Tanzania, and carefully noted signal availability on all major roads and in pilot villages. One particular network, one which was identified beforehand by my local collaborators as the best for use in rural areas, was available across most of the research area. This did not guarantee that the network would be available in every sample village, but it left us with substantial optimism. When we began data collection, we were fortunate to find a network signal in at least some part of each of the sample villages. The network did not reach some respondents' homes, however these households tended to be no more than a few moments walk from a signal. Many villagers knew precisely where network coverage began and ended.

The REAP sample consists of 300 cotton farmers drawn from 15 villages in northwest Tanzania. Villages were chosen at random from among the primary cotton-growing districts. Within each village, 20 sample farmers were randomly selected from a list of cotton farmers that was constructed from the village registry with the assistance of local leaders. Sample farmers were invited to a meeting, at which the research team explained the details of the project and provided some initial training. Respondents were shown how to answer questions about subjective distributions by allocating a fixed number of beans or seeds to boxes corresponding to the bins of a histogram.<sup>1</sup> Participants were given ample time to ask questions and discuss this method amongst themselves. From among the 20 sample farmers, 13 were chosen to participate in a year-long phone survey, for a total of 195 phone survey participants. We fully involved the farmers in this stage of selection, inviting them to draw the names of phone survey participants from a hat in front of the entire group, so as to reinforce the notion of random selection. While a high degree of sensitivity is required any time researchers descend on a village and randomly choose households to participate in a study, we felt that even greater care had to be taken when the perceived benefits of participation – receipt of a phone – were substantial. Prior ownership of a mobile phone did not exclude participants from receiving an additional phone from the project.

The phones were distributed on a later day, when we returned to the village to conduct the household interviews. Enumerators distributed phones at the end of the interview, after providing any necessary training on phone usage. They gave respondents laminated documents with pictures of histogram bins, which respondents use to answer subjective distributions questions over the phone. One of the

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<sup>1</sup> This method of gathering subjective distributions is quickly becoming standard in development economics research. See McKenzie *et al.* (200) for a helpful review.

laminated sheets lists the scheduled calling dates for that village for the ensuing 11 months, along with contact numbers for the research team. Each village was given its own set of calling days. With 15 villages receiving calls on a Monday-Friday schedule, the respondents from each village have a scheduled calling day once every three weeks.

In each village we made arrangements with a “charging station”, where survey participants can charge their phones. While none of our sample villages is on the electric grid, some source of power is available in every village, be it a generator at the school, a house with a solar panel or an individual with a small collection of car batteries. Most of the owners of these power sources operate them as businesses, collecting a small fee for the charging of mobile phones. With the assistance of survey participants, we selected one location for charging the survey phones, and signed a contract with the station for a single free charge by each survey household during the couple of days prior to each prearranged calling day. We paid a portion of the contract in advance, with the balance to be paid at the end of the project. We left extra copies of laminated survey materials at the charging stations, along with a list of survey participants and scheduled calling days.

One month before the beginning of REAP data collection, new phone regulations came into effect requiring that all mobile phone lines be registered with the Tanzanian government. Photo identification and a signature were required to register a line, making it impossible for us to register the phones in respondents’ names while in the villages. Instead, every survey phone was registered in advance, in the name of the project director. We are trying to make arrangements with the phone company to allow the research team to authorize registrations directly while in the villages, so that lines can be directly transferred to respondents during our final return visit. If this turns out to be impossible, we will issue a new line to each respondent once the survey is over, and the burden of registering this line will rest with the phone respondents.

Mobile phone companies will cancel a SIM card (a phone line) if it is not used for a certain period of time, or if no pre-paid credit is assigned to the phone for a certain period. Many of the respondents in our sample are very poor, and are unlikely to purchase phone credit on a regular basis, if at all. Both to prevent the cancellation of project SIM cards and to compensate respondents for their participation in the survey, we transfer a small amount of credit to each phone after successful completion of each interview. The ability to make such credit transfers has rapidly become standard across mobile companies in most countries. Many respondents eagerly await our calls, so that they can make use of the phone again once the transfer has been received.

Since our baseline visit to the survey areas, two enumerators have been making calls to each of the villages on the prearranged days. To save on calling costs, we take advantage of a special block price on within-network calls, offered by our mobile network. Each day we pay about \$1.50 per phone for 4 hours of unlimited within-network calls. On most days this is sufficient to complete all interviews. Interview time varies according to individuals’ responses and to the length of the round-specific questionnaires. The shortest interviews last about 10 minutes, while the longest REAP interviews have taken close to an hour. Average interview time is just under 19 minutes. Many respondents cannot afford to charge their phones between survey rounds, so we try not to consume the entirety of their single free charge by administering overly long interviews.

Only on the very best of days are enumerators able to reach all 13 respondents in the scheduled village. To date, across the first six rounds of the survey, we have reached an average of 8.4 respondents on the scheduled day. We have encountered a host of small obstacles which prevent interviews from taking

place as planned. Sometimes respondents are not available due to network problems in their areas. On other days, heavy rains interfere with network availability at the project office. In some cases, respondent phones fail to charge properly and thus are out of battery power on the scheduled day. During those periods in which seasonal cultivation requirements call for substantial labor input, many farmers spend long days in their fields, which are often outside the range of network coverage. Whatever the reason, it remains the case that despite our best efforts to make all necessary arrangements regarding scheduling and phone charging, short of committing to a particular time and day to call each respondent, it is still very difficult to stick exactly to the prearranged schedule.

Despite these challenges, *eventual* response rates remain extremely high. The vast majority of respondents who are not interviewed on the scheduled day are interviewed in the ensuing few days. Those respondents whom we do reach on the prearranged day often assist us by tracking down others and notifying them that we will call the next day at a particular time. During our baseline visit we took the mobile numbers of village leaders, charging station owners, and anyone else who could be of any help to the project. These people often help REAP enumerators by locating respondents who are not answering their phones. Some respondents have lost their phones, others have battery problems, still others have phones that do not function at all. In almost all of these cases, respondents are still able to participate by borrowing the phone of a friend or neighbor who is also in the survey.

A few months after completion of the baseline survey, we re-visited each of the survey villages. During these visits we held a short meeting with respondents and village leaders. We distributed some new survey materials, with variations on the histogram bins used to solicit subjective distributions, replaced broken phones, faulty batteries and malfunctioning SIM cards, and visited the charging stations to “top up” our contracts. In a few villages we changed the charging station altogether, at the request of respondents. Although these visits were only recently completed, it appears that they reenergized respondents who may have been experiencing fatigue induced by participation in the survey. They also allowed us to demonstrate our commitment to the project and to thank respondents for their ongoing participation, things I believe to be important for maintaining the good will of participants.

During the recently completed follow up visit to the research areas, we also laid the foundations for the next phase of the REAP project. In this phase of the study we are investigating various mechanisms for sharing market price data, gathered from central markets, with REAP sample farmers, who live primarily in remote villages. In each of the regional capitals and primary market towns nearest to the research villages, we found individuals working either in or near the agricultural markets, and made arrangements to call and collect price data from each of them on a weekly basis. We identified multiple “market respondents” in each location, both as insurance against attrition and as a means of verifying the accuracy of incoming data. After each successful call, we transfer a small amount of credit to these respondents’ phones.

### **III. Challenges, Solutions and Lessons Learnt**

In this section I discuss the primary issues that we have encountered in setting up and running the REAP phone survey. I divide the discussion into five subsections: Infrastructure Issues; Selection and Participation; Data Quality; SMS vs. Calling; and Maintenance Costs. In each subsection I highlight the strengths and weaknesses of the phone survey method, as well as some mistakes we’ve made and strokes of good fortune we’ve enjoyed so far. On balance, the REAP experience suggests that in a wide variety of settings, phone-based data collection is not only feasible, but also likely to be superior to

traditional face-to-face enumeration, due to both cost savings and improved data quality. The limits to the feasibility of phone-based research appear to be those imposed by the usefulness of high frequency data collection, the sensitivity of the questionnaire material, and the coverage area of the available mobile phone networks.

## 1. Infrastructure Issues

In this subsection I discuss two components of the local infrastructure that are vital to the implementation of a phone survey: a power source for charging phones, and access to a mobile phone network. Shortcomings in the former can likely be overcome; shortcomings in the latter, perhaps not.

### *Charging the Project Phones*

We were fortunate that although none of our villages are connected to the electrical grid, a power source is available in all of the villages selected for REAP. Anecdotal evidence suggests that these independent sources of electric power, be they generators, solar panels or automobile batteries, have proliferated alongside mobile phones, in response to the demand for electricity by mobile customers in rural villages. If it is true that mobile network access is highly correlated with the availability of such power sources, this bodes well for potential phone survey projects in other countries.

A pre-existing source of electricity is not necessarily required for a village to participate in a phone survey. Researchers who select villages that receive a mobile network signal (and thus can feasibly be included in the sample), but do not have electric power, may be able to establish a charging station specifically for the purpose of supporting the research. At the start of the REAP baseline survey, we were prepared to do just such a thing if we selected a village with no power source. Setting up a charging station, most likely with solar power in our case, would have required a significant capital outlay on our part. But we viewed this as the price of random sampling. More importantly, the establishment of a charging business in a remote village would have had significant spillover benefits to the rest of the community, and would have provided a source of substantial income for the person given control of the station. This would have been a very positive development for the community, if managed carefully. It could also have been very disruptive, if such an endowment led to the impression that researchers had descended on the village and favored some residents with a potentially life-changing power station, others with phones, and everyone else with essentially nothing.

The charging station system implemented for REAP, in which each respondent receives one free phone charge in the day or two prior to each scheduled call, has been largely successful, though not without some minor hitches. In a few villages we changed the charging station altogether when we returned to the survey areas a few months after the baseline visit. Respondents requested such changes because either the original charging station had ceased to operate, or the charging station owner refused to honor the terms of the contract. In the latter case, respondents had been paying to charge their phones in the days prior to a scheduled call. In one geographically large village, we established new contracts with two charging stations, one at each end of the village, and respondents were assigned to the station of their choice.

We've received a greater than expected number of complaints about faulty or short-lived batteries. In order to ensure ongoing participation, we replaced about 10% of the original batteries during our first follow up visit. Some battery problems are unavoidable given the available infrastructure. For example,

in one village, respondents report that the highly irregular voltage from the power source has ruined their phone batteries in a short time. Other battery problems are due in part to a lack of proper training. During the baseline visit, we did not tell respondents to ensure that the battery was charged completely, for many hours, before using it for the first time. We also did not advise participants to turn their phones off when battery power is very low, to preserve long-term battery life, rather than letting the phones die completely. Nor did we instruct respondents to turn their phones off when not in use or when a network signal is unavailable. These features of mobile phone ownership were taken for granted by both foreign and national members of the research team, but were unknown to many respondents. During the first follow up visit we trained participants on these aspects of phone ownership, but at that point it was too late to preserve the life of many of the original batteries.

We have found that in many cases, the owners of the charging stations take advantage of respondent ignorance of mobile telephony. Like many mobile phones, the project phones display a “full” battery image once the battery is about 75-80% charged. Many charging station owners unplug the phones at this point and declare the battery charged, rather than waiting for a “charge complete” message to be displayed on screen. During our follow-up visit we instructed the respondents to check for this message when taking their phone from the charging station. We also amended the charging station contracts to require that every project phone be charged to 100%. We are hoping that these changes improve battery performance over the remaining months of research.

### *Network Access*

While it may not be prohibitively expensive for researchers to provide survey participants with a power source, it is impossible to provide a network signal to villages not covered by the existing mobile infrastructure.<sup>2</sup> Inconsistent mobile network coverage effectively creates a sampling problem, since it can introduce substantial bias at the village selection stage. I discuss this issue here rather than in the following section, on sampling.

The limitations of the mobile network may present the most definitive challenge to the feasibility of collecting data using mobile phones. If mobile coverage is not universally available in the study areas, network access is very likely to be correlated with other important features of household and village life, such as distance from major towns, road quality, water supply and average wealth. Researchers who find that network shortcomings preclude sampling from the original population of interest face tough choices about their project. One possibility is to scrap the phone idea altogether and gather data in the traditional face-to-face fashion. Another is to draw the sample for the baseline survey from *all* areas of interest, regardless of network coverage, and then continue the phone survey in those villages with network availability, using household and community characteristics observed during the baseline to construct sample weights. Unfortunately, such weights will only be useful if the observables used to construct them are not substantially correlated with network access. Such correlations cannot be measured without first committing to this method of data collection. Furthermore, econometric analysis on data gathered in this manner requires the strong assumption of independent distribution of unobservables. A third possibility is to establish a calling station at a point as close as possible to a sample village, and schedule calls on days when respondents will be near the station. Such an

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<sup>2</sup> I suppose it would be possible for researchers to provide respondents with satellite phones, which are not tied to the domestic mobile network. But I doubt that the audience of this paper includes many researchers with a budget large enough to buy satellite phones for survey respondents.

arrangement requires that the distance between the village and the calling station not be too great. Also, setting up a calling station in this manner may simply replace one form of selection bias with another, if the capacity to travel regularly to the calling point is correlated too closely with age, disability, gender, domestic responsibilities, employment status, or other variables of interest.

## 2. Selection and Participation

The REAP project has been fortunate to enjoy very low attrition rates and a high degree of participant interest. In this section I analyze our experience with sampling, participation and attrition, with the aims of describing the general issues faced in selecting respondents for a phone survey, and identifying the primary causes of our successful retention, to date.

### *Sampling*

It is difficult to imagine a situation, at present, in which researchers conducting a mobile phone-based survey in a low income country could sample from an available list of phone users. In many developing countries, phone lines can be purchased without undergoing a formal registration process. New SIM cards are very inexpensive, and usually available anywhere that phones or phone credit is sold. If a sizeable number of phones are unregistered, then clearly their owners are not identifiable from registration lists. Even if registration is required, many phone users have multiple phone lines, one for each of the major networks. One can never be sure which line will be in use at any particular point in time. In addition, some of these users may allow some of their lines to lapse into disuse on a regular basis.

Because the REAP population of interest includes all cotton producers in northwest Tanzania, we could not limit our sampling frame to only those farmers who already owned phones. Such inclusive sampling is necessary for any survey that seeks to be representative at the household or individual level in a low income country setting. Phone ownership is highly non-random, and almost unobserved among those in poverty. To prevent the introduction of substantial sampling bias, we realized early in the project design stage that we would need to provide phones to some or all respondents.

For other research questions, it may be possible to rely on respondents' personal phones for enumeration. In Tanzania, phone ownership is essentially ubiquitous among traders, transporters, merchants, business people, university students, government workers and urban formal sector workers. Studies that require sampling from one or more of these populations may find that phone distribution is unnecessary, as respondents can be successfully interviewed using their personal phones. Such an arrangement would be substantially less expensive than one which involves phone distribution, but it would present its own set of challenges. Researchers would in all likelihood have to make use of multiple mobile networks, which would raise capital and calling costs slightly but otherwise not be overly problematic. More importantly, attrition rates may be higher in such a setting, both because phone endowment appears to engender a deep sense of commitment to the project, and because the opportunity cost of frequent survey participation will be higher among members of wealthier, phone-owning subpopulations. I discuss these issues in more detail in the following subsection.

Within each survey village, we drew our sample from a list of cotton farmers that we constructed from the official village registration book. These books are not updated frequently, so village leaders assisted

us by removing from the list individuals who had died or moved away, and adding individuals who had moved into the village or formed new households since the most recent registry update. We learned very quickly that it was best not to mention the phones until *after* the final list was made and the sample was drawn. During piloting, some village leaders clearly tried to manipulate the listing, so as to increase the probability that they and their friends would be selected to receive a phone. In almost all villages, once the sample was drawn and the entire project was explained, village leaders requested that they be included as additional participants (a request that we denied, as gently as possible).

Upon meeting the REAP sample farmers, we found that a non-trivial number of them owned a mobile phone prior to their selection for the study.<sup>3</sup> From a budgeting perspective it was tempting to make use of these pre-existing phones, as the potential cost savings were substantial. However, we chose instead to distribute a phone to each respondent, regardless of prior ownership. We did this for two reasons. First, despite our insistence that the phones be viewed not as a form of compensation but as a research tool, respondents generally considered the phones to be part gift or grant. We did not want some of the survey participants to feel that they were given less than others. Secondly, although I am not overly concerned about the wealth effect of the phone distribution, we wanted to endow all participating households with goods of equal value.

#### *Attrition and Participation*

Once a sample has been selected, visited and invited to participate in a phone survey, the success of the project hinges on the ongoing participation of selected respondents. Attrition is a concern in any panel study, but potential attrition rates are particularly high when project staff will be out of sight, and possibly out of mind, for most of the survey period. Prior to beginning the REAP survey we expected substantial attrition, due to lack of interest, network problems, or, most likely, respondents selling the phones. To date we have been pleasantly surprised. In the first six rounds of the survey, an average of 192 of the 195 respondents has been interviewed. Most of the missing interviews are due to temporary circumstances, such as a severe illness on the part of the respondent or a family member. Only one respondent has completely abandoned the survey.

Certain features of the study appear to have been very helpful in maintaining participation. The REAP sampling frame was explicitly restricted to cotton farmers, and we introduced the project as a study of cotton production in Tanzania. Farmers in the research areas value cotton greatly – its nickname in the local language is “white gold” – and they are excited to see outside interest in their cultivation practices. Also, all of the respondents in the REAP sample live in culturally homogenous, rural villages. Life in these villages is characterized by substantial cooperation and neighborliness. People mix and mingle regularly, and are accustomed to passing news to each other. Except for short periods of intense work around planting and harvest, the opportunity cost of time in the villages is not very high. When a pre-specified calling day arrives, respondents are very helpful in tracking each other down and inducing participation. If a particular respondent is not answering her phone, another will offer to pass by her house or fields to inquire on our behalf. Some respondents have dedicated hours of their time, walking around the village in search of other participants.

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<sup>3</sup> We estimate that between a quarter and a third of REAP farmers have a personal phone, though we cannot be sure. During the baseline interview we asked about phone ownership, but many respondents seemed evasive, despite our assurances that everyone selected for the phone survey would be given a phone regardless of current ownership.

Such a high degree of cooperation among survey participants was made possible in part by the nested sampling method, in which villages were selected in the first stage, and then multiple respondents were selected from within each village. This sampling method is standard practice in smaller, traditional field surveys, which lack the resources to randomly select respondents from higher levels of geographical aggregation. It is difficult to overstate the value of the spillover benefits of this village level sampling, most of which were unanticipated, for maintaining participation in REAP. In many REAP villages, the thirteen phone survey participants have formed an informal association, with no prompting from us. They have elected group leaders to spread news, track down non-responsive participants, and speak on their behalf. Respondents report feeling that they are part of something important. It seems very unlikely that response rates would be so high if respondents had been selected from a higher level of geographic aggregation, such as the district or region. The sense of within-village group commitment to the project has been truly invaluable, and will be fundamental to the final success of the project.

### *Compensation*

Of course, low rates of attrition are also due in part to the benefits of participation. As mentioned above, many respondents look forward eagerly to the 1,000 Tanzanian shilling (about \$0.76) credit transfer that they receive as compensation for each completed interview.<sup>4</sup> Our original plan was to transfer a small amount of credit to each participant once a month. However, with the calls scheduled in 3-week intervals, this was a logistical nightmare. Both respondents and enumerators had difficulty keeping track of who was owed what amount of credit at what time. Also, respondents are most likely to have a charged battery, and thus to acknowledge the receipt of a credit transfer, on the day of the interview. After the first two rounds of calls we changed to our current policy, in which every respondent receives a credit transfer immediately after every successful call. The positive effect of this simpler arrangement on participation rates has clearly outweighed the slightly higher cost of making credit transfers more frequently.

Some respondents view the single free battery charge that they receive during each round of the survey as an additional form of compensation, rather than as a means of ensuring that they can participate in the survey. There is nothing wrong with this perception, and we are glad to see that survey participants can make use of the phones for purposes other than answering our questions. However, we remain concerned that some respondents might attempt to rush through their interviews, answering quickly and in such a manner as to reduce the number of additional questions, if they perceive that honest participation will consume too much battery power. To date, enumerators have not reported suspicions of this behavior. Nevertheless, we aim to keep the average interview time at 20 minutes or less, to preempt any such behavior on the part of respondents.

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<sup>4</sup> For those who may attempt to implement a similar system: we have learned that it is best to dedicate a single phone to credit transfers, separate from the ones used for calls. If an enumerator tries to use a single phone for both tasks, he will have to top up his phone with credit far exceeding that needed to purchase his daily call bundle, in order to transfer the additional credit to respondents after interviews are completed. But should the interviewer over-run the bundle, which in our case occurs after four hours of talking in a twelve hour period, the extra credit will be consumed very rapidly at the out-of-bundle rate. Therefore, each morning the interviewers top up their “interview phones” with the exact amount of credit needed to purchase call bundles, and top up a separate “credit transfer phone” with compensation credit.

### *Timing*

The REAP team spent two months conducting the baseline survey. The phone survey did not begin until the baseline survey was near to completion. This introduced a potentially harmful asymmetry into the experiences of respondents. Those whom we visited at the beginning of the project had to wait as long as seven weeks to receive their first phone call, while those interviewed at the end of the baseline survey waited only a few days. To mitigate the effect of the delay, while we were still in the field, enumerators called back to respondents from the first villages, to greet them and to remind them of the first scheduled calling date. However, we did not prearrange a day for these calls. Many respondents were unreachable when we called, largely because, we learned later, their phones did not have any power. We had only arranged for free charging in the day or two immediately prior to a scheduled call, and the poorest respondents in the survey were unable to purchase phone credit or pay for charging during the period between the baseline visit and the first free charge.

One way to avoid this problem would be to have a team of phone-based enumerators already in place when the baseline visits begin. Phone enumerators could then phase villages into the phone survey immediately after they are visited by the baseline field team. Such an arrangement requires careful planning, and enough supervisors and other resources to simultaneously manage data collection in the field and over the phone. It also precludes the possibility of field enumerators joining the phone survey team. One member of the REAP field team joined the phone survey team after completion of the baseline survey, and it has been helpful for him to draw on his field experience when administering the phone questionnaire.

A less onerous way to deal with the asymmetrical lag time between baseline visit and first phone interview would be to schedule calling days into the field work. If the project director arranges an extra day of charging and phone calls for the first baseline villages, the field team can take a break from the baseline survey and spend a day calling back to these villages. Whether or not the data gathered during this call is of any use is inconsequential. Such an “extra” round of the survey would primarily serve to reduce the lag time between the baseline visit and the start of the phone survey.

While designing the REAP survey we faced another timing issue – how often should we call? Calling very often over an extended period of time would not only be an annoyance for all involved, it would also increase the expenses of phone credit and enumerator time. However, calling too infrequently would in all likelihood raise attrition rates, as respondents lose touch with the project. It seems likely that the optimal lag between calls is related to the length of the project and the length of each interview. Calling many times a week for 2-3 weeks is not likely to be such an annoyance as calling many times a week for an entire year. Likewise, interviews that last only a few moments will be tolerated more frequently than those that last close to an hour. The REAP experience suggests that a 3-week gap between calls is unlikely to induce high attrition rates, at least over the first few months of the project. We have yet to see whether attrition rates will remain so low as the survey continues, but we are optimistic.

### 3. Data Quality

#### *Multiple Languages*

A number of REAP participants are not fluent in Swahili, the national language. We interview this group in Kisukuma, the tribal language native to the ethnic group that is most common in the research area. It is not uncommon in East Africa for research teams to interview a proportion of respondents with their tribal language, rather than with the national language. In a face-to-face survey it is difficult to manage multiple language interviews seamlessly, unless all enumerators are fluent in all possible interview languages, or all respondents who are not fluent in the national language can be identified during sampling, so that the appropriate enumerator can be assigned to these respondents. However, it is often the case that an enumerator does not discover the limits of a respondent's comprehension until the interview has begun. In these cases the enumerator usually finds a translator from among the household members, with the guidance and approval of the respondent.

In a phone survey, translation requirements can be handled very smoothly, as long as an appropriate proportion of the enumerators (in our case, 1 of 2) are fluent in the primary tribal language. If at any point an enumerator who does not speak the tribal language has doubts about a respondent's comprehension, he or she can stop the interview and transfer it to an enumerator who speaks the local language. In practice this was only necessary at the beginning of the REAP phone survey, because during the baseline interview and the first round of REAP calls we identified all of the respondents who are not fluent in Swahili. The Kisukuma-speaking enumerator always calls these households. This ensures that all interviews are conducted without the assistance of translators, reducing the likelihood of error at the interview stage.

### *Supervision*

Traditional field surveys usually employ one supervisor for every group of three or four enumerators. The supervisor's tasks are generally oriented toward logistics, training and the maintenance of survey quality. Such tasks may include training of interviewers, survey scheduling, meeting with local officials, management of expenses, quality assurance via checking questionnaires, and communicating with project directors. In a phone survey, these tasks can usually be accomplished more quickly and at lower expense than in a traditional survey. If interviewers are directly entering data into a computer while gathering it over the phone, which is advised for reasons discussed below, questionnaire checking can be automated and performed almost instantly. Supervisors rarely have the opportunity to directly observe enumerators during face-to-face interviews, while in a call center they can directly evaluate enumerator performance by listening to the interview. In our experience, most community leaders have phones, so the supervisor can remain in contact with local leaders throughout the survey period. All of this can be done from one office, rather than throughout the research areas. The end result is that one supervisor in a phone survey can do the work of many in a traditional survey, without incurring transport and living expenses for most of the survey period.

### *Inability to Control Environment*

Enumerators are unable to observe the respondent or directly influence her physical surroundings during a phone interview. This is a non-trivial matter. Experienced face-to-face enumerators read the body language and facial expressions of the respondent, to see if the he or she is tired, frustrated, confused or intentionally deceptive. While it is still possible to read these cues over the phone, doing so is more difficult. REAP phone survey enumerators have learned to listen closely, to detect annoyance or

deception on the part of respondents. But it is sometimes difficult for them to identify a respondent's state of mind with so little to go on.

There is another drawback from the lack of control that the enumerator has over the setting of a phone interview. Interviewers conduct traditional face-to-face interviews in private, away from non-respondents, so as to protect the confidentiality of the data. If a respondent who is not a senior member of the household is hesitant to request privacy from parents or elders, it is incumbent on the enumerator to firmly but politely request privacy. Unfortunately, phone survey enumerators cannot confirm whether or not respondents have moved to a private location, and cannot assist in ensuring confidentiality. This may introduce willful error by a respondent, if he is embarrassed or if he considers the questionnaire matter to be at all sensitive. If the subject matter of a research project is very private in nature, touching on issues of gender, domestic violence, corruption or other sensitive matters, it seems unlikely that reliable data could be gathered via phone.

In addition to feeling some embarrassment or hesitation, a respondent who is not interviewed in private may seek the assistance of others when faced with a difficult question. This is not necessarily problematic if a respondent asks his or her spouse to help remember non-sensitive data, such as expenditures on school fees, or the year of some one's migration. However, in the REAP survey, respondents provide subjective distributions over uncertain future events by placing seeds or beans in boxes corresponding to the bins of a histogram. Despite extensive training, a small percentage of respondents still have difficulty answering these questions. Such respondents sometimes seek the assistance of a friend or family member. Thankfully, REAP enumerators can usually hear when these respondents seek assistance from some one else, because the respondent will directly call out to some one nearby, asking for advice about the likelihood of future events. Enumerators work very hard to impress upon respondents the importance of providing their *own* expectations, no matter how "incorrect", without calling for the opinions of nearby friends or family members.

In the previous section I discussed the extraordinary willingness of respondents to spend time locating one another on behalf of the project. When one respondent helps us interview another whose phone is lost or damaged, the latter respondent often borrows the former's phone to complete the interview. After observing this behavior on the part of participants, I speculated that it may have been possible to implement the entire REAP project by giving phones to only one or two villagers, who could have acted as wandering "phone-keepers", carrying phones from one respondent to the next on a pre-arranged calling day. However, phone survey enumerators were quick to point out that if we implemented such a model, it was extremely likely that these phone-keepers would listen to the interviews, and that participants would be tempted to check with the phone-keeper to see if their answers corresponded to those of others. Interview confidentiality would be extremely difficult, if not impossible, to maintain. For the purposes of REAP, this issue was substantial enough to render the idea of the "phone-keeper" method infeasible. However, researchers gathering non-sensitive data and asking relatively straightforward questions may find that such a model allows for a substantial increase in sample size without incurring high marginal costs.<sup>5</sup>

### *Data Entry*

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<sup>5</sup> I do believe, however, that the sense of enthusiasm and belonging to the project, which has been so helpful in maintaining participation in REAP, would be largely absent under the "phone-keeper" model.

With regard to data entry, phone surveys are perhaps unambiguously superior to traditional surveys. Data gathered via paper surveys is transcribed twice: once by the enumerator during the interview, and again by the data entry technician on some future date. This introduces additional personnel, computing and supervision costs, and causes a significant delay between completion of data collection and the availability of data to researchers. More importantly, double transcription of data substantially increases the expected number of errors in the raw data.

REAP phone enumerators enter the data directly into a computer during the interview, eliminating the time, expense and likely introduction of additional errors that are characteristic of traditional data entry. As discussed below, such a system contributes substantially to data quality. And it is very satisfying for researchers to spend the evening cleaning and analyzing data that was gathered that same afternoon. I have spoken with some researchers who are concerned that a paper record provides extra security in the event of computer problems or power outages. While this may be true in the extreme, we have not found this to be a substantial cause for concern. REAP data is backed up multiple times each day, and the back-up is stored overnight in a separate location.

#### *Follow-Up, Clarification and Additional Questions*

After returning from a traditional field survey, waiting for data entry and cleaning, and finally perusing the new data set, researchers often discover that despite their best efforts to fully train enumerators on the meaning and intention of each question, some of the questions seem to have been misunderstood by respondents, enumerators or both. Even more frustrating, in many cases, is the realization that the inclusion of one or two additional questions would have allowed researchers to test unanticipated yet interesting hypotheses. Both of these setbacks can be avoided in a phone survey, provided that supervisors and primary researchers remain actively engaged with the incoming data. REAP enumerators who discover mid-interview that they are unsure of the meaning of a question, or do not know how to handle a particular response, have been trained to ask for guidance right away. Whether the confusion stems from the wording of the question or from an unanticipated response by a participant, the correct interpretation or procedure is immediately shared with the other enumerator. If a new survey round has just begun, the team calls everyone back and re-administers the misunderstood question. Otherwise, a clarification question is inserted into the next round of the survey, which in our case is only three weeks away.

In addition, instantaneous data entry allows the primary researchers themselves to identify coding errors, misunderstandings and missing data, almost in real time. The procedure for dealing with problems identified in this manner is essentially the same as the above: call back if it's easy, otherwise clean up the problem in the next round. The REAP team tends to call back more often when a problem is identified by me, rather than one of the enumerators, because on a day-to-day basis I am most likely to identify inconsistent or missing data from only one or two households, whom we can easily call for quick clarification. The enumerators have so far been more likely to identify problems that are applicable to all households, due to a shortcoming in the questionnaire or a misunderstood question.

#### 4. SMS vs. Calling

In the early stages of planning, some thought was given to the possibility of gathering REAP survey data via SMS, rather than through interviews conducted over the phone. I determined that the nature of the

study required that we actually call each respondent, rather than rely on SMS messages. We are able to gather substantially more data with each round of phone calls than we would with even very high frequency SMS enumeration. Also, some of our respondents had no experience with modern technology before receiving a phone from the project. These participants would be very unlikely to successfully send and receive SMS messages. Illiteracy would prevent participation by some others. Lastly, although an SMS message may be successfully delivered by the mobile network, there is no way for the sender to be sure that it is actually read by the recipient. Given that many REAP respondents' phones are without battery power for one to two weeks at a time, it is likely that in many cases the messages sent by the project would not be seen for days or weeks. With our current arrangement we are sure to know whether or not a respondent is available, and we can enlist the help of some one else in the village if our calls are not answered.

I do not have sufficient experience with SMS surveys to fully detail the costs and benefits of this method in settings other than REAP. Clearly the "market data" phase of REAP, a simple method of gathering crop price data from dispersed markets by calling individuals who work at or near these markets on a regular basis, could easily be implemented with SMS if we were willing to invest more time training our network of market observers. However, given the relative paucity of data that we are gathering from these markets, and the fact that our current arrangement allows our network of market observers to be passive recipients of phone calls rather than initiators of SMS messages, we elected to call these individuals.

Of course, there are a wide variety of settings in which SMS data collection is just as feasible as phone calls, and significantly more cost effective. There are other projects in Africa have made use of SMS enumeration networks to conduct research and share price and other data across mobile networks. There are also a range of exciting NGO and private business initiatives in Africa which gather substantial amounts of market data through a large, SMS-based enumeration network, and share it with remote stakeholders. High quality software which implements and manages an automated SMS data sharing system is available free of charge to researchers and non-profit organizations. On the whole, it seems that best practices for collection and distribution of data via SMS are more advanced than are those for phone-call based enumeration of a household or individual level survey.

## 5. Maintenance

Once a phone survey is up and running, it still requires some maintenance. As has been mentioned, we plan to re-visit the survey areas twice during the course of the project. It may have been better for us to be situated to return to the field on a more frequent basis, in the event of broken phones or charging problems. However, had we demonstrated the capacity to return to the villages frequently, this may have reduced the degree of community involvement cooperation among respondents. It would also have raised costs substantially. After our successful first visit to the field, we are considering canceling the second trip and only returning to the villages for the final re-interview, if no major difficulties arise between now and then.

### *Follow-up Visits*

It is inevitable that over an extended period of time, some of the phones, batteries and charging cables provided by the survey will be damaged or lost. This will particularly be the case if the project makes

use of relatively low quality phones, as we did with REAP. Over the first 5 months of the REAP survey, 8% of respondents reported a lost, damaged or malfunctioning phone. These respondents have continued to participate in the survey rounds, using the phones of their friends or neighbors, though it sometimes takes a few days to track them down for an interview. Replacement of damaged survey materials takes place periodically, when a team member returns to the sample villages.

We have estimated that at least twice during the eleven months of the REAP phone survey, a member of the research team will need to visit the research areas to replace damaged items. Such visits also provide an opportunity to discuss the project with respondents, address concerns, and ensure that charging stations are functioning properly. The first follow up visit took place in January 2010, about four months after the start of the phone survey. We were prepared to meet with respondents individually during these visits, rather than disrupt their lives by calling a meeting of all survey participants. However, we found upon reaching each of the survey villages that participants preferred to come together and meet with us as a group. These meetings not only made our task in the villages far simpler by reducing the amount of time we spend driving from house to house, they also appear to have had a very positive effect on the project atmosphere.

### *Lost or Sold?*

As soon as respondents understand that research staff will replace damaged items, an element of moral hazard is introduced. Not only are respondents more likely to be careless with a phone if they believe it to be replaceable – they are also more likely to sell the phone and claim that it was lost. Trying to minimize the additional expenses induced by this moral hazard, while still maintaining a spirit of good faith between researchers and respondents, has been one of the trickiest aspects of REAP management. To deter sales of the project phones, we told respondent from the outset that we can only *exchange* malfunctioning phones and batteries for new ones, but we cannot replace items that have been lost. Each time a respondent tells a phone enumerator that his phone or battery has ceased to work, we instruct the respondent to keep the damaged item safe, so that we can exchange it on our next visit. We have replaced all items that aren't working properly, regardless of whether the phone malfunctioned or was crushed, mangled or otherwise damaged. Some respondents with battery problems have purchased replacement batteries with their own money, while they wait for us to arrive. During our visits, we compensate these respondents for the purchase price of a battery, and take the old batteries away.

If a respondent loses the project phone but has another personal phone, we ask her to continue participating in the survey using her personal phone. To incentivize ongoing participation, we still transfer credit to the respondent after each interview. While being careful not to promise anything, we have told such participants that at the end of the survey we will redistribute to respondents who have lost their phones as many of the damaged phones as we can successfully repair at low cost. We make the point that our budget is limited, and that we would like to replace all lost phones, but budget restrictions prevent us from doing so. Respondents have generally been very understanding on this matter.

Some survey participants who lose the project phone do not have another phone. In a few of these cases we have violated our strict policy on replacements, and given the participant a second phone. We make these determinations on a case-by-case basis. Unfortunately, once we decided to occasionally violate our own policy, determining when to do so has proven to be more of an art than a science. In

one village the respondents and village leaders were unanimous in assuring us that one of the respondents lost his phone, and many other items, when his shop was robbed. We did not hesitate to replace his phone. In other cases, we ask about the availability of other phones in the household, and generally assess the likelihood of the respondent's ongoing participation. If a respondent lives very near to other participants, we usually ask him to continue working with the project using his neighbors' phones. We are more likely to replace the phones of those who live in more isolated areas. One very wealthy respondent told us with a twinkle in his eye that he had lost both the project phone and his personal phone. We expressed our condolences but did not offer a replacement, and he laughingly agreed to find a way to keep participating.<sup>6</sup>

We are quite sure that many "lost" phones were actually sold by the participants. Although we have not told the respondents this, *we don't care*. What matters for our purposes is that respondents continue to participate in the survey. If those who have their own phone would rather not discuss the whereabouts of the project phone, but continue to answer our calls on the scheduled dates, we don't ask. The management challenge lies in finding a way to maintain participation without inducing sales of phones by participants looking to acquire a free replacement. I doubt that there is a perfect way to manage this situation.

It's not entirely clear whether individuals who owned phones prior to their selection for REAP are more or less likely to sell the project phone before the survey is complete. There are forces working in opposite directions, and the net effect is ambiguous. The marginal value of a phone falls substantially after the first one, suggesting that phone owners would perceive much lower spillover benefits from keeping the phone during the entire survey period, and thus be more likely to sell. However, phone owners are also wealthier in expectation than those who do not own phones, and thus less likely to face credit constraints that require quick action such as the selling of the phone for cash. We plan to ask about sales of project phones during the face-to-face follow-up interview that is scheduled for summer 2010, though we are not sure of the best way to incentivize respondents to be truthful on this matter.

#### **IV. Conclusion**

On balance, the experience of the REAP study suggests that phone-based enumeration of relatively complex economic surveys in low income countries is not only feasible, but also, under the right circumstances, superior to traditional data collection methods. Relative to a traditional survey, the cost savings of a phone survey are substantial, as long as the questions of interest call for repeated enumeration of the same households. In addition, the centralized nature of phone-based data collection allows for rapid detection and correction of errors, interactive participation by the primary researchers in real time, and streamlined data entry.

There are situations in which a phone survey is infeasible, inappropriate or both. If the project in question calls for random sampling of rural households, network coverage throughout the study area should be investigated prior to committing to the phone method, so as to prevent the introduction of substantial sampling bias. Elicitation of sensitive or potentially embarrassing data over the phone is unlikely to be successful, as it is impossible for phone enumerators to ensure respondent privacy during the interview. Lastly, it's unlikely that the phone survey method will be cost effective for studies that do not require relatively high frequency enumeration of a single set of respondents. We don't yet know

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<sup>6</sup> We had already heard from numerous others in the village that he sold our phone immediately after receiving it.

how long is “too long” for respondents to wait between interviews, but it seem likely that as the lag between interviews grows, attrition rates will too.

Perhaps the most exciting aspect of mobile phone based research is the potential it offers for collecting entirely new types of data sets. Current best practices in questionnaire design and data collection methodology are based on the traditional development economics field survey. With the proliferation of mobile telephony comes the possibility of collecting high frequency data from panels of households at reasonable costs. This should greatly expand the range and number of high frequency panel data sets gathered by development economists, without requiring a massive inflow of new research funding to the discipline.

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