ABSTRACT

In the face of growing food demand from a burgeoning population, African agricultural markets remain highly segmented with severe asymmetric information, numerous intermediaries in the supply chains, and prices that are highly variable across both space and time. This has potentially severe welfare costs in numerous dimensions; farm-gate prices are depressed on average, prices are highly volatile in the face of local production shortfalls, and the time path of prices means that typical households are selling when prices are low and buying when they are high. A combination of sophisticated contracting and information technologies may be able to overcome these problems, but several recent studies have illustrated that one-dimensional approaches are likely to be ineffective. This project aims to combine the market linkage services of a well-established and highly reputable private sector brokerage firm with high-frequency data collection, an innovative digital trading platform, and a set of contractual guarantees to provide a multi-pronged set of solutions to these problems. Using highly scalable technologies, we aim to develop a suite of tools and methods that both measure the shallowness in African food markets and offer solutions for market deepening.

NARRATIVE DESCRIPTION

In the face of growing food demand from a burgeoning population, East African grain markets are plagued by poor integration. The symptoms of shallow markets can be seen across space (leading to highly variable prices that do not follow the Law of One Price) as well as across time (leading to prices that tend to be low when farmers are selling and high when they are buying). Given the inability of markets to efficiently move food from surplus to deficit regions, this poor integration has a major effect on both farmer incomes and on food security. While poor roads and infrastructure frequently get much of the blame for the isolation of African food markets, price data from the region suggest that price dispersion regularly exceeds estimates of transport costs. As a result, we must turn to alternate explanations to fully understand limited market integration. The most likely culprits are imperfect information and contractual uncertainty, which lead to high search costs and large information rents for intermediaries. Solving these problem, however, has proven challenging. Several studies have provided only price information to farmers (Fafchamps & Minten, Mitra et al.). However, lacking the means to provide their own transportation to alternative markets, farmers appear unable to take advantage of this information and so these interventions do not offer farmers any truly improved outside option. Without changing the structure of market intermediation, these interventions appear to be ineffective at improving farmer income. Improving farmer welfare and stimulating greater market integration, then, appears to require strategies that fundamentally shift the nature of intermediary relationships and the degree of contractual uncertainty.

We propose a multi-pronged intervention that aims to address these research questions and build sustainable, private-sector solutions to some of the intermediation issues that have plagued African food markets. The three prongs of our study work to simultaneously alter the intermediaries, the information, and the contracting options available in food markets. First, we are working with **AgriNet,** the major private-sector supply chain company in Uganda to implement a randomized

expansion of their Commission Agents model to 220 new communities across 15 districts of the country. Secondly, we will work with **IPA** to implement a high-frequency market price survey using innovative SMS-based tools developed specifically for the project, capturing biweekly prices for the three major food crops (maize, beans, and rice) in 260 markets across the study area and then feeding these prices back to traders and farmers in treatment areas via an SMS subscription service. Thirdly, we will collaborate with **Kudu**, a digital food trading platform developed by computer scientists at Makerere University that allows farmer groups to contract directly with major buyers, using a distance- and price-based matching algorithm to provide Pareto-optimal market contracts to both sides of the market. With this multifaceted approach we hope to protect the food security of consumers (who face expensive or unavailable grain supplies during the lean season), as well as to promote more integrated markets, with smoother food supply across seasons and improved livelihoods for smallholder farmers.

Output Market Inefficiencies

Output market inefficiencies prevent smallholder farmers from connecting with large buyers, resulting in fragmented supply chains and isolated markets susceptible to localized shocks. These inefficiencies are a product of high transaction costs: search costs, distance, poor infrastructure and information asymmetries between buyers and sellers (Key et al, 2000). As harvest levels vary across seasons, buyers must continually update their information on the quantity and quality available for sale in the many villages from which they would like to buy. To collect this information, buyers must physically visit the villages themselves or build relationships with representatives from each village whom they can call; both search strategies are costly. Limited collective action on the part of farmers offers few opportunities for buyers to purchase in bulk; instead, buyers must bear travel from farm-to-farm on poor roads to collect small surpluses (Mitra et al. 2013). Contractual risk may also dampen buyers' willingness to engage in trade with remote villages. Buyers must make up-front investments in

transportation out to rural villages without guarantees that any agreements made in advance regarding

quantity or quality of available crops will be carried out as promised once they arrive. This makes

trading in remote villages a risky proposition for buyers, as they must bear the transportation costs for

an uncertain return. Without legal recourse when agreements are breached, buyers may find

purchasing from remote areas too risky. They may instead choose to trade only with trusted farmers or

brokers with whom they have repeated interactions, and may simply forgo it entirely. As a result of

these risks and expenses that diminish access to trade networks, smallholder farmers must accept

whatever price is available locally. At a market level, rural villages remain poorly integrated and prices

vary widely across local markets.

These transaction costs may also shape the market structure in a way that further restricts

competitive trade (Antras and Costinot, 2011). They give rise to middlemen, who provide information

and reliable connections between smallholders and buyers; however, farmers frequently report that

middlemen collude. Buyers also face limited competition, as information about the location of surpluses

is not publically available, instead forcing buyers to rely on extensive – and expensive – networks of

contacts to identify villages with surpluses. Therefore, once buyers identify a smallholder willing to sell,

they are often able to offer a price below what competitive forces would dictate. Increased competition

among buyers and shorter supply chains would improve the price received by individual smallholders, as

well as reduce price dispersion across markets.

Given the role that transaction costs play in discouraging trade, it is not surprising that they have

negative effects on production, with yields dropping as farms are farther away from large buyers across

comparable agro-ecological areas (Dorosh et al, 2010). Delgado, Narrod and Tiongco (2008) also

support this, suggesting that smallholder participation decreases as transaction costs increase. On the

other hand, using information technologies to reduce transaction costs has been shown to relax output

market inefficiencies. The availability of mobile communication has decreased grain price dispersion in

Niger (Aker 2010) and increased farmer market participation in Uganda (Muto and Yamano, 2009). Yet, intermediary activity remains a black box in many of these studies, limiting their ability to speak to how the introduction of mobile phones reduces search costs for specific agents and whether this alters market structure. Moreover, much less is known about other major transaction costs that hamper agricultural market efficiency, such as contractual risk and limited credible information about quality and quantity. Relaxing these market constraints, by offering services and technologies specifically designed to link farmers and buyers, could generate further improvements in supply chain efficiency.

Finally, in addition to these supply chain inefficiencies that inhibit proper spatial arbitrage in food markets, farmers may also face challenges that inhibit their ability to engage in efficient temporal arbitrage, including limited access to storage technologies or to the financial inputs required to make storage palatable to agricultural households. Like many agricultural markets across sub-Saharan Africa, most Ugandan crop markets feature large seasonal price fluctuations, as urgent household needs force farmers to sell their produce immediately after harvest, flooding the market. Access to credit, which could fill this gap by allowing farmers to store part of their crop until prices are more favorable, is low in rural areas and is rarely specifically tailored to rural residents' needs. In addition, what crops farmers do store are typically stored in their homes in the most basic conditions that do not feature the necessary airflow and pest containment required for long-term storage. Improved access to credit and storage facilities could improve farmers' ability to engage in temporal arbitrage and, ultimately, improve the seasonal price fluctuations that characterize African grain markets.

Description of Treatments and Evaluation Design:

Treatment

The study will bring together three institutions to implement an intervention that aims to 1) improve the information available to farmers and brokers across the country; 2) engage a novel

technology to offer a completely new vehicle through which long-distance agricultural transactions

might be conducted; and 3) provide the reputational and financial guarantees that may enable this new

system to thrive.

The core field operations of the program will be implemented by the private company AgriNet,

currently the largest private-sector market brokerage firm in Uganda.   AgriNet currently operates in 35

districts of Uganda, using two primary modalities.   The first of these is a set of Contract Farming

arrangements, whereby they sign forward contracts with major buyers such as Ugandan Breweries and

then organize supply from farmers.   The second is a set of Trader Alerts, which feed basic market

information as well as contact information of large buyers to farmers, whom AgriNet assists to bulk and

sell at higher prices than are available on spot markets.   To provide on-the-ground facilitation of both of

these services, AgriNet recruits, trains, and certifies local entrepreneurial traders as Commission Agents

(CA) who act as "trusted intermediaries" between smallholder farmers and buyers.   Our project will

assist AgriNet to carry out a large, randomized expansion of their market linkage services and will

substantially deepen the tools available to them in their trader alerts by providing much more detailed

price information, new contracting opportunities through a digital trading platform, and price

guarantees for a randomized subset of the transactions taking place through Kudu.   The firm provides

explicit forward contracts and purchase guarantees to farmers who operate through the Contract

Farming side of AgriNet, but the operations for our study will focus primarily on enhancing the Trader

Alerts system.[1]

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[1] We are also working to assist AgriNet in establishing contracts that would allow them to act as intermediaries in order to bring up to capacity the woefully under-utilized satellite warehouses that have been built across much of the study area by WFP and USAID over the past years. It is widely recognized that these warehouse facilities have failed to live up to their promise because they are typically operated by local NGOs or community groups that lack the financial depth and sophistication needed to provide the intermediation needed to make warehousing work (Natural Resources Institute Final Report, 2014). AgriNet is extremely eager to take on the role of providing this intermediation, and we have had preliminary conversations with the USAID mission in Kampala about the possibility of supporting this activity, potentially exploiting a Development Credit Authority that is to be established with several Ugandan banks in October 2014.

The Kudu platform is a sophisticated double-auction mechanism allowing farmers to post bulked quantities of grain for sale at a specified location and reservation price. Buyers then post positions in the system (essentially a location, a desired crop, and a maximum price that they are willing to pay). The system finds the Pareto frontier of space/price matches within each crop type and presents the buyer with the three sales lots that are the best fit. The system has been operational for 18 months and has met with some real success, but has also found that ramping up supply and demand in tandem is challenging, and that only 13% of the lots for sale effectively transact through the system. The alliance with the study project provides them with several distinct ways of improving the product. First, the many intermediaries in African agricultural trade have arisen precisely because long-distance contracting requires trust that is hard to facilitate between strangers. AgriNet CAs can be of substantial assistance as intermediaries in this respect, in that they are trained professionals with a corporate reputation to uphold, and they can be asked to certify not only the quantity of sales lots but also the quality. This has been a major sticking point of the system to date, and since AgriNet CAs are extensively trained and experienced in quality grading we plan to add an AgriNet trademark to Kudu sales that are posted by a CA. The CAs will make their standard sales commission (5% of transaction value) on Kudu sales, and so the premise of the interlinkage is that this ability to certify adds more than this amount to the value of the contract.

Secondly, given that Kudu is a tool for building efficient spot markets, the core source of contractual risk is on the buyers' side, because they incur the transportation costs. To understand the role of this risk in Kudu contracting, we have raised substantial funds from IGC to provide transport cost guarantees on a randomized subset of the Kudu contracts. Because the Kudu system already uses the distance between the buyer and seller as a matching dimension we can reimburse dissatisfied buyers with a per-kilometer payment if a contract fails to transact after they have already travelled to the village (as certified by the CA).

The final dimension of the intervention involves creating an aggressive information feedback loop. At present AgriNet sends information on major district market prices to CAs every month and asks them to update publicly visible whiteboards with this information. Given that there is tension between the private information benefits of the CA and the public good of more transparent markets, we wish to push the public good dimension harder as a part of the study. At the time of doing the baseline surveys in treatment sub-counties, we will enroll any interested farmers and traders into a push SMS system that will include the current district price data, the data on more localized village markets from treatment communities in the Market Survey, and data scraped from the Kudu system informing them of the prices at which local lots are currently selling on Kudu. We believe that this service will serve to broadly disseminate market information to as large a group of actors in treatment sub-counties as possible. While AgriNet sees this enhanced push SMS service as a major potential market over the longer haul, we are asking for $25,000 from BASIS so as to be able to make this service free to users for the first two years of the program.

Evaluation Design

We have identified 15 districts and 110 sub-counties that are food producing areas that are relatively remote and hence not yet well integrated with the main food markets of southern central Uganda. These markets have been identified by AgriNet as being attractive targets for expansion. To manage the logistics of the study AgriNet will recruit seven new Network Managers, each of whom will be responsible for operations in two districts and for roughly 35 CAs. We are requesting $50,000 in direct support to Agrinet to help cover the costs of the expansion required to conduct this RCT; the need to expand quickly and to leave half of the surface area of the study districts untreated both add costs on to their operations that are a direct product of the research design, and hence seem legitimate to be covered by the research side of the grant.

We will randomly assign half (55) of the markets to the treatment (blocking on district, stratifying by agricultural yields and selecting exactly half of the sub-counties that contain the main district market into the treatment). In each of these 55 treatment sub-counties, AgriNet will recruit, train, and certify 4 CAs. The activities of a CA are not typically restricted to a single specific market (many of which meet only weekly or biweekly), and so the decision to recruit 4 CAs per sub-county and then to use the sub-county as the unit of randomization is based on an assessment of the realistic spatial footprint of their operations. The objective is to blanket treatment areas with new information and services while not creating spillovers to markets in the control.

Hence, the research design is as follows:

1. **Control**: In the 55 control sub-counties, AgriNet will not execute any activities. In the control groups, 130 markets will be selected for the market price survey and trader baseline, and 1500 households in the catchment area of those markets will be randomly selected for the household survey.

2. **Treatment:** The 220 CAs in the treatment group will offer Contract Farming services, will link farmers to large buyers, and will operate the enhanced Trader Alerts system. The amount of grain farmers have for sale will be fed onto the Trader Alert platform and blasted to potential buyers and vice versa. Kudu as integrated in the Trader Alerts will serve to electronically bulk the grain, allowing buyers to view what is available for purchase at the village-level. In addition, information on local market prices will be fed back to farmers, enabling them to sell when prices are most favorable and to negotiate for the prevailing market price.

To identify the primary sampling unit for the analysis, IPA will survey these areas and identify the 2-3 most important agricultural buying markets in each sub-county at which some mobile phone coverage is available (this is almost ubiquitous in rural Uganda). IPA will then conduct a Trader Survey, which is an enterprise survey that tracks the revenues, income, volumes, crops, and locations of trading

for 5 traders in each study market as well as every individual selected to be a CA. In addition they will

conduct an agricultural Household Survey for 11 households that are active in agricultural markets (e.g.

not in subsistence) within a pre-specified geographical catchment area around study markets, for a total

of 3,000 household surveys.   The combination of trader and household surveys will enable a

comprehensive view on whether the interventions proposed here alter intermediaries' method of

connecting with farmers, whether this encourages additional market linkages to form, and, ultimately,

how this impacts the profits of both farmers and intermediaries.

To measure the impact of the intervention on price dispersion, IPA will also coordinate a Market

Survey. For this, we will recruit two merchants per market who operate at fixed locations (and hence

know prices in a specific market very well).[2]   These two merchants will be recruited as paid

enumerators, given training in how to interact with the SMS survey system being developed by UCSD,

and paid to answer a detailed market survey every two weeks by having mobile airtime sent to their

phones in return for having entered timely and reasonable data.   This provides us with much more

granular market data than is currently available in Uganda, both in terms of time (updated twice

monthly) and space (information for a broad set of rural markets rather than the major district market

information which is currently marketed by FIT Uganda and used by AgriNet for the Trader Alerts

System).   We also hope that the development of this low-cost, high frequency system for price data

collection will be a public good for other researchers interested in collecting similar data in the future.

This construction of a massive data portal is anticipated to have several impacts. First, following

Mitra et al. (2013), we expect to see price dispersion across markets decrease. To the extent that the

market power of intermediaries is decreased by a more transparent system of price dissemination,

average prices to farmers may increase and average profits of traders may decrease. By examining the

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[2] The types of traders who are selected as CAs and who will be studied in the Trader Survey are typically peripatetic, moving to different markets on different days to buy, often orbiting around a location at which they have stores that can be used for bulking. Therefore, they are not suitable candidates to collect this price information.

impact of the contractual guarantees, we will gain insight in the extent to which search costs and contractual risks are complementary in restricting adherence to the Law of One Price.

Power Calculations:

The Primary Sampling Unit for our study will be a rural agricultural market, and the unit of randomization will be the sub-county. We will select an average of 2.5 agricultural markets in each of 110 study sub-counties for a total of 260 markets. We will conduct a market survey every two weeks in each study market, and then will sample traders and farming households purposively in a manner that is intended to give a representative sample of the traders who operate in those markets and the farmers who are trading in the catchment area of each study market.

We will follow 1300 traders (5 per market) and 3000 households (11.5 per market) as a part of the study. We can therefore consider the power of a clustered analysis of the market price data (260 observations in 110 clusters) or of the household data (2000 observations in 110 clusters) as follows:
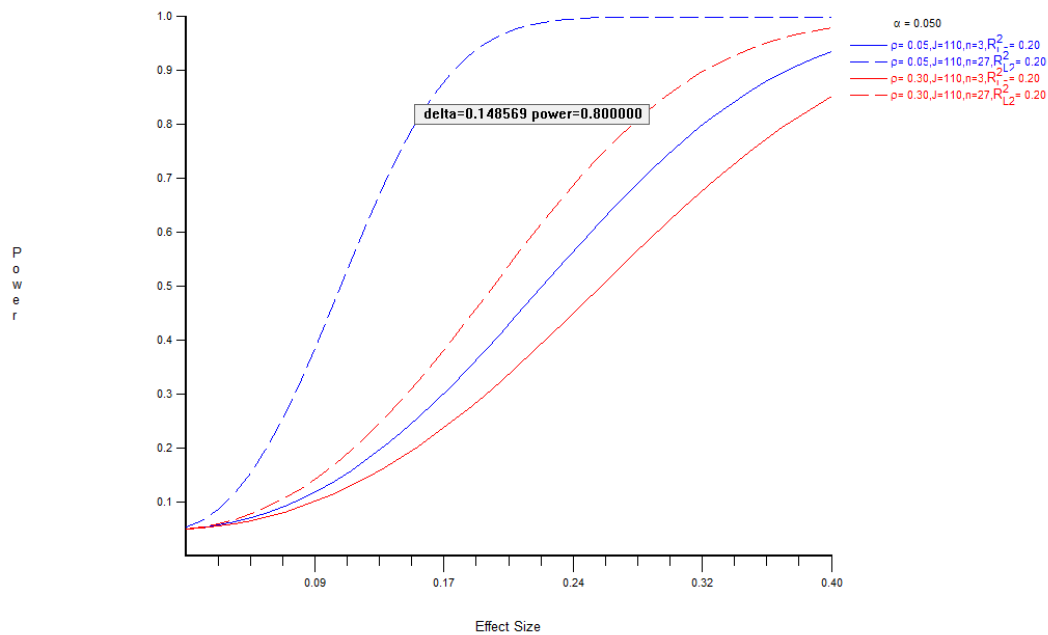
The dashed blue line shows the power curve for household surveys on agricultural output where data from adjacent Kenya has shown ICCs to be .05 (Burke 2013) and where we will have an average of 27 surveys per sub-county. These are relatively well-powered to detect small effects, with an MDE of .148σ. The solid red line shows the power of a cross-sectional analysis of the market survey data where ICCs are higher (.3) and the number of observations per sub-county is lower (3) and here we are powered to detect effects of .37σ. However, we will have high-frequency data, which should substantially improve the power of the eventual tests.

Randomization of contract guarantees via Kudu at the transaction level offers extensive power. With a sample size of 4,800 transactions, there will be 2,400 treated transactions (1,200 TMB transactions and 1,200 transactions through Kudu). Among the treated transactions, 800 (400 from each of the systems) will be offered the low, 25% guarantee; 800 the medium, 50% guarantee; and 800 the high, 75% guarantee. Using the standard significance of .05 and power of .8, and assuming that level one covariates will explain 20% of the variation in outcomes, the comparison of treated to control contracts will have a standardized minimum detectable effect of .07, and the comparison across guarantee amounts will have a standardized MDE of .12σ.

Partner Information:

Makerere University and Kudu. Founded from within the College of Computing and Informatics Technology, Kudu was developed beginning in 2010 and was launched in 2012. The developers, Richard Ssekibuule and John Quinn, devised a novel double auction mechanism in which buyers and sellers separately communicate their requirements and the prices at which they are willing to trade. Kudu has ongoing modest support from Google and will use these resources to cost-share on the project by providing radio advertising in major demand markets to produce buyers in tandem with our field efforts to generate supply, and also to run a small call center that can confirm by telephone any SMS orders

whose syntax is unclear. The Kudu system registers the location of users on first use of the system, and from there a single text message is sufficient to execute a buy or sell order. Please see "A Mobile Market for Agricultural Trade in Uganda", (ACM-DEV 2013) for more details of the pre-existing platform.

BASIS resources will be used to support co-PI Ssekibuule in adding in the necessary new features of the system to support our expanded Trader Alerts: additional crops, quality grading, the AgriNet trademark and randomized transaction guarantees. Ssekibuule has previously served as Head of Department at Makerere's CCIT and developed the code for Kudu as a part of his PhD research.

Makerere University is the preeminent educational institution in the country. We will utilize the deep networks for several key features of the project. First, a workshop focusing on impact evaluation for Technology in Development will be conducted at Makerere in 2015. This multi-day workshop will be offered to faculty and students at Makerere and will combine IT work from Ssekibuule's teaching with material from a capstone on 'Evaluating Technological Innovation' taught at UCSD by McIntosh. Second, we will hire a computer science graduate student for one full year to work on the project and receive mentorship from project PIs while working to deepen the capabilities of Kudu. Finally, Makerere will assist in the preparation of a Policy Outreach Roadshow to be conducted at the conclusion of the research to share lessons with USAID missions in East Africa.

AgriNet is the largest private-sector agricultural broker currently operating in Uganda, and has formed numerous partnerships with development NGOs such as MercyCorps, as well as having worked with major organizations such as USAID. In addition to their head office in Kampala, AgriNet has a regional office in the North and the East of Uganda. In each of the regional offices AgriNet works with a Regional Manager who is in charge of the whole region and Network Managers who each supervise CAs in one district.

Innovations for Poverty Action. IPA is a major international research nonprofit with offices in 42 countries dedicated to promoting effective solutions to global poverty problems. IPA's participation will ensure three critical dimensions of the project. First, it enables the collection of high-quality data from households and traders. Secondly, it allows us to maintain a presence on the ground focused solely on preserving the quality of the research project, and hence to keep close tabs on the quality of the implementation of the RCT. Finally, the logistical support of IPA permits us to innovate in data capture as we work to perfect and scale the SMS-based Market Survey platform.

Development Impact and Impact Indicators:

We see several distinct dimensions in which this project offers concrete potential for scale-up. First, by demonstrating that a high-tech approach to market intermediation can be effective we are working at the nexus of technological innovation and information economics to pioneer novel solutions to age-old problems of intermediation. By collaborating with the leading private-sector agricultural broker in Uganda, we have a partner who is willing and able to bring the product to scale (although our RCT itself will already operate in a full 12% of the country). The Kudu platform can be scaled up very cheaply, and it is a market whose efficiency should improve as it deepens with greater use.

The SMS market survey is itself an activity that we are eager to scale, given the paucity of granular data on agricultural markets across the African continent. Not only does the sale of this market information provide a solid business model for a private-sector firm, but organizations such as WFP or FAO that are concerned with food security may find real-time price data from rural markets of real use in building famine early-warning systems. We are building the SMS market survey system as a piece of open-source code that will be posted on the website of the Policy Design and Evaluation Lab at UCSD and shared as widely as possible; we are working with a stripped-down tech platform that plugs sim cards into dongle modems and pushes surveys and mobile airtime payments out automatically through

a server system that can be easily mounted and can be operated without zero-rated phone numbers or USSD short-codes, and thereby does not require acquisition of APIs from local telecoms. This makes the system very easy to establish in new countries that may lack sophisticated telecoms regulation or easy access to USSD, greatly facilitating the scaling of the platform. This market information – and the IT infrastructure to capture it – are public goods, which we will disseminate as widely as possible.

Moreover, results of this study will shed light on broader issues of agricultural output market development. Geographic fragmentation and poor integration of smallholder farmers into the supply chain has long been known to characterize these markets; however, this study will provide novel evidence on the ability of an information and coordination technology to integrate markets.   Such evidence will be relevant for development practitioners and policymakers interested in identifying concrete programs that can promote broader market development. Below we describe how the lessons learned in this study are relevant to the USAID Missions in Uganda and throughout East Africa, as well as to these individual countries' Ministries of Agriculture. Our outreach plan (also described below) specifically targets these audiences.

Collaboration and Capacity Development:

This project represents an exciting collaboration between several teams. By bringing together the CCIS department at Makerere with the BASIS and DIL teams from the University of California we hope to foster collaboration in the space of development engineering. UCSD will host Ssekibuule to network with the software engineers at PDEL when he is in the US for the BASIS meetings. US-based PIs will conduct a workshop at Makerere and work closely with the Ugandan graduate student to be employed on the project.

In the product space, Kudu has recognized the need for an on-the-ground partner, and has also been looking for ways to marketize the very unique price data that emerge from the transactions in the

system. AgriNet provides an excellent vehicle for both of these goals, giving a network of field agents

and potentially serving as a buyer of Kudu data once the research phase of the project has ended.

The workshop at Makerere in 2015 will be offered to students and faculty at Makerere's College

of Computing and Information Sciences as well as to AgriNet management and others from local

Ugandan universities and development organizations who are interested in conducting evaluations. The

workshop will cover experimental and quasi-experimental methods for evaluation, and will focus on

student interaction through group exercises, hands-on Stata trainings, and concept notes for

evaluations. All U.S.-based PIs have experience organizing and teaching such workshops.

Finally, we hope this project will broadly contribute to the development of improved mobile-

based data collection methods, both for Kudu and AgriNet and for other development researchers and

practitioners. The technology developed by Kudu and used by the AgriNet Commission Agents will

dovetail with a broader project currently under development at UCSD to conduct market surveys using

mobile phones. Being designed in collaboration with engineers from CalIT2, this system will push survey

modules to the phones of surveyors (or market traders in other contexts), integrate data in real time

into a back-end system that cross-checks newly entered data for consistency and distributes payments

to surveyors for correct survey via mobile money. This project represents the first large-scale

deployment of the market trader data capture system, and a close relationship with programmers at

Makerere University will help us prototype the system quickly and leave them with sufficiently

enhanced data capture abilities for critical market outcomes.

Support of USAID Objectives and Initiatives: USAID's Mission in Uganda has two dual goals for its

agricultural programing: reducing food insecurity and increasing household incomes. The program

proposed here has the potential to address both of these goals. First, consumers would benefit from

more stable food prices across seasons, if the program is successful in encouraging farmers to store and

sell later in the season. In addition, consumers in deficit areas would benefit from the more

geographically even supply of food that would result from more integrated markets. Finally, farmers

themselves would be able to derive higher incomes from their yields if they were able to time sales

optimally and access large, national buyers.

Feed the Future Uganda specifically works to transform subsistence farms into more commercial

operations. Closely aligned with this program, their efforts focus on integrating regional markets and

encouraging farmers to engage with wider trade networks. In a logic identical to the one underpinning

this proposal, Uganda's FTF Implementation Plan notes that linkages to commercial markets are crucial

for smallholder farmers, because without this, farmers "suffer from lower prices when production

increases, even as food shortages and insecurity exists in other parts of Uganda and East Africa" (FTF,

2010c), resulting in lower incomes for these farmers and worse food security for consumers in deficit

areas. Investment priority 2.2.3 "Regional Trade and Market Penetration," as outlined this document,

specifically suggests using electronic information platforms such as the mobile-based system we

propose to evaluate here to provide real-time market pricing information to farmers and buyers of

agricultural produce (FTF, 2010c).   The Uganda Multi-Year Strategy highlights efforts to promote farm-

level aggregation and market linkages (run in conjunction with DANIDA), as well as market-information

system programs, which are very similar to the program proposed here (FTF, 2011). In addition, FTF

cites increasing farmers' skills in post-harvest handling and storage technologies as an explicit

investment goal of this program.

USAID - Uganda has specific programming that closely mirror the services described in this

proposal, having pursued input services with Phase 1 Interventions from the 1990s to early 2000 and

output services with Phase 2 Interventions from 2003 to 2008 (FTF, 2010c). The proposal offers a

unique opportunity to understand the linkages between these potential investments, yielding insight

into the best value for money for future programming.   It should be noted that the FTF Implementation

Plan for both Kenya and Tanzania highlight similar challenges and investment priorities (FTF, 2010a; FTF, 2010b). Given similarities in the across these neighboring countries we believe our results in Uganda will be relevant for policymakers in Kenya and Tanzania. We will therefore target our dissemination and policy outreach activities broadly across East Africa, as described below.

We have met on multiple occasions with staff from the USAID mission in Uganda, including people in the Food Security, FTF, and Economic Growth teams.   They are closely appraised of our project, and we have investigated the possibilities for collaboration on several fronts including the potential operation of under-used warehouse capacity in treatment sub-counties by AgriNet as a part of the study innovations.

Policy Integration and Outreach: The US-based PIs will travel to Uganda once a year, during which time they will reach out to the USAID Mission in Uganda, as well as the Ministry of Agriculture and other interested Ugandan government ministries, to update them on the progress of this project. In order to formally disseminate the results of this research at the end of the final year of the project, the PIs will jointly conduct a multi-country trip to meet with the USAID Missions in East Africa, the region to which we believe our results will be broadly applicable. We will also endeavor to meet with World Bank, Ministry of Agriculture, and other development organization officials during this dissemination trip. Finally, all PIs will attend annual BASIS meetings, as well as any other US-based opportunities to conduct outreach and encourage the incorporation of evidence from this study into policymaking.

Other Funding Sources: We have requested BASIS funding for the first two years of this three-year evaluation, including a full household baseline survey and two years of the trader surveys. We have raised substantial additional funding for this project, including $200,000 from the Agricultural Technology Adoption Initiative, $197,263 from the International Growth Center, $100,000 from the Global Center for Food Systems Innovation at Michigan State University, $40,000 from the Development

Impact Lab at UC Berkeley, and $42,000 from the Policy Design and Evaluation Lab at UCSD. The market

survey and contract guarantees are funded for the full two years of the study. We will need to raise the

resources to fund the endline trader survey and the endline household survey, but given a clean

implementation and promising preliminary results from the study we are confident that we will be able

to do this.

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APPENDIX 1: ANTICIPATED OUTPUTS

In addition to the academic publications that we hope will result from this work, we will also prepare less-technical reports for use by AgriNet and Kudu to inform their scale-up plans, as well as by other NGOs interested in developing similar programs. In other dissemination efforts, the US-based PIs will travel to Uganda once a year, during which time they will reach out to the USAID Mission in Uganda, as well as the Ministry of Agriculture and other interested Ugandan government ministries, to update them on the progress of this project. In order to formally disseminate the results of this research at the end of the final year of the project, the PIs will jointly conduct a multi-country trip to meet with the USAID Missions in East Africa, the region to which we believe our results will be broadly applicable. We will also endeavor to meet with World Bank, Ministry of Agriculture, and other development organization officials during this dissemination trip. Finally, all PIs will attend annual BASIS meetings, as well as any other US-based opportunities to conduct outreach and encourage the incorporation of evidence from this study into policymaking.

Expected Program Impacts
1. The introduction of CAs + Kudu services increase trade in the sub-counties in which it is offered, triggering convergence to the law of one price across treatment sub-counties. 2. Contractual guarantees increases the rate at which eligible trade deals are executed. 3. As markets are integrated and farmers gain access to additional output markets options, farmer revenues increase 4. Effects on trader profits are ambiguous: decreased search costs and contractual risk should increase profits for existing traders; however, if this allows enough new traders to enter into these markets, the effect of competition may drive down mark-ups.
Policy and Programming Recommendations (if expected impacts are found)
1. Market information services must go beyond price information to include quantity and quality detail, as well as contact information for specific intermediaries, in order to be utilized by smallholder farmers. 2. Mobile matchmaking services represent the ultimate reduction in search costs. However, their use may require addressing contractual and trust issues that arise when new trade partners are matched. 3. Programs attempting to improve market access for smallholders must take seriously the incentives and constraints faced by intermediaries in order to induce these intermediaries to overcome the transaction costs required when engaging with smallholders. 4. Programs that promote greater market access for smallholders result in both increased revenues for farmers in surplus areas and reductions in staple food prices for consumers in deficit areas, as a result of the convergence to the law of one price.
Adoption Promotion Activities
1. AgriNet is eager to use the results of this study to guide scale-up its services. As a private-sector provider, AgriNet offers a real and sustainable opportunity for large-scale expansion. 2. Kudu, which is a particularly cheap technology to scale, will also use this evaluation to determine whether the CA in-village support network and contractual guarantees are a useful component to their scale-up. We will report on these scale-up activities in our final grant report. 3. To facilitate lessons from this evaluation informing the scale-up, we will prepare non-technical reports for use by AgriNet and Kudu (as well as other private-sector businesses and NGOs interested in developing similar programs). 4. We will also produce academic publications from this study, which we hope

will advance the literature on rural markets integration. We hope that this will shape the agenda for future evaluations that build on what is learned in this project.

5. The lessons learned in this study will be relevant to the USAID Missions in Uganda and throughout East Africa, as well as to these individual countries' Ministries of Agriculture. We will specifically meet with these audiences in our outreach "road show," to take place at the completion of the project.

6. Finally, the project will construct a public-facing database of grain prices and availability and disseminate this information as broadly as possible. This market information – and the IT infrastructure to capture it – are public goods, which we will disseminate as widely as possible. We will track how this database and underlying IT infrastructure is being used and adapted by other development NGOs and governmental agencies working on similar market-based campaigns.