Community Knowledge Worker Pilot Report

GRAMEEN FOUNDATION

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Acknowledgement

Grameen Foundation would like to thank the following organizations and individuals who made the Community Knowledge Worker pilot possible and a success.

Special thanks to the Bill and Melinda Gates Foundation for funding the Community Knowledge Worker pilot and to MTN Uganda for its on the ground support in implementing the project.

In addition, we would like to acknowledge the support of the organizations that provided content for the applications, sourced CKWs, commissioned surveys and/or partnered with Grameen Foundation during the implementation of the pilot. These collaborators included; The UN World Food Programme, IITA (International Institute of Tropical Agriculture), National Agricultural Research Organization (NARO), Technoserve, SNV Netherlands Development Organization Uganda, Uganda Department of Meteorology, National Agro-input Dealers Association (UNADA), Appropriate Technology Uganda (AT Uganda), National Agricultural Advisory Services (NAADS), Busoga Rural Open Source and Development Initiative (BROSDI), Uganda Commodity Exchange (UCE), Café Africa, FIT Uganda - Infotrade, Appfrica Labs, Open Mind, Google and Yo! Uganda.

Whitney Gantt, Eric Cantor, Saurin Nanavati, Adam Taylor, Sarah Mugisha, Julius Matovu, Ian Mubiru, Richard Nuwagaba and Sam Rich, thank you for your contributions to this report.

Executive Summary

Grameen Foundation's (GF) Community Knowledge Worker Initiative is based on the belief that a distributed network of intermediaries, or Community Knowledge Workers (CKWs), can use mobile devices to collect and disseminate information to improve the livelihoods of smallholder farmers. The CKW Initiative relies on mobile devices as a tool to extend the reach of centralized expertise through "feet in the field." Such local intermediaries are crucial for contextualizing knowledge and providing a channel to effectively represent the voice of the farmer. Through a planning grant from the Bill and Melinda Gates Foundation, GF implemented a nine-month Test of Concept in Uganda focused on answering key questions to further develop, test, and refine the CKW model and gain strategic insight on how to scale the project. During the pilot, which began in December 2008 and ran through August 2009, Grameen Foundation prototyped mobile information services and conducted mobile surveys using various technologies. In partnership with local agricultural organizations and MTN-Uganda, the CKW team recruited and trained over 40 CKWs and laid the groundwork to extend the CKW network across Uganda. CKWs completed over 6,000 surveys and had over 14,000 interactions with smallholder farmers.

Pilot Metrics

Table 1: Extending the Reach of Extension: Principal Pilot Activities

CKW Network	Achievement
CKWs	Recruited, retained, and provided ongoing training, support, and monitoring to 38 CKWs operating in two districts
Partnerships	Collaborated with 17 organizations in the following areas (worked with some partners in multiple areas): • Content development (7) • Identification and sourcing of CKWs (8) • Data collection (3) • Technology (3)
Trainings	Conducted 14 CKW trainings on: • Business skills • Mobile applications • Agricultural information • Data collection
Focus Groups	Held 20 focus groups to gather feedback from CKWs and their clients on: • Technology preferences; usefulness of information, challenges; scaling; business models and incentives; gender; social equity, and more
Farmer Interactions	CKWs had over 14,000 interactions with farmers: • On average, each CKW provided 15 services per week

Table 2: Delivering Impact Through ICT: Mobile Data Services Tested During Pilot

Data Services	Achievement
Mobile Applications	Prototyped and tested eight mobile applications and tested 6 different mobile technologies to assess demand and user preferences: • Prototyped and tested seven mobile information services • Developed and conducted four mobile surveys • Tested six mobile technologies including SMS keyword search, Java menu guided search system, live voice hotline, HTML application pre-loaded on phones, SMS surveys, and Java form based surveys with photos and GPS coordinates
Information Queries	CKWs responded to over 8,000 queries on the following: • Organic agricultural tips and advice developed using local knowledge • Agronomic techniques for coffee and banana • Market opportunities and market prices • Location and contact numbers for agricultural input dealers • Expert agricultural advice covering crops and livestock • Banana disease diagnosis and control
Surveys	CKWs conducted over 6,000 surveys in which farmers were asked about: • Crop production forecasting (Uganda Commodity Exchange-UCE) • Market information (World Food Program-WFP) • Banana disease incidence and knowledge of control methods (IITA-International Institute for Tropical Agriculture)
Mobile Transfers	Over 500 transfers of airtime and cash incentives using mobile technology

Findings

Through the pilot, Grameen Foundation answered key questions related to building and maintaining the CKW network, developing mobile information services, and collecting data. In addition, we gained insight on potential business models, preferred technologies, partnerships, social equity, and impact. Primary findings include:

CKW Network

- **CKWs do serve as trusted intermediaries** and have become information resources in their communities; they **act as interpreters and direct farmers to information they can act on** to improve their livelihoods using the suite of tools available on their phone

- **CKWs should be recruited from existing extension organizations to maximize impact** and GF will need to develop deep partnerships with these organizations to ensure that the information provided via CKW mobile services is linked to access to resources

- **CKWs need intensive training** in mobile technologies, agricultural information, survey techniques, and business skills; **trainings should be spread over time and reinforced with skills testing** to ensure CKWs internalize trainings and master skills

- Partners can provide basic agricultural training, which greatly increases the value CKWs bring to farmers, boosts their credibility, and serves as an incentive for CKW performance; CKWs should serve as more than an information hub, acquiring basic proficiency in agricultural practices to act as ICT-enabled extension workers

- **CKW-to-CKW support structures can reduce support requirements of field officers** but ongoing support is critical

Impact and Social Equity

- **Farmers do act on the information they receive from CKWs** and these behavioral shifts lead to impact over time

- **Women and poorer farmers are frequent users** of CKW information services

- Women face greater obstacles to becoming CKWs but perform on par with men. **Program design should facilitate women's participation**

- There is **high demand for pest and disease control information.** GF should develop mobile services targeting this information for a range of crops and livestock

- CKWs find that the **mobile menu-based search system is easier to use than free-form SMS** and the menu-guided information service should be expanded to cover a wide range of crops and livestock

- **CKWs use the suite of mobile services as a toolkit,** using multiple services **to offer the most complete and accurate answer to a farmer's question**

- **Farmers** appreciate the on-demand nature of services and ***approach CKWs when they need information***

- **Linking CKWs to agricultural experts increases CKWs' credibility** in communities and the value they provide to farmers

Data Collection

- **Transportation** costs, **data quality,** mobile **network coverage, and farmer suspicion of CKW intentions are the biggest challenges** to reliable and timely data collection

- **Spatial distribution of CKWs must be carefully planned** to conduct meaningful GIS (geographic information system) analyses and to balance the need to decrease CKW transportation costs with potential for survey fatigue and bias

- **When surveys are paired with information dissemination,** as they were when CKWs conducted banana disease monitoring surveys, **there is a built-in incentive for answering survey questions** and high demand from farmers for surveys

- **Cost savings** realized through data transmitted **over GPRS and** the higher demand for the **enhanced survey capabilities of java-enabled phones outweigh the initial higher cost of purchasing java-enabled rather than basic phones**

- There is **substantial demand for geo-referenced data. GPS enabled devices can be used to monitor CKWs to improve accountability.** GF should explore business models that support the cost of GPS-enabled phones

Business Model and Incentives

- Demand for call services, battery charging, airtime, and other phone products is high, and **the sale of telecom services can contribute to CKW unit sustainability**

- CKW incentives are skewed towards data collection. **Survey payments must be linked to information dissemination** to ensure that **sustainability and impact goals are equally weighted**

- **Non-financial gains,** such as status, skills and knowledge acquisition, and access to resources **serve as important incentives** for CKWs and can be developed through building the CKW "brand" and recognizing CKWs through official local channels such as radio or local government forums

- **Demand for village level, panel data is high** and can support the network if the CKW network and data collection system can ensure data quality

Next Steps

Based on the promising results from the Test of Concept, the Bill and Melinda Gates Foundation awarded Grameen Foundation a four-year grant to expand the Community Knowledge Worker Initiative across Uganda. Grameen Foundation aims to build a CKW network that is capable of serving over 200,000 smallholder farmers while proving a replicable and portable model which can be scaled to other regions. In this next phase, our team will continue to deliver and measure impact while building a sustainable model. Through strategic partnerships with data consumers as well as MTN-Uganda, GF will ensure sustainability for individual CKWs and the CKW organization. GF will also work with key players in the agriculture sector to recruit, train, and support CKWs, content partners who provide expert agricultural advice and market information, and data consumers whose programs and products benefit from up-to-date and accurate information from rural villages. GF has begun working with partners to recruit a new group of Community Knowledge Workers who will begin offering services in early 2010. The pilot findings documented in this report will inform strategic and operational decisions as Grameen Foundation seeks to build this social enterprise, and can also inform similar efforts of other practitioners.

Contents

Introduction

Background and Rationale

Agricultural Extension as a Tool for Poverty Eradication

Achieving high and sustainable rates of growth in the agriculture sector remains one of the key challenges for reducing poverty in Sub-Saharan Africa. The agriculture sector provides over half of the total income for the poorest three-quarters of the population (FAO, 2003). Farmers represent about 85% of the population in Sub-Saharan Africa and they also make up the vast majority of the poor. Yet the untapped potential of its agriculture sector is one of Africa's greatest opportunities. It is the role of national extension services to help farmers fulfill that potential but, because of a number of challenges, rural poverty remains one of the largest development dilemmas facing African countries.

Agricultural development efforts in Sub-Saharan Africa have had limited success in raising farmer incomes due to a number of challenges:

- A five-fold increase in African population over the last 60 years has put huge demands on the soil, making farming more difficult and increasing demands on extension services
- Poor infrastructure and high transportation costs make it difficult for extension workers to reach the needs of a growing number of farmers in remote areas
- Lack of appropriate incentives and limited monitoring capacity result in low levels of extension agent accountability to the farmers they serve
- Disconnect between scientists and farmers: information flow between researchers and farmers is limited, leading farmers to perceive scientists are not meeting their needs while scientists see farmers as slow to adopt new techniques
- Organizations serving rural communities are often unable to disseminate knowledge to farmers because they lack an effective, affordable system for communicating with them
- Data is costly to collect and thus collected infrequently, often with paper forms of different standards, without GIS (geographic information system) data. Much of the data collected never reaches its destination. Or, when data does arrive, organizations do not analyze or act upon the information because they lack the capacity to do manual data entry
- Lack of a centralized point to collect and disseminate information from the field means that there is no comprehensive system for analyzing data or a mechanism to feed this information back to farmers so that they can act upon it to improve their livelihoods

These challenges extend across the agriculture sector, limiting the growth of the sector as a whole. Although a number of government, private, and non-government organizations are working to address these issues, limited information flow severely constrains the ability of farmers to obtain timely, specific, and actionable information on crop issues, market prices, and a range of

other topics. At the same time, agricultural extension programs, private companies, and research institutes lack an efficient method to obtain detailed and relevant information about on-the-ground needs of smallholder farmers. Further, information that is collected and disseminated is often incomplete, out-dated, and/or delivered in isolation, making it difficult for farmers, policy makers, and agricultural companies to act on this information. As a result, the livelihoods of smallholder farmers (SHF) are inhibited by lack of access to relevant agricultural and market information.

Community Knowledge Worker Model: A New Approach for Reaching the Last Kilometer

Grameen Foundation's mission is to empower the world's poorest people to lift themselves out of poverty with dignity through access to financial services and information. Our Grameen Technology Center focuses on technology that makes microfinance operations more efficient, creates income-generating opportunities for the rural poor and provides rural communities access to information and knowledge.

GF believes that it can help solve information asymmetries and other key challenges facing extension efforts by addressing the critical information gap that exists in the agriculture sector today. Through its Community Knowledge Worker (CKW) Initiative, GF seeks to improve information flows by creating a sustainable business model based on the dissemination and collection of relevant information to smallholder farmers living on less than $2 a day – ultimately decreasing the cost of introducing new and improved agricultural techniques and raising daily income through increased crop production and revenue. In the CKW model (Figure 2), a distributed network of village-level intermediaries are equipped with mobile phones and a suite of relevant applications to provide on-demand information to smallholder farmers and data to a range of agricultural actors, including government agencies, commercial buyers, and research organizations. By offering a dynamic, two-way information channel, a scaled CKW network will provide the link between agricultural research institutes, service providers, and private companies and smallholder farmers.

CKWs are trusted local intermediaries serving farmers who lack basic access to up-to-date information on best farming practices, market conditions, pest and disease control, weather forecasts, and a range of other issues. The CKW model is designed to improve farmers' lives by enabling them to get the information they need to improve yields and access lucrative markets. It relies on mobile phones to serve as a tool to extend the reach of centralized expertise through "feet in the field." Such local intermediaries are crucial for contextualizing knowledge and providing a channel for both delivering actionable information and collecting information to effectively represent the voice of the farmer. Upon request from a farmer, a CKW will use his or her mobile phone to access actionable information to meet farmer needs. This approach is complementary to existing agricultural outreach efforts – with a mobile device as an enabler to deliver services more effectively. We expect more relevant, timely, and frequent interactions will increase adoption of best practices, increase yields, and increase income.

Working with a range of local partners, the CKW Initiative will equip respected community members, who are often already involved in agricultural outreach, with the training and technology to better meet farmer information needs. ICT-enabled agricultural extension delivered at the village level through Community Knowledge Workers will complement existing systems, with the potential to transform the agricultural extension framework in Uganda and beyond.

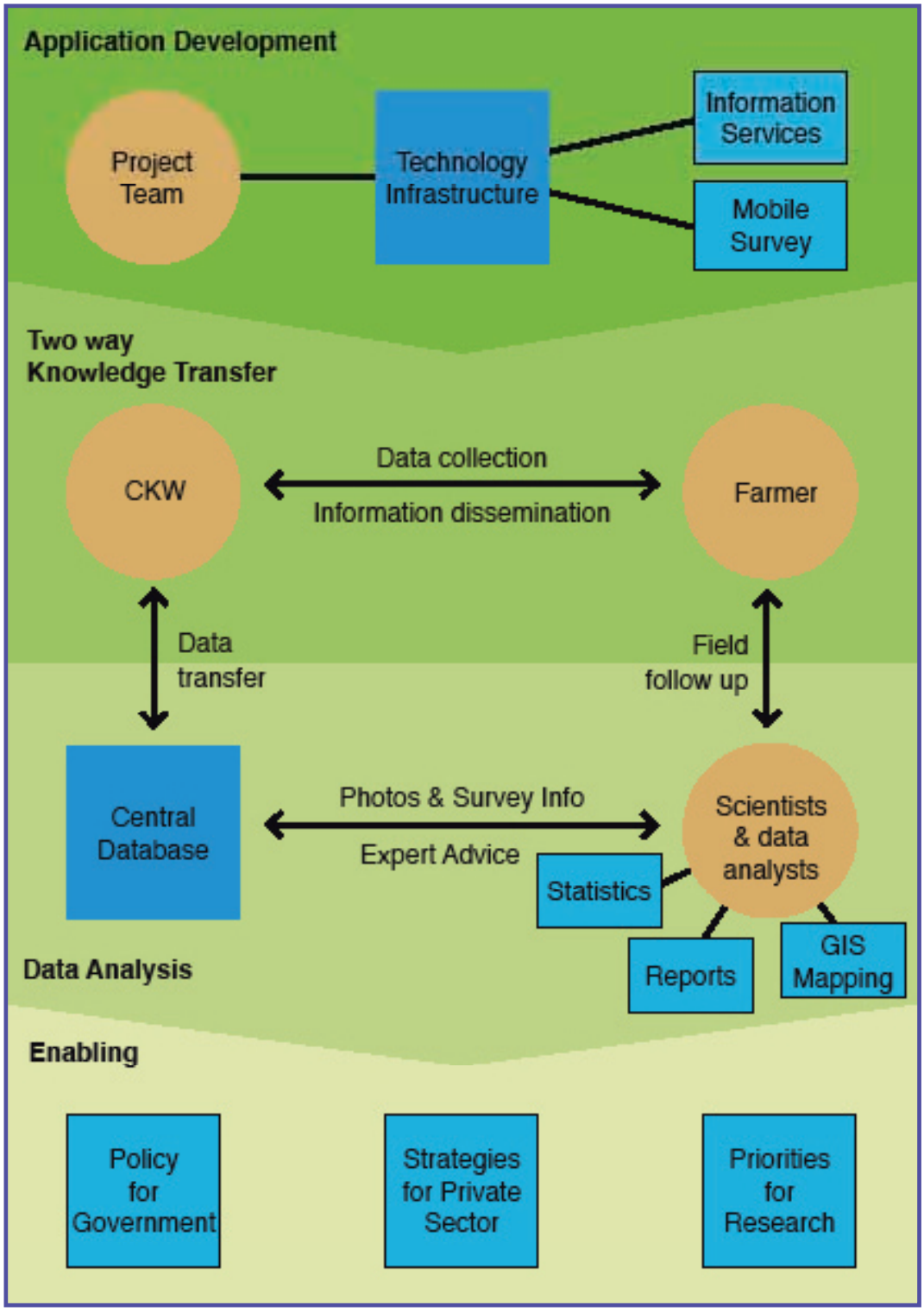

Figure 1: CKW model

The CKW model offers the following benefits:

- A dynamic, two-way information channel that enables agricultural organizations to respond quickly to changing needs and to send data from the field to experts and feed recommendations from experts back to farmers to complete the information loop

- Mobile tools and an integrated verification, analysis, and reporting system to collect and analyze real-time, granular data and share it with multiple stakeholders

- Considerable cost savings that enable the collection of panel data to track trends over time.

- Mobile information services that ensure information consistency, decrease the cost of information dissemination, and offer the means to update information as often as necessary

- Sustainable business model at the CKW individual and organizational level to ensure that CKWs have the incentive to offer services to farmers with minimal monitoring

A CKW in Bushenyi carrying out a banana survey

- Technology platform that enables remote communication between CKWs and support team, a system to monitor CKW performance and track outreach, and timely (mobile) transfer of incentives to ensure high-quality service delivery

- CKWs bring services to the farm gate, reaching even the most remote rural communities where the poorest farmers often live, and those farmers who cannot travel to solicit advice or attend trainings due to disability, age, or poverty

- Information is available on-demand: farmers approach their nearest CKW to ask for information on what they need, when they need it

- Local ownership and accountability as CKWs live and work with the farmers they serve.

The CKW Initiative advances Grameen Foundation's efforts to develop innovative and sustainable approaches to use technology for the benefit of the world's poor. It also leverages the extensive knowledge and expertise from its Application Laboratory (AppLab) Program in Uganda (www.applab.org). The Community Knowledge Worker Initiative is part of the Information and Communications Technology (ICT) Innovation program which is directed by Grameen Foundation's Grameen Technology Center in Seattle, Washington

Community Knowledge Worker Test of Concept

Overview

In Uganda, the agricultural sector employs more than 80% of the labor force and is the main source of livelihood for more than 85% of the population, the majority of whom are categorized as poor people living on less than $2 a day (Uganda Vision 2035; May, 2008). SHFs have great potential to drive economic growth in Uganda because they account for 21.5% of the country's GDP (CIA Factbook, 2009). In addition, almost 94% of agricultural production takes place on smallholder plots, including virtually all food production (Uganda Vision 2035; May 2008). Through a nine-month planning grant from the Bill and Melinda Gates Foundation, Grameen Foundation implemented a "Test of Concept" to develop, test, and refine the Community Knowledge Worker model.

From December 2008 through August 2009, Grameen Foundation partnered with MTN-Uganda to assess the viability of creating a distributed network of CKWs tasked with improving the livelihoods of Uganda's smallholder farmers. GF conducted desk and field research and implemented a Test of Concept to refine the CKW model and gather insight to design a scaled Community Knowledge Worker program. In February 2009, GF began implementing a small pilot in Bushenyi and Mbale districts designed to answer questions related to how to identify, recruit, train, and support a sustainable network of CKWs. The CKW team recruited and trained over 40 CKWs and established relationships with CKW source partners, content partners, data consumers, and a range of agricultural organizations. CKWs administered over 6,000 surveys and had over 14,000 interactions with smallholder farmers during the pilot. The project exceeded all grant milestones. Key learning and strategic insights from the pilot informed the development of a full CKW grant proposal, leading to the award of a four-year grant to scale the project in Uganda.

Report Objectives

This report outlines major achievements, learning, and strategic insights. The findings outlined below will be used to develop a sustainable CKW network committed to improving the lives of smallholder farmers. In addition, we hope that by sharing our results, other organizations can learn from our experiences and contribute to the extension of best practice in Information and Communication Technologies for Development (ICT4D).

Goals and Metrics

Milestones and Major Accomplishments

The CKW Test of Concept aimed to answer questions related to the design of a long-term, sustainable, and scalable agricultural outreach program which utilizes a network of village intermediaries equipped with mobile technologies to reach even the most remote and underserved smallholder farmers. The project exceeded all grant milestones (see Appendix A).

Highlights of GF's activities include:

- Established core CKW team
- Completed review of the local agriculture ecosystem, including in-depth analysis of existing extension framework
- Recruited CKWs in two districts and provided them ongoing training, support, and monitoring
- Built relationships with 17 agricultural and technology organizations through Test of Concept
- Prototyped four information services and field tested an additional two, using four mobile technologies
- Developed and administered four types of surveys using four mobile technologies
- Built and tested a technology platform
- Received a grant to develop a Community Level Crop Disease Surveillance system
- Researched mobile data collection and identified a range of potential data consumers
- Developed a potential business model with promising revenue sources
- Designed scaled project and submitted and received a grant for a four year follow on project

Pilot Metrics

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Surveys	CKWs conducted over 6,000 surveys in which farmers were asked about: • Crop production forecasting (Uganda Commodity Exchange-UCE) • Market information (World Food Program-WFP) • Banana disease incidence and knowledge of control methods (IITA-International Institute for Tropical Agriculture)
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Achieving Impact

Behind the pilot metrics lies the project's overarching objective: to assess the feasibility of the CKW model and design a scalable model which delivers impact, enabling smallholder farmers to increase their incomes. Although the short length of the pilot meant that it was not possible to measure impact, we were able to identify mechanisms through which the CKW model could promote behavioral shifts that would lead to impact over time. Further, during the Test of Concept, the surveys CKWs conducted provided agricultural organizations with up-to-date information on crop production, marketing trends, and banana disease incidence and knowledge of control methods. This information served as a channel for these organizations to better understand and address farmer needs. Likewise, during the pilot, smallholder farmers used information services to decide when to plant crops, how to treat pests and diseases, and determine a fair market price for their produce.

Sam, a CKW in Bushenyi, teaching a group of farmers

The CKW model has multiple leverage points for improving the livelihoods of smallholder farmers and seeks to achieve impact by:

- Targeting female farmers and farmers earning under $2/day
- Developing mobile services that provide actionable, on-demand information to meet the needs of SHFs
- Collecting data that enables service providers to understand and address challenges that keep SHFs in poverty
- Building partnerships to accelerate the impact of SHF poverty-reduction projects

The information that CKWs provide to farmers leads to impact through two avenues:

Increased Productivity (higher yields or reduced losses)

- Adoption of improved agronomic techniques
- Increased usage of agricultural inputs, such as fertilizers and improved seeds
- Early detection and treatment of crop and livestock diseases
- Better decision-making for crop selection and land utilization

Increased Revenues (increased revenues for goods sold)

- Cost savings/gains realized through improved decision making
- Broadening market access
- Better understanding of farming as a business

Improving Outcomes for the Most Disadvantaged

While we expect to see behavioral shifts for a wide range of SHFs, we anticipate that the impact associated with these behavioral changes will be greatest for the most disadvantaged farmers and for female farmers for several reasons:

- There is great potential for CKWs to serve female farmers and many interviews with CKWs reveal that many of their clients are women. They explain that this is because phone ownership among female farmers is lower, female farmers do the bulk of field labor, women tend to be more eager to learn new techniques that can improve productivity, and women in middle class farming households are the ones left to manage farms when men have migrated to cities to find jobs
- The CKW currently acts as an interpreter for those farmers who do not speak English, who have lower literacy levels, who do not own phones, and who are less familiar with how to use services on phones. While some of the information applications CKWs offer are available to

the general public, many repeat clients tend to be female and poorer farmers since they have the greatest difficulty accessing information on their own

- CKWs are able to travel to farmers who, because of lack of mobility due to age, disability, or lack of resources, are isolated in their villages and generally have the lowest access to information

Although metrics and milestones focused on process-oriented achievements, we were able to identify and document behavioral shifts among CKWs and their clients. Anecdotes gleaned from focus group discussions, field research, interviews, and follow-up visits provided GF with insight on how to maximize impact in the scaled model; these and other learning are outlined in the key findings section at the conclusion of the report.

During the pilot, the CKW team prototyped a range of mobile information services to understand farmer demand for information and the potential for information services to lead to impact. Table 3 overleaf shows examples of impact areas associated with Test of Concept mobile information services.

Information Service: Farmer's Friend

Behavioral Shift *Adoption of improved agronomic techniques*
CKW *Laban Rutagumirwa*
Organization *BUDAFA (Bushenyi District Farmers Association)*

Impact Example

Laban, a CKW in Bushenyi, was in the field collecting surveys when he met an elderly woman who was distraught because her goat's neck was so swollen that it could no longer eat. The woman was 6 km from the nearest trading center, very poor, and was taking care of many grandchildren. She didn't have money to treat the goat and was planning to slaughter it.

Laban told her that they could use his phone to try and find a solution. He typed "control goat bloat" in an SMS query and immediately they received an answer back telling the woman to mix 500mg of rock salt with 1L of water and give the solution to the goat.

Laban's training as a CKW enabled him to choose the most relevant mobile information service and enter the SMS query in a way that it would have the highest chance of a being recognized by the system—much like a reference librarian would do. Laban saw the woman two weeks later and she was very happy because the goat had recovered.

Table 3: Impact Areas Associated With Pilot Information Services

Information Need/ Query	Source	Sample Answers	Tech Tool	Expected Impact
Market prices for agriculture commodities – "How much can I sell simsim for in Lira?"	FIT Uganda	"Retail 1,000 Shs Wholesale 700 Shs"	SMS keyword search; Agricultural hotline	Farmers learn market prices and improve bargaining position or travel to location where they can earn maximum revenues
Market opportunities – "Who will buy my matoke?"	User generated content	"Sell matoke mbarara 50 bunches at 2500 Shs"	SMS trading bulletin	Farmers receive increased revenues through identification of interested buyers
Improved agronomic techniques -- "What should I intercrop my coffee plants with?"	NARO; IITA; Café-Africa; Uganda National Coffee Development Authority	"Coffee plants can be intercropped with bananas at a spacing of…."	SMS keyword search; Java form menu search; Agricultural hotline	Farmers learn and adopt improved agricultural practices that lead to increased yields
Location and application of agricultural inputs – "Where can I buy improved groundnut seeds?"	Uganda National Agro-Inputs Dealer Association (UNADA) and Appropriate Technology Uganda	"Vet Drug Shop, 0701333500, Kyambugimbi TC, farm tools, seeds, feeds, animal drugs."	SMS keyword search;	Farmers have convenient means to locate and interact with input dealers and increase uptake of inputs, boosting yields
Pest and disease detection and control – "How do I control nematodes on my bananas?"	IITA; NARO	"ALWAYS CLEAN YOUR SUCKERS to fight nematodes. Remove roots + peel corm…"	SMS keyword search; Java form menu search	Farmers decrease losses by early detection, identification, and elimination of pests
Seasonal and Daily Weather Forecasts – "When will the rains come?"	Department of Meteorology	"Rains to begin in late April with above average rainfall expected May in Eastern region"	SMS keyword search	Farmers know when to plant, spray, harvest, and dry to reduce crop losses
Information on post-harvest handling – "How can I get my coffee to meet grade A standards"	Café-Africa; Uganda Coffee Development Authority	"Dry cherries on mats, or wire mesh on raised platforms, DO NOT DRY COFFEE DIRECTLY ON BARE SOIL …"	SMS keyword search; Java form menu search; Agricultural hotline	Farmers capture higher prices by meeting higher quality standards and adding value through processing

Accelerating Impact Through Strategic Partnerships

Grameen Foundation collaborated with 17 organizations and companies in the agriculture and technology sectors during the Test of Concept and established deep partnerships with three organizations:

- **MTN-Uganda** is the country's leading telecommunications provider. MTN-Uganda has been the backbone for all AppLab Uganda initiatives and provided financial, infrastructure, and technical support to implement the CKW Initiative. MTN provided the telecom services and products necessary to conduct the pilot, including airtime for surveying and information dissemination, the technology platform to send mobile survey payments as well as airtime transfers, and a short code to access the pilot's mobile information services. By integrating core MTN services, such as mobile money, into the project, Applab realized substantial efficiency gains in its field operations. MTN also provided the physical and technological infrastructure to carry out the project. This support extended to field visits as well as to CKWs who got bicycles from MTN so they could travel to conduct surveys. Working with MTN also lent the project brand recognition in rural areas where skepticism of new organizations is high. Finally, MTN Public Access extended its culture of enthusiasm for community development and knowledge from many years of leveraging ICT for development.

- **IITA (International Institute for Tropical Agriculture)** develops agricultural solutions with partners to tackle hunger and poverty. IITA works with partners in Africa and beyond to reduce producer and consumer risks, enhance crop quality and productivity, and generate wealth from agriculture. IITA operates a research for development agenda and develops solutions through an unprecedented network of partners across Sub-Saharan Africa and through links to Advanced Research Institutes across the world. IITA provided content for the banana tips mobile information service and was the lead partner on the banana disease monitoring and control project (described in detail in the section on the Community Level Crop Disease Surveillance system). IITA trained CKWs in banana disease identification and control, conducted back-end analysis of banana disease monitoring survey data, carried out field and lab sampling, and provided GIS analysis and mapping of survey data.

- **Uganda's National Agricultural Research Organization (NARO)** provides guidance and coordination of all agricultural research activities in the national agricultural research system in Uganda. NARO contributed to the CKW project in a number of areas, providing expert advice for the live agricultural hotline service, validating agricultural tips for the Farmer's Friend information service, and partnering with us on the Community Level Crop Disease Surveillance project. Through NARO's Agricultural Research Information Service, experts provided answers to 1,050 questions from CKWs and their clients. A team of NARO scientists reviewed and certified the scientific validity of the **Google SMS Tips** application "Farmer's Friend," which CKWs offered to farmers throughout the pilot. Finally, NARO's **National Banana Research Program** collaborated with IITA to lead CKW trainings on banana disease identification and control, conduct field follow-up visits, and provide existing data on banana disease statistics in Uganda.

GF developed partnerships in each of our core areas of operation: building the CKW network, collecting data, and developing information services. In addition to the partners listed above, a number of organizations contributed content for information services, provided questions for and feedback on surveys, and/or nominated CKWs to participate in the Test of Concept. These partnerships were central to the success of the pilot, and we will continue to collaborate as our partners provide the path to achieve impact, scale, and sustainability.

Building a Network of Community Knowledge Workers

Overview

The Test of Concept was designed to answer key questions about recruitment, training, support needs, and monitoring requirements of CKWs to better understand farmer demand for information and to identify opportunities to increase smallholder farmer income through improved access to information. GF's aim was to assess what makes a good CKW and to build an infrastructure in which CKWs could effectively carry out their role as information intermediaries, improving the lives of farmers in the process.

The project piloted in two districts, Mbale in the East and Bushenyi in the West. Our team selected pilot sites based on partner location, network coverage, and agro-ecological zones. In addition, our team chose two distinct cultural and linguistic areas to maximize learning (See Figure 4).

GF recruited 50 CKWs from seven source organizations for a one-month trial (see Table 4). GF provided these organizations with a list of criteria and asked that they use the criteria to nominate candidates. Criteria included: experience in community outreach, trusted by community, resident in rural village, literacy, and fluent in English. In addition, gender balance was a priority, and we asked that at least one-third of nominees be women. CKWs included input suppliers, farmer group leaders, community level extension agents, members of district-level farmer associations, and members of Rural Information System Centers. During the one-month trial, CKWs were evaluated against performance targets; only those meeting or exceeding targets were eligible to continue with the program. By the close of the pilot, 38 CKWs remained in the program, and these CKWs continue to provide services to farmers.

Figure 2: CKW pilot sites

GF worked with partners to conduct 14 CKW trainings on business skills, mobile technologies, data collection methodologies, information services, and agricultural practices. Through these trainings, CKWs learned to use seven mobile information services and conduct four unique surveys. At the beginning of the pilot, CKWs received a toolkit which included a mobile phone, a car battery to charge phones, and training materials on how to use the phone. Later in the pilot, after learning that CKWs were traveling as far as 20 kilometers to conduct surveys, MTN provided them bicycles. CKWs also earned airtime for disseminating information to farmers and cash payments for conducting surveys.

GF used its technology platform to monitor CKW performance against targets, evaluate survey quality, and communicate with CKWs via SMS bulk messages or "blasts." GF conducted 20 focus groups and numerous one-on-one interviews with CKWs to learn about their experiences and challenges and to solicit their input on how the program could be improved. Our team also sent out independent researchers to re-administer a sub-sample of surveys and talk with CKWs and their clients. In addition, a field officer in each district supported and monitored CKWs to capture learning, provide additional training, follow-up on CKW performance issues, and observe CKW interactions with clients.

Results and Findings

In the formal extension system today, on average, one extension officer serves an entire sub-county, or roughly 16 villages. As a result, rural communities have limited access to on-demand agricultural information and showed a high demand for CKW services throughout the pilot. Farmers and farmer group leaders often approached CKWs and requested that they travel to neighboring sub-counties to share information and training. Farmers routinely sought out CKWs to obtain information to help them treat pests and diseases, get accurate weather forecasts for planting, and earn more for their crops. For example, a farmer in Mbale who had lost his groundnut crop because the rains came late and his seeds died contacted his local CKW to access regular weather forecasts so that he could plan the rest of his planting season and preserve his livelihood.

On average, CKWs devoted 10 hours per week to providing fellow farmers with a range of information services and collecting surveys. Female CKWs put in extra effort to balance pilot activities with their family obligations. This included incurring extra costs compared to their counterparts to get to distant survey areas and hiring labor to maintain household and field activities while they are away.

CKW Performance Analysis

While we did conduct an analysis on CKW performance based upon personal characteristics (age, gender, education level, CKW source organization, profession) the number of CKWs involved in the pilot was not sufficient to draw reliable conclusions. Nonetheless, we can attempt to identify trends that draw on both the data and our personal observations from working with the CKWs. There was no notable difference in performance between male and female CKWs, which is encouraging considering the additional barriers that women face to participate fully. In terms of age, conclusions were difficult to draw. CKWs spanned a wide age range, with the youngest participant being 21 years old and the oldest being 65 years old. We learned that there is a trade off when targeting either young or old CKWs for participation as those who are advanced in age, 50 years and above, are more committed and trusted by their community members, but often exhibit health related problems like poor eye sight and short memory. A number of older CKWs seemed to have problems

Gideon and Narsisio, CKWs in Bushenyi

understanding the survey tools and technologies. For example, on a survey for the World Food Program (WFP), instead of recording the name of the person interviewed, many older CKWs put their own contact details or left that section un-answered.

On the other hand, younger CKWs (below 30 years old) were more energetic and could easily travel to complete surveys but often lacked motivation to conduct work and did not take the time to fully explain survey questions to clients. Likewise, some of the young CKWs prioritized other engagements before their CKW activities and their performance suffered as a result. Some these of CKWs also complained that the compensation for conducting surveys was insufficient.
CKWs in the middle range, from 30-39, emerged as the leaders in both information services and survey administration. In general, the best performers were under the age of 50 and the poorest performers were between the age of 50 and 65, although each age category had both high and low performers. Despite these generalizations, two of the top performing CKWs were over the age of 60, showing that commitment, education, and experience should be prioritized over age and other biological characteristics.

We did notice a difference between CKWs was in relation to level of education and profession. CKWs with secondary and higher levels of education exhibited a better understanding of their role as a CKW, especially in relation to data collection. These individuals tend to be fluent in English (despite using fluency in English as a selection criteria, "levels" of fluency varied substantially) and were comfortable using the various phone functions and the GPS units. Ultimately they were more effective than CKWs who did not complete secondary education. However, those with the highest level of education tended to also have high levels of responsibility (as in the case of a local government leader or a bank manager) and proved to be less available to perform CKW duties, despite the fact that they took leadership roles during trainings and other CKW gatherings. Thus,

A Day in the Life of a CKW

The CKW serves as a link between the smallholder farmer and a variety of actors in the agricultural space. On any given day, a CKW might be found in the market conducting a mobile survey with a farmer in a nearby stall, teaching a neighbor at a wedding how to use a new information service on her phone, or speaking about his or her role as a community resource at a farmer group meeting. The CKW may accompany the farmer to his or her field to better understand the challenge raised or to do an onsite survey to determine disease incidence.

Deus Kamusisha, pictured at left, is a CKW from Bushenyi who recently visited a woman who was having trouble with her coffee. The coffee rot was damaging her family's plants. She was worried because her father used the money that he earned from selling this crop to pay her siblings' school fees. By texting a simple query to a specialized agriculture application on his phone, Deus was able to provide advice on how to deal with the problem.
A CKW also spends part of his/her time collecting surveys. By administering surveys to farmers in the areas they serve, CKWs like Deus compile detailed, up-to-date information on rural areas that would otherwise be unavailable or too costly to collect on a frequent basis. CKWs are trained to use their mobile phones to administer surveys, cutting the time between data collection and submission to almost zero. Between March 10 and April 21, 2009, Deus conducted a total of 35 surveys.

CKWs who have completed secondary education but are not engaged in a full-time demanding profession tend to be the best CKWs. We also observed that CKWs who had professions where they were already heavily engaged in agriculture (farmer, agricultural trainer) or who are involved in community mobilization generally performed very well.
Further analysis on gender, CKW characteristics, and CKW clients is available in the section on monitoring and evaluation.

Table 4: CKW Source Organisations

CKW Source Organizations	Description
TechnoServe	TechnoServe helps people in poor rural areas build profitable businesses that create income generating opportunities for their families and communities. TechnoServe works to develop business solutions in the banana, cotton, fresh produce, and dairy sectors in Uganda and trains and supports hundreds of farmer associations across the country. Four CKWs from TechnoServe's cotton producer associations participated in the pilot.
SNV Netherlands Development Organization	SNV fights poverty by promoting sustainable and equitable production, income, and employment opportunities. SNV implements its agricultural projects throughout Uganda and is an expert in value chain analysis. SNV works with a range of farmer groups and nominated three members to participate as CKWs.
Uganda National Agro-input Dealers Association (UNADA) and Appropriate Technology Uganda (AT Uganda)	UNADA and AT Uganda support a network of rural input dealers and promote the use of agricultural inputs, such as improved seeds and fertilizers, to improve farmer productivity. UNADA is the umbrella organization for over 2,000 rural input dealers in Uganda. The dealers sell agricultural inputs such as improved seeds and fertilizers and also educate farmers about the benefits of inputs use and provide safety advice. Three rural stockists, or input dealers, participated in the pilot.
National Agricultural Advisory Services (NAADS)	NAADS is the extension arm of the Ministry of Agriculture, Animal Industry, and Fisheries (MAAIF) whose mission is to increase farmer access to information, knowledge, and technology for profitable agricultural production. The NAADS extension network is nationwide and is central to the government's poverty eradication plan. NAADS implements extension activities at multiple levels and 13 CKWs were recruited from NAADS sub-county farmers' forums and community-based facilitators.
Busoga Rural Open Source and Development Initiative (BROSDI)	BROSDI employs technology to improve the lives of Uganda's poor. In the agricultural sector, BROSDI has built, trained, and supported farmers groups in 19 districts in Uganda. Through these groups, BROSDI works with over 400 knowledge brokers. BROSDI also partnered with MTN, Google, and Grameen Foundation to generate content for the Farmer's Friend application. BROSDI nominated four CKWs to participate in the pilot.
Uganda Commodity Exchange (UCE)	UCE seeks to improve farmers' livelihoods by facilitating market linkages to commercialize farming. UCE is working with a range of stakeholders to establish a warehouse receipt system. Farmers can bulk produce through their associations and deposit their produce in the warehouse, where they will be issued a receipt against which they can take out loans to cover urgent expenditures. UCE also implements rural information system tele-centers which provide market and other information to farmer groups. Five CKWs were recruited from UCE.

Mbale Farmers Association (MBFA) and Bushenyi District Farmers Association (BUDAFA)	Uganda's Farmers' Federation is an umbrella for farmers associations at the district level. These farmer-led organizations support collective marketing and enhanced agricultural production through sensitization on best agronomic practices. The two district farmers associations had six CKW representatives.

Recruitment

The recruitment process was relatively successful, with partners nominating high-capacity candidates committed to helping poor farmers improve their livelihoods. However, the more decentralized the recruitment process was the more it became politicized. In particular, local level extension offices tended to nominate individuals who, while often qualified, saw the position as an opportunity to solidify political support and struggled to nominate female CKWs, and those that were nominated were, on the whole, not qualified to do the work. In our discussions with CKWs, they suggested that GF directly involve farmers and community groups in nominating candidates to increase accountability and legitimacy because, they argued, farmers and other community groups are best positioned to know who would make a good CKW. They also suggested that we target women's groups to increase their participation.

Training

Our team executed one-day trainings to reduce costs and make the time commitment for CKWs more feasible, especially for mothers with young children and other female CKWs. Trainings were always rushed, with some applications receiving very little emphasis. However, for the banana diseases training, CKWs attended three-day residential trainings during which time they went out to the field and did practical demonstrations with trainers.

CKWs training on taking photos for mobile surveys

The Community Level Crop Disease Surveillance project was more intensive than prior CKW activities and required that CKWs gain an in-depth understanding not only of how to conduct the mobile survey on the phone, but also how to identify and control three different banana diseases. A number of findings emerge from comparing these trainings. For example, knowledge retention levels are much higher when trainings span multiple days and CKWs have time to internalize training content and when CKWs are required to demonstrate their knowledge in a real use case

scenario and test well on it. CKWs also clearly valued the knowledge they gained on banana diseases. This moved CKWs from being purely "information hubs" to being true extension agents who could interpret the information they provided to clients and speak to farmers with confidence about the best course of action, with a link to scientific experts in cases where they needed support or clarification.

In addition, we learned that CKWs must master a range of skills, most of which are completely new to them. For example, many CKWs had never sent an SMS and a few CKWs did not own a phone prior to the project. Further, many CKWs did not have a good grasp of how to organize their schedules to complete CKW activities or how to calculate the profit they earned from being a CKW. They struggled to evaluate the value proposition of their participation in CKW activities and, although they carried out the activities, they did so without a clear plan or understanding of the benefits they accrued or costs they incurred. Breaking subject areas into modules and spending adequate time on each module should address many of these issues. We also noted that despite distributing easily digestible, simple, and engaging training materials (see Appendix B for sample training materials), CKWs rarely used these materials as a reference. Testing CKWs on each subject area and requiring them to familiarize themselves with the materials would serve multiple ends, letting our team understand in which areas CKWs need further instruction, identify weak CKWs who may need follow-up, and ensure that CKWs familiarize themselves with the training materials for future reference. CKWs were required to pass final written and mobile exams as well as a banana disease survey practical demonstration to be qualified as official enumerators for banana disease monitoring and to graduate from the CKW program. As CKWs studied for these exams, they became much more proficient and knowledgeable about the different services.

Incentives and Motivation

We found that the 38 CKWs who remained in the pilot through its completion demonstrated a high degree of commitment to their activities and took great pride in their role as Community Knowledge Workers. They often voiced how important it was that they reach out to farmers in their villages as they knew that these farmers had few, if any, other avenues to access information. CKWs and clients alike commented that farmers tended to trust the information CKWs delivered because farmers saw CKWs adopting many of the techniques they promoted. Clients also knew where to find a CKW if the information they provided was not accurate, thus making the CKW accountable.

Cash payments for surveys and mobile airtime transfers for disseminating information served as incentives for CKWs; however CKWs also emphasized the value that they placed on offering needed services to their communities, how they enjoyed the newfound recognition they received in the village, and how they had become much more knowledgeable since becoming a CKW. T-shirts, a CKW logo, certificates and other regalia identifying CKWs as part of a specialized information corps, and CKW marketing materials and posters added to the prestige CKWs enjoyed and went a long way in motivating them.

Challenges

CKWs did face an array of challenges, including traveling long distances to conduct surveys, having some farmers doubt their intentions because they perceived that CKWs were making money off them, and household disputes for female CKWs. There were also a number of technical challenges such as limited network connectivity, limited battery life of phones, and CKWs accidently changing the settings on GPS units. Field officers played a key role in helping CKWs resolve these problems. However, the field officer support model is not scalable, so GF must explore other structures for providing crucial support services to CKWs.

Recommendations from Experiences Building CKW Network

Recruitment

- CKWs should exhibit the following characteristics:
  - Previous agricultural experience
  - Literate
  - Fluent in English
  - Comprehend the importance of practicing good data collection techniques
  - Willing to commit a minimum of 10 hours a week to CKW activities
  - Able to attend multiple day trainings
  - Committed to targeting services towards the most vulnerable villages/families
  - Good eyesight and fit enough to perform field work
  - Availability to travel within a 5-10 km radius of home
  - Enthusiastic about community development and able to effectively mobilize community participation
- The recruitment of CKWs should involve rigorous vetting, considering that nomination processes are often politicized
- Mobile network connectivity should be a prerequisite when recruiting CKWs to ensure effective participation
- Spatial distribution of CKWs should be evaluated to ensure maximum availability of services, decrease transportation cost, support the business model, and enable the collection of geo-referenced data

Training

- Trainings should span multiple days and be organized into modules to ensure content mastery and retention
- Training modules should focus on equipment use, business skills, agricultural knowledge, mobile information services, data collection methodology, mobile surveys, and basics of GPS
- CKWs should be tested on each training module with practical and written examinations and should be required to pass each module before moving to the next. CKWs should be required to pass all base modules before being certified as a CKW and incentives should be linked to certification
- Weekly mobile quizzes should be administered to assess weak areas and weak CKWs. Field support staff should use these quizzes as a mechanism for targeting follow-ups
- Training on new applications and surveys should include a half-day refresher course
- GF should work with partners to incorporate specialized training in agricultural techniques and market skills, such as post-harvest handling or crop disease identification
- GF should provide specialized training on survey techniques, with emphasis on probing, estimating acreage, and soliciting income and production information
- Training videos explaining the roles and responsibilities of a CKW could assist to standardize training of potential CKWs. Select videos could be uploaded onto CKWs phones as refresher courses.

Support, Monitoring and Incentives

- GF should test a tiered field support system in which the most capable CKWs supervise a small cohort of CKWs to minimize demands on field officers and ensure scalability
- A dedicated staff member should track mobile application usage and behavior on a daily basis for effective and timely monitoring and troubleshooting
- Field officers and CKW supervisors should be trained in:
  - Simple troubleshooting techniques, such as installing an application program on their phone through SMS and phone call instructions
  - Taking quality digital pictures
  - Following survey administration protocol, focusing on survey preparation, data collection, and data transmission
- CKWs should be required to purchase the CKW toolkit through a microfinance institution (MFI) loan to ensure sustainability and promote self-selection of entrepreneurial individuals
- The CKWs should be offered business management skills to help them internalize the potential benefits of the program, giving them a chance to make informed decisions
- Recognition in the community and status as a leader serve as powerful incentives for many CKWs. Building a strong CKW brand helps create non-financial incentives for high CKW performance
- CKWs are highly sensitive to incentives. Small promotions can help reinforce use of a new information service or bolster low survey numbers
- The CKW business opportunity should incorporate a wide offering of telecommunication services so that CKWs have additional income-generation opportunities beyond data collection

Gender & Socio-economic Equality

- CKW sources should deliberately include women's organizations to ensure balanced gender participation. GF should aim for a CKW network that is 50% female
- Gender sensitization should be part of CKW training
- GF should perform a thorough gender analysis and design a program to maximize benefits for female CKWs and clients and to minimize obstacles that would limit female inclusion
- Female CKWs should receive additional facilitation where necessary to ensure participation and equity, especially in relation to training schedules and transportation for data collection.
- GF should work with a social impact specialist to minimize the disproportionate capture of project benefits by the elite members of a community and to ensure that by recruiting, training, and equipping the better educated individuals in a village, we do not inadvertently exacerbate intra-village socio-economic disparity .
- There may need to be a program to assist the most disadvantaged farmers to become CKWs by offering subsidized equipment kits and/or extra training

Developing Mobile Information Services for Smallholder Farmers

General Overview

Mobile phones have been rapidly accepted and adopted in developing countries and are often viewed as one of a household's most important assets, serving as a business tool, a means to connect to the world, a status symbol, and much more. Mobile phone usage is on the rise in rural communities. Villagers often use the phone for a range of agricultural operations, including getting to know the prices of crops at various markets, receiving instantaneous information regarding seed-variety, fertilizer, and pesticide availability/application, and calling distant livestock/agriculture specialists for technical advice. Farmers report significant savings in both time and money by reducing unnecessary travel and time-related expenses, increasing bargaining power through access to market information, and increasing yields or reducing losses through access to remote technical advice. Research also provides evidence on the key role that mobile phones are playing in improving the information transfer between farmers and research institutions, government agencies, agricultural input dealers, agriculture specialists, buyers, and other farmers.

The GF team has developed and tested seven agriculturally focused mobile information services, five of which were prototyped specifically for the CKW project (See Table 6). In addition, GF prototyped four mobile information services and deployed two additional mobile information services to learn about farmer demand for different types of information, assess preferences for different technologies, and identify possible behavioral changes that occur as a result of access to different types of information.

GF sourced content from a range of leading agri-business and agricultural research organizations and worked with a number of technology providers and agricultural agencies to develop the services, including:

- FIT Uganda through its Info-Trade service promotes Business and Agricultural Marketing Information in the country by collecting, analyzing, tabulating, and disseminating price data from over 20 markets, covering a total of 46 commodities. FIT Uganda gave the project permission to disseminate its market information via a SMS keyword search application

- Google, MTN-Uganda, Uganda Department of Meteorology and BROSDI provided access to the Farmer's Friend which offers 3-day and seasonal weather forecasts, information on affordable organic agricultural inputs and remedies, and the Google Trader application which provides a tool for creating market opportunities by linking farmers and traders through an SMS bulletin board

- Uganda's National Agricultural Research Organization, OpenMind, a US based NGO bringing the internet to rural communities through innovative solutions, and Appfrica Labs, a local technology incubator, partnered to develop an agricultural hotline

- IITA (International Institute for Tropical Agriculture) provided information on banana pests and disease control and agronomic techniques for banana production

- Uganda National Agro-Input Dealer Association (UNADA) and Appropriate Technology Uganda (AT-Uganda) provided GF with data from their census on national agro-input dealers for the input supplier directory

- GF used coffee production manuals produced by Café Africa and Uganda Coffee Development Authority to develop the coffee agronomic and post-harvest handling techniques application

Table 5: Agricultural Information Services Usage

Application	Description	Approximate time period[1]	Total Usage	Average Usage per CKW per month
Farmer's Friend	SMS searchable database on local, organic tips and advice and 3-day and seasonal weather forecast	Feb-August	4,381	14 queries
Google Trader	SMS trading bulletin that links farmers to traders	Feb-August	607	1 query
AppLab Question Box	Live, local language hotline that offers gateway to internet and expert agricultural advice from nation's leading research institute	April-August	2,880	16 queries
CKW Search: Coffee & Banana	Series of java forms guides user through menu system to create a SMS keyword string on agronomic techniques in banana and coffee production	June-August	754	6 queries
Input Supplier Directory	A SMS based key-word search service that gives location and contact for shops offering specific agricultural inputs	June-August	576	5 queries
Banana Disease Control Tips	Pre-loaded html pages pop up when survey is complete; shows control measures for disease identified in survey; also available via SMS and java based CKW search	June-August	Usage reports not available	N/A
Market Prices	A SMS based key-word search services that gives retail and wholesale prices for 46 commodities in 20 markets	August	407	7 queries
Totals			**8,128**	**40 queries/ month**

[1] Applications were launched at any point during the month. CKWs in Bushenyi were trained two weeks after those in Mbale. Monthly averages are calculated using number of weeks for which the application was deployed rather than full months—this leads to some discrepancy between the last two columns in the table.

CKW Test of Concept Information Services and Analyses of Findings

1. Applab Question Box

Calls to AQB Call Center and Call Center Performance

Analysis of calls to the AQB call center show that 63% of the calls came from CKWs in the Mbale region and 37% from the Bushenyi region. Operators were able to answer roughly one-fourth of questions during the initial three minute phone call; 39% of calls required greater searching, either in the database or online, and received a call back within 15 minutes; 36% of all calls were escalated to the agricultural expert at NARO. On average, the call center received 130 calls per week, with the highest weekly volume reaching 348 during the week of May 17. The top performing CKW placed a total of 149 calls for an average of 6.5 calls per week while the lowest performing CKW placed 25 calls for an average of just over one call per week.

Call Fluctuations Over Time

The number of calls per week fluctuated over the course of the pilot (See Figure 8). The major peak in calls during the week of August 9-15 can be attributed a promotion we ran in which we awarded a prize to every fiftieth CKW caller. The lower call volume witnessed from mid-June through the pilot end can also be attributed to the introduction of a separate incentive we offered when CKWs began conducting the time-sensitive banana disease monitoring surveys. We compensated CKWs at $1.50/survey. The clear correlation between call volume and incentives demonstrates the challenges associated with designing incentives that will encourage CKWs to use one service while not discouraging the use of another.

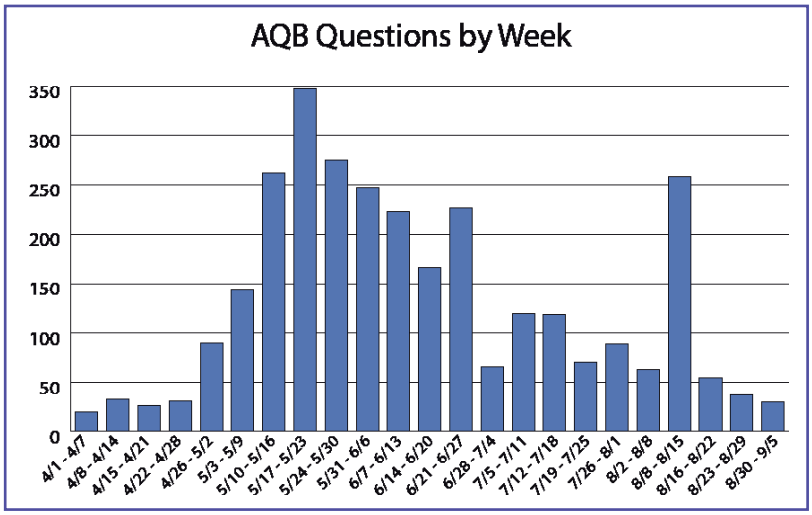


Figure 3: AQB Questions by Week

Focus on Agriculture

By far, the greatest number of questions asked during AQB calls were on agriculture (65%). Approximately one-fourth of all agriculture-related calls were on the subject of animal husbandry. Sixty-eight percent of these questions related to a problem that the farmer's animal was having (in most cases health-related). Twenty-seven percent of users asked questions about using the specific disease name, e.g. Newcastle disease in poultry, foot and mouth disease in cattle, etc., while 41% of users sought answers by describing symptoms their animal was displaying, e.g. "What causes cattle to tear up and then causes blindness?" The remaining 24% of questions were focused on general practices related to animal husbandry, for example "How do you rear or manage rabbits?"

The other 73% of agricultural questions not related to livestock focused on a specific crop. The most frequent crops that AQB users had questions about were bananas (18%), coffee (10%), and beans (8%). Other crops for which questions were received include maize, cabbage, cassava,

Table 6: AQB Summary

Applab Question Box (AQB)

Description

AQB is a live, local language hotline that brings the Internet and expert agricultural advice to individuals who may never see a computer, visit an agricultural specialist, or read in English. Villagers can ask their Community Knowledge Worker a question on a range of topics, who then calls a local-language telephone operator to find the answer. The AQB operator searches pre-approved websites and the local AQB database and then calls the CKW back with the answer, translated back into the local language. When operators can't find the answer to an agricultural question, they 'escalate' the question to an expert from Uganda's National Agricultural Research Organization (NARO). Seventy percent of all questions related to agriculture and the answers show great potential to improve smallholder farmer livelihoods.

Anticipated Impact

Callers to AQB will experience improved livelihood outcomes due to: increased revenue and decreased losses for agricultural activities. We observed numerous examples in which farmers used the remedies suggested through the helpline to treat livestock and crop diseases before their crops were destroyed or animals were so sick they had to be brought to the vet or slaughtered. Farmers also used information from the hotline to address pest problems, address nutrient deficiencies, and learn about planting, spacing, starting new enterprises, or proper livestock care.

Technology

- Mobile phones
- Live voice
- Internet
- Local database

Content Partner

- Appfrica Labs, local technology incubator
- OpenMind, US based NGO
- Uganda's National Agric Research Organization

Average No. Calls/CKW/Week 4

Total Calls (4.1.09-9.1.09) 2,880

Sample Query

"What is the cause of my cabbage rotting before they mature and the cure?"

Response

The major disease of cabbage is black rot caused by soil-borne bacteria. This disease cannot be controlled by chemicals. Use preventive measures such as practicing crop rotation and planting healthy seedlings certified by reputable dealers. Copenhagen variety matures early and is resistant to black rot.

CKW Praise for AQB

"It is easy to use. All you have to do is call and they answer your questions." *CKW , Nicholas Bashongoka*

"Sometimes people who don't read don't trust the SMS. The AQB operator speaks in Luganda and they hear it themselves so they trust it." *CKW, Fredrick Makawa*

CKW Criticism of AQB

"A response telling them to go and look for an agricultural extension worker discourages them a lot." *CKW, Sarah Komuhangi*

"I do not use AQB very much because of poor network coverage in my community. It is easier for me to use SMS services." *CKW, George Shiondo*

avocado, potato, tomato, eggplant, groundnuts, pineapple, and passion fruit, among others. As in the case of animal husbandry, many of the farmers sought a solution to a problem that he or she was encountering, generally related to nutrient deficiency, disease, or pest; these cases accounted for 60% of all crop-related questions. Thirty-four percent of these calls dealt with problems of unknown origin to the farmers, so they sought solutions through the description of the problem they faced. For example, farmers asked, "What makes the stem of the banana plant rot?" Twelve percent of these questions were on specific crop diseases (banana wilt, spotted leaf disease, etc.) and 14% were specific to pests (caterpillars, aphids). In many cases, farmers did not know the name of the pest, but rather described it, for example "Cabbage has green pests and inhibits cabbage from maturing." An additional 13% of all crop-related questions covered general questions about cultivation, "What is the depth and width of the hole in which you want to plant coffee?" while 8% of crop related questions focused on nutrients, "Which type of fertilizer should I use in my coffee garden, which is one year old?" Other subject areas that received small number of questions include seed types and intercropping techniques (3%).

A significant number of farmers also used the system to inquire about market prices with 16% of all crop-related questions being devoted to market information. In most cases, questions targeted a specific crop in a specific market, for example, "What is the price of white beans in Nakawa market?" These findings illustrate farmer demand for different types of information, and the CKW Initiative will use these findings to prioritize the development of information services on a variety of content areas. The table below shows more sample AQB questions and answers.

Table 7: AQB Sample Agricultural Questions and Answers

Stephen, a CKW in Bushenyi, offering AQB service to a farmer

Questions	Answers
Is it ok to intercrop coffee and maize?	Ideally newly planted coffee should not be inter-planted, but kept weed free with the space between the rows mulched. However, many farmers with limited land grow food crops into young coffee. The intercrop will compete with your coffee for nutrients. If you must intercrop, then use soybeans, groundnuts, and non-climbing beans and confine to 2 meters of the inter-row. Two crops can be grown per year for the first two years; they should be rotated.
What is the price of rice in Palissa?	2,400 Shs. retail; 2,000 Shs. Wholesale
What is the cause of my cabbage rotting before they mature and the cure?	The major disease of cabbage is black rot caused by soil-borne bacteria. This disease cannot be controlled by chemicals. Use preventive measures such as practicing crop rotation and planting healthy seedlings certified by reputable dealers. Copenhagen variety matures early and is resistant to black rot.
What is the cause and cure for a goat having diarrhea?	Controlling worms is vital to successful goat farming. The most common parasite is a blood- sucking worm that lives in the goat gut. Affected animals may become anemic and will not grow or breed well. Worms can be controlled by using anthelmintic medicines and by management practices such as avoiding wet swampy areas for feeding and grazing in bushy areas; also cut and carry feed. Housing goats on raised wooden floor which allows droppings to fall through to the ground is another way of reducing spread of worms. Signs of worm infestation include: (1) diarrhea (2) the hair on the goat may look dry and (3) goat may show signs of a pot belly. If infestation is high, the worms may even show in the dung. Get deworming medicines in liquid or tablet form. It is very important for a farmer to prevent by deworming goats regularly, especially during rainy season. Deworm at least three times in a year: at the beginning, in the middle, and at the end of the rainy season.
The coffee seeds change into a dark color, what is the cause and control?	Coffee berry disease is the most serious fungal disease of Arabica coffee. It attacks coffee flowers and fruits all stages of growth, but is more destructive on young berries when it causes berry fall. Berries attacked at early stages form brown sunken scars. Badly affected seeds go completely brown to black and beans inside are destroyed. Control: Use copper fungicides at 3 weeks intervals; these are Kocile 101 and Copper oxychloride. Apply at least six times in a season, at the onset of rains, and keep plots well pruned and weeded.

Feedback and Findings

In general, CKWs find AQB easy to use and like seeking answers through a live operator. However, CKWs sometimes did not use the service because call center Monday thru Friday, 9am-5pm) hours were not convenient. Many farmers were in their fields or they did not

have good network coverage to place calls. Some CKWs lost interest in the service in when operator call backs, particularly at the start of the pilot. In addition, the turnaround time for expert advice could take as long as four days, which many farmers found too long and placed additional burden on CKWs who had to then seek out the farmer to return the answer. In addition, CKWs were often in the field when operators phoned back and didn't have writing materials to document the answer. The AQB team sought to address many of these issues during the pilot period, experimenting with different technologies such as voice mail and SMS and decreasing call turn-around time, overall vastly improving quality of service by the end of the pilot. However, despite challenges, most CKWs and farmers valued the information disseminated via AQB and decided it was worth the wait.

Information Service: AppLab Question Box

Behavioral Shift *Cost saving realized through improved decision making*
CKW *Gideon Rwakiguma*
Organization *NAADS*

Impact

A woman came to Gideon, a CKW in Bushenyi, complaining that her cow had a strange skin condition. The fur was eaten away leaving a big wound. Gideon told her that he could call the agricultural hotline to get a treatment recommendation.

The operator told them to get aloe vera leaves, boil them, and use the hot solution to clean the wound. The operator instructed them that after cleaning the wound, they should place the cooled aloe vera leaves on the wound and leave them to dry. After one week the woman came back to Gideon to thank him because her cow's wound had healed. The woman was able to treat her cow without incurring any cost, and she was able to act on the information immediately.

2. CKW Search

Analysis of Coffee Queries

Forty-one percent of coffee queries focused on Arabica coffee while 58% were on Robusta. Seventy-eight percent of the questions on Robusta came from Bushenyi whereas 79% of the queries on Arabica came from Mbale—figures that reflect the varieties grown within each region.

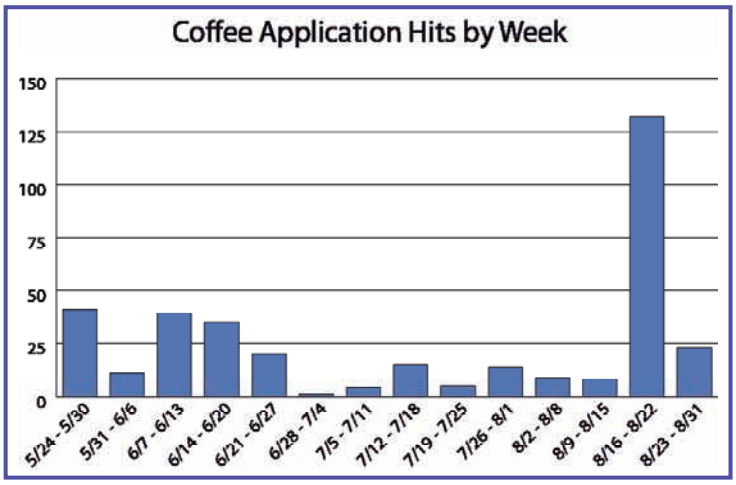


Figure 4: Hits on Coffee Application by week

The greatest number of questions focused on pests (22%), with garden preparation a close second (17%). Questions on diseases and planting each represented 14% of all queries, followed by soil (13%) and plant (10%) management, and harvesting and post-harvest handling (each 5%).

Usage Over Time

Excluding the week of 8/16-8/22, during which CKWs were incentivized to use the coffee application, the average total number of hits per week was 17. During the incentive, usage spiked to 132 queries, demonstrating CKW response to incentives.

Analysis of Banana Queries

Banana queries were split between districts with 54% coming from Mbale and 46% from Bushenyi. Farmers used the service most for inquiring about banana diseases (27%) and soil management (24%). Banana planting represented 18% of queries, followed by plant management (13%), garden preparation (11%), and pests (8%).

Excluding the promotional week, there was an average of 20 hits on the banana application per week. This application was promoted alongside the coffee application. We saw an even more dramatic peak in banana queries during this week when queries reached 261.

A few factors may explain the seemingly low usage of these two applications. CKWs were trained on the banana and coffee service and on the World Food Program survey on the same day. The training on the World Food Program survey was the first on a java-form based survey and required that CKWs not only learn how to load, conduct, save, and send the survey, but also how to take, save, and attach photos to the survey. As a result, very little time was spent training the CKWs on the application. As a result,

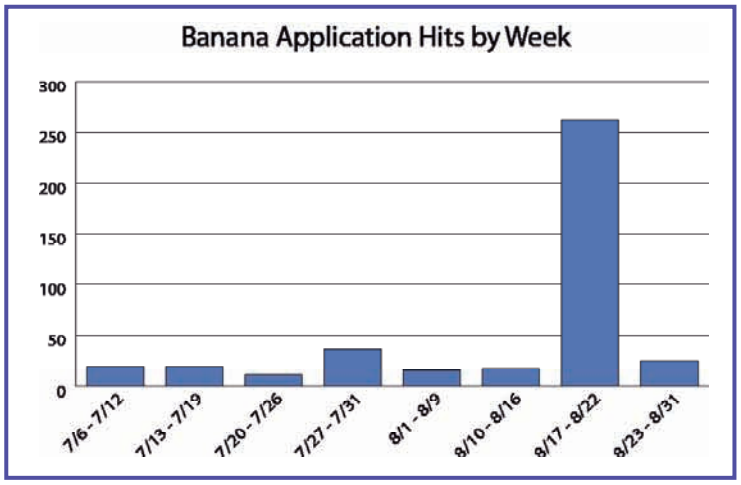


Figure 5: Hits on Banana Application by week

many CKWs had only tried the application once or twice, usually during the training, but never became accustomed to using the application; whereas, those who used the application tended to have substantially higher usage numbers (i.e. about one-third of CKWs did not use the application at all, while those who did use the application used it frequently). This is an interesting finding when compared to AQB and Farmer's Friend, both of which CKWs trained on in isolation and for which specific airtime incentives and weekly targets were given to drive usage in the beginning when CKWs were familiarizing themselves with the service. From this analysis, it appears that each application requires a targeted training and incentives to drive usage before CKWs master the application and make an informed decision on whether the application meets their needs.

Shortly thereafter, CKWs began conducting banana disease monitoring surveys. During this period, the overall usage of information services fell. While we had expected to see CKWs offering information services while carrying out survey activities, we saw that this was often not the case. CKWs noted that the time demands associated with carrying out an intensive survey prevented them from reaching out to provide farmers with information services. During the banana disease surveys, CKWs instructed farmers in disease identification and control using farmer guide books, posters, and other print materials and were disseminating important information. However, CKWs did not depend upon the phone to deliver this information. Finally, much of the information on bananas that was available on CKW Search was also available in the print booklets which CKWs distributed to farmers. These findings have important implications for training and incentive structures (See Recommendations on Mobile Information Services).

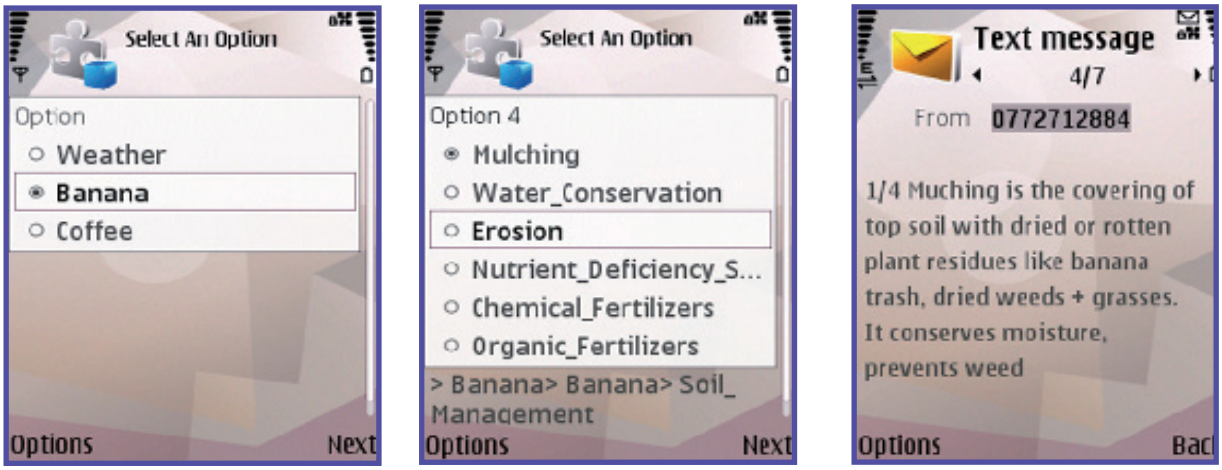


Figure 6: CKW Search query and response screenshots

Table 8: CKW Search Summary

CKW Search: Coffee and Banana Tips

Description

CKW search provides two separate services: Coffee Tips and Banana Tips. The CKW team used content provided by IITA and Uganda Coffee Development Authority (UCDA) and Café Africa to develop the application. IITA provided technical sheets on a range of cultivation issues for banana while Café Africa provided coffee producer manuals developed with UCDA, which the CKW team translated into SMS-friendly queries and responses. Topics covered include garden preparation, planting, soil management, plant management, diseases, pests, harvesting, and post-harvest handling. CKWs guide users through a series of menus and farmers choose the topic they'd like information on from each menu, selecting more specific information under each menu. The application then sends an SMS text using the selected fields from each menu and the CKW receives an SMS, or text message, with the answer. Potential usage cases are varied and the application can handle a range of content areas beyond these two crops.

Anticipated Impact

Uptake of improved coffee and banana farming practices will lead to better yields and decreased losses, leading to improved livelihood security for smallholder farmers. Post-harvest handling recommendations will also enable farmers to bargain for a higher price for their coffee harvest.

Technology

- Mobile phones
- SMS
- Java-based application

Content Partners

- IITA
- Café-Africa
- Uganda Coffee Development Authority

Number of unique tips

- Coffee: 86
- Banana: 45

Average No. Hits/ CKW/ Week

Coffee 0.7

Banana 0.9

Total Hits

Coffee (May 24-Aug 31) 354

Banana (May 24-Aug 31) 400

Sample Coffee Query

Coffee >Arabica >Pests Diseases >Pests >Berry Borers

Response

Coffee Berry Borers are small black beetles covered in thick hairs that damage the fruits + lead to as high as 50% yield loss. Symptoms include fruit drop of young, green cherries. They make a small hole in the cherry + cherries have damaged beans. To control borers, keep area around tree clean, remove dropped cherries + remove carry-over fruit from trees.

Sample Banana Query

Banana >Plant Management >De-suckering

Response

De-suckering keeps plants from competing for water, light, nutrients + maintains high yields. De-sucker banana mat to 3 plants at each growth stage: mother, daughter + granddaughter. Use knife, panga, or spade to de-sucker. Cut sucker pseudostem off near its corm + twist sharp point of knife or panga in growing point to kill it. Take care not to harm daughter plants. Suckers must be removed from flowering up to harvest time. Maintain 1-2 suckers on the opposite side of the bunch of the mother plant. Always choose suckers which come from well down on the corm.

CKW Experience of CKW Search

CKWs like CKW search because they can learn about additional topics by scrolling through the menu system to see what information is available. They have also found that they get more detailed and accurate information from CKW search than from other services, as a query on CKW search never "fails," and they would like to have more crops, such as cassava, and livestock included in the service. - *CKW focus group in Mbale, Sept. 20, 2009*

Mobile Service: CKW Search

Behavioral shift Adoption of improved agronomic techniques
CKW *Jackie Buteme*
Organization SNV

Impact

Jackie is a CKW in Mbale who liked to use CKW search, a menu-guided application on bananas and coffee, to help farmers learn how to reestablish banana plantations after adopting control measures. After conducting disease monitoring surveys, CKWs would explain appropriate control measures for dealing with diseased plants.

In many cases, farmers needed to destroy infected plantations, yet they lacked information on how to establish a new plantation in a clean area. After one of her surveys, a farmer explained to Jackie that he wanted to establish a new banana plantation in a clean field and was not sure of the appropriate spacing for planting banana suckers.

Jackie used the CKW search application on bananas to find out the appropriate spacing. She sent the query via SMS and received back a message: *Space 3m between planting rows and 3m between plants within the row, or wider if soil fertility is low...*

When Jackie passed by the farmer's plot later in the week, she saw that he had used the advice to plant the new banana suckers. Based on this change in behavior, the farmer expects that his plantation will yield better fruit, minimize the spread of disease, and lengthen the viability of the soil. Other farmers have approached CKWs to learn the appropriate spacing and number of plants per acre for crops such as maize, bananas, coffee, and groundnuts.

3. Google Applications

Table 9: Google Applications Summary Google Tips and Google Trader

<table>
<tr><th>Google Tips 6001/6</th><th>Google Trader 6007</th></tr>
<tr><td>Description 6001/6
A Google SMS Search powered service, providing relevant and actionable information on weather, agriculture tips and advice, as well as sexual & reproductive health and clinic locations.</td><td>Description
A SMS marketplace application that allows users to buy and sell goods and services on the phone using a SMS bulletin where they can post and search.</td></tr>
<tr><td>Anticipated Impact
Improved livelihood outcomes through: increased revenue and decreased losses for agricultural activities; improved health outcomes by improved ability to understand health issues and increased consultation at local clinics.</td><td>Anticipated Impact
Improved livelihood outcomes due to increased household income resulting from improved market integration.</td></tr>
<tr><td colspan="2">Technology
• Mobile phones, SMS, Google Search Technology</td></tr>
<tr><td colspan="2">Content Partners (Google Tips)
• Straight Talk Foundation and Mary Stopes Uganda (health)
• Busoga Rural Open Source Development Initiative (BROSDI) (agriculture)
• Department of Meteorology (weather)</td></tr>
<tr><td>Average No. of Hits/ CKW/ Week - 3.8
Total Hits - March 10 - Aug 31 - 4381</td><td>Average No. of Hits/ CKW/ Week - 0.7
Total Hits - May 19 - Aug 31 - 607</td></tr>
<tr><td>Sample Query: Cabbage Blight

Response: Leaf yellowing or drying may be a sign of leaf rust disease or cabbage blight. To control it, practice crop rotation and remove weeds and cabbage remains.</td><td>Sample Query: Sell a big bull about 500 Kg at Pallisa supa ariet village
Response: Thank you! Your post will soon be seen by other buyers and sellers on 6007. Reply with HELP for more options. (Buyer contacts seller directly or via CKW).</td></tr>
<tr><td>CKW Experience
This was the most popular service offered because users received instant answers and affordable remedies on a wide range of topics relevant to farming communities.
“The weather service is good for planting because they give a 3 day forecast and you can get it when you are in the field. If you miss the weather on the radio don't repeat it.”
CKW focus group in Mbale, Sept 20, 2009</td><td>CKW Experience
“I sent a message on 6007, offering 1,000K beans, sorted Kaneywa. After one week there was someone in Busano subcounty who wanted to buy beans. He came, negotiated and bought the beans.”
CKW, Agnes Nanda</td></tr>
</table>

Google Apps Analysis of Queries

We do not have the same ability to analyze the content of the queries for the Google Applciations as we only receive reports from MTN-Uganda on the number of hits per CKW. For the next phase of the CKW project we hope to have access to the queries themselves to build a better understanding of how farmers are using the service and what types of information are most in demand.

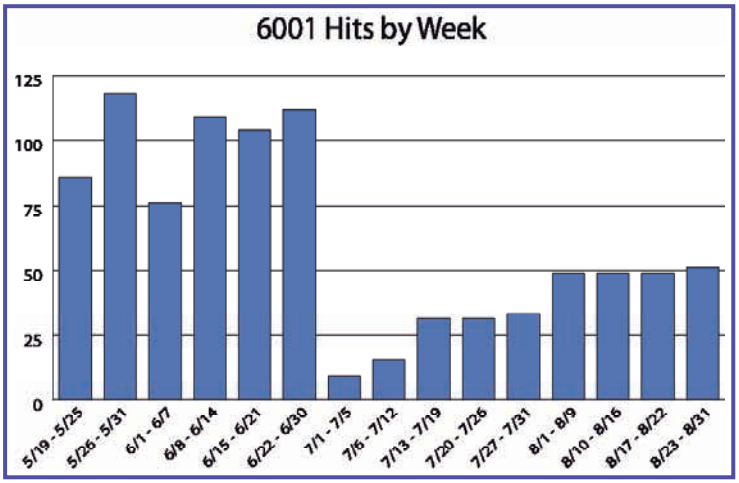


Figure 7: 6001 Google Health Tips hits per week

Usage Over Time

When the pilot began, CKWs used two different 4 digit phone numbers, or short codes, to access agricultural/weather (6006) and health (6001) information. Beginning in mid-May, agricultural information previously available on 6006, migrated to the 6001 short code. Hits for 6006 reflect this transition as hits drop almost to zero after June 1st. In addition, it is clear that there is a drop in usage during July, although usage begins to pick back up in August. This drop corresponds to the training and deployment of the banana disease surveys mentioned previously.

Google Trader (6007) showed high usage at the beginning of the pilot when CKWs had usage targets and accompanying airtime incentives for trying it. Feedback from CKWs suggested that farmers were discouraged after the initial trial period when few buyers contacted them or CKWs about posted goods. However, the application was in a pilot stage and had not be publically deployed or marketed, and the service is driven by users posting and searching content. Nevertheless, there were a few stories from CKWs who were able to successfully broker a deal using Google Trader. This is particularly impressive because with just 19 CKWs in each region, we were able to support the development of local market opportunities. The small uptick in usage towards the end of the pilot corresponds with the harvesting period, and the low usage in previous months may be as much a reflection of farmers having few goods to sell as their experience with the service.

CKW Feedback

Many CKWs and their clients realized that in addition to serving as a SMS trading bulletin, Google Trader enabled farmers to assess the market price for various goods by comparing the prices posted by sellers in multiple locations. This market price information was relevant for bargaining with traders. In cases where CKWs were using the service as a source of market information rather than to locate a commodity or buyer, some CKWs noted that the amount

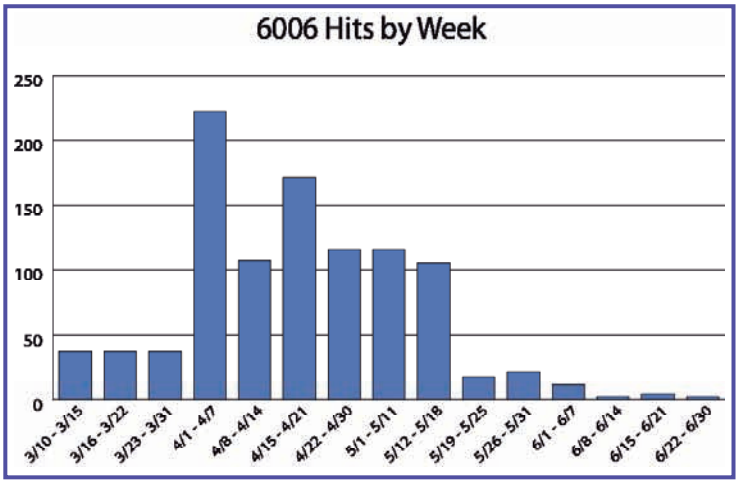


Figure 8: 6006 Google Agri/ Weather Tips hits per week

of typing required to post an item for sale discouraged them from using the service. In the last month of the pilot, GF introduced a new application in partnership with FIT Uganda that provided market price information for a range of commodities in 20 markets. CKWs noted that clients would come to them to ascertain the market price of a certain commodity and CKWs would use the two applications together to compare the prices received to give the most complete information available.

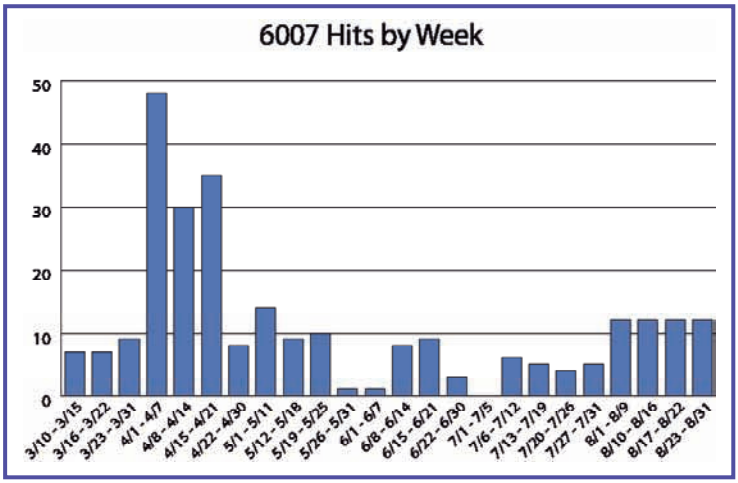


Figure 9: 6007 Google Trader hits per week

Information Service: Google Trader

Behavioral Shift *Broadening market access*
CKWs *Agnes Nanda & Frederick Makawa*
Organization *NAADS*

Impact

CKWs Agnes and Fredrick offered Google Trader to farmers in their areas during the CKW pilot. A farmer asked Fredrick to post an advertisement that the farmer was selling beans. Five kilometers away, Agnes approached another farmer who wanted to buy beans for planting the next season's crop.

Agnes searched the system and saw Frederick's ad, which included a price for beans that was lower than what her farmer had found in the nearest trading center. Agnes called the number listed on the posting and connected the two farmers to finalize the deal.

The two parties created a local market opportunity, which is challenging, especially during the off-peak season and with small quantities, and minimized transport and transaction costs by completing a local transaction.

4. Commodity Market Prices

Analysis of Queries

The commodity market prices service was used to determine prices for 42 different products, although 6 products represented 50% of all queries. Of the most frequently queried products, 12% were for matooke, 10% for eggs, 9% for beans, 7% for cassava, 6% for coffee and 6% for honey.

Figure 10: Market Prices hits per week

Usage Over Time
Not counting the promotional week of Aug. 30-Sept. 5, the market price service received an average of 15 hits per week. As with the other applications, the number of hits increased dramatically during the promotional week, reaching a total of 333 (or 82% of the total number of hits).

Table 10: Commodity Market Prices Summary

Market Prices		
Description Through collaboration with FIT Uganda, the Commodity Market Prices application provides farmers with up to date prices for over forty frequently traded agricultural products in over twenty regional and district markets. FIT Uganda sends out a twice-weekly e-mail with market prices, which the CKW team then uses to update the SMS-based application.		
Anticipated Impact By knowing market prices, farmers are in a better position to negotiate with buyers and traders. We anticipate access to this information will lead to improved earnings from farm sales.		
Technology: • Mobile phones, SMS	**Content Partners:** • Infotrade, FIT Uganda	
Average No. Hits/CKW/ Week 1.8	**Total Hits** (Aug 8-Sept. 19): 407	**Number of Tips:** Over 900, updated 1-2 times per week
Sample SMS Query - Price cassava flour Mbale **Response -** Retail 900 Shs per Kg, Wholesale 800 Shs per Kg		
CKW Experience "A man harvested his beans and was looking to sell them. He approached me and I was able to find out prices in three different trading centers. The farmer learned that he could sell for Shs 1,000/Kg locally or for Shs 1,400 Kg further away. Because the cost of transport would be less than the extra income he would earn by transporting the beans, he decided to sell the beans in the more distant market." *CKW George Wamateke*		

5. Input Supplier Directory

Analysis of Queries

The input supplier directory had a high "fail rate" with 63% of all queries returning no matches; not surprisingly, usage for the input supplier directory was lower than expected as a result. While our partners gave us very useful information, which farmers demonstrated a demand for, a number of aspects ultimately undermined the use of the input supplier directory. GF trained CKWs on the input supplier directory and introduced the first java survey as well as the CKW search application on coffee and banana all at the same time. Time was limited, so our team demonstrated to CKWs how to use the application but did not provide any practice activities or require that CKWs demonstrate how to use it. There were also no usage targets for the input supplier directory. As a result, many CKWs did not fully understand what information the application offered or how to use it. Training was especially important on this type of application because users had to follow a rigid format for entering their keyword search via SMS to assure a successful match against the database and the return of the information the user was searching for.

There were also issues with technology, application design, and product support. The input supplier information was packaged for a SMS keyword search structure, and users had to text the district, the sub-county, and the input that they were searching for, in that exact order, to receive the answer back. Because the applications were in the pilot phase, CKWs were working with prototypes, and it was not possible (or economic) to build all desired functionality for each application. In the case of the keyword search applications developed specifically for CKW (which did not use the Google technology found in Farmer's Friend or Google Trader), keywords had to be texted in the exact order that they appear in the database or the queries would "fail" (i.e. not return a match). Because the CKW platform was not advanced enough to make the next best match when search terms were in a different order or when two of three words matched but the third did not, a high number of queries failed. This discouraged CKWs who gave up on using the application.

To minimize the failure of queries, our team could have packaged the content in such a way that no matter what CKWs entered, they received a reply back giving them some information of value or a help message that directed CKWs on how to re-enter the search terms so that they could get the appropriate reply. The information was packaged for dissemination at a particular political administration level, the sub-county level, yet many input suppliers at that level did not have one or another input so no match would be found. To improve the service, help messages could be attached to potential queries where no information was available. Many CKWs also tried to search by lower political administration levels, such as a parish, rather than sub-county, so replies could have been categorized by both parish and sub-county to ensure higher success rates. Finally, there was no one staff person dedicated to product support to monitor failed messages and modify content based on these messages. There are a number of relatively simple methods for addressing these issues (See Recommendations on Mobile Information Services). Our team has taken steps to address these issues and after the close of the pilot added the input supplier directory to the java based menu system. Usage has increased and failed queries are no longer an issue.

Table 11: Input Supplier Directory

Input Supplier Directory		
Description Through collaboration with Uganda National Agro-Inputs Dealer Association (UNADA) and Appropriate Technology Uganda (AT Uganda), GF developed an input supplier directory for Bushenyi and Mbale. The partners provided GF with up-to-date census information on their input supplier members. GF created an SMS keyword search application that allowed farmers to search for a supplier by entering district, sub-county, and input desired. Users then receive a message with contact details, location, and inputs offered for input suppliers in their region.		
Anticipated Impact By knowing where to find the input they need and being able to call ahead to check availability, farmers realize cost savings through improved decision making and are more likely to use inputs like fertilizers and improved seeds, which deliver large productivity gains.		
Technology: • Mobile phones, SMS		**Content Partners:** • UNADA, AT-Uganda
Average No. Hits/CKW/ Week: 1	**Total Hits** (May - Aug): 576	**Number of Tips:** 222
Sample SMS Query - Mbale Busiu seeds **Response** - Mary Gibutayi, 0783559493, Busiu, Mbale. Seed+seedlings, fertilizers, pesticides, herbicides.		
CKW Experience CKW Geoffrey in Mbale discussed how clients had approached him on various occasions to find out information about where they could locate improved seed and other inputs. However, most often he got a message from the system saying that no match had been found. He found this discouraging and gave up but suggested that GF address the problems as the service had high potential and farmers illustrated demand for information on inputs.		

General Findings on Mobile Information Services

We have documented a number of cases in which farmers acted on the information they received from the mobile applications developed during the pilot and either realized cost savings, minimized losses, or earned higher revenues for goods sold. Over time, it should be possible to quantify these livelihood improvements as well as measure increases in productivity. Further, by offering these services, GF learned a substantial amount about farmer demand, CKW and farmer preferences for technology, use case scenarios for mobile information services, and improvements that GF can make to increase the functionality and relevance of mobile applications.

Specifically, CKWs told us that they and their clients value the on-demand aspect of the services. For example, Mary, a CKW in Mbale, stated that even though she can get weather information on the radio, it only airs at a certain time. She noted that the phone, on the other hand, is "a direct pipeline to information" that she can access it whenever she needs it no matter where she is. Similarly, clients appreciated the breadth of information provided on market prices, covering prices in multiple markets across the country, when compared to the local radio's announcements which were limited to local markets and depended on farmers calling the information in (thus leading farmers to question the motives and dependability of the information). Our team also learned that CKWs do use the mobile services as a toolkit, often leveraging one service off another to compare answers, give more complete information, or provide information covering multiple steps in the agricultural cycle (i.e. getting post-harvest handling tips for coffee as well as checking coffee prices in different markets), thereby increasing the ability to act upon the information, or what we refer to as the "actionability" of information. For example, after advising clients on disease control methods during a survey, CKWs would sometimes use the mobile information services to give clients information on how to establish new crops to supplement their income while they wait for their plantations to recover.

We also learned that when a message "fails" or an answer takes multiple days to arrive, CKWs and their clients are easily discouraged and sometimes do not come back to try an application again. Most applications were never field-tested due to the aggressive timeline of the pilot, however, by designing, building, and testing applications to create the best user experience from the beginning, applications will enjoy early success and are more likely to see sustained usage. Our team should explore technologies that minimize fail rates, such as CKW search, but that are available across a wide range of phones. Interestingly, we did not see any clear preference for voice versus SMS technology, with CKWs exhibiting strong but different preferences from CKW to CKW. This demonstrates the importance of exploring a wide range of technologies and offering a suite of services that CKWs can choose to use based on their needs and preferences. Finally, through the pilot, GF learned the importance of providing sufficient training, follow up on each information service, and strong product support.

Recommendations On Mobile Information Services

Information Demand

- Farmers have a high demand for pest and disease information, and this content should be developed for multiple crops and livestock
- Agricultural hotline should be tailored to farmer schedules and offered in the evenings when farmers congregate in trading centers. The hotline should also employ multiple technologies so that CKWs can save answers on the phone rather than having to write them down
- GF should develop an agricultural information channel that delivers dynamic, seasonal information covering the entire life cycle of crops and livestock; farmers can then subscribe to the channel of their choice based on the crops they grow or livestock they rear
- Information services should cover a wide range of crops and livestock as most farmers' livelihood strategies depends on diversification
- Whenever possible, information services should be linked and packaged to maximize a farmer's ability to act on information, for example, giving a fertilizer recommendation and then providing the option for the farmer to locate nearest fertilizer vendor

Design, Deployment & Support of Product

- GF should do extensive field testing of applications prior to deployment to understand and build for best user experience
- Dedicated staff should monitor product performance and quickly modify application structure and content to reduce fail rates and provide product support to users
- CKW technology platform and short code should accommodate multiple help messages so that keywords linked to a certain application return a targeted message that will enable user to resubmit query and receive a response
- When applications are first deployed, we should roll out a system of targets and promotions so that CKWs quickly familiarize themselves with how the applications function and what information they provide

Mobile Technologies

- GF should adopt a "good, better, best" approach and build applications that allow farmers with basic phones to access information directly while fully exploiting the greater functionality of CKW phones to offer more context rich applications
- GF should develop services using a range of mobile technologies as users do not demonstrate a clear preference for one technology and each offers unique advantages
- GF should do more prototyping with voice technologies as literacy and language issues continue to be a problem for many CKW clients
- There is great potential for location-based applications to deliver highly localized scientific recommendations to farmers and to provide farmers with knowledge about the location of inputs, clean planting materials, collection points, etc. GF should develop these applications for GPS and non-GPS enabled devices using cell tower triangulation techniques, when possible. This technology could also simplify and minimize fail rates associated with applications which require users to enter their location to find location specific information.
- GF should explore how mobile money technology coupled with the CKW network could help address bottlenecks in the value chain and generate income for CKWs
- GF should experiment with sending java menu-guided search queries over mobile internet (GPRS) rather than SMS to realize the same considerable cost-savings associated with sending survey data over mobile web rather than SMS
- GF should experiment with range of ICTs that improve CKWs' ability to share information, including projector phones and audio recording devices

Mobile Data Collection to Support Development of Products and Services for Smallholder Farmers

Overview

Currently, monitoring smallholder farmer activity, learning about their needs and demands, and tracking trends at the village level—for example, tracking disease, monitoring food security indicators, or documenting adoption of improved agriculture techniques—is usually an expensive and logistically challenging process and is conducted rarely as a result. Further, data collection is often time consuming, uncoordinated, and dependent on paper forms, which are prone to errors on several levels and ultimately limit livelihood opportunities of smallholder farmers:

1. Field data rarely gets collected at the farm-level, which limits a granular, high resolution analysis of village level agricultural events

2. Local agricultural service providers, and the farmers they serve, do not have access to real-time technical advice nor do they have the ability to accurately communicate field observations to remote agriculture specialists, limiting on-site decision making and rapid knowledge sharing

3. Currently, data collection conducted via the agriculture extension system is highly dependent on the training of extension officers, which in many cases is not monitored by the institution developing scientifically based technical advice and/or the data analysts—this threatens the integrity of information being collected

4. Collecting field data is usually a paper-based process which risks transcription error: pages get torn and dirty; handwriting is poor; data collection forms are not standardized or properly formatted for easy data input

5. All paper data forms have to be relayed from the field back to a central collection point—risking loss of data and leading to substantial lag between collection and analysis, making both data verification and analysis difficult

6. The data collected or information delivered is not geo-referenced (i.e. it does not have geographic coordinates linking data to the location where it is collected) so activities and events which the data describes cannot be easily followed up on, verified, spatially analyzed, or linked to targeted information dissemination

7. In most cases, the data collected is never input into a shared centralized database due to the enormous resource commitment required to do manual data entry, the lack of technological infrastructure, and/or the lack of dedicated, trained staff members. As a result, the various actors who need this information to better serve farmers, such as scientists, policy makers, project managers, GIS and data analysts, and other stakeholders, cannot access it. Data is either never analyzed at all, is done so in isolation, or sits with one organization rather than

being shared with multiple service providers where it can be analyzed from multiple angles. The result is the dissemination of untimely or incomplete technical advice to farmers or, often, no advice at all

8. Lack of low-cost data collection mechanisms means that private companies along the agriculture value chain incur additional costs and production losses due to information bottlenecks that lead companies to make decisions with incomplete information about farmer demand for products, market opportunities, and/or production forecasts

To address these problems, Grameen Foundation tested the feasibility of building a village level network of CKWs who serve as data collectors for a wide range of organizations and companies. Using mobile technologies, the CKW network can dramatically reduce the cost of collecting data, collect more granular and timely data, and increase the likelihood that data is analyzed and acted upon by linking it directly to a centralized database. GF used the Test of Concept to answer strategic questions related to the design of such a system. Questions focused on data quality and verification, mobile technologies, CKW training and capacity, survey design, incentive structure and business models, and demand for data collection.

Using a range of mobile technologies, CKWs collected data from rural communities in three unique surveys for four organizations: Uganda Commodity Exchange (UCE), World Food Program (WFP) and IITA (International Institute for Tropical Agriculture) in conjunction with Uganda's National Agricultural Research Organization (NARO). In addition, CKWs filled out a weekly customer satisfaction survey for GF and its partners on the AQB hotline product. Survey topics included crop production forecasting, SHF bulking and marketing behavior, market access, banana disease incidence, and knowledge of disease control methods. Surveys also provided demographic and baseline data on farmer households. Partner organizations provided sample survey questions and survey results were shared with partners at the conclusion of the survey. Our team trained the CKWs on survey methodology, taught them how to use the functions on the phone to complete surveys, and followed up with various monitoring activities to assess CKW capacity, evaluate accuracy of data collected, and improve data quality.

Grameen Foundation also interviewed leaders in mobile data collection to document best practices to achieve low-cost, high-quality data collection using mobile devices. In addition, GF interviewed a number of potential data consumers to assess demand for data collection and understand the data requirements of companies, research organizations, and other entities serving farmers. As this report focuses on pilot findings, these results will not be discussed in detail; however, Table 14 summarizes rural market data demand and the types of data which could be collected via the CKW network to meet this demand.

Results and Findings

By testing multiple surveys with various organizations who have a demand for rural market data (rural market data consumers), GF learned CKWs' capacity to collect different types of data and the challenges associated with each (See Table 15). CKWs conducted a total of 6,266 surveys, completing an average of 10 surveys per week during the pilot. GF analyzed survey data and results of its monitoring activities to draft recommendations on how to build a reliable, robust, and scalable data collection system (See Recommendations on Mobile Data Collection). Survey results also provided GF with additional insight on the needs and behaviors of SHF and these findings will be used to develop relevant information services that meet SHF demand.

Table 12: Rural Market Data Consumer Demand

Types of Rural Market Data Consumers	Categories of information	Examples
NGOs/ Humanitarian Organizations	• Agricultural data • Early warning data • General household data • Monitoring and evaluation	• Types of crops produced, yields, inputs used, prices, etc. • Crop disease/failure, pest infestation, disease • Health indicators, income, livelihood data, etc • Baseline data, number of participants, behavior change over time, final evaluations.
Private Sector	• Agricultural production for buying purposes • Agricultural input needs • Production techniques and adherence to quality standards • Consumer demand	• Types of crops produced, yields, quality, certifications (e.g., organic, Fair Trade) • Seeds, fertilizers, etc • Consumer preferences, ability to pay, brand recognition, etc
Governments/ Ministries	• Agricultural data • Early Warning data • General household data	• Types of crops produced, yields, inputs used, prices, etc. • Crop disease/failure, pest infestation, disease • Health indicators, income, livelihood data, etc.
Research Institutions	Any or all of the above, based upon the focus of research	Any or all of the above, based upon the focus of research

Table 13: Test of Concept Surveys

Topic	Partner	Technology	Period	Total no. of surveys	Average surveys / CKW /week
Crop Production Forecasting	Uganda Commodity Exchange	Coded SMS with multiple answers in a single SMS	March (4 Weeks)	1,934	12
AQB Customer Satisfaction	OpenMind	Single question/ answer SMS	Apr - May (5 weeks)	200	1
Crop Production and Marketing	World Food Program	Java form with photo	May - Jun (3 weeks)	1,141	10
Banana Disease Monitoring	IITA; NARO	Java form with photo and GPS	Jun - Aug (8 weeks)	2,991	10
Total				**6,266**	**10**

Technology Platform

Grameen Foundation is technology agnostic and aims to develop and utilize open source tools that deliver the widest benefit to poor. GF worked with a local technology vendor to build the pilot platform to meet multiple requirements. Our team was able to build information services, conduct data collection and analysis, and monitor, communicate with, and report on the CKW network all on a centralized platform.

CKWs surveyed smallholder farmers within their communities and sent the results directly to the CKW platform using their mobile phones. GF accessed the data via a web-interface where our team then analyzed and synthesized data and delivered results to interested third parties. The CKW technology platform provides the tools to collect data in a number of ways, including:

- Coded surveys where answers are coded in advance on a laminated card, which CKWs carry with them to interviews. Answers are submitted in a single SMS text message
- SMS conversations (or "ping pong") where GF sends out a message containing one survey question and CKWs reply with an SMS containing the response
- Java-based surveys which can accommodate images and which are sent over MTN mobile internet (GPRS). (GPRS does not require CKWs to connect to the internet via a browser to send survey data)
- Java-based surveys with GPS coordinates and other multi-media

Testing the above technologies revealed that there are substantial benefits to using java-form based surveys, including decreased opportunities for error; greater flexibility and specificity in questions; ability to include photos, GPS, and other multimedia; more user friendly interface that permits user prompts, messaging, and alerts; decision logic that can guide user through different survey branches or prompt user to revisit a contradictory reply; ability to accommodate longer surveys; remote updates; and lower data transmission costs. Our analysis and observations show that the advantages offered through the use of java-form based surveys far outweigh the slightly higher costs of java-enabled handsets ($55 at low-end) compared to basic hand-sets ($25) (See Table 16). We also found that CKWs preferred java surveys, which they found to be easier to complete and with which they experienced fewer failures when submitting surveys. For example,

if a CKW made a mistake entering the keyword for an SMS-coded surveys, the system would not recognize the survey.

Although GF began the pilot testing three handsets, including a high-end Nokia N-95 ($350), a Nokia 1680 ($55), and a Nokia 1200 ($25), by month three, GF switched out all Nokia 1200s for 1680s so that all CKWs could participate in java-based surveys. Our team documented the performance of different hand-sets to articulate the ideal CKW phone (See Recommendations on Mobile Phone Data Collection).

Table 14: Data Transmission Cost Analysis: Java versus SMS

Phone type	SMS/ survey	Surveys/ month	Cost/ survey	Cost/ Mo	Cost/ Mo USD
Basic Phone	3	40	330 UGX	13,200 UGX	$ 6.60
Phone type	**Kilobits/ survey**	**Surveys/ month**	**Cost/ survey**	**Cost/ Mo**	**Cost/ Mo USD**
Java Enabled	6	40	15 UGX	600 UGX	$ 0.30
Assumptions: UGX per USD = 2000. Phone Costs: Basic = $25, Java enabled = $55 Data Size (kilobit): SMS survey= 1, Java form survey (average = 50) Transmission cost (UGX): SMS (per message) = 110, GPRS (Per kilobit) = 2.5. Cost Savings per GPRS kilobit = 44					
Δ Basic Phone vs. Low-end Java: $30					
Δ Monthly data Transmission Costs of Basic Phone vs. Low-end Java: $6.30					
Break Even Point: 5 months					

Training, Support, and CKW Performance

Our CKW team trained CKWs on survey methodology, covering survey administration skills and etiquette, preventing bias, and probing techniques. We also taught CKWs how to use the various mobile survey tools. Our team trained CKWs on the simplest mobile survey tools first and progressively introduced more complex technologies and subject matter, culminating in the banana disease monitoring survey which included both photos and GPS coordinates. The banana disease monitoring survey was piloted as a Community Level Crop Disease Surveillance system. The survey enabled the CKW team to delve even deeper into mobile data collection by collecting surveys for multiple months, building more robust training, monitoring, and analysis components, and establishing deep partnerships with two agricultural research institutes (See Community Level Crop Disease Surveillance subproject).

While trainings effectively introduced the tools and questionnaires to the CKWs, one-on-one follow up was often necessary to troubleshoot technology problems and to guide CKWs through the process of conducting a survey in the field. While this is resource intensive and likely not scalable, GF observed that peer-to-peer support systems were effective in bringing poor performers up to speed and that with practice, CKWs were able to consistently collect complete, high-quality surveys. A number of techniques can be employed to support skill-building and improve data accuracy during and after survey trainings, including field-based demonstrations, extended trainings, built-in tips in survey application, decision logic in survey application to reduce errors and guide user behavior, and pre-loaded videos demonstrating survey techniques on phones.

Although CKWs at first found mobile data collection to be challenging, we found that over time they improved at troubleshooting technical issues, became comfortable navigating the different mobile survey functions on the phone, and submitted more complete and higher quality surveys. For example, during the banana disease monitoring survey, the CKW team compared survey

results from months 1 and 2 and found that on average survey completeness, or those surveys that answered all questions, included correct GPS coordinates, and attached photo of disease symptom improved. The pilot demonstrated that CKWs' survey skills improve with time and that training and support needs also decrease over time (See Monitoring and Evaluation).

Sample Results from CKW Surveys

The results below demonstrate the type of information CKWs can collect using their mobile phones and also demonstrate how this information could be used to improve the livelihoods of smallholder farmers.

WFP Crop Production and Marketing Survey Results

- Land Ownership: 57% of respondents owned less than 3 acres
- Top Three Crops Grown: (1) Beans, (2) Banana, and (3) Coffee
- Selling Crops: 30% of respondents sold more than half of their produce
- Top Three Uses of Income from Crop Sales: School fees (32%), Home expenses (19%), and Health (18%)
- Source of Market Information: Radio (39%); Internet (1 respondent out of over 1,000); Mobile phone (6%)
- Usefulness of Market Information: 76 % of farmers said price information was useful
- Quotes from Farmers on Why Information Was Useful:
  - "Because I sold as I heard"
  - "Comparison of prices for sale"
  - "Current price helped me to decide to sell or not to sell"
  - "Gave me a decision for farm gate price"

For Sample Results from the Community-Level Crop Disease Surveillance Sub-Project, please see the next chapter.

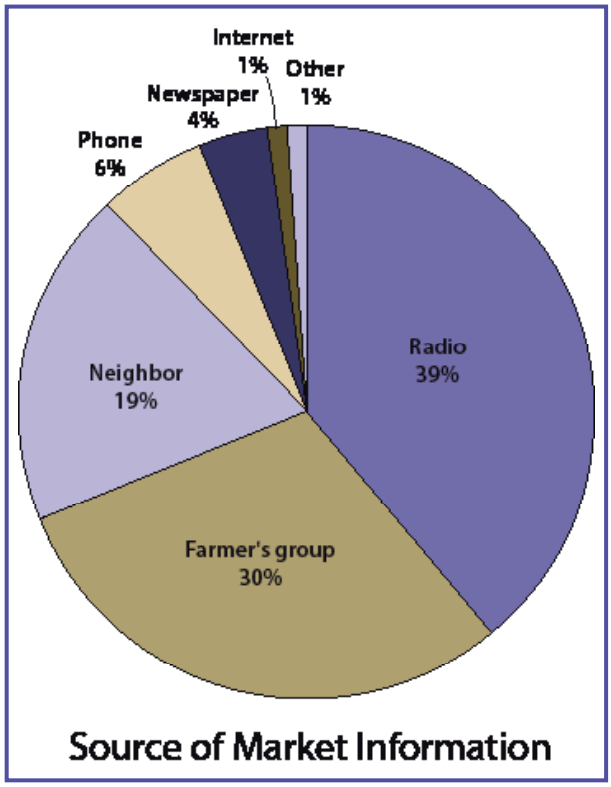


Figure 11: Source of market information for smallholder farmers

Challenges

While there is great potential for the CKW model to revolutionize rural data collection, there are substantial challenges associated with collecting high-quality, accurate data in a sustainable manner without creating bias or survey fatigue. During the pilot, GF documented these challenges and gained early insight on how to address them. GF will continue to test and improve the data collection system throughout Phase I of the follow-on project and will work with various experts to develop solutions (See Recommendations and Monitoring and Evaluation).

Key challenges witnessed during the Test of Concept:

- Farmers sometimes refuse to participate in surveys because they perceive that CKWs are "making money" off them
- Farmers are skeptical of a survey's purpose and either over or underestimate answers to questions about household assets leading to bias. For example, farmers underestimate land-holdings or annual income if they think that data will be used by the government to tax them
- Farmers often request compensation or incentives from CKWs to participate in surveys
- CKWs sometimes forget to send saved surveys leading to delay in analysis and late payment
- Intermittent network connectivity or areas in which no network is available led to challenges sending and updating surveys
- CKWs had to travel long distances to get to farmers which was time consuming and costly
- Photo quality was sometimes too low to be of value because the low cost mobile devices produced low resolution photos, CKWs were inexperienced in taking photos, and network capability associated with sending higher quality but larger image files was limited
- CKWs were not experienced as enumerators and didn't know how to "probe" for answers
- Acreage and household income information was notoriously difficult for CKWs to accurately collect
- For longer surveys, CKWs could only complete an average of three surveys before needing to recharge their phones
- Lack of QWERTY keyboards made text entry difficult and sometimes led to errors in entries

Recommendations on Mobile Data Collection

Mobile Survey Functionality

- For all but the simplest surveys, GF should use java form surveys because they are cheaper to send, can accommodate more questions and greater complexity, offer quality controls, and provide multimedia options such as photos and GPS coordinates
- Mobile survey capabilities should be expanded to provide the following functionality:
  - Alert CKWs when a question has not been answered
  - Provide tips at beginning and end of survey, reminding CKWs how to measure acreage, probe for answers, or save and send surveys
  - Automatically cross-reference answers and prompt CKW to revisit a question when answers are contradictory
- Surveys should accommodate more than one picture
- The mobile survey application should be more "user friendly," offering drop-down menus, automatic prompts if a user misses a question, the ability to navigate backwards to correct errors, and interviewer tips for individual questions
- Surveys should show only one question at a time and allow CKWs to click through survey to ensure that questions are not missed by scrolling

CKW Platform

- Adding, changing, or editing questions currently causes problems if mobile surveys are updated in one region and not another (resulting in all CKWs needing to update surveys simultaneously). Back-end features should inform all CKWs of survey updates, with instructions for new questions. The system should detect if the new survey has not been uploaded and alert the sender and our team if an old survey is submitted
- There should be a centralized troubleshooting messaging system where the CKW team, partners, and data analysts can report technology issues and where the database manager can go to resolve technology issues
- There should be a CKW helpline—either voice or SMS—to which CKWs can call/text their technology problems, questions about surveys, etc.
- The technology platform should include a filtering function that automatically filters incomplete, test, or duplicate data into a separate folder and sends an SMS alert to the sender when the survey is incomplete
- The platform should automatically "clean" all GPS coordinates so that they are in the preferred format and be able to identify and flag duplicate coordinates
- The CKW platform should also include a centralized location to report on CKW performance, technology, data quality issues, etc. A dedicated staff member should monitor posts and messages and prioritize follow up

Survey Design & Sample

- Survey questions should be provided in local languages to reduce the "lost in translation" error
- CKWs should complete a small baseline survey for each farmer and/or sign them up for the agricultural information channel to develop a national farmer databank. These baseline surveys should be linked to all subsequent surveys for that farmer on the backend
- Surveys questions include quantities of crops grown and/or livestock reared to understand the importance of individual crops/livestock for household income and food security

Data Verification & Quality

- GF should hire a dedicated "back-checker" in each region to re-administer surveys and these individuals should periodically be required to rotate regions to ensure the integrity of survey results
- CKW areas of operation must be large enough to cover multiple villages to reduce the opportunity for bias and reduce the need for a "back-checker" to visit each village to evaluate a single CKW
- All CKWs with GPS-enabled devices should be required to register their coordinates for every survey as an additional verification tool
- GF should set clear and strict consequences for data falsification and clear guidelines on data quality. Any CKW who intentionally falsifies data should be terminated and CKWs with poor data quality should be put on probation and offered additional support during this time period
- Re-administration of surveys should immediately follow original survey to minimize risk that responses vary because of changing agricultural conditions and to reduce recall error

Data Collection Incentives

- CKWs should be paid on a weekly basis so that the link between incentives and performance is clear
- GF should explore providing farmer incentives for survey participation to prevent survey fatigue but must be careful not to create bias or expectations in doing so
- Data collection incentives must be linked to information dissemination incentives to compensate for larger incentives received from data collection

Mobile Devices

- The ideal handset would cost under $100, be able to capture GPS coordinates, offer QWERTY keyboard for easy data entry, be java-enabled, and include a quality camera (and possibly projection capabilities)

Community Level Crop Disease Surveillance Sub-Project

Overview

An important challenge threatening the livelihoods of smallholder farmers in Africa is the gap between scientific research and farming practice on crop disease control. Farmers are frequently unaware of current and emerging threats and lack knowledge about how to identify and control diseases. Likewise, researchers lack mechanisms for disseminating up-to-date information to farmers and monitoring the uptake of disease management techniques at the community level. Further, it is difficult to collect timely, granular data on disease spread and the effectiveness of on-farm control methods. These information gaps permit disease epidemics that negatively impact crop yield and quality and ultimately food security and income at the household, community, and national levels. Through the CKW project, Grameen Foundation, in collaboration with multiple partners, developed and tested a Community Level Crop Disease Surveillance system (CLCDS). This sub-project of the CKW Initiative was funded through the Bill and Melinda Gates Foundation under the AgCommons Initiative's QuickWin Grant program.

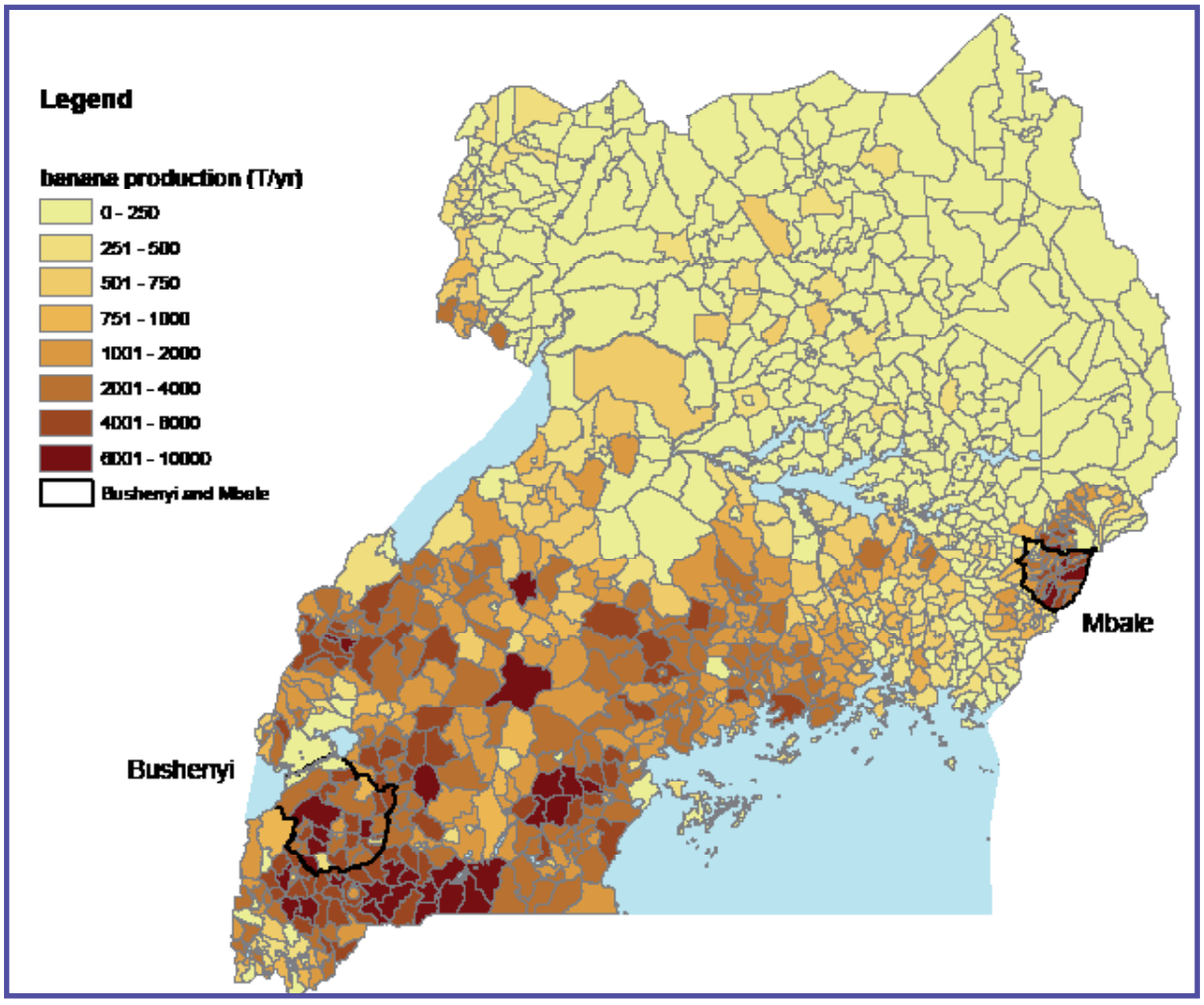


Figure 12: Banana production for Uganda (Bushenyi highlighted in SW, Mbale in E)

Approximately one-third of the bananas produced globally are grown in Sub-Saharan Africa, where the fruit provides more than 25% of food energy requirements for more than 100 million people (See Figure 25). In Uganda, a strong correlation exists between banana production, income generation, and food security. Despite the existence of advanced control techniques, a number of diseases have devastated Uganda's national banana trade sector and have jeopardized the livelihoods of more than 100 million people across Sub-Saharan Africa.
Food security and livelihoods of millions of people in Sub-Saharan Africa countries who cultivate banana are under severe threat from three banana diseases:

1. Panama disease also known as Fusarium Wilt
2. Banana Bacterial Wilt (BBW)
3. Banana Bunchy Top Disease (BBTD)

IITA and NARO performed economic evaluations of the impact of BBW and reported annual losses of between $70 million to $200 million USD for Uganda alone. Given this situation, Grameen Foundation partnered with IITA, Uganda's National Agriculture Research Organization, and MTN-Uganda to develop and test a Community Level Crop Disease Surveillance system blending the strength and effectiveness of a community-level knowledge network with the strong scientific input of the research community. This project serves as a case study for assessing the feasibility of a participatory GIS (Geographic Information System) enabled plant diagnostics network. Mobile phone applications, a centralized database, and GIS mapping were integrated to provide a blueprint for how a range of agriculture-focused field organizations can collect data, explain events, predict outcomes, and adapt and refine strategies with more accurate, cost-efficient, and timely information.

By combining the power of mobile tools, a centralized database, and GIS mapping, field surveillance can be directly linked to the research community to overcome the current gap in timely and comprehensive communication. Such a network of real-time information exchange can:

- Enhance scientists' ability to monitor crop disease outbreaks and disseminate information to farmers in remote areas where regular visits by extension agents and agricultural scientists may not be possible
- Decrease the spread of crop disease, especially in high-risk areas affected by endemic and emerging diseases
- Empower smallholder farmers to halt crop disease spread through access to timely information
- Enable agricultural experts to plan preventative measures in a cost and time-effective manner
- Permit scientists to target where to collect plant samples of new or suspicious disease reports (for subsequent confirmatory diagnosis in the laboratory)
- Enable scientists and extension agencies to determine the efficacy of recommended control measures

- Enable scientists to identify new variants of disease that may be resistant to existing control methods
- Enable scientists to prioritize research investment
- Provide policy makers and researchers direct information from smallholder farmers (SHF) to prioritize future investments and interventions based on quantified demand

A multi-disciplinary team, consisting of professionals in the fields of plant pathology, agriculture-based data analysis, geospatial information systems, information and communication technology (ICT), and agriculture extension, came together to test the CLCDS. Our team developed a technological system and process to enable CKWs to link to scientists to identify, map, monitor, and control banana disease within their communities. Select farmers were prioritized for on-site follow-up visits based on specific criteria such as presence of a new pathogen, areas of high crop disease concentration, and/or abnormalities in the data set submitted by a particular CKW. Each CKW was individually evaluated on subject matter knowledge, quality of data submitted, and ability to follow survey administration protocol to identify the ideal character profile of an effective CKW. The CLCDS was tested within the CKW pilot in Bushenyi and Mbale districts.

Results and Findings

Data Collection

Over the course of two months, 38 CKWs using mobile phones, MTN Mobile Internet, and GPS devices collected 2,991 surveys documenting the presence of three banana diseases in Mbale and Bushenyi districts. These surveys provided a substantial dataset showing the spatial distribution of banana disease incidence in CKW communities. In addition, CKWs gathered information on farm characteristics, farmer knowledge of control methods, and farmer demand for agriculture information using mobile survey tools.

CKWs followed a set data collection methodology when conducting surveys:

Step 1 Record farmer biometric and demographic information

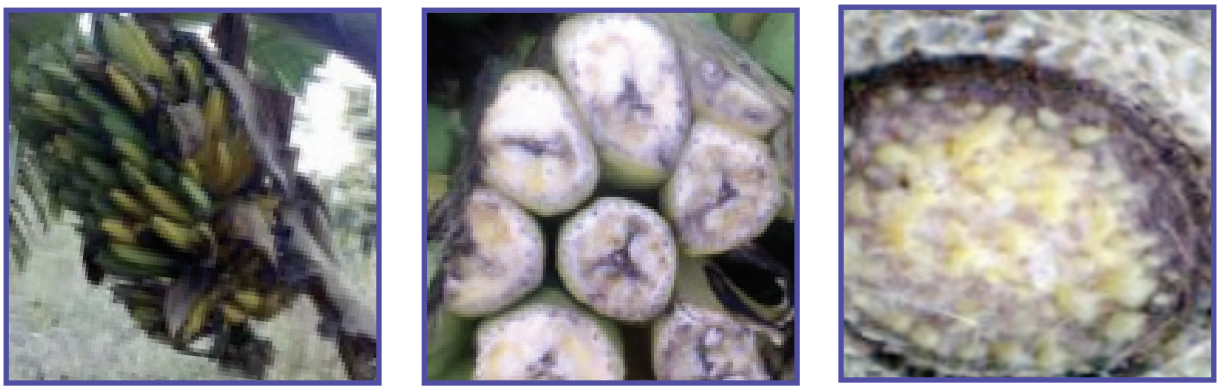
Step 2 Visit a diseased plant on the farm and carry out a systematic symptom identification process

Step 3 Take photographs of specific disease symptoms and attach photos to the surveys (See Figure 19)

Step 4 Tag all surveys with GPS coordinates

Step 5 Input information into the mobile phone survey application. (Many CKWs wrote answers on paper as they were conducting the survey and later entered the answers into the mobile phone)

Step 6 Save survey and send to CKW centralized database



CKW's photos of BBW symptoms:
1. Early maturing bunch, 2. Brown stains inside banana fingers, 3. Yellow ooze from cut pseudostems

Once CKWs submitted their surveys, scientists used a web-interface to view the database (housed on the CKW platform) and download survey results for analysis. Experts from IITA and NARO also carried out field visits to confirm a CKW's disease diagnosis. Our team of scientists viewed thousands of digital photos of disease symptoms which CKWs submitted with their surveys. These photos helped IITA and NARO decide which CKWs were accurately diagnosing plant diseases by cross referencing the picture with survey data gathered. This data also acted as a pillar of an early warning system. Scientists immediately followed up on surveys showing photos of mysterious symptoms or symptoms that suggested a plant was infected with BBTD. In cases where the CKW's diagnosis of a disease was not substantiated by the data or photos provided, IITA and NARO scientists conducted follow-up visits (See Figure 20).

Scientists taking plant sample to confirm a CKW's diagnosis

Sample Results from Banana Survey

Source of Planting Materials

In both districts, the majority of farmers sourced planting materials from their own farm or from other farmers (See Figure 21). This has important implications because of the way banana disease spreads. The suckers of infected plants do not necessarily show any disease symptoms, and as a result, infected planting materials are often a leading cause of disease spread. Further, farmers often use infected tools when transplanting or preparing planting materials. Using this information, organizations like NARO and NAADS can create targeted information campaigns that emphasize that banana diseases can be spread through infected planting materials. Likewise, this data shows that farmers either do not have information about sources of clean planting materials, such as government programs or suppliers, do not have access to these resources, or do not understand the value of using these resources to source planting materials.

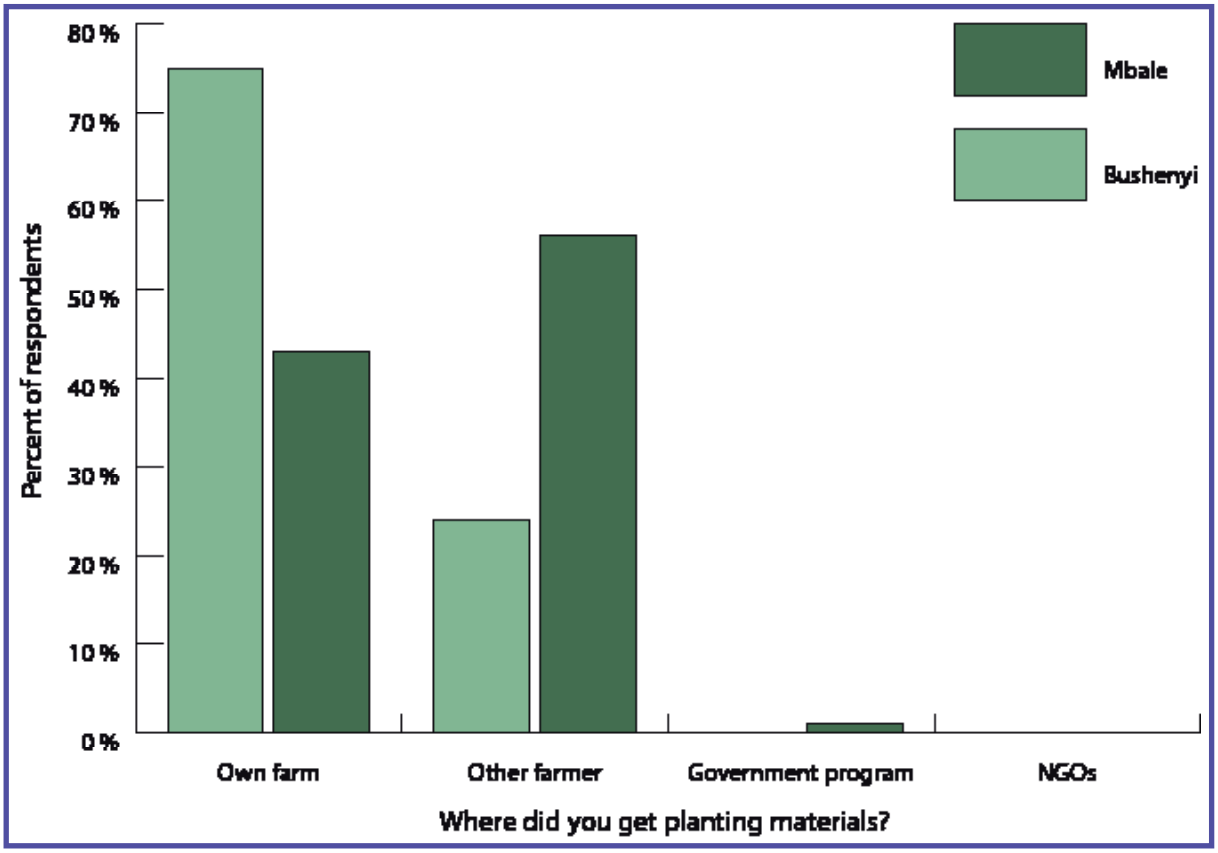


Figure 13: Source of banana planting materials

Farmers Knowledge of Diseases

Most farmers have heard of Banana Bacteria Wilt (BBW), the most devastating banana disease in the recent years in Uganda. More than half of the interviewed farmers (57%) had also heard of Panama Disease. Banana Bunchy Top Disease (BBTD) has not yet reached Uganda and less than 3% of the interviewed farmers reported that they had heard about this disease (probably from the CKWs). Knowledge of the symptoms of BBTD and how to control it was essentially zero. It is critical that extension organizations and research institutes understand and address farmers' lack of

knowledge about BBTD, as the spread of the disease from neighboring countries is imminent and its arrival could again devastate the banana sector. Despite the fact that scientists and government agencies are aware of the risk posed by the introduction of BBTD to Uganda, farmers do not have the information they need to identify the disease and prevent its establishment. This lack of knowledge highlights the high potential for the CKW system to improve information flows from agricultural specialists to farmers and vice versa.

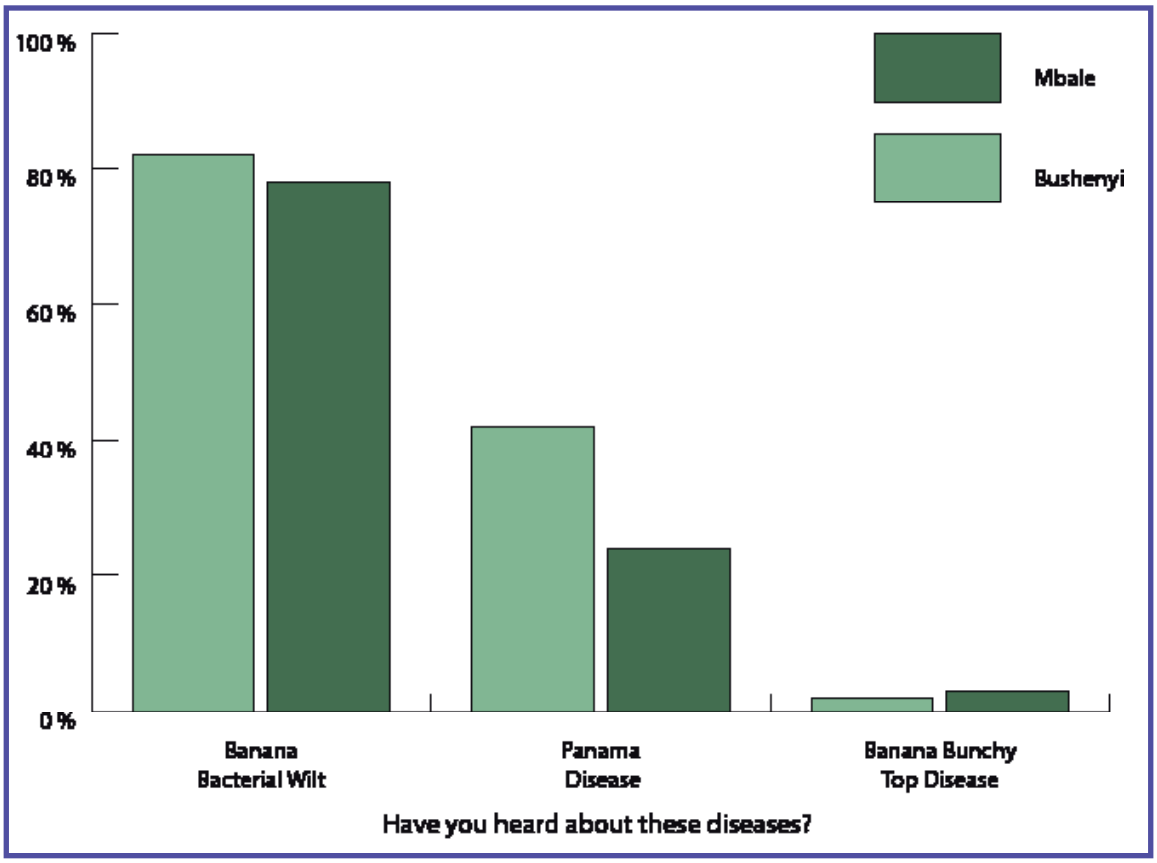


Figure 14: Percentage of farmers who have heard of BBW, Panama Disease or BBTD

The information gleaned from CKW pilot surveys can help inform not only the activities of our partners, but also provides GF with insight relevant for project design. For example, Figure 26 shows the percentage of survey respondents, (out of approximately 3,000) who own a phone or have a telephone contact while Figure 24 shows types of agricultural information farmers would like to see. This information demonstrates that CKWs have the potential to serve as an important channel to access information as many farmer households do not own phones. It also illustrates that farmers have a high demand for pest and disease information and this finding is corroborated by findings from AQB and other applications.

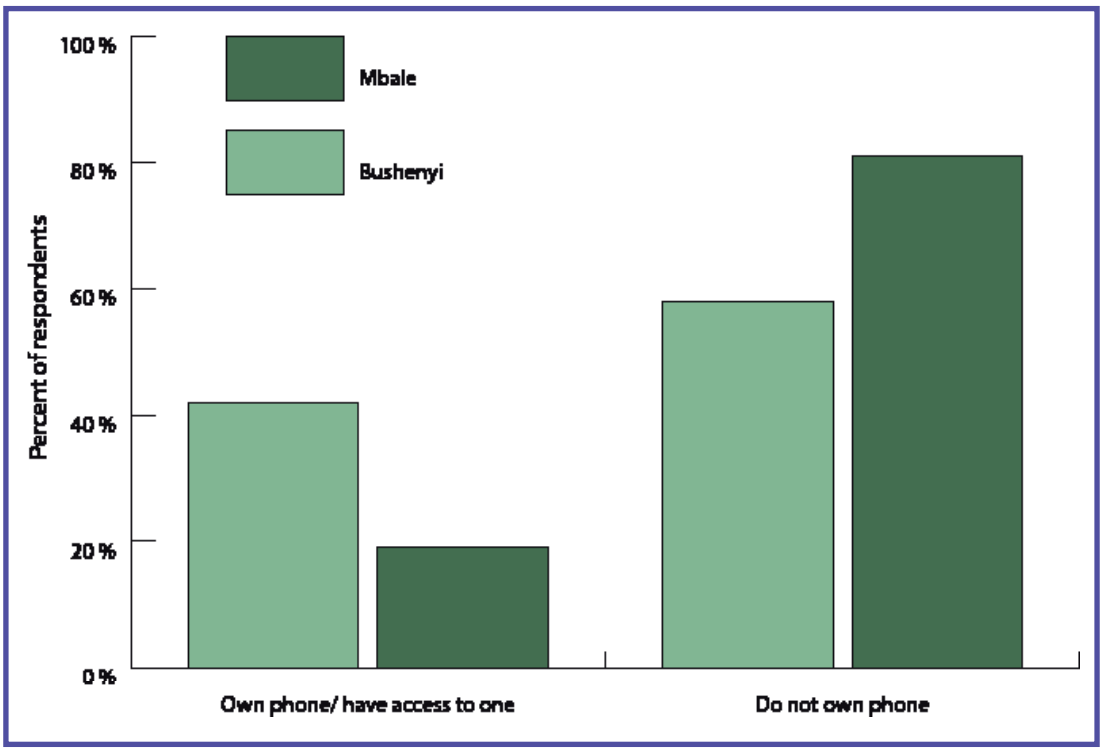


Figure 15: Number of households who own phones

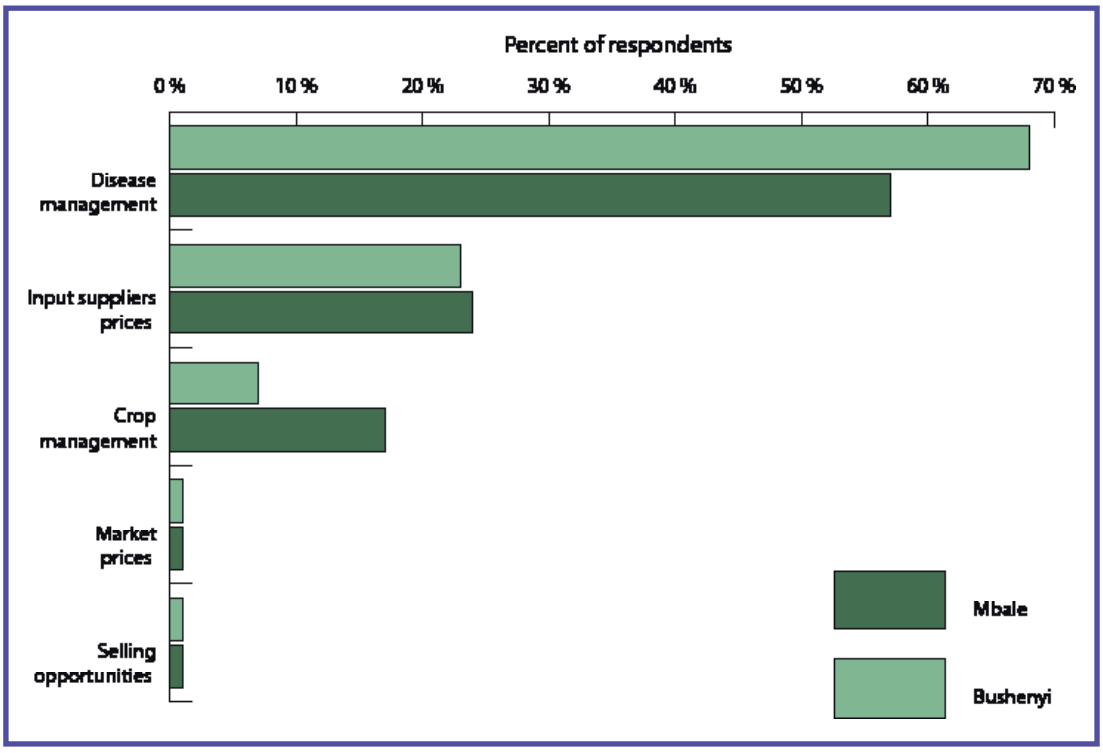


Figure 16: Farmers' demand for different types of agricultural information

Knowledge and Adoption of Disease Control Techniques

Results showed that despite a suite of campaigns in Uganda targeting BBW, farmers' knowledge of the disease's symptoms was not universally understood. Methods for controlling BBW were also not understood and were not being deployed. While many farmers were able to recall some control measures, most farmers were not practicing them due to the difficulty of implementation. Although many banana disease control measures are impractical or labor and/or time intensive, there are also a number of control methods that are practical and require far less labor.

Findings from the banana disease monitoring (BDM) survey illustrate that farmers in survey regions are much less likely to know the easiest control methods. This has a large impact on whether or not farmers adopt control measures.

For example, BBW is often spread when farmers manage banana plants (cutting dead leaves or harvesting, etc.) with tools that have not been sterilized. The recommendation to sterilize tools by placing them in fire is clearly not practical and has probably deterred farmers from using this method. Yet, farmers were most familiar with this method. The practice of surface sterilizing tools with old cloths soaked in diluted solutions of locally available bleach is more practical, but this method was not well known or being used among farmers. Farmers were also not using the recommended method of removing male flower buds to prevent insect transmission of BBW. This is surprising considering that it is perhaps the easiest control method to adopt. Farmers can use forked sticks rather than tools (machetes or knives) as they do not transfer the disease. These sticks are readily available on every farm as they are used to support banana plants as bunches develop to prevent stem breakage.

Banana transport

Further, the control method for BBW that farmers most widely understood was that of uprooting infected plants and burying them. The practice of uprooting infected plants will only occur if farmers are first familiar with the symptoms produced by BBW, which is obviously a current constraint based on findings on farmer knowledge of disease symptoms. Even when farmers do know disease symptoms, they will only adopt control measures if they appear to be practical and feasible. Early disease control campaigns recommended that farmers uproot and bury all diseased plants, which is clearly impractical, based on the time and effort requirement, and has therefore not been adopted. A much more practical and effective method is to uproot and chop plants into large pieces and allow these pieces to sun-dry, but farmers were not familiar with this method. Even in cases where infected plants had been removed, there was a lack of awareness that to keep a plantation disease free, clean planting material (suckers) must be used to replace infected plants, and suckers can only be planted after fields have been fallow for three months.

The current resurgence of BBW in Uganda is testament to the fact that previous initiatives have failed to impact farmer practice towards controlling this disease, largely because existing initiatives have not been able to communicate the most practical control methods to farmers, lack of continual surveillance, and dissemination of incomplete and infrequent information. These findings demonstrate the potential for using the CKW network and accompanying mobile tools and platform to provide a bidirectional information loop, which allows scientists and extension programs to communicate with farmers on a regular basis to curb the spread of disease and deliver widespread impact to SHF.

Information Dissemination

CKWs also trained all survey respondents in the CLCDS sub-project in scientific methods for banana disease detection, preventative measures, and control procedures. The first and most crucial step to controlling any crop disease is the correct and rapid identification of the disease. Only after a farmer has recognized the symptoms and identified the disease can he or she adopt the appropriate control methods. Thus, information dissemination is a critical component of the CLCDS. The knowledge transfer component of CLCDS was achieved through on-farm demonstrations and the distribution and explanation of visual, farmer reference guides targeting banana disease and pest management. CKWs physically demonstrated how to properly sterilize tools, prepare clean planting materials, remove the male bud using a forked stick and differentiate between various banana diseases symptoms and potential causes. By the end of the two month pilot period, CKWs had trained more than 3,000 farmers in the appropriate methods for banana disease identification, preventative measures, and control procedures. They also provided all survey respondents with a "Farmer Guide to Managing Banana Disease and Pests" which IITA developed and NARO translated into two local languages. This guide, along with hundreds of banana disease posters (also illustrating identification, prevention, and control themes), served several purposes:

- Explained how farmers could identify, prevent, and control banana disease and pests through visual illustrations and easy-to-follow instructions
- Rewarded farmers for their time in completing the survey
- Provided farmers with authoritative confirmation that the information CKWs were delivering was factual

- Enabled farmers to use reference material to answer questions that might arise in the future about other pests and diseases

- Increased information reach as farmers shared what they learned with their neighbors or relatives

GF also developed two unique technology tools to disseminate information on bananas. First, CKWs had access to a mobile phone application offering information on agronomic techniques for bananas, which, among other topics, provided tips on how to establish new plantations after adopting disease control measures. They also had access to the full suite of CKW information services, if the farmer had additional questions about other agriculture crops/issues outside of bananas.

In addition, the java survey application utilized decision logic so that the survey itself became a diagnostic tool. The survey application would use the responses given by a farmer during the survey to open a page on the phone browser at the conclusion of the survey (a "pop-up") which showed information on disease identification and control, including photographs illustrating disease symptoms (achieved by launching a hyperlink to internal text and image files). The internally stored files contained the specific control measures necessary to prevent the spread of the diagnosed banana disease. This functionality tested if real time data inputted into a "smart" survey could be used to mimic the decision making process made by experts when detecting banana disease and assigning the appropriate control measures. Although the diagnostic element of the tool functioned well, its usefulness as an outreach tool was limited because the size of the mobile screen made it cumbersome to review the material. As a result, CKWs preferred to use the printed reference guides. However, in the future, in the absence of print materials, (for example when print materials have been exhausted, lost, or deemed too costly to print) CKWs could reference the material on the phone.

Finally, CKWs were able to access a panel of agriculture specialists from IITA and NARO who verified CKW diagnoses, answered CKW questions and requests for additional information, and offered support in cases where the CKW identified an abnormality and was either unable to diagnose the disease or suspected that the disease was BBTD. Through follow-up visits, the scientist reinforced the CKW's role as a knowledge agent in the community, verified presence of a disease, and evaluated the adoption of control practices.

Mapping and Findings from Geospatial Analyses

The aim of the CLCDS project was to assess the feasibility of using a village-level network of information officers equipped with mobile phones and GPS devices (sometimes integrated into the phone) to conduct participatory GIS mapping to combat the spread of crop diseases. Our hypothesis was that by training and equipping village-level CKWs with a GPS device and a two-way information channel, scientists could map disease incidence, and over time, better understand the spread of diseases, the adoption rate of control techniques in different geographies, and how these and many other factors intersect to impact farmers livelihoods. Scientists could then use this information to prioritize actions and communicate recommendations back to farmers via the CKW channel. Because all data collected though this model is geo-referenced, or linked to a specific location through GPS (Global Positioning System) coordinates, scientists are able to analyze it on many levels, enabling them to spatially overlay a number of interacting variables to determine how disease spreads and the factors influencing the success of control campaigns. By conducting

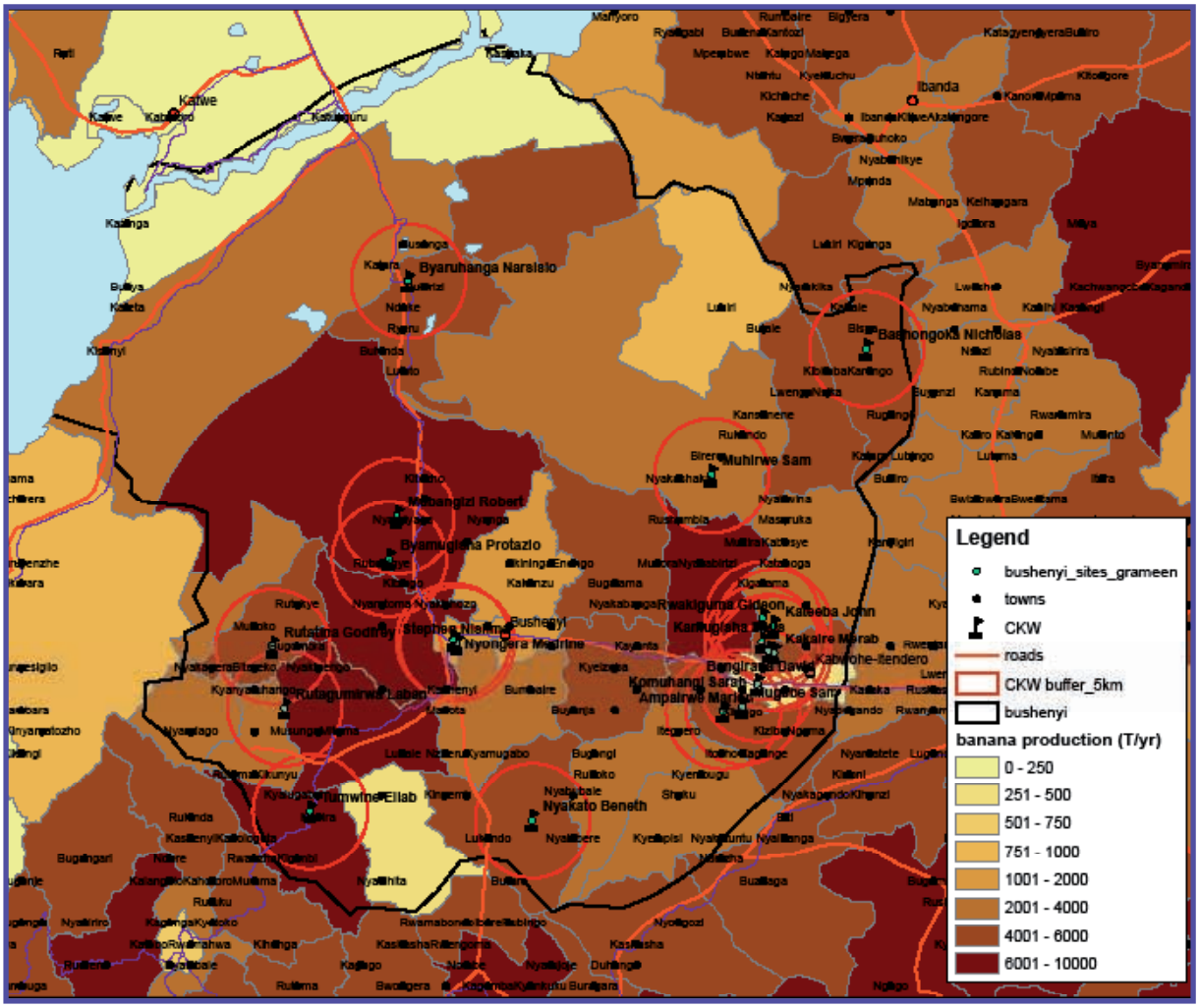


Figure 17: CKWs surveys overlaid on banana production in Bushenyi

geospatial analyses on survey results, it is possible to make predictions and then plan and prioritize according to these predictions. For example, the caloric intake of a certain crop can be overlaid against disease incidence to evaluate a disease's potential threat to food security in different regions. The project provided many important findings on how to design a participatory GIS, mediated by CKWs, for crop disease monitoring and control and highlighted challenges associated with implementing such a model.

The GPS data enables a number of analyses that otherwise would not have been possible including: mapping CKW reach, mapping disease incidence, overlaying the results of scientist follow-up visits and lab analyses to original CKW diagnosis, and comparing results and CKW reach during months one and two. In addition, the GPS coordinates enabled our team of scientists to return to the precise location of a survey to conduct a follow-up visit.

IITA's GIS unit conducted GIS analyses and developed accompanying maps under each project phase:

1. During the planning phase, IITA developed maps showing the physical geography and population density of each pilot district. Normally these maps would serve as a tool to develop a sampling plan but, because of the timing of the project, CKWs were selected before the CLCDS project began. In an ideal scenario, these maps would have been

used to develop a sampling plan to select CKWs so that the data they collected could be overlaid with a range of other data and compared according to variables such as elevation, precipitation, population density, and/or level of cultivation

2. During the implementation phase, maps showed results (by disease) for each CKW, showing the geospatial distribution of the three different diseases and the area a CKW covered. During this phase, IITA GIS specialists also created maps showing farms selected for follow-up as well as the results of the visits

3. At the close of the pilot, results from the first and second months were combined to highlight differences between the two months

Within two months, the coordinates of 1442 farms in the Bushenyi and 1549 farms in Mbale district were recorded and mapped (See Figures 18 and 19). The colored dots indicate surveys conducted by the various CKWs.

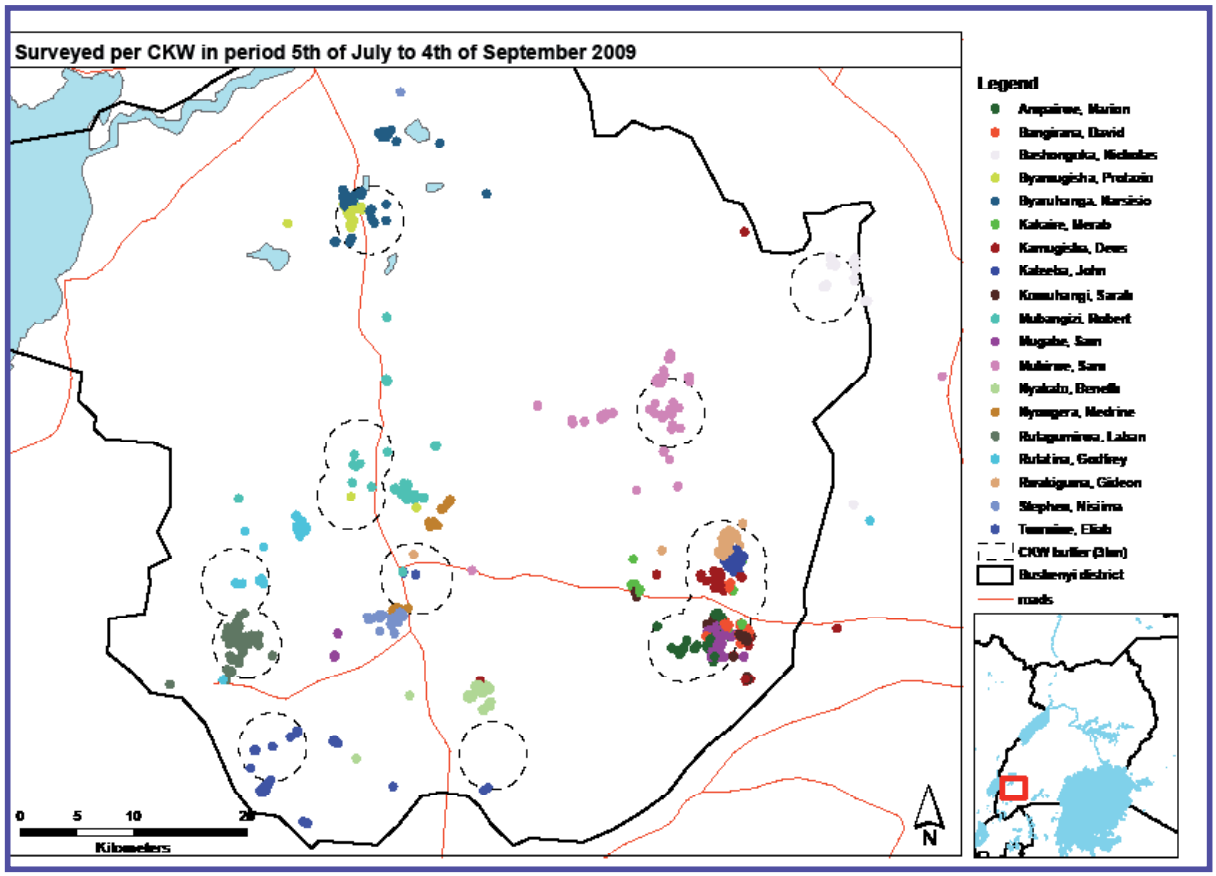


Figure 18: CKW Banana disease surveys in Bushenyi

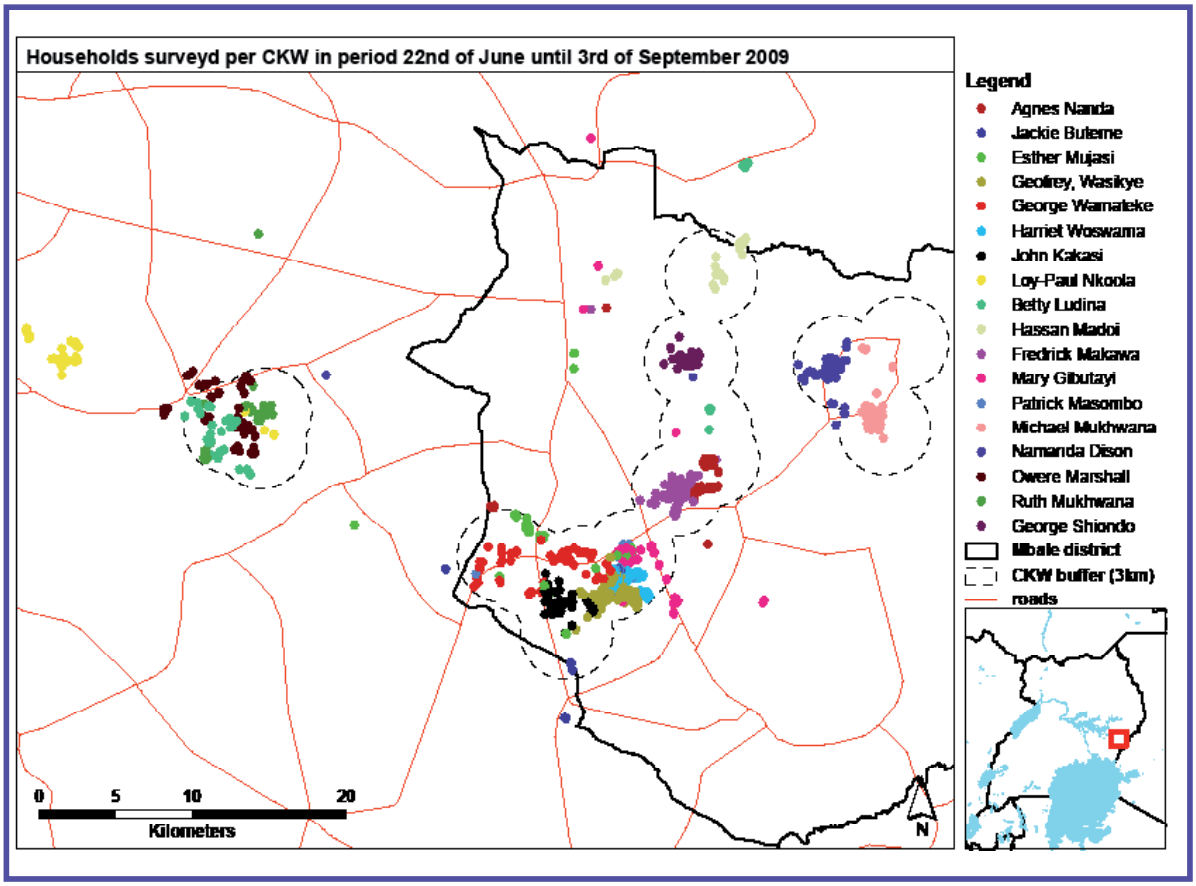


Figure 19: CKW Banana disease surveys in Mbale

Challenges

- The CKW Initiative predated the CLCDS project and CKWs had already been selected and operating before the CLCDS began planning activities. As a result, geospatial distribution was not a criterion in CKW selection. CKWs were often clustered or, conversely, very widely spread, leading to an uneven distribution that affected our team's ability to carry out meaningful geospatial analyses

- Not all CKWs had GPS-enabled phones, meaning that they had to take a reading from a GPS unit, write it on paper, and then input coordinates into the phone. This process opened up opportunities for transcription errors

- Many CKWs also struggled with the GPS units—sometimes they would inadvertently change the setting on the device, enter previously saved coordinates (ultimately entering the same coordinate set for two surveys), or misread the coordinates. This was especially problematic during the first month. Our team was able to identify these errors and either contacted CKWs to get correct coordinates or manually changed the coordinates to the appropriate format. This manual cleaning of data was extremely cumbersome and time consuming

- Only towards the end of the project was it possible for all three partners to access the data via the web-interface. As a result, data was sent back and forth electronically leading to issues around version control and challenges associated with sending large files

- Our team initially planned to develop maps showing disease incidence overlaid with historical, demographic, and other data but found that many research institutions were

- either not willing to share data or that no data had ever been collected, limiting the type of analysis that could be done

- One of the aims of the project was to get much more granular data from rural communities. For example, a similar study of disease incidence by NARO provided an average of 60 observations per district—or less than the number of observations completed by one CKW during the CLCDS project. It is not surprising that another obstacle to analysis was lack of data at the community level. It was difficult to overlay demographic, agriculture, and other data in a meaningful way because even when such data did exist, it was not granular enough show variation at the village level

Ester and David in cleared banana field

To destroy infected plants was one of the control methods CKWs advised farmers on during the banana disease survey

Mobile Service: Banana Disease Monitoring Survey

Behavior shift *Adoption of disease control techniques*
CKW *Joseph Nashimola*
Organization *NAADS*
District *Mbale*

Impact

Joseph is a beekeeper and he used to refuse to cut the male buds off of his banana plants as he feared that this would hurt his honey production. Through his work on CLCDS, he learned not only the importance of removing male buds for fighting disease, but also the correct technique for doing so.

In the past, information dissemination was inconsistent and farmers often received only partial information as it was passed mouth to mouth from farmer to farmer. For example, many farmers would cut off the male buds using a machete but would spread the disease to their other plants through the dirty blade, leading to total crop loss. As a result, some farmers don't trust this approach as a way to fight disease. CKWs help to solve this problem by providing consistent information directly from scientists to farmers using their training materials, phone, and one-on-one survey visits.

Joseph managed to overcome farmer skepticism by displaying charts that clearly demonstrate how the disease is spread and by accompanying farmers as they remove the male buds with a forked stick. In addition, farmers trust the technique because they see Joseph using it in his own fields. By adopting this technique, farmers are limiting their losses due to banana disease.

Recommendations Based on CLCDS Experience

CKW Network

- Target CKW recruitment to ensure geospatial distribution to maximize spatial uniformity of CKW area of operation. Uniform distribution will assure that observations cover a region and are not clustered in specific areas for geospatial and temporal analysis
- Add a geospatial module to training curriculum so CKWs understand the basics of geographical positioning
- Train on measuring acreage and estimating severity to expand data analysis possibilities

Project Sample & Survey Design

- To ensure meaningful geospatial analysis, the following steps should be used to define sample design:
  - Define target variable
  - Define desired results
  - Determine geographic area of interest
  - Consider transportation, budgetary, and other constraints
  - Consider availability of other data
  - Redefine desired results based on feasibility assessment from steps 4/5
  - Select spatially uniform CKW sample based on outputs of steps 1-6
- Add an accurate severity measurement to the questionnaire
- Reduce survey length and break survey into multiple parts that are administered only when relevant to reduce survey fatigue
- Require CKWs to enter precise numbers, using free-form text, for acreage and severity measures instead of selecting from number ranges
- Develop surveys with help of agriculture research survey design experts

Analysis

- Overlay GIS disease distribution maps with other data such as demographics, crop distribution, growing conditions, farming practices, calorific dependency on certain crops, and other biophysical and socioeconomic data to do predictive sensing of disease spread and risk in various locations
- Spatially correlate the incidence/severity of diseases to other geographic data (geophysical and social economic). Data from latest census at sub-county level would allow for the analysis of more spatial correlations
- Identify travel time to closest location of clean planting materials to determine access costs and feed this information back to farmers via CKWs
- Track and map CKW outreach efforts as well as existing agriculture extension efforts

Technology

- GPS should be an integrated function in the phone to reduce human error in transferring data into the mobile survey application
- Back end functionality should allow GPS data to translate to district, sub-county, parish, and village names to reduce CKW work load and the errors in transcription.
- Digital cameras on mobile phones should have adequate picture quality to decipher plant disease symptoms
- CKWs should be able to edit saved surveys both before and after submitting surveys to ensure that surveys can be updated to submit missing data
- Database should be integrated with an easy-to-navigate and user friendly website so that analyzed data can be disseminated for public consumption

Monitoring & Evaluation

Overview

Due to the short period of the pilot, GF did not carry out a base-line or formal impact assessment. However, the pilot set out to identify mechanisms through which the CKW model could promote behavioral shifts that would lead to impact over time. GF carried out a wide range of activities to identify these behavioral shifts. Our team utilized the following measures and assessments to monitor project progress and better understand CKW and farmer experiences with the pilot:

- Application usage reports for each CKW
- CKW performance reports, CKW and farmer observation, and case studies by GF field officers
- 129 follow-up visits by NARO and IITA scientists under the CLCDS project
- Field samples and lab analyses to determine accuracy of banana disease monitoring data
- CKW written and mobile exams
- Field demonstration of banana disease monitoring survey for field supervisor by each CKW
- Field research with CKWs and their clients
- Re-administration of at least four surveys for each CKW and comparison of results with originals
- More than 20 focus groups with CKWs and their clients

Through these activities GF learned the potential impact of CKW services, challenges CKWs face in their work, and demand for different types of information. GF also identified socio-economic factors that should be considered when recruiting CKWs and developing impact targets and gained insight on what motivates CKWs, accuracy of CKW data collection, and what type of data is most straightforward and challenging for CKWs to collect.

Results & Findings

Impact and Social Equality

The potential for CKW activities to deliver impact in the communities where they work is high and multiple M&E channels documented that CKWs and their clients act on the information delivered through the CKW channel. For example, field researchers visited David, a randomly selected client of Ester, a CKW in Mbale, to re-administer a survey. David had 5 acres of matooke (banana), but half of his plantation was infected with banana bacteria wilt. He had earlier consulted Esther on how to deal with the sick banana plants, and Esther carried out the banana disease monitoring survey and instructed him on disease control techniques. Ester informed David that he must destroy all sick plants to preserve the rest of his plantation. When the field researchers visited David to re-administer the survey, they found him cutting down the sick banana plants. By the time they arrived, he had already cut down about an acre of his banana plantation. The photograph shows David standing in the area where he had cleared the sick banana plants. Other examples can be found throughout the report in the Impact Example Boxes.

Similarly, a team of scientists from NARO and IITA carried out 129 follow-up visits with CKW survey respondents and found that at least some disease control measures had been adopted in almost every case. During these follow-up visits, scientists also polled farmers to compare the agriculture extension services provided by CKWs with those of the existing agriculture extension services. Farmers unanimously answered that there was no comparison, because their local agriculture officer had never personally visited their farm to collect information or give actionable, customized advice. Furthermore, most farmers interviewed did not know how to contact their local agriculture extension officer (often stating that they had never seen such a person visiting their village). This finding highlights the important of the CKW outreach method in which extension is carried out through trusted community members whom villagers can seek out in the market, the garden, at a wedding or some other social function to ask advice. Moving forward, GF will need to ensure that this model is integrated with the existing extension system so that CKWs strengthen the national agricultural extension framework.

Through focus groups and field research GF explored the socio-economic status of CKWs and their clients to better understand the profile of a CKW, assess if CKWs are reaching the poor, and evaluate the risk for elite capture.

CKW Characteristics

All CKWs stated that their most important livelihood is subsistence farming. A few CKWs also held positions with other organizations, owned inputs shops, or worked with rural savings and loans cooperatives or banks. Others were retired government officials or teachers. Thus, CKWs are almost always farmers but often bring additional skills built through other professions or roles in the community, to their CKW activities.

CKWs in Bushenyi appeared to be slightly wealthier than those in Mbale, having larger land-holdings and nicer houses on average. This will be relevant as we expand to new districts where lower or higher incidence of poverty may affect incentives CKWs need to complete activities or the skill set they bring to the job.

Almost all CKWs had completed secondary education, which is not surprising since fluency in English was a pre-requisite for participation in the program. But those with secondary education performed much better than those who had not.

CKWs tended to have higher levels of education, own more land, and have homes made of improved building materials when compared with the average farmer in their village. This suggests that CKWs are of a higher socio-economic class than the average farmer and raises questions about the risk of exacerbating intra-village socio-economic disparity and elite capture. While we observed CKWs reaching out to many types of farmers, it will be important to address these risks in the design of the scaled project and use metrics to understand if we are successful in mitigating these risks.

CKW Client Characteristics

CKW clients vary in age, gender, and occupation. CKWs report that many of their clients are between the ages of 15 and 35. This is likely because people in this age range are most actively engaged in agriculture—either offering labor in other people's gardens or tending to their own gardens. In addition, youth easily learned and embraced the mobile delivery channel of CKWs services. Rwakiguma, a CKW from Bushenyi noted that: "Most of the people who came to me to use the AQB service are the youth because the youth quickly understand how it works when I explain it to them."

More research needs to be done to assess whether CKWs are reaching the poorest and most disadvantaged farmers. CKWs gave many examples of traveling to remote areas to assist farmers who otherwise wouldn't have access to information and also described how poorer individuals in their villages would seek them out to ask questions about disease treatment or market price information. However, they also distinguished between the "active" and "non-active" poor and seemed to believe that the non-active poor were hopeless.

CKW Outreach

Researchers selected random farmers in CKW villages to assess how well the farmers know their local CKWs. The farmers interviewed were familiar with CKW services, an indication that the services are popular and that people find it easy to approach CKWs.

In field interviews, all CKWs interviewed (12/12 interviewed on this particular topic), had been back to visit the clients to whom they had disseminated information to the week prior. They reported that they frequently follow-up with clients to assess whether they are acting on the information, to see if they can assist farmers, and assess what the results are. In a number of cases, CKWs described how after they gave a farmer information, they also helped the farmer locate the materials needed to act on the recommendation. (GF never emphasized that CKWs should conduct any follow-up with clients, but CKWs were doing it of their own accord).

For example, George Wamatke, a CKW in Mbale, explained that he had visited a farmer to conduct a survey and found that his mango trees were being attacked by a fungus. George offered to call AQB, the agricultural hotline, about the problem. The question was escalated to the AQB agricultural expert and when the answer came back George told the farmer of a chemical he could spray to address the problem. The farmer wasn't able to go to the trading center to look for the chemical so George went for him, found the chemical, bought it and returned it to the farmer who then paid George and sprayed his trees. Both George and the farmer were excited that there was a

solution to the problem and that they could purchase the needed chemical in the trading center near their village.

Gender

Women faced significantly higher barriers to becoming CKWs, including: generally having lower levels of education; lower likelihood of being fluent in English; higher agricultural labor demands meaning that they are less likely to have experience in community development or be exposed to CKW nominating organizations; and greater household responsibilities which lower ability to attend recruitment sessions.

A Day in the Life of a Female CKW

CKW *Agnes Nandaha*
Organization *NAADS*
District *Mbale*

5am Agnes wakes up and goes to "dig in the garden," taking care of all tasks associated with planting, weeding, pruning, and maintaining the family crops, which include those for household consumption as well as those for sale in the market.

9am She returns to the house to cut grass for the cow, fetches water for the cow and her family, cleans the house, and looks for the day's food.

12pm Agnes prepares meals for her retired husband and the orphan children under their care.

2pm Agnes leaves the house to go conduct her surveys and share information services.

5pm The female children prepare supper, and Agnes goes to the trading center to relax and socialize.

Women also faced additional challenges and costs compared to their male counterparts once they became CKWs. For example, all female CKWs stated that they shared the airtime they received from the project with their husbands and most gave a portion of their earnings to their husbands. Female CKWs also had to complete work in the garden, cook morning and mid-day meals, take care of children, and complete housework before heading out to conduct surveys or offer information services. Most women CKWs didn't know how to or don't see it as socially acceptable to ride a bicycle, necessitating them to hire someone to pedal the bicycle while they sat as passengers to conduct surveys. Women sometimes also had to hire labor to work in their gardens so that they could travel to conduct surveys. Some female CKWs had small children and were dependent upon the availability of relatives for childcare, thereby limiting the number of surveys they could do in a week; for example, Jackie, a CKW and young mother in Mbale, had to wait until her 8 year old sister arrived home from school to watch her infant son so she could carry out her CKW activities. Occasionally, husbands were jealous of their wives' phones or the extra status they had gained in

the community. However, on the whole, women CKWs stated that their husbands were supportive of their participation and reported that they enjoyed the work, the opportunity to go outside the home with a purpose, assisting their communities, and the status they gained from their role as a CKW.

CKWs gave contradictory reports regarding the percentage of female clients they served. Some CKWs indicated that the majority of their clients were female and attributed this to the fact that women are the ones primarily responsible for agricultural work and are less likely to own their own phones. However, other CKWs stated that the majority of their clients were male and suggested that this is because male CKWs are more frequently in the company of men and find it easier to interact with male members of their community at trading centers and other social forums. These findings demonstrate the importance of developing a clear strategy for ensuring gender equity and suggest that there should be an equal split of male and female CKWs to ensure that female farmers also appreciate benefits of CKW services and that women can take advantage of the opportunity to become a CKW.

Mobile Data Collection

Field officers were originally tasked with re-administering 5% of surveys for each CKW to evaluate CKW performance as enumerators. Although field officers conducted follow-up surveys for the first SMS survey for Uganda Commodity Exchange, GF quickly realized that the re-administration of surveys was both time intensive and time sensitive. For example, it takes considerable time to relocate a survey respondent and field officers would often travel with the CKW to find the individual, thereby reducing the validity of the exercise. Field officers had neither the time nor the training as enumerators to conduct follow-up surveys. As a result, GF hired research consultants to re-administer surveys for the last two surveys (for WFP and IITA). These consultants randomly selected two WFP surveys and one banana disease monitoring survey to re-administer for each CKW. In addition, a team of scientists from NARO and IITA conducted 129 follow-up visits to check data and evaluate if CKWs had accurately diagnosed the banana disease. Finally, through field visits and focus groups, GF solicited feedback on application performance and preferences for different technologies.

Data Accuracy

Data accuracy was measured by comparing the consistency between original and re-administered survey responses and correct disease diagnosis based on lab analysis and scientists' verification field visits. GF found that CKWs effectively collected observational data such as disease symptoms. CKWs accurately identified banana disease symptoms but this may reflect the targeted training CKWs received in banana disease identification compared to other topic areas such as estimating acreage. In addition, GF compared the survey results collected by CKWs under CLCDS with existing (comparable) survey data from NARO and found that reported incident rates were quite similar. Straightforward questions with little opportunity for misinterpretation, such as crops grown or demographic information such as head of household, were consistently accurate, suggesting that variations in accuracy in other areas probably relate to a CKW's ability as enumerator rather than to carelessness or intentional data falsification.

CKWs struggled to collect information on income—it's unclear if this is because respondents do not want to disclose that data to a "peer" whom they may know or if it is due to the difficulty associated with estimating annual household income. Comparing the responses in the re-administered survey with the responses of the surveys administered by the CKWs, clients generally gave professional enumerators higher earnings figures than those they gave the CKWs. Both CKWs and clients had a

problem estimating the percentages of crops the clients sold in the last season. This may be partly because most people in rural areas do not use percentages in calculations and few farmers in rural areas keep records of what they have sold or how much they earned—which means that these types of questions required extra probing and explaining on the part of enumerators to get an "accurate" answer.

Similarly, CKWs consistently struggled to estimate acreage, with serious implications for potential to collect disease severity data, production estimates, and other data that depends on acreage measures to complete analysis. In re-administered surveys, a number of respondents reported that they own or farmed more acres of land when compared to the responses they gave the CKWs. This problem may be partly due to the fact that CKWs were asking clients to estimate the land they owned using acres as a unit of measurement whereas professional enumerators were able to use units farmers were familiar with and translate these back to acres.

Data Verification

Early surveys included insufficient bio-data making it extremely difficult to locate respondents and thereby limiting our ability to follow up with respondents to re-administer surveys. Because survey re-administration was time consuming and field officers did not have the time to focus on this activity, significant time elapsed between the time the survey was originally administered and the time it was re-administered. As a result, it was difficult to assess if inconsistencies in survey responses were due to a change in circumstance or due to the enumerator's ability to solicit the "correct" answer. For example, some surveys asked farmers to project crop production; because surveys were re-administered closer to harvest time, inconsistencies in responses could reflect a change in the farmer's production estimate rather than a difference in surveying technique or skill.

CKW Characteristics in Relation to Their Performance as Enumerators

People with low education levels, specifically those who never completed secondary education, seemed to struggle to understand the meaning of some questions. It's unclear whether this was due to lack of fluency in English or lower level of education more generally. As a result, these CKWs wrongly interpreted the questions to respondents and respondents in turn provided the wrong answers, increasing the error rate. CKWs with higher education levels appeared to be more confident and conducted more surveys per week than less educated CKWs. However, those who had high levels of education but who also had demanding professions tended to be very busy and, in addition to completing fewer surveys, also often had higher levels of inaccurate surveys (presumably because they rushed through the survey).

Survey Design

On longer surveys, survey fatigue seemed to be an issue and some questions were not answered completely or at all. Survey questions that required CKWs to give in-depth explanations of a concept before farmers could answer the questions, led to high levels of error. For example, a question on the banana disease monitoring survey asked farmers to estimate their production for "bumper" and "scarcity" crops. CKWs and respondents alike struggled with these concepts and often confused them, leading to answers that were inconsistent with logic.

CKW Feedback on Data Collection Experience

At times, farmers were not willing to participate in surveys because they perceived that CKWs were using them to make money. However, there was high demand for banana disease monitoring surveys because the knowledge farmers gained on disease control through participating in the survey had the immediate tangible benefit of reduced crop losses. Due to this high demand, CKWs often traveled as far as 10km to conduct surveys to meet farmer requests. In other instances, CKWs

felt compelled to get the best quality surveys and would travel these distances to find farmers growing all the crops targeted in a survey. As a result, transport costs and logistics were one of the largest obstacles facing CKWs. In areas where network quality was poor CKWs struggled to contact field officers to request clarification or troubleshoot technology problems, affecting the quality of their answers. This also made it harder to follow up on these surveys as CKWs sometimes had to wait multiple days before they had connectivity to send surveys.

Business Model and Incentives

Farmer Willingness to Pay and Charging for CKW Services

In interviews with CKW clients, most respondents noted that the information CKWs are providing is very useful and that they would be willing to pay something for it. However, they also emphasized that many people in the rural areas would not be able to afford to pay if the fee was too high. Out of the 38 CKWs interviewed, only 3 had attempted charging clients for the CKW services. GF neither prohibited nor prodded CKWs to charge farmers for services.

CKWs on Charging for Services

I came up with the idea of charging some clients for the services I offer because I realized many people were coming to me to access the services and in the end my phone would run out of battery and I would spend money to charge the battery and so I had to find a way to offset that cost. But I don't charge every one, I charge those I know can afford to pay, and it is mainly on AQB.
Ludina Betty, Mbale

There are people who used to come to me to seek information, especially on 6001 and after I have given them the answer, they would ask me if they needed to pay. At first I said no, but over time, I decided to let them pay.
Nicholas Bashongoka, Bushenyi

Income Generating Opportunities

CKWs earned anywhere from $10-$70 per month through survey payments. The amount CKWs earned depended on the compensation offered for a particular survey (which was calculated based on the anticipated time required to complete the survey), the number of surveys conducted, and the number of surveys which met quality and completeness standards. CKWs were expected to cover their own transportation costs, although all received bicycles as part of the program. When talking about survey payments, CKWs would couch the discussion in terms of the "very little" they earn. There were notable differences between the two districts in that regard, with those in Bushenyi often asking for additional "facilitation" monies to conduct activities and sometimes

stating that the survey payments were not sufficient. Despite this feedback, research shows that the financial incentives should have been quite substantial as 85% of Uganda's SHF live on under $2/day, and the cash flows that they do receive are quite irregular due to the nature of agricultural seasons. For example, using the survey payment figures from the pilot, over the course of a year, CKWs would increase their income by anywhere from 16% to over 100%, if they are in fact a $2/day farmer. A number of observations help explain this somewhat contradictory feedback:

- Over time it was clear that CKWs were intentionally cautious when discussing payments - CKWs wanted to maximize their potential earnings and therefore did not want to convey that survey payments were high for fear that GF would scale payments back

- CKWs generally had very limited business skills. Most CKWs did not keep track of nor could they recall what they earned through data collection. Most CKWs also did not know how to calculate their household income and as a result could not estimate what percentage CKW activities contributed to this income. As an example, during training, some of the CKWs commented that they were using so much airtime offering the CKW services to farmers that GF should offer discounted airtime to them to perform their work. Our team then walked the CKWs through the mathematics of the airtime and cash incentives that they received for their activities. At the end of the demonstration, the CKWs realized that not only had they not used any of their own airtime to offer services but that they were receiving a substantial additional amount as compensation for their activities. Through the pilot our team learned that it is important to build CKW business acumen as a core skill area and clearly explain and track benefits CKWs accrue through their participation in the program

- Another possible explanation is that some of the CKWs (perhaps the most disenchanted) are of a higher socio-economic class and are not in fact $2/day farmers, meaning that the incentives offered had a much lower impact on household income and thus were less of an incentive

Another similar finding was that rural communities expect and are used to NGOs coming in and "handing out" services, inputs, products, etc. for free. Most NGOs and government programs also pay community workers or "volunteers" a stipend and have few monitoring mechanisms in place. An individual's performance is not directly linked to their compensation. As a result, CKWs always spoke of their role as volunteers rather than entrepreneurs, which was probably also linked to the fact that if farmers perceived that they were paid to conduct the work, they would be less likely to trust CKWs or award them the status they received as a community volunteer.

Nevertheless, when interviewed by outside consultants, CKWs stated that the cash payments were a good incentive and many have used the payments in a number of different ways to make their lives better. For instance, some CKWs used that money to open up savings accounts, to buy livestock or agricultural inputs, or to pay school fees for themselves or their children. Further, observations suggest that the incentives (financial and otherwise) offered to CKWs are effective, as all but one CKW, who was elected to public office, have expressed their strong desire to remain in the program. In addition, the majority of CKWs conducted the maximum number of surveys for which they could be paid each month. Nevertheless, more targeted research with CKWs needs to be carried out to define appropriate financial incentives that neither over nor under compensate CKWs for their work.

CKWs Use of Income from Surveys

"The plan I have for that money is that I am keeping that money in my mobile money account as savings. I want to go to Mbale town one of these days and open up an account in a bank and keep that money there as my savings."
Jackie Buteme, Mbale

"I got 140,000 UGX and I used that money to pay for my school fees. You know I went back to school for adult education, I am now in senior three."
Ludina Betty, Budaka

"I saved that money. I want to buy a cow."
Rutagumirwa Laban, Bushenyi

"I used the money to expand the house (create more room) for the cows."
Paul Nkoola, Mbale (pictured)

Monitoring and Evaluating CLCDS Sub Project

The Project Team monitored CKW performance through the following evaluations:

- Each survey was analyzed based on completeness: all survey questions answered, correct GPS coordinates recorded, and photo attached, before a CKW received payment for the survey; this also served as a key metric for measuring CKW performance. Where data was found to be incomplete, a GF staff member made a troubleshooting call to the CKW to ensure that the problem was quickly resolved to improve the quality of future surveys

- Each CKW received two individual monitoring and feedback sessions. The GF project team monitored each CKW while he or she was conducting a live survey in the field, in months one and two, and then rated the CKW's performance to provide feedback on survey administration and information delivery performance

- IITA analyzed data collected from each CKW, and, in cases where data was incorrect, a follow-up field visit was carried out to increase capacity of the targeted CKW and associated framers

- CKWs were required to distribute the "Guide to Pests and Diseases" to each farmer they surveyed— this allowed the project team to map the spread of extension materials across the targeted districts and also served as a verification tool to confirm that on-farm surveys had been completed as reported

- Finally, each CKW was awarded a Certificate as a "Banana Disease Monitor" upon completion of the pilot. To receive this certificate, each CKW had to pass a written and field-based exam to evaluate communication skills, disease detection, survey methodology, accurate

photography, and ability to clearly explain disease control measures to surveyed farmers. CKWs also had to conduct a minimum of 40 complete surveys

Data Verification

The project team analyzed the data gathered by CKWs and shortlisted select farmers for follow-up visits in cases where survey photos and diagnosis suggested that there might be a new pathogen (BBTD), there was high disease concentration, and/or there were abnormalities in the data set submitted by a particular CKW. Using the GPS coordinates from the surveys, our team mapped each CKW survey entry and the project team used these maps, and CKW knowledge of local areas, to locate select farms for follow-up visits. Scientists from IITA and NARO conducted these data verification visits to confirm the accuracy of the surveys with on-site diagnosis and sampling infected plants, to determine if the surveyed farmers implemented the appropriate control measures, and to further investigate the farm to determine the level of disease severity. Our team brought plant samples to the IITA laboratory to diagnose the causal agent responsible for observed symptoms. On average, the process took 11 days from the time a CKW submitted a disease report (and our team then traveled to the field to investigate the report, interview the CKW and farmer, and collect a sample) to the time the analysis came back from the lab.

The data gathered was also compared to existing data of past extension activities facilitated by NARO targeting the spread and control of Banana Bacterial Wilt (between 2001 and 2006). The results of this comparative analysis showed the findings to be similar, with one major difference: cost per survey administered. Data collection via CKWs was roughly 1/10 of the cost of similar activities administered through government-sponsored agriculture extension officers. Further, over 100 farmers that participated in the pilot project were also questioned to verify if there was uptake of the CKWs' recommendations for banana disease management. In almost all cases, the observed farmers had adopted either some or all of the recommended practices for banana disease management.

Recommendations from Monitoring and Evaluation Activities

Social Equity & Impact

- GF should recruit more female CKWs. Male CKWs are less likely to have female clients
- GF should develop "good, better, best" content options for information services so that even the poorest farmers can act on the information delivered (e.g. include some information that does not require farmers to expend monies or travel to act on information)
- Special incentives will need to be developed to ensure that CKWs reach the poorest farmers
- M&E specialists should be hired to assess how gender plays a role in access to and impact of CKW services
- A CKW monitoring/rating system will need to be developed to ensure that CKWs do reach poorest farmers. This can be achieved through peer feedback, mobile customer satisfaction surveys with clients who own phones, and through targeted follow-up visits by field staff

Data Collection

- CKWs should be trained in enumerator techniques such as probing and estimating acreage
- GF should explore the potential to use GPS tracking applications and assess the feasibility of having CKWs track actual acreage of farm or sample acre plot to estimate severity
- Survey design should use proxies for household income to increase farmer willingness to give CKW sensitive financial information
- GF should train CKWs in how to present surveys and, whenever possible, link participation to clear and immediate benefits associated with survey participation
- GF should explore the idea of crediting CKWs with "vouchers" for every survey they complete so that CKWs can offer free information services to farmers for participating in a survey. Other farmer incentives could include airtime or "coupons" for discounts on agricultural inputs
- Questions that require CKWs to give in-depth explanations to farmers should not be included in surveys
- GF should carry out additional trials to determine which types of information CKWs collect with low and high accuracy rates

Business Model & Incentives

- Demand for call services, battery charging, airtime, and other phone products is high. Selling these can contribute to CKW unit sustainability; GF should secure a special tariff for CKWs
- CKW incentives that are skewed towards data collection and survey payments must be linked to information dissemination to so that sustainability and impact goals are equally weighted
- GF should develop a training module on business skills and build individual business plans with CKWs to maximize their economic benefits from additional revenue opportunity and ensure that CKWs understand the business case for conducting CKW activities
- GF should conduct a series of trials to understand appropriate data collection fee structure for CKWs and price point for information services. The former could be achieved by paying CKWs in different regions different amounts and observing behavior, while the latter can be achieved through reverse billing on a dedicated short-code
- Some farmers will not be willing or able to pay for information services. GF should explore a system to (cross) subsidize the distribution of information to the poorest farmers, perhaps by offering CKWs a certain percentage of discounted or free information services each month which CKWs can use to either stimulate business or help poorest farmers who can't pay

Summary of Key Lessons Learned

CKW Network

- CKWs do serve as trusted intermediaries and have become information resources in their communities. They act as interpreters and direct farmers to actionable information using the suite of tools available on their phones
- CKWs should be sourced from existing extension organizations to maximize impact. We will need to form deep partnerships with CKW source organizations to ensure sustainability
- CKWs need intensive training in mobile technologies, agricultural information, survey techniques, and business skills. These trainings should be spread over time and reinforced with skills testing to ensure absorption
- GF partners can provide agricultural training, which greatly increases the value CKWs bring to farmers, boosts their credibility, and serves as an incentive for CKW performance. CKWs can serve as more than an information hub, having basic proficiency in agricultural practices, so they can act as ICT-enabled extension workers
- Peer-to-peer support structures can reduce field demands, but ongoing support is critical

Impact & Social Equity

- Farmers do act on the information they receive from CKWs. These behavioral shifts can lead to impact over time
- Women and poorer farmers are often frequent users of CKW information services
- Women face greater obstacles to becoming CKWs but perform on par with men. Program design should facilitate women's participation

Information Services

- There is a high demand for pest and disease control information with farmers requesting this information for a wide range of crops
- CKWs find guided menu based search system easier to use than free form SMS
- CKWs use suite of mobile services as a toolkit, using multiple services to offer most complete and accurate answer to a farmer's question
- Farmers appreciate the on-demand nature of services and approach CKWs when they need information
- Linking CKWs to agricultural experts increases their credibility in communities and value they provide to farmers

Data Collection

- Transportation costs, data quality, mobile network coverage, and farmer suspicion are largest challenges
- Spatial distribution of CKWs must be carefully planned to conduct meaningful GIS analyses and to balance the need to decrease CKW transportation costs with potential for survey fatigue and bias
- When surveys are paired with information dissemination, as in the banana monitoring pilot, there is a built in incentive for answering survey questions and high demand from farmers for surveys
- Cost savings realized through data transmitted over GPRS and the higher demand for the enhanced survey capabilities of java enabled phones outweigh the initial higher cost of purchasing java enabled rather than basic phones

Outstanding Questions

During the nine month Community Knowledge Worker pilot, Grameen Foundation gained considerable insight into the feasibility and design of the CKW model. Perhaps one of the most important areas of learning, however, relates to those questions for which we do not yet have answers. The project team will address these questions in the next phase of the project and the first sixteen months will continue to be a period of learning to improve and refine the model. Below are a list of the key questions and challenges we will have to tackle as we move forward:

CKW Network

- Do partners have the field networks that can provide the resources to support CKWs over time and, if not, what other options exist to sustainably support the CKW network?
- What caliber of CKW will need to be recruited to meet data quality standards?
- How do we engage organizations with whom we will not have deep partnerships (especially small-scale community based organizations serving farmers)?
- How do we provide the after-training support needed for CKWs to be effective at scale?

Impact and Social Equality

- How do we incentivize CKWs to reach the poorest farmers?
- How do we achieve 50% female participation without over-burdening female farmers and how do we support female farmers to overcome obstacles to their participation such as lower literacy levels and higher labor demands?
- How do we support the participation of most disadvantaged farmers and still recruit CKWs who can meet skills requirements?
- How do we minimize potential for elite capture and ensure that by providing CKWs with access to information and other resources we do not exacerbate intra-village socio-economic disparity?

Mobile Information Services

- What is the adoption rate for the various advice delivered through the CKW channel and how do adoption rates link to impact gains for different types of information?
- How do we efficiently deliver information in local languages?

Mobile Data Collection

- What is the appropriate service area for a CKW that achieves uniform spatial distribution and effectively balanceswide-spread access to information services, feasible coverage area for conducting surveys, and potential for survey saturation and bias?
- How do we ensure data quality?
- How do we develop survey sample design and farmer incentive structure to maximize survey participation and minimize survey fatique and bias?
- What is the size of the market for rural market data collection and how many CKWs will that demand support?

Business Model and Incentives

- How do we effectively link incentives for information dissemination to survey payments to achieve impact?
- Is there a business model for using GPS enabled handsets?

The Path Forward

Grameen Foundation's goal in the CKW Initiative is to build a self-sustaining model for the CKW network that reduces the cost of adoption of new and improved agricultural practices and increases smallholder farmer income. Based on the promising results from the Test of Concept, the Bill and Melinda Gates Foundation awarded Grameen Foundation with a four year grant to expand the Community Knowledge Worker Initiative across Uganda. Grameen Foundation aims to build a CKW network that is capable of serving over 200,000 smallholder farmers while proving a replicable and portable model which can be scaled to other regions. In the next phase, the team will continue to deliver and measure impact while building a self-sustaining model. Through strategic partnerships with data consumers and leading agricultural organizations, GF will ensure sustainability for individual CKWs and the CKW organization. GF will work with key agricultural players to recruit, train, and support CKWs (often existing extension agents), content partners who provide expert agricultural advice and market information as well as information on resources and opportunities available to farmers, and data consumers whose programs and products benefit from up-to-date and accurate information from rural villages. Planning efforts are underway and GF has begun working with partners to recruit a new group of Community Knowledge Workers who will begin offering services in early 2010.

Appendices

Appendix 1: Progress Against Planning Grant Milestones

GF outlined a number of milestones to meet over the course of the nine month planning grant. We have summarized planning grant progress to date against milestones below. Planning grant objectives included testing the CKW concept, exploring key questions related to how to best design a full-scale program, and identifying conditions needed to launch a full-scale effort. As a result, key outcomes from the planning grant are process oriented and focused on how to best design a full-scale project to achieve impact at the smallholder farmer level while using BMGF funding as a step toward achieving long term sustainability.

Milestone A: Identify project team, hire project consultant, begin planning Test of Concept, develop field and desk research strategies

- GF hired a full time Project Officer to work in Uganda and oversee the CKW Test of Concept to oversee the project on a fulltime basis. She has experience working on the AppLab program as well as experience conducting gender analyses in natural resource management
- GF hired a full-time CKW Test of Concept lead. She is a Ugandan with nine years of experience with agricultural organizations working with smallholder farmers with particular focus on gender issues
- GF hired a project consultant with a private sector business background and extensive experience working with agriculture extension workers and farmer associations
- GF conducted extensive desk research to inform design of a sustainable model, including two consultant assignments examining smallholder farmer experiences, challenges, and demand for information in Uganda, analysis of leverage points for information to deliver impact, and a thorough analysis of Uganda's agricultural extension framework and opportunities for the CKW project to complement and strengthen extension efforts

Milestone B: Identify and begin recruiting Test of Concept CKWs, select regions for CKW deployment, choose information and training partners

- GF worked with partner organizations to identify and select the first round of CKWs
- The CKW Test of Concept ran for seven months in two districts, Mbale and Bushenyi
- Information and training partners provided content for mobile applications and support training and supporting the CKW network

Milestone C: Interview smallholder farmers, CKW sources and local companies and organizations and develop project design recommendations

- GF conducted more than 20 CKW focus groups to solicit and incorporate candid feedback on CKW experiences into program design
- GF also had Ugandan project officers located in the regions where the CKW test of concept was conducted, allowing further, frequent interactions with CKWs and opportunities for providing information and receiving feedback
- GF collected multiple smallholder farmer anecdotes about day to day interaction with CKWs. Anecdotal information will inform project design

- GF held numerous partner and networking meetings with key agricultural stakeholders to solicit their input and buy -in on model, and discuss future collaboration prospects.

Milestone D: Research information resources, delivery mechanisms and business models and interview potential consumers of rural market data

- GF actively worked with on-the-ground implementation partners to administer surveys through the CKW network and CKWs collected nearly 6,000 surveys over the course of the pilot
- GF conducted over 20 interviews with potential local and international data consumers to learn about demand for rural data as well as held interviews with leading organizations in the mobile data collection arena
- GF developed a business model to understand what it would take to achieve CKW unit and organization sustainability

Milestone E: Recruit, train and deploy 30 CKWs; monitor project progress and refine parameters as necessary

- Prototyped seven applications providing information on 3-day and seasonal weather forecasts, market prices, location of input suppliers, farming tips based on local knowledge, an SMS bulletin for linking buyers and sellers, a live agricultural hotline linked to an agricultural expert, and an information service that gave best agronomic techniques for producing and processing coffee and banana
- Recruited and trained 50 CKWs on these applications. Assessed performance of CKWs and focused on the 40 most effective CKWs
- Developed four surveys incorporating five different mobile technologies for World Food Program, Uganda Commodity Exchange, IITA (International Institute for Tropical Agriculture), and OpenMind. CKWs administered over 6,000 surveys

Milestone F: Synthesize findings, articulate scalable project design and sustainable business model(s)

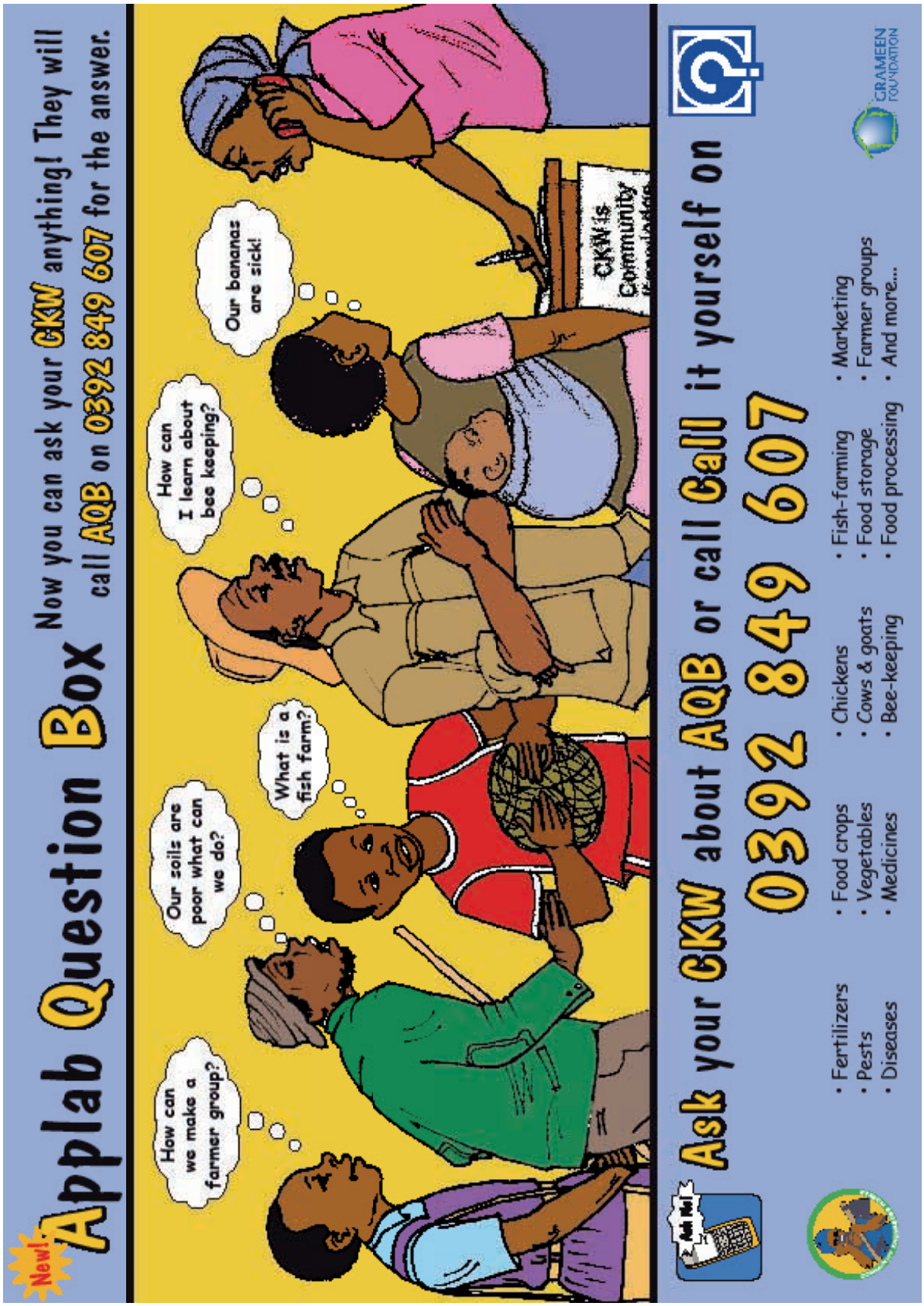
- Though the CKW pilot, we gained a deep understanding of the challenges that must be overcome to build and scale a sustainable network of CKWs
- Developed project design for a scalable and sustainable CKW project, articulated in the second grant proposal to BMGF and which will serve as the foundation for the business plan for the scaled model

Appendix 2: Marketing Materials for CKW Apps

All marketing and training materials were developed by Sam Rich, fourthway.co.uk

Appendix 3: 6006 Flyer

Appendix 4: AQB Poster



Appendix 5: CKW Training Pamphlet on Banana Disease Monitoring

CKW Trainings: Advanced Level

3. Banana Disease Monitoring

Contents

The Role of the CKW

Give information to the community

As Community Knowledge Workers we have lots of skills and can find out lots of information for people in our community.

We can help people get information about weather, agriculture, health and other topics. We can make money by charging a small fee for these services.

Give information about the community to others

We can also collect information about our community.

The government, NGOs and some businesses want to find out about our village. We use surveys to collect information and send it to them.

We think that in the future these organisations will pay us to do surveys.

3

About the Survey

Why do we need a survey about Banana Diseases?

1. To find out how much farmers know about different banana diseases
2. To fill in the gaps in the farmers' knowledge and teach them more about banana diseases
3. To find out where diseases are, what damage they are causing, and how they are moving around Uganda
4. To help government and NGOs plan how to fight diseases

Make an appointment

This survey is long. We will take photos of the farmer's sick plants, so we need to make the survey in his homestead. Phone the farmer to arrange to meet him before you go.

Things to carry with you

1. Phone + check battery
2. Etrex + spare batteries
3. This Survey Guide
4. Copies of Survey
5. Farmer Disease Guide
6. Pen & paper
7. Bleach

4

Taking the Survey

Brief the farmer

- This survey takes a long time. So before each survey, brief the farmer about **why** we are doing the survey
- Brief the farmer about **what sort of questions** we will ask - about banana diseases in their shambas, and about symptoms and control methods
- We will **bleach tools** when we cutting plants
- We will **take photos** of sick plants to send to NARO and IITA to help us with diagnosis

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Paper - Photos - Phone

1. Go through each question of the survey with the farmer. Write the answers on a new paper copy of the survey
2. Write the Farmer Number on the top of each page of the survey. The first farmer you survey is F1, the second is F2 etc
3. At the start of the survey, take the GPS location and save it, as described below
4. Write the GPS co-ordinates on the paper copy of the survey in Questions 5-7
5. Turn off Etrex after finding GPS location to save battery
6. At the end of the survey bleach tools before cutting plants.
7. Take photos of the sick plant (as described at the back of this booklet)
8. Enter the survey answers on your phone and save survey

5

Using Etrex to find your position

① Using Etrex

Etrex is a tool that finds your position. It uses the Global Positioning System or GPS. GPS works by connecting to satellites in the sky. You must be outside to use it. Press the **Power** button to turn it on. After a few seconds, the screen will look like this.

② Go to the Menu

Press the **Page** button to see the different pages on the screen. Press **Page** 4 times until you see the **Menu**.

③ Go to Mark

You can see choices in the **Menu**. Press the up and down buttons to highlight the different choices. To find your position, highlight the word **Mark** and press **Enter**.

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④ Mark Waypoint

Etrex calls positions "Waypoints". To find a position you have to "Mark a Waypoint". The GPS location will be shown at the bottom of the **Mark Waypoint** screen. The picture shows the GPS location of Grameen's offices: N 00 21.520 E 032 36.552

⑤ Saving Waypoints

Etrex saves all your waypoints. You can find them and check positions.

From the **Menu** go down to **Waypoints** and press **Enter**. You will see a list of Waypoints. Use the Up and Down buttons to highlight different Waypoints, and press **Enter** to see the GPS positions.

Using Etrex for surveys

- We use GPS positions to find out exactly where each survey was made. With GPS you can find any position in the world within 10 meters
- When you get to Questions 5 in the survey use the Etrex to find your position
- Write the GPS position in the box under the village name in Question 5-7

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Using Nokia N95 to find a position

① Open GPS data

The Nokia N95 can find your position using the Global Positioning System or GPS. GPS works by connecting to satellites in the sky. You must be outside to use it. Go to **Menu**, **Tools** and go down to **GPS data**. Press the centre button to open it.

② Open Position

To find your position, go down to **Position**, and press the centre button to open it.

③ Write your position

You will see your GPS position displayed on the screen. Write down your longitude, latitude and altitude on the survey.

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④ Save your position

Go to **Options**, and select **Save Position** by pressing the centre button. You must write a name for the position. You can use the farmer's name for each survey.

⑤ Finding saved positions

Your saved positions are saved in **Landmarks**. To find them,go to **Menu**, **Tools** and go down to **Landmarks**. Press the centre button to open it.

Using N95 for surveys

- We use GPS locations to find out exactly where each survey was made. With GPS you can find any location in the world within 10 meters
- The N95 automatically sends the GPS location for each survey
- Write down each GPS location on the survey in the box under the village name in Question 5-7

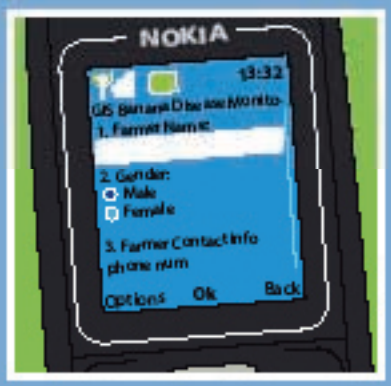
Entering the survey on a phone

Open the GIS Application

New surveys are found in the GIS application. To find it, go to **Menu**, **Applications**, **CKW**. Press the centre button to open it.

Open the Survey

You will see a list of options. The first is our survey, the **GIS Banana Disease Survey**. Press the centre button to open it. You will have to wait a few seconds for the survey to load.



Questions 1-4 The farmer

The first questions ask you about the farmer. To select the gender in question 2, use the up and down buttons, and press the centre button to select.

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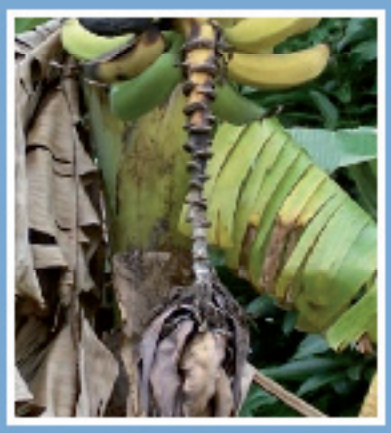
Banana Bacterial Wilt: Symptoms



① Male bud wilts and fruits ripen early

Banana Bacterial Wilt or BBW causes the male bud to wilt, and the fruits to ripen when the bunch is still young.

BBW affects all types of banana. It has caused 90% losses in some areas.

② Leaves yellow and wilting

BBW causes the younger leaves turn yellow and wilt when they are still young.

③ Fruits with brown stains

BBW causes the fruits show brown stains when cut.

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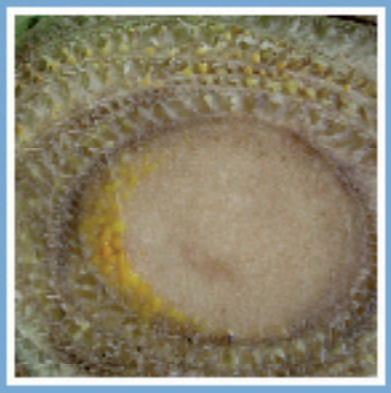

④ **Stem oozes yellow pus**

BBW causes yellow pus to ooze from a cut stem.

Banana Bacterial Wilt: Control

How is BBW spread?

BBW is caused by bacteria. The bacteria is spread from a sick plant to a healthy plant by:

- Stingless bees going to the male bud
- Tools like knives and hoes
- Planting sick suckers in new gardens

Stop BBW

- **Remove the male bud**
  Use a forked stick to remove the male bud after the last cluster forms
- **Destroy sick plants**
  Heap and bury sick plants and suckers
- **Use clean suckers and tools**
  Plant only clean suckers and disinfect tools with fire or bleach

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Fusarium Wilt: Symptoms

Yellow skirt around plants

The oldest leaves turn yellow. The yellow spreads from the outside of the leaf.

The older leaves collapse and look like a yellow skirt around the plant.

Infected plants fail to produce fruit.

Young plants can appear stunted.

Red or brown stains

Red or brown stains are visible on the cut stem. The stain starts out pale red, turns darker and eventually becomes brown.

It can be found in the stem, the base and roots of the plant.

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Fusarium Wilt: Control

Spread of Fusarium Wilt

- Fusarium Wilt is also known as Panama Disease, and can cause yield losses of up to 100%
- It affects many types of bananas including gonja, kisubi, kayinja, kamaramasenge and bogoya
- It is a fungus that lives in the soil. It spreads through the soil and from mother plants to their suckers
- The fungus lives in the soil for 30 years infecting new bananas when they are planted

Stopping Fusarium Wilt

- Remove infected plants and their suckers, even when symptoms are not seen. Destroy infected plants and their suckers. Do not move suckers from infected areas to clean areas
- Fusarium Wilt spreads in the soil that is on tools and shoes. Keep them clean to prevent it spreading
- The best method of stopping fusarium wilt is to grow resistant varieties. Try highland cooking and beer banana varities, and Cavendish bananas. You can also use FHIA 17, FHIA 23, and other hybrids from NARO.

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Banana Bunchy Top Disease: Symptoms

① Narrow upright leaves are bunched

Banana Bunchy Top Disease is easy to spot. The leaves are bunched together on severely infected plants. STUNTED.

It is in Kenya and Rwanda, and will soon come to Uganda. Watch out for BBTD!

② Leaf edges yellow or bleached

BBTD causes the leaves turn yellow and wilt when they are still young.

If you see BBTD symptoms contact your sub-county agriculture office.

③ Dots and dashes on leaves

If you look closely you will see dark dots and dashes on the leaves and branches.

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④ **Aphids in banana stem**

BBTD is caused by a virus, but it is usually transmitted by aphids. Where there is BBTD you will usually find aphids in the stem.

Where is BBTD?

- BBTD has not yet been found in Uganda. But it is already in Rwanda, and DR Congo.
- If you see BBTD symptoms contact your sub-county agriculture office.

Stopping BBTD

- **Destroy sick plants**
  Dig up and bury infected plants and their suckers. Check the surrounding plants for symptoms
- **Use healthy planting materials**
  Never use suckers from sick fields, even if they appear healthy. They may be infected but will not show symptoms until later

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Your Notes

Our Partners

IITA gives us expertise in banana disease detection, disease control practices and Geospatial Information Systems (GIS).

NARO, the National Agricultural Research Organisation, gives us expertise in banana disease and agriculture extension.

IITA and NARO will work together to make follow up visits with farmers, collect soil and plant samples and shadow our CKWs.

NARO

IITA
Research for Nourish Africa

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Taking photos

How to take photos

- At the end of the survey take photos of the symptoms on the sick plant
- We can only send photos of a small size. To take small photos, open the **Camera** and go to **Options**, **Settings**. On the 1680, Image Quality should be Basic, and Image Size should be 160 x 120. On the N95, Image Size should be Small.
- Go to **Menu**, **Gallery**, **Images** to see your photos. Delete all but the best 2. Go to **Options** to delete or rename images.

Renaming Images

Rename the images with the farmer code, then the name of the disease code and then the symptom code.

The Farmer Code is "F" and a number. The first farmer you survey is **F1**. The second is F2, the third is F3 etc.

The Disease Codes are:
BBW for Banana Bacteria Wilt,
FW for Fusarium Wilt or
BBTD for Banana Bunchy Top Disease.

The Symptom Codes for BBW are:
MB for the male bud rotting;
YO for yellow ooze; or
RB for rotting bunch.
For FW the only reliable symptoms are the Red or Brown Stains in the cut stem - code **RBS**.
For BBTD the only reliable symptom is the Bunchy Top - code **BT**.

Do not leave spaces in image names.
Examples: F1bbwmb or F2fwrbs or F3bbtdbt

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