Dynamics of Agribusiness Decision Making in Uganda

by

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B.S. Mechanical Engineering and Society, Technology, and Policy,
Worcester Polytechnic Institute (2016)

Submitted to the Institute for Data, Systems, and Society
in partial fulfillment of the requirements for the degree of

Master of Science in Technology and Policy

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 2018

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Abstract

Uganda is a developing country in East Africa that faces high poverty rates among a confluence of socio-political issues. In the pursuit of fiscal and political stability, international development organizations are working to create an environment in which business prospers and livelihoods are resilient. Agriculture, in particular, employs 75% of the population and accounts for 85% of Uganda’s export earnings. However, many smallholder farmers experience volatile cashflows around crop cycles. Consequently, farmer livelihoods are vulnerable to uncertain growing conditions, market price fluctuations, and financial shocks, such as hospital bills or school fees. Subject to a high degree of uncertainty, it is difficult for farmers to improve their quality of life through agriculture alone.

Agribusinesses—commodity traders in particular—are well positioned to help farmers access knowledge, goods, and services to increase yields and improve crop quality. In some cases, provision of knowledge, goods, and services aligns with an agribusiness’s regular profit-earning strategies. For example, some traders provide farmers with financing to purchase seeds and fertilizer at the beginning of the growing season; the farmer benefits from less cash volatility while the trader ensures crops will be available at harvest.

This thesis explores the extent to which trader business strategies might be leveraged to mutually benefit agribusiness growth and farmer livelihoods. Specific goals were to identify common business strategies used by agricultural commodity traders and understand the mechanisms by which certain business strategies also benefit farmers. Semi-structured interviews and subsequent qualitative analysis shed light on the types of business strategies traders adopt. System dynamics modeling was then used to explain why certain strategies can be mutually beneficial. The combination of qualitative and quantitative methods yielded unique insight on ways mutually-beneficial behavior might be encouraged.

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Acknowledgments

Writing a thesis is no small feat. This work would not have been possible without support from innumerable colleagues, friends, and family members. First and foremost, my advisor, Dr. Jarrod Goentzel, guided me through the academic somersaults of asking difficult questions, narrowing the scope to a single, manageable, research topic, and conducting a rigorous investigation despite gaps in data and methodological challenges. Additionally, Dr. Rogelio Oliva provided invaluable feedback as I developed my system dynamics model.

My research and experience at MIT has been generously supported by the United States Agency for International Development's Mission to Uganda through the USAID/Uganda Feed the Future Market System Monitoring Activity (contract number AID-OAA-A-12-00095), headquartered at the Massachusetts Institute of Technology (MIT) and The George Washington University (GWU). Opinions expressed in this publication do not necessarily reflect the views of the United States Agency for International Development, the United States Government, MIT, or GWU. However, I am deeply grateful to USAID/Uganda Feed the Future staff who made this work possible, particularly Andrew McCowan, Rita Lakerojek, Douglass Griffith, and Marion Kyomuhendo.

Special thanks go out to Tim Russell, Micaela Wiseman, Courtney Blair, Dr. Erica Gralla, Megan Peters, and Jillian Miles, my teammates from the USAID/Uganda Market System Monitoring Activity. In particular, I am so grateful to Tim Russell for being my advocate, sounding board, and reality checker, always ready to challenge my assumptions, push me think more critically about my work, and, at the same time, help me find the silver linings. Tim, I really couldn't have done this without you. In the second year of my studies, I was extremely fortunate to work with Micaela Wiseman, the best lab-mate ever, who was a constant source of reassurance. Numerous colleagues in Uganda facilitated fieldwork, especially Jackson Isiko and Jane Asiimwe, translators who let me drag them all over Iganga district, and William Kigozi, our driver.

In addition, the following people were influential and supportive throughout my time at MIT: Michael Windle and Olumurejiwa Fatunde, colleagues from MIT’s Humanitarian Supply Chain Lab; the TPP 2018 and 2019 cohorts, my friends and fam from day one; the Center for Transportation and Logistics Cohort of Research Post-docs and Students (CTL-COPRS), the first people to hear me present my work and let me draw on the walls; and finally the finance team at MIT’s Center for Transportation and Logistics, who watered my plants, fed me when I was wilting, and never failed to make me laugh.

I owe a huge debt of gratitude to TPP Academic Administrator Barbra DeLaBarre, my cheerleader, life coach, and fashionista, for drying my tears and quelling my fears each time I hit road blocks over the past two years. Similarly, I would not even be here without TPP Admissions and Administrative Assistant Ed Ballo who first encouraged me to apply to TPP. And no thesis would be complete without input from TPP’s Academic Director, Dr. Frank Field. Since day one I have deeply admired the thoughtful, meticulous, and passionate way he steers TPP. Thanks for pushing me to keep going, Frank.

One of the greatest challenges in graduate school is to build a support group, find the people who will give you an open invitation to supper, send you words of encouragement at all hours, go out of their way to check in and make sure you are okay. The people who love you unconditionally, and you really have no idea why except that it’s mutual. The people who inevitably become lifelong friends. A number of those mentioned above certainly fill this role in my life, but there are a few others who went above and beyond for me. Dr. Shlomiya Lightfoot and family welcomed me into their home, gave me thoughtful insight on my work throughout, and kept me laughing and playing when things got tough. My dear friend Natalia Guerrero, who sponsored more dinners than I can count, helped me find artistic outlets for all kinds of stress and kept cheering me on when I wanted to quit. Finally, thanks to Nikhil Mallareddy, who was there at the end.
I don't think it is possible to express in writing (and certainly not on the Acknowledgements page, though I'll give it a shot) the gratitude, love, and admiration I have for my parents and brother (and fuzzy brothers, Russell and Bently). With family challenges squeezing us all, you somehow managed to encourage me to take advantage of every opportunity at MIT, explore my interests to the fullest, and keep working hard, even when it was hard to keep working. Thanks for all the love, puppy videos, and time spent listening to me talk about my thesis, though I know half the time it didn't make any sense to either of us. This is for you, Dad.
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Chapter 1

Introduction

Uganda is a developing country in East Africa that, like many African nations, faces high poverty rates among a confluence of socio-political issues, including rapid population growth, high unemployment, and climate change. In the pursuit of fiscal and political stability, international development organizations are working with the Government of Uganda to create an environment in which businesses prosper and livelihoods are resilient. Agriculture, in particular, is a prevalent and promising area of engagement for development organizations.

In Uganda, the agricultural sector employs 75% of the population and accounts for 85% of export earnings (USAID/Uganda, 2017). However, many smallholder farmers, who typically cultivate less than two hectares, experience volatile cashflows around crop cycles (US Agency for International Development, 2013). Before the growing season begins, farmers invest in seeds, agrochemicals, tools, and field preparations; at harvest time, farmers receive concentrated income from sales, though not without risk. Financial services are limited in rural Uganda, and crop insurance is essentially non-existent for smallholder farmers (US Agency for International Development, 2016). Consequently, farmer livelihoods are vulnerable to uncertain growing conditions, market price fluctuations, and financial shocks such as hospital bills or school fees. Subject to a high degree of uncertainty, it is difficult for farmers to improve their quality of life through agriculture alone.

Presumably, improved access to knowledge, goods, and services would enable farmers to increase yields, improve crop quality, and become better connected to agricultural markets (US Agency for International Development, 2016). Agribusinesses—commodity traders in particular—are well positioned to help farmers access these resources. In some cases, providing knowledge, goods, and services to farmers aligns with a business’s profit-earning strategies (Feed the Future Knowledge-Driven Agricultural Development, 2015). For example, some traders offer financing for farmers to purchase seeds and fertilizer at the beginning of the growing season; the farmer benefits from less cash volatility while the trader ensures crops will be available for purchase at harvest.

This thesis explores the extent to which trader business strategies might be leveraged to mutually benefit agribusiness growth and farmer livelihoods. Specific goals were to identify common business strategies used by agricultural commodity traders and understand the mechanisms by which certain strategies also benefit farmers. Semi-structured interviews and subsequent qualitative analysis shed light on the types of business strategies traders adopt. System dynamics modeling was then used to understand the ways in which certain strategies can be mutually beneficial. The combination of qualitative and quantitative methods yielded unique insight on what incentives exist or might exist to encourage mutually-beneficial behavior. Conclusions shed light on opportunities for development organizations to engage traders in activities that strengthen the agricultural supply chain and ultimately lead to more resilient businesses and livelihoods.
Chapter 2

Background and Literature Review

2.1 Agriculture and Economic Growth in Uganda

Located at the equator, and perched upon the East African Plateau, Uganda experiences two growing seasons and is endowed with fertile soil ripe for crop production. Agricultural exports include coffee, maize, wheat, rice, and a variety of pulses (Uganda Bureau of Statistics, 2010). Commodities consumed domestically include cassava, millet, sorghum, ground nuts (peanuts), potatoes, sweet potatoes, matooke (an indigenous variety of green banana), and various fruits and vegetables. Indeed, Uganda has the potential to be the breadbasket of East Africa (USAID Feed the Future, 2011).

Currently, agricultural production is largely subsistence-based. According to the 2009 Agricultural Census, the average national holding size is 1.1 hectares (Uganda Bureau of Statistics, 2010), and it is believed that many smallholder farmers are disconnected from markets (USAID Feed the Future, 2011). Ongoing research is exploring the extent to which smallholder farmers across Uganda have access to and utilize agricultural inputs, services, information, finance, and sales channels.

Rich literatures of economics and social policy support the theory that development occurs as economic systems modernize and governance systems democratize (e.g. Michael Todaro, 2015, Viscusi, Vernon, Jr., Harrington, and Harrington, 2015, Duflo and Banerjee, 2012). In the aftermath of nation-wide genocide under dictator Idi Amin, Uganda has spent four decades rebuilding social and political institutions with assistance from numerous international development organizations. Support for smallholder farmers has been a major focus alongside addressing HIV/AIDS, malnutrition, education reform, governance, and others (US Agency for International Development, 2016).

In 2013, the US Agency for International Development mission to Uganda instituted the Feed the Future-Value Chain project (FTF-VC) to strengthening the agricultural supply chains for maize, beans, and coffee (US Agency for International Development, 2013). Market facilitation is an approach to improving livelihoods for individuals by strengthening the institutions and businesses that form the system in which they are nested. Through market facilitation, FTF-VC “focuses interventions at strategic leverage points within a system, such as economic or social structures and incentives, in order to optimize its functionality and inclusiveness for improved development results” (Feed the Future Knowledge-Driven Agricultural Development, 2015).

Under USAID FTF-VC, the Market System Monitoring Activity, headquartered at MIT's Center for Transportation and Logistics and The George Washington University, is developing approaches for assessing the systemic impact of FTF-VC market facilitation activities (Market System Monitoring Activity, 2017a). One of the tools produced by the Market System Monitoring Activity is the Supply Chain Role Map (SCR). The SCR is a diagram that depicts how materials, cash, and services flow between actors that fill different roles. In addition, the Behaviors, Relationships, and Conditions Map (BRC) is a diagram that captures complexity among system conditions, behaviors taken by various actors, and relationships between types of actors. Detailed information about the BRC and SCR maps can be found in Appendix E, excerpts from the System Maps Release Notes produced by the Market System Monitoring Activity in 2017 (Market System Monitoring Activity, 2017a). These maps, based on empirical
2.2. QUALITATIVE RESEARCH METHODS

evidence, are useful tools for capturing and communicating complexities and causal relationships in the agricultural market system. In March 2017, for example, USAID hosted an event where these mapping approaches were used to engage a wide variety of stakeholders in identifying opportunities for future interventions and setting development priorities (Market System Monitoring Activity, 2017b).

The SCR map (Figure 2-1) brings clarity around the roles of actors in the value chain; this study focuses on the outputs side of the map. The Market System Monitoring Activity has developed a categorization of roles that differs from other organizations in a few key ways. In the SCR framework, an agribusiness may fill several supply chain roles, but role titles do not comprehensively define actors. Roles are more general categories of activities in which actors engage.

![Figure 2-1: Supply Chain Role Map. Developed by the Market System Monitoring Activity, the SCR Map shows how materials, money, and services flow among actors in Uganda's agricultural market system.](image)

A relevant construct used in the BRC Map is the idea of system conditions. Conditions, defined broadly, are “qualities or attributes of the market environment that enable activities or changes in the market system” (Market System Monitoring Activity, 2017a). Examples may include policies, political will, and training programs. Furthermore, conditions can be categorized as enablers and barriers of systemic change. Enablers and barriers include social, political, environmental, and technological factors that define the context in which a market exists. It follows that certain systemic conditions enable growth through trade.

It follows that there is a set of enabling and impeding conditions under which individuals see trade as a mechanism for increasing income. As the results and analysis show, individuals have indeed seen such opportunities in trade. A guiding question is, how can these conditions—these institutions—be reinforced through the efforts of development organizations to strengthen incentives for agricultural commerce? What incentives could drive adoption and reinforcement of these conditions? In order to approach these questions, this thesis combines the development of grounded theory through qualitative research with differential equation modeling to provide additional explanations and insights.

2.2 Qualitative Research Methods

Qualitative research hinges upon triangulating data sources through rigorous analysis (Berg & Lune, 2012), weaving together information from different sources to obtain a deeper understanding of context and offer explanations. In the 1967 seminal work *Developing Grounded Theory*, Glaser and Strauss position qualitative research as a normative process of theory-building through data-driven inductive reasoning. Qualitative research is one avenue toward developing grounded theory. Stemming from Dr. Kathleen Eisenhardt’s work, case-based research
is well-established in literature and practice as a method for developing grounded theory (Barratt, Choi, & Li, 2011; Eisenhardt, 1989; Ketokivi & Choi, 2014; Yin, 2009).

Qualitative methods for conducting case-based research and building grounded theory can be subdivided into two categories: data collection methods and data analysis methods. Data collection methods include interviews, focus groups, ethnography, action research, and archival study (Berg & Lune, 2012). Sampling for interviews in qualitative research studies often involves random walk or snowball sampling methods, the former of which consists of interviewing people met randomly in a selected area and the latter of which samples from a list of references and then connections leading from those references.

Methods for analyzing qualitative data range from quantitative approaches, such as word counts, to pattern matching and content analysis (Berg & Lune, 2012; Yin, 2009). Coding is a useful tool for identifying common themes among numerous narrative documents, such as interview transcripts, stories, and reports. Atlas.ti is a software package that enables code creation, document annotation, and various tools to observe patterns across and within documents.

Less formal analyses also emerge as a qualitative researcher engages the population studied (Berg & Lune, 2012). Action research involves constant observation and curiosity over an extended period of time. At some point, saturation is reached where the researcher stops learning new things and is able to articulate a deep and nuanced understanding of a context.

Qualitative research methods were widely used in the course of this work. Results from qualitative analysis provided a basis for quantitative modeling using System Dynamics, discussed below.

2.3 System Dynamics Modeling

In the vernacular, people often talk about “the system” and how it works for or against them. At a higher level, underlying causal system structures can be analyzed with a variety of modeling methodologies, including discrete events modeling, agent based modeling, and differential equations modeling. The method chosen depends on the question or problem at hand.

System dynamics modeling, a form of differential equations modeling that had its genesis at MIT in the mid twentieth century, has been widely used to analyze complex social and qualitative systems (Sterman, 2000). System dynamics models view the world through stocks and flows, quantities of things and the rates at which they change. Vensim and other software packages provide a user-friendly interface to graphically portray causal loops and define mathematical functions that govern interactions among variables. The rest of this section reviews relevant established models that informed this thesis.

In the context of agricultural commodity markets, the Market Growth Model is an intuitive reference (Morecroft, 1983; Sterman, 2000). Combining firm-level decision-making and perceptions about the demand for and price of goods, the Market Growth Model provides an analytical framework for analyzing a firm’s behavior in a broader market system. In the Market Growth Model, the firm has some market power over prices, supply, and employment. The main decisions a firm makes are whether to invest in production capacity and whether to hire workers. These decisions are driven by demand, which in turn is driven by price and the firm’s ability to deliver.

The Market Growth Model has several elements that are useful to understanding the dynamics that affect farmer livelihoods. The idea of capacity utilization is analogous to a farmer’s decision on how much of their field to sow. Similarly, a trader's business sometimes behaves like the firm in the Market Growth Model: negotiating prices,
2.4. FRAMING CURRENT WORK

deciding how much inventory is profitable to procure and how much storage space is necessary, hiring employees when appropriate.

The Stock Management Model, notably, John Sterman’s incarnation in *Business Dynamics* concerning the production of Widgets (Sterman, 2000), provides structures for simulating deterministic material flow rates, order placement decision-making, and interactions among supply chain actors. Stock management is essential to both traders and farmers in their decisions on how much to plant or purchase. The Widgets model contains stocks and flows for materials in various stages of production. Similarly, farmers have stocks of crops growing in their fields and crops in storage. In the Widgets model, *Work in Process Inventory* is modeled as a pipe delay, a construct that transfers nicely to crop production.

Several elements of the Stock Management Model are inapplicable or unavailable in the current context. Order rates and order fulfillment, though relevant measures for some traders who have sales contracts with exporters or government procurement entities (e.g. school, food aid), bear no weight on farmer production. Farmers will produce as much as possible without adjusting production to meet demand, and demand itself is not known.

Several other models are also worth noting. The Bass Diffusion Model (Sterman, 2000), which explains delays in adoption of new technologies, is relevant to understanding how information and knowledge of agricultural practices spreads among the farmer population. The Getting Big Fast Model (Sterman, Henderson, Beinhocker, & Newman, 2007) describes how a firm can get ahead of competition by using new technologies, just as an agribusiness might have a competitive edge after adopting or inventing a new agricultural technology. Finally, the Commodity Cycles Model (Sterman, 2000) offers a structure of underlying market dynamics and how firms update their decision-making processes based on the current state of the system and available information.

Reviewing variables included in all of these models highlights the challenges with modeling in data-poor environments. Due to poor record keeping and the informal nature of many businesses, USAID/Uganda lacks data on the number and size of firms, their inventory flows and revenues, earnings, strategies and operations. Business records are difficult to obtain and often incomplete, and small agribusinesses do not seem to cogently control inventory flows. Demand is driven by both domestic and export markets, and sales channels are multitudinous and varied for many traders.

2.4 Framing Current Work

Empirical methods in economics research are typically based on the logic of causal inference. Statistical and econometric methods have become the norm for precisely estimating the impact of specific interventions. Yet, capturing the complexity of the Ugandan agricultural market system in a system dynamics model requires nuanced understanding of the linkages and interactions among actors. The Market System Monitoring Activity’s “Behaviors, Relationships, and Conditions” map, a first graphical representation of the system was developed through short-term studies and stakeholder engagement. While this map does not fully capture feedback loops, decision-making policies, market forces, or levels, it sheds light on the complexity of interactions. Modeling the full scope of market growth is outside the scope of this paper.
Chapter 3
Research Design and Methodology

3.1 Research Questions and Approach

Market systems are complex; numerous parallel causal feedback loops make it difficult to isolate the effects of a single decision or policy. Like chaos theory dictates, the outcomes of complex systems are impossible to accurately predict beyond a certain time step. Logically, if policy makers could predict the effects of the behaviors of market actors, programs and interventions could be designed with less uncertain (and criticized) effects. This is impossible to do without trial and error.

While neoclassical economics explains how trade can lead to growth and why individuals may decide to enter a market, academia has less to say about how heterogenous business strategies used by individual actors affect market systems in aggregate. In addition, the socio-cultural nuances unique to each country, district, and town make it difficult to generalize grounded findings or, inversely, adapt and apply theories developed from first principles. My research aims to fill a piece of this gap by exploring the incentives that motivate Ugandan traders to adopt various business strategies and the mechanisms by which said business strategies affect smallholder farmers. Though the context is unique, the causal structure of the system may be more universal.

Thus, there are three questions I address in the following chapters:

1. What business strategies are used by traders in Uganda?
2. How do these strategies affect farmers, and
3. What is the structure of the underlying system that governs mutually beneficial behavior?

I approach these questions using both qualitative and quantitative methods. The nature of a business strategy is qualitative in nature, and thus qualitative methods, described in detail below, were used to gather information about business strategies. Qualitative analytical methods were appropriate for drawing connections among and across interviews since the goal was to characterize the nature of business strategies used, not necessarily to discuss the extent to which each is employed in Uganda.

Quantitative methods, notably System Dynamics, were used to approach the second question. As explained in Chapter 5, System Dynamics modeling is useful for articulating the feedback loops and key factors that cause observed trends. Lacking comparable farmer-level data, System Dynamics modeling allowed me to develop a hypothesis about the ways in which trader business activities can benefit farmers. Section 6.3 notes opportunities for future work that elaborates on the feedback mechanisms I describe.

Finally, in the discussion in Chapter 6, I tie together the qualitative and quantitative analyses to propose incentives that exist or might exist to encourage traders to use business strategies that strengthen the market system. In particular, I analyze the reasons traders gave for why they use various business strategies and describe where incentives exist or might emerge in the market system.

Throughout, the analysis and conclusions reflect my interdisciplinary training in mechanical engineering, science and technology studies, and technology and policy. Having completed numerous technical projects with social components, my approach is to analyze data with the expectation that there is no single 'right answer' to
socio-technical inquiries, but that solutions can be designed. Nuance and details are important. Technologies, broadly defined, exist within complex contexts. Data and information present only snapshots of a more intricate landscape. The role of the researcher is to put the pieces together, fill in blanks with logic and previous work, and distill poignant, accessible insights.

In the sections and chapters that follow, I have attempted to piece together evidence to show that traders can and do make decisions that benefit farmers. Furthermore, there are opportunities for USAID and other development organizations to promote these mutually beneficial business strategies.

3.2 Qualitative Methods

Data was collected and analyzed using qualitative methods. Semi-structured interviews held in August 2016 and August 2017 were the primary source of information on trader business strategies and the reasons traders adopt them. Originally for related USAID/Uganda studies, interview reports were digitized and then analyzed using pattern matching, content analysis, and narrative analysis. The following sections describe the process used to develop interview instruments, conduct interviews, and analyze the data.

3.2.1 Semi-Structured Interviews on Quality Differentiated Pricing

The first set of interviews, held in August 2016, explored the nature of quality-differentiated pricing (QDP) among Ugandan traders. Quality-differentiated pricing occurs when traders set prices based on crop quality. The extent of QDP in the Uganda market was previously poorly understood, and, per request of USAID/Uganda, we took an inductive approach to generate new theory on how traders evaluate crop quality and set prices.

This analysis used a multiple case study approach in which we compared the experiences of six Ugandan commodity traders. Traders were purposively selected to represent variety in location, business size, commodity, organizational structure, and level of success in providing and accessing quality-differentiated pricing. Research support was provided by the Feed the Future Uganda Commodity Production and Marketing Activity (CPMA) staff, who facilitated interviews with knowledge of local markets and language. Table 3-1 summarizes notable demographics of each trader.

An interview guide was developed to conduct semi-structured interviews with the traders. Two interviews were used as pilot studies. The interview guide was revised after reviewing transcripts and initial learnings from the pilots, and four additional interviews were held using the revised version, reproduced in Appendix B. Interviews lasted one to two hours and were accompanied by short tours of processing facilities and store rooms where appropriate.

Interviews were structured around four topics:

- **Background**: general information about what crops traders deal in, the numbers of farmers and village agents they work with, and who they sell to;
- **Buying**: how traders have improved the quality of crops they are able to buy; how they set their prices and purchase crops; and how they interact with village agents and farmers;
- **Selling**: learn how traders access markets and provide high-quality products to achieve good market prices; learn about the challenges they face in accessing markets and good prices; and,
CHAPTER 3. RESEARCH DESIGN AND METHODOLOGY

- Business practices: learn about how changes in business practices have affected quality and prices; learn about traders’ goals for the future and barriers to progress.

In total, five MSM team members were involved in the interview process. Interviews were captured with an audio recorder and later transcribed. Field notes and short summaries were also recorded electronically. Data collection methods received approval from the MIT Committee on the Use of Humans as Experimental Subjects (COUHES) and the Institutional Review Board of George Washington University to ensure appropriate handling of human subjects information.

Table 3-1: Characteristics of traders interviewed in August 2016

<table>
<thead>
<tr>
<th>Trader</th>
<th>Region</th>
<th>Organization Type</th>
<th>Commodity</th>
<th>Annual Production</th>
<th>Storage Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Central</td>
<td>Multiple collectors, sells domestically</td>
<td>Bean Seed</td>
<td>300-500 MT</td>
<td>566 MT</td>
</tr>
<tr>
<td>2</td>
<td>Central</td>
<td>Multiple collectors</td>
<td>Coffee</td>
<td>730 MT</td>
<td>100 MT</td>
</tr>
<tr>
<td>3</td>
<td>Central</td>
<td>Multiple collectors</td>
<td>Maize (some Coffee)</td>
<td>500-1000 MT</td>
<td>100 MT</td>
</tr>
<tr>
<td>4</td>
<td>Central</td>
<td>Multiple collectors</td>
<td>Maize (some Beans)</td>
<td>700-1000 MT</td>
<td>250 MT</td>
</tr>
<tr>
<td>5</td>
<td>Western</td>
<td>Cooperative; farmers sell directly</td>
<td>Coffee</td>
<td>280 MT</td>
<td>unknown</td>
</tr>
<tr>
<td>6</td>
<td>Western</td>
<td>Multiple collectors and distributors</td>
<td>Maize</td>
<td>7,200 MT</td>
<td>10,300 MT</td>
</tr>
</tbody>
</table>

Full analysis of QDP interview data is included in Appendix A, a report originally produced for USAID in March 2017. Relevant findings and analysis are discussed in Chapter 4.

3.2.2 Semi-Structured Interviews with Agribusinesses in Iganga District

The second set of interviews, held in August 2017, was used to understand and categorize the business strategies employed by different types of agribusinesses. Forty semi-structured interviews were held with traders, dealers, processors, and agents in Iganga district.

Interviews were designed to complement a survey on farmer market engagement, providing context around quantitative data. Iganga, one of the districts selected for the Farmer Market Engagement Study (FMES), was selected for additional interviews because of its proximity to Kampala, dense population, and availability of translators. Interviews lasted 45-90 minutes and were primarily conducted in Lusoga with the assistance of translators. With two interview teams, we completed forth interviews over five days.

Interviews were held in the trading centers of Busembatya, Namirembe, Idudi, and Iganga Town. Five interviews were also held in villages ten to fifteen kilometers away from trading centers. Trading centers were purposely selected to represent different parts of the district. Within each location, we used a combined random walk/snowball sampling strategy to find interviewees. Upon arriving in a trading center, input dealers, traders, and processors could be identified by storefronts. At the conclusion of each interview, we asked for connections to other types of agribusinesses or business partners. This was how we were able to interview agents, who are often transient and lack a store or other permanent location.
3.2. QUALITATIVE METHODS

We aimed to interview two or three of each type of business in each trading center and overall completed between nine and twelve interviews with each type of actor. It quickly became clear that our notion of business typology was prematurely discrete, that agribusinesses often opportunistically adopted a portfolio of business activities that made them more difficult to define than we expected.

Interviews were semi-structured, with a list of questions that had pre-meditated answer choices for easy note-taking and additional space for explanations and commentary. Questions were divided into seven topics:

- Basic business information and demographics;
- Business model, including information on customers, suppliers, and whether the agribusiness works with agents;
- Ways the business engages with farmers, if applicable;
- Primary business activities (these questions were retrospectively used to better categorize business types);
- How the business accesses information;
- Cost structure and access to finance; and,
- Narrative about how and why the business was started.

Additional questions were asked for each type of business, where appropriate. The interview questions have been reproduced in Appendix D for reference. Topics were approved by MIT COHES prior to commencement of the interviews, and interviewees were compensated 20,000 UGX (about $5.00 USD). After all interviews were complete, notes were typed up in a format that corresponded with the interview questions. A memo with preliminary findings, reproduced in Appendix C, was delivered to USAID/Uganda shortly after interviews were complete.

3.2.3 Analysis of Interview Data

The objective of this analysis was to identify categories of trader business strategies observed in fieldwork. Interview data were approached from the methodological perspective of grounded theory, generalizing from empirical evidence, narrative accounts, and observation.

For the traders interviewed on Quality-Differentiated Pricing, findings emerged through coding and pattern matching. Interview recordings, field notes, and memos were transcribed and reviewed. Important themes were identified via a deep reading of one transcript. Rather than cherrypicking mentions of pre-determined topics, attention was devoted to emergent topics that came up in discussion. These themes were then compared to the research questions and used to construct a set of codes, tags used to annotate transcripts. Codes included: Quality perception, Quality change, Action taken to improve quality, Driver of quality change, Price perception, Price change, Action taken to improve price, Driver of price change, Price based on quality, Driver of QDP, Buy, Sell, Decision-making on buy/sell, Decision making on investment, Transaction process, Goals, Challenges, Requests, Sustainability, Intervention, Relationship, Relationship change.

Once a list of codes was developed, the interview transcripts were reviewed and annotated in Atlas.ti, which allowed coded text segments to be sorted and collected thematically. Subsequently, patterns were identified throughout the transcripts. Notes on main themes were recorded on worksheets and in a Microsoft Excel spreadsheet. The data tables that appear in Chapter 4 were constructed based on careful analysis and review of transcript quotes. Each data point was cross referenced to a transcript and considered in context for relevance.
CHAPTER 3. RESEARCH DESIGN AND METHODOLOGY

For the interviews conducted in Iganga, findings were derived from similar pattern matching analyses and narratives. Since interviews were more structured and reports were typed in a format that retained the original questions asked, no coding was necessary; data that corresponded across interviewees was already tagged, in a sense. Again, spreadsheets were used to make notes of the similarities and differences among respondents. In addition, field notes and reflections diligently recorded during the interview period were important in this analysis, providing observational evidence to enhance the content provided by interviewees.

In the analysis of this second set of interviews, special attention was paid to the rationale behind decisions made by agribusinesses and the context in which these decisions were made. Ultimately, the rationale underlying decisions made in various contexts was distilled to a more nuanced understanding of the types of business strategies used. These rationale were then analyzed using system dynamics modeling, as described in the next section.

3.3 System Dynamics Modeling Methodology

Findings from the qualitative analysis described above were used to develop a system dynamics model of a farmer-trader transactional relationship. With system dynamics, differential equation models are developed using a graphical interface that enables iterative analysis of causal structures. Rather than building a model and assessing the outputs of the model, as is often the case with mathematical modeling, system dynamics modeling can be explanatory. Once a model can recreate known trends, or reference modes, the causal structure of the model can be analyzed more deeply.

My goal was to build a model that simulates known cash and inventory flow, then systematically change variables and connections to observe the effect each part has on cash and inventory levels for traders and farmers. I developed the base model using Vensim software, drawing on model structures from literature and causal links identified by traders in interviews. The base model was considered complete when simulations showed trends that mimicked the known reference modes described above. I then added additional variables and structure to simulate the potential effects of different business strategies and articulate why these strategies work. The model is explanatory, rather than predictive.

Reaffirmed in interviews, we know that farmer cash is highest during harvest and lowest during the growing season. Consequently, farmers are most vulnerable to financial shocks that occur during the growing season. The dynamic hypothesis that guided model building was that this volatility is due to the fact that farmers face long delays between periods of earning income. Chapter 5 describes the model building process and how this dynamic hypothesis was clarified and assessed.

The shortcomings of qualitative data analysis are well documented. In this case, the sample size is small, interviews were localized, and, though legitimate methods in social science research, snowball and random walk sampling likely introduced selection bias. Coding is not an exact science, allowing room for interpretation of cultural and linguistic nuances. No doubt, another researcher would read into interview reports with a different perspective. Throughout, I have tried to be transparent in communicating the logic used to draw conclusions.

Yet, these methods are appropriate for answering the research questions. This thesis is not intended to distill universal truths, but rather to examine rationale offered by Ugandan traders and unravel the causal influences and effects of their decisions. In addition, this work provides an example of how system dynamics, paired with qualitative data, can be used to identify drivers of systemic change in an international development context.

Recognizing that Ugandan agribusinesses are operated by both men and women, I have chosen to use the gender-neutral they/their pronouns throughout.
Chapter 4

Trader Business Strategies

Through qualitative analysis of interview data, I propose a taxonomy of trader business strategies. There are four high level ways that traders grow their business: increase quantity sold, improve quality, sell at higher prices, and diversify business activities. Quantity, quality, price, and activities can be thought of as pathways to business growth; traders then adopt sets of strategies to cause change in one or more of these dimensions. Approaches to alter quantity, quality, price, and activities are not mutually exclusive. On the contrary, they are tightly intertwined. This section first addresses the diversity and fluidity of trader business activities, then discusses how said activities affect quantity, quality, and price. Secondary analysis investigated how these strategies mutually benefit traders and farmers.

4.1 Traders opportunistically diversify business activities, often filling multiple roles

During interviews, it quickly became clear that actors do not play discrete, exclusive roles such as those defined by the Market System Monitoring activity (Figure 2-1 is reproduced here for reference). Agribusiness activities often span several roles. For example, a business that operates a milling machine might also buy and sell grain at the wholesale level, filling the roles of both processor and trader. Some businesses that identify as traders also have storefronts where they sell grain at the retail level.

Many of the business owners interviewed started out playing a single role in the market, usually one that required low startup capital such as using a bicycle to collect and sell grain, and then diversified to take advantage of new opportunities. Several role combinations appeared frequently among actors who self-identified as traders or whose primary business activities fall under the trader role:

- **Trader**: buys from collectors/agents/brokers and sells to other businesses. These pure traders do not interact with farmers or end consumers.
- **Trader-collector**: may buy from other businesses, but also has direct interactions with farmers. These traders have potential to provide farmers with production services, improved inputs, information, and credit.
**Trader-processor:** usually buy from and sell to other businesses, but also transform commodities. Some trader-processors own processing equipment, some pay for processing services. Regardless, these traders purchase one commodity and sell a transformed commodity. For example, they may purchase whole grain maize and sell maize flour.

**Trader-retailer:** buys from other businesses (traders or collectors) and sells to individuals in local markets.

**Trader-exporter:** buys from other businesses (traders or collectors) and sells to buyers in other countries. Agribusinesses that self-identify as traders seem to move smaller quantities and purchase from a smaller geographic area than those who identify as exporters.

Some traders and collectors who identified as 'agents' or 'brokers' filled more than two roles. When asked why they started their business, a common response was that they saw trading, processing, exporting, etc. as a way to overcome poverty and have a more stable livelihood. As their businesses grew, they were able to invest in additional assets (e.g. milling machines, silos, trucks) and diversify business activities, effectively assuming more roles.

While the role map framework is useful for understanding the various activities that take place to move commodities from producers to consumers, actors rarely play one role exclusively. Rather, **diversification into new roles is seen as an opportunity, one of which many agribusinesses take advantage.**

### 4.2 Increasing quantity sold

Traders often commented that their businesses are limited by the current yields and volumes of crops they trade. This sentiment was sometimes framed as a request for further trainings that would help them work with farmers to increase yields. Sometimes, it was a lamentation that limited supply prevents them from becoming exporters themselves. Overall, it was clear that quantity is a significant obstacle in the minds of the traders. Traders understand that there are several avenues by which increased quantity leads to growth, evidenced by statements such as:

- “The money I have determines the amount I can buy.”
- “If I have money, I buy as much as I can”
- “I saw this was the business that could lift me from poverty...You buy your stock and sell it in bulk to make the difference.”
- “The amount we buy depends on the amount of money we have. We store in bags in the house and spray the room.”
- “I need more farmers [so that more grain is available to buy.]”

These quotes and others reveal a number of tactics by which traders increase the quantity they sell. Table 4-1 summarizes these modalities in generic terms. The quantity purchased and sold depends on the number of suppliers, the amount each supplier can sell, the amount lost to spoilage, and capacity constraints.

Of these tactics, increasing yields and reducing loss warrant further inspection. After all, farmers, not traders, are responsible for determining the quantity grown per acre and preventing short-term spoilage. Farmers can use a variety of techniques, known as Good Agricultural Practices (GAP), to increase yields. These practices include irrigation, soil-maintenance techniques, use of fertilizers, planting drought-resistant varieties, spraying pesticides and herbicides, harvesting when crops are ripe, and the use of quality inputs (as opposed to counterfeits, which are rampant in Uganda.) When farmers use Good Agricultural Practices, they can expect to produce more crops
4.2. INCREASING QUANTITY SOLD

Table 4-1: Factors that affect trader quantity

<table>
<thead>
<tr>
<th>Quantity Determinant</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Suppliers</td>
<td>Traders can increase the number of farmers and other suppliers they source from. If each supplier can provide a certain amount of grain, the effect of adding more suppliers is multiplicative.</td>
</tr>
<tr>
<td>Farmer Yield</td>
<td>Some traders work closely with farmers, training them in ways to increase the quantity produced on a given plot. Yield is greatly improved when farmers use Good Agricultural Practices.</td>
</tr>
<tr>
<td>Post-Harvest Loss</td>
<td>Using good post-harvest handling practices, including drying and hermetically sealed storage bags, farmers and traders can both reduce spoilage and crop infestations. With less loss, traders have more quantity to sell.</td>
</tr>
<tr>
<td>Storage</td>
<td>Traders can purchase additional silos to increase the space they have for grain storage. Increased storage allows them to purchase more grain when it is available, alleviating one of the budget constraints on purchase quantity.</td>
</tr>
<tr>
<td>Cash</td>
<td>Traders purchase what they can afford. Some keep records to assist in assessing how much cash to invest in purchases.</td>
</tr>
</tbody>
</table>

According to traders, the quantity of commodities they deal in is affected by the number of suppliers they have, the amount produced by each supplier, the amount lost to spoilage post-harvest, and the amount they can purchase given storage space capacity and cash constraints.

per acre than without. Similarly, farmers who use good Post-Harvest Handling practices (PHH) can prevent post-harvest loss by drying crops to prevent spoilage.

Traders, then, can affect the quantity produced by encouraging farmers to use GAP and PHH. Traders typically engage farmers through:

• providing trainings, demonstrations, and continuing advice;
• offering spraying and pruning services;
• providing farmers with quality inputs or credit for inputs at the beginning of the season; and
• giving traders tarps to dry crops after harvest.

Interestingly, through these activities a trader takes on the role of a provider of agricultural production services or extension services. As a provider of extension service, traders equip farmers with knowledge and skills to be more productive. There is a suite of services and trainings recommended by USAID/Uganda and other development organizations, all intended to help farmers increase yields and improve crop quality. Traders may arrange trainings with an external organization, train farmers themselves, or provide ad-hoc advice. Topics range from use of good agricultural practices to proper post-harvest handling techniques. Traders who invest in farmer skills and knowledge typically have relationships with farmers that go beyond transactions.

Since no interviews were held with individuals who identified as service providers, little information was available for deeper analysis of how being a service provider benefits traders. At the surface, provision of services increases agricultural productivity, which in turn increases trader income, which enables traders to continue providing services. Yet, there is likely something deeper going on; many traders seem to provide these services out of obligation to farmers with whom they have established business or personal relationships, not as a business strategy on its own. The role of the service provider is enacted in extraordinarily diverse ways and provides
ample opportunity for further investigation.

Formal financial services are expensive and scarce in rural Uganda. Some traders lend cash or give cash advances to farmers. Some provide farmers with financing to purchase seeds and fertilizer at the beginning of the growing season or provide farmers these inputs directly. This form of in-kind credit can enable farmers to plant more than they may have otherwise been affordable. Often, when traders provide credit they arrange buying agreements with farmers that are enforced through verbal agreements and social capital or, occasionally, official signed contracts. Providing inputs allowed farmers to plant and, in some cases, also ensured that farmers were using quality inputs. Counterfeits are common in Uganda. Some manufacturers dilute chemical fertilizers and pesticides. Often, seeds are old or have an extremely low germination rate. Several third-party services have arise to mark verified inputs using ICT-enabled scratch labels, but have had difficulty gaining traction among farmers. Traders who are aware of these services or have direct connections to quality input dealers can procure quality products for their farmers. Providing tarps reduces post-harvest loss. Both efforts increase the quantity produced by farmers.

4.3 Improving quality

For many traders, improving quality is another strategy for growing business. Some traders claim that their reputation is staked on quality, that customer retention depends on delivering reliable goods. For others, quality-differentiated pricing and reduction in post-harvest loss are sufficient financial incentives for investing in quality. Objectively, attention to crop quality is important for avoiding public health hazards like aflatoxins and for improving food security by reducing loss to spoilage and insect infestations.

Uganda subscribes to the East African Grain Quality Standards, established by the East African Community, but has few policies or regulations in place to incentivize investment in quality improvement for domestic markets. For export commodities, including coffee and maize, quality standards are imposed by international buyers. Coffee quality standards, for example, are enforced because exporters will only be able to sell coffee that has been adequately preserved and processed. Certain types of crop certifications (e.g. organic, non-GMO) impose additional quality requirements that require verification by a third-party auditor. However, few farmers in Uganda are currently subject to or have access to these avenues of quality enforcement. Instead, quality is perceived and adjusted according to less formal heuristics.

Though quality is measured in different ways for different crops, interviews revealed that there are common attributes traders consider when evaluating quality. While formal quality standards are not always in effect, Table 4-2 briefly describes a number of quality attributes that traders consider when buying and selling.

For some attributes, there are things traders can do to improve quality. Similar to the quantity determinants described above, each tactic has context-dependent nuances. Some traders differentiated quality based on well-defined grades. For example, maize traders identified five grades of milled maize that depend on coarseness of grind and whether the bran has been removed. One trader similarly noted three grades of beans. In the case of coffee, traders distinguished between kiboko and Fairly Average Quality (FAQ), the former of which is dry, unprocessed coffee cherries and the latter is hulled. Traders who discussed grade said that different grades fetch different prices and agreed that there were clear differences between grades.

For other quality attributes, the line between good and bad quality is more ambiguous, partly due to lack of measurement technologies. Moisture content, for example, can be estimated by placing a few pieces of grain inside an empty water bottle with salt; if the salt sticks to the side of the bottle, the grain is not dry enough. In
Table 4-2: Quality attributes described by traders

<table>
<thead>
<tr>
<th>Quality Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture content</td>
<td>The percentage of water in a product; generally, drier products are considered higher quality since they perish less quickly.</td>
</tr>
<tr>
<td>Foreign matter</td>
<td>Rocks and other inedible objects reduce the quality of goods and must be removed.</td>
</tr>
<tr>
<td>Spoilage</td>
<td>Molds and bacteria can cause crops to spoil, leaving metabolites linked to cancer and liver disease. Aflatoxins are harmful metabolites present in spoiled maize; Ochratoxin-A is a similar byproduct in coffee.</td>
</tr>
<tr>
<td>Roughage</td>
<td>Coffee and maize have hulls—roughage—around the seed and grain, respectively, that are removed during post-harvest processing. Crops with hulls intact are considered lower quality.</td>
</tr>
<tr>
<td>Size and shape</td>
<td>Small and/or deformed crops are less desirable. They may be indicative of poor agricultural practices or poor growing conditions. Traders use screens of different mesh size to sort crops like maize or rice by size.</td>
</tr>
<tr>
<td>Color</td>
<td>In the case of coffee, the color of the hull indicates maturity. When coffee berries are red (cherries) they are ready for harvest.</td>
</tr>
<tr>
<td>Grade</td>
<td>Coarseness of grind for commodities that are milled (e.g. maize, wheat, millet, cassava) is perhaps most universal. The finer the grind, the higher the grade.</td>
</tr>
<tr>
<td>Variety</td>
<td>For some crops, certain genetic variants are valued more highly and considered better quality. <em>Arabica</em> coffee is considered better quality than <em>Robusta</em>, for example. Some species of rice have larger grains.</td>
</tr>
</tbody>
</table>

Quality is multidimensional. Traders describe a number of commodity attributes that affect quality, listed here. Some attributes, such as variety, are discrete, while others, like amount of roughage in a milled commodity, are continuous.

Table 4-3: Tactics to improve crop quality

<table>
<thead>
<tr>
<th>Quality Determinant</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good Agricultural Practices (GAP)</td>
<td>Certain production practices improve the quality of crops produced. Agrochemicals can reduce damage from insects and plant diseases. Fertilizer and attention to soil quality affect the size of produce and, for some crops, the flavor. Planting and harvesting at the right times affect crop size, color, and shape.</td>
</tr>
<tr>
<td>Post-Harvest Handling (PHH)</td>
<td>Post-harvest handling practices include drying (to remove moisture and reduce perishability), grain cleaning (to remove dirt, rocks, and other foreign matter), and fumigation (to kill pests and prevent mold).</td>
</tr>
<tr>
<td>Processing</td>
<td>Overlapping with PHH, quality can be improved by removing hulls and milling. Processing is the key to increasing grade and transforming goods to higher value commodities.</td>
</tr>
<tr>
<td>Storage</td>
<td>Distinct from the other categories, which are mainly focused on improving quality, improved storage practices are paramount to preventing the loss of quality. Using hermetically sealed storage bags and silos, crop quality can be preserved for longer periods of time by preventing infestations and rotting.</td>
</tr>
</tbody>
</table>

Traders explained that crop quality is affected by the practices used in crop production, post-harvest handling, and processing. While these practices are intended to improve quality, storage technologies preserve current quality.
contrast, a few traders used electronic moisture meters, which displayed a precise moisture percentage. Electronic moisture meters were uncommon though, partly because they were expensive. Similarly, many traders acknowledged the danger of aflatoxin contamination, but had no way of actually testing for aflatoxins other than by checking for spoilage via sight and smell.

Traders attribute quality-improvement to the use of GAP, PHH, processing, and storage, described in more detail in Table 4-3. Traders acknowledge the value of having quality inputs and seed. Drying and the use of adequate post-harvest storage facilities prevent spoilage from molds and insects. In particular, emphasis was placed on the use of tarps for drying to prevent contamination and achieve lower moisture content.

### 4.4 Increasing price margins

A number of traders who kept records of goods purchased and sold used those records to make business decisions. As one trader astutely stated 'If the business does not bring a profit, it is not a business.' To sell at the highest marginal price, traders use a variety of tactics including commodity transformation, negotiations, bulking, and arbitrage, summarized in Table 4-4.

<table>
<thead>
<tr>
<th>Price Determinant</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformation</td>
<td>Trader-processors take advantage of the price difference between whole-grain and milled commodities.</td>
</tr>
<tr>
<td>Negotiations</td>
<td>Buying agreements, established business relationships, and rhetoric are a trader's friends when seeking high price margins.</td>
</tr>
<tr>
<td>Arbitrage</td>
<td>Some traders compare prices offered in different trading centers when deciding where to sell. Others take advantage of seasonal price changes that correlate with the growing seasons.</td>
</tr>
<tr>
<td>Quality</td>
<td>Related to processing and post-harvest handling, some trades offer and receive prices linked to quality.</td>
</tr>
</tbody>
</table>

As discussed above, trader-processors add value through commodity transformation. Processing improves the quality of a commodity through preservation and transformation. Processed (milled, hulled) goods are valued differently from their whole-grain counterparts. Grain that is dried, shelled, and milled properly will be better preserved and ready for consumption. Furthermore, the coarseness of the grind and percentage of hull in the mix determines the quality grade. Higher grade commodities sell at higher prices.

Traders negotiate with buyers and suppliers to get good prices. Several say they retain farmer-suppliers and customers by offering them better prices than the current market rate. Buying agreements are one tool for negotiating prices. Traders who develop long-term relationships with buyers and suppliers are able to get and give better prices. Similarly, traders say they offer and receive better prices when buying and selling in bulk. While the effects of these practices on income warrants further study, trader testimony supports the idea that relationships among buyers and suppliers enable a firm to achieve more reliable income.
4.4. INCREASING PRICE MARGINS

Traders engage in arbitrage by selling crops in market centers where prices are better or storing crops when prices are low in order to sell during other times of the year when prices are high. Most traders interviewed either negotiate with exporters, select where to sell based on prices advertised, or both. Traders report using cell phones to communicate with buyers in large market centers and selling to the highest bidder. In all cases, access to price information is essential. There is an established literature base explaining how information technology and cell phones help buyers and sellers make more informed decisions, effectively improving market efficiency and stabilizing prices (e.g. Feyrer, 2009; Jensen, 2007). While I did not collect information or experimentally test the effect of trader decisions on prices, traders' reported behavior is consistent with current findings on how technology enables arbitrage and stabilizes prices.

In selling to the highest offer, traders emphasized the importance of having connections to multiple exporters. "I need more buyers," one trader said, after making a similar appeal for increased supply. When traders are connected to more exporters, they have more options and can compare prices. Traders may prefer one exporter over another because of proximity. Length or reliability of relationship can also motivate traders to prefer one exporter over another. Data from the 2017 interviews suggests that traders who have a set number of buyers tend to trust them more, whereas traders who do not have established relationships with traders are more skeptical of their buyers. Most traders either call ahead to see what prices are offered on a given day or they access the prices over the internet. Once they know the prices offered at each location, they have more leverage to negotiate with a preferred exporter.

Similarly, traders who keep business records are able to more formally estimate which times of the year prices will rise. Uganda has two growing seasons, March to June and August to December. During the growing season, supply is low and prices are high. At harvest, prices plummet with a glut of supply. Some traders attempt to take advantage of these price fluctuations by storing crops when prices are low and selling several months later once prices rise. Traders who store grain properly can benefit from these increased prices later in the season. Improved storage technologies preserve crops, preventing spoilage or pest infestations. The potential for arbitrage based on price fluctuations increases the importance of having adequate storage facilities that prevent crops from spoiling. Weather can also affect prices: when there is rain, crops are more prone to spoilage. If a trader has silos or other storage facilities, they can keep crops dry and sell at a higher price after the rain.

It is unclear whether individual firms have market power. However, traders with assets are able to better take advantage of such arbitrage opportunities. Those with trucks can access farther, larger market centers. Those with silos and other storage facilities can preserve crops to sell in the off-season.

Quality-differentiated pricing (QDP) arises when crop quality affects the unit price offered or received. There are two distinct approaches to QDP that traders articulated:

- **Price based on quality grade**: actors use distinct pricing brackets for different grades determined by common perceptions of specific quality characteristics. As described above, grades are fairly uniform, with distinct and standardized grading schemes for certain crops such as maize and beans.

- **Price based on adjusted weight**: certain quality attributes (e.g. moisture content, presence of foreign matter) affect the weight of a given quantity purchased; many buyers perform secondary processing that results in weight reduction. Therefore, they may 'reduce the kilograms' purchased in a transaction to account for reduced revenue potential.

Traders that do not distinguish quality grades typically employ a method known as reducing the kilograms. Traders publicize a nominal price per kilogram, then, if quality is poor, pay for fewer kilograms than the scale measures. The process for ascertaining quality is not standardized, and adjustments may be arbitrary. Traders
explained that they use this method to account for post-harvest loss, presence of stones and other foreign objects, and additional weight of moisture or hulls. Here, we find that quality affects both quantity and price.

It is difficult to determine the catalyst for QDP, and thus challenging to identify where to initiate interventions. Buyers are only willing to pay more when better quality goods are available, but sellers only have the incentive to produce better quality goods when they know the extra effort will be rewarded. This type of dynamic is a positive feedback loop in which an action produces a result that enables more of the same action, and on and on. This results in something of a paradox: better quality goods must be available for a buyer to pay more for them, but better quality goods will only be produced if a buyer is willing to pay more for them. Initiating this reinforcing loop requires both changes to happen together.

4.5 Quantity, quality, and price are closely linked

Quantity, quality, and price are closely linked. In this section, I use mathematical notation to describe the complex relationships between these three attributes that traders understand to influence business success. The equations here are a first step toward building a differential equations model that simulates the behavior of complex systems over time, discussed further in Chapter 5.

Since traders earn a margin on each kilogram sold, income is effectively the sum of marginal price from all transactions over time. Mathematically, income can be represented by an integral function since price and quantity are both time-dependent variables.

\[ Income(t) = \int_0^t \text{Marginal Price}(t) \times \text{Quantity Sold}(t) \, dt \]  \hfill (4-1)

If prices were constant, traders could grow their businesses simply by increasing the quantity of crops they buy and sell. Quantity is equal to the cumulative amount produced by suppliers over time, minus the quantity lost post-harvest. While transactions are discrete, quantity is described with a continuous function to link the qualitative findings in this chapter with differential equation modeling in the next. The quantity a trader sells can be expressed in mathematical terms, where the amount purchased is the sum of yield from each supplier \((n)\), aggregated over time \((t)\), minus post-harvest loss. The amount a trader can purchase is constrained by cash and storage or holding space; a trader cannot procure more than can be stored and, unless credit is available, cannot purchase more than their budget allows.

\[ \text{Quantity Sold}(t) = \int_0^t \int_0^n (\text{Quantity Purchased}(n) - \text{Loss}(t)) \, dn \, dt \]  \hfill (4-2)

Quality is more difficult to objectify, but can be described as a function of grade and other quality attributes determined by processing and post-harvest handling. Storage also influences quality by preventing degradation and spoilage.

\[ Quality(t) = f(\text{PHH, Processing, Storage}) \]  \hfill (4-3)

Following from the analysis in Section 4.4 above, price is a function of quantity (e.g. through bulk sales), quality
(via grade and other attributes that add value), negotiations, and arbitrage. The relationships between these elements and price is not uniform among traders, so price can be described most generally simply as a function of these elements:

\[ \text{Marginal Price}(t) = f(\text{Quantity Sold}(t), \text{Quality}(t), \text{Negotiations}, \text{Arbitrage}) \]

A noteworthy insight is that tactics used by traders to improve or preserve either quantity, quality, or price often impact more than one of these attributes. Figure 4-1 provides a high-level view of how tactics, such as providing production services or training, influence quantity, quality, and price in simultaneous and complex ways. The influence of each tactic on quantity, quality, and price is also summarized in Table 4-5.

Concluding the analysis of business strategies, three things are clear. First, traders adopt additional roles when an opportunity presents itself. Consequently, actors who identify as "traders" actually fill a variety of roles in the supply chain.

Table 4-5: Tactics affect quantity, quality, and price simultaneously and in complex ways

<table>
<thead>
<tr>
<th>High-level Strategies</th>
<th>Quantity</th>
<th>Quality</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers use Good Ag. Practices (GAP)</td>
<td>Increase yields</td>
<td>Size, color, variety</td>
<td>*</td>
</tr>
<tr>
<td>Post Harvest Handling (PHH)</td>
<td>Prevent loss, remove contaminants that add weight</td>
<td>Grain cleaning, drying</td>
<td>*</td>
</tr>
<tr>
<td>Processing</td>
<td>*</td>
<td>Grade, preservation</td>
<td>Grade</td>
</tr>
<tr>
<td>Storage</td>
<td>Prevent loss</td>
<td>Prevent quality degradation</td>
<td>Arbitrage</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other Tactics</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide Ag. Services</td>
<td>GAP</td>
<td>GAP, PHH</td>
<td>*</td>
</tr>
<tr>
<td>Training</td>
<td>GAP, PHH</td>
<td>GAP, PHH</td>
<td>*</td>
</tr>
<tr>
<td>Invest in Assets</td>
<td>Ag. services</td>
<td>PHH, Processing, Storage equipment</td>
<td>Transport to other markets</td>
</tr>
<tr>
<td>Offer credit, inputs, tools</td>
<td>GAP, quality inputs</td>
<td>PHH, drying</td>
<td>*</td>
</tr>
</tbody>
</table>

This table organizes tactics according to how they influence quality, quantity, and price of goods traded. In the top half, each row is a high-level strategy and entries are tactics grouped by whether they affect quantity, quality, or price. In the bottom half, each row is a tactic that does not directly affect quantity, quality, or price, but that does affect one of the strategies in the top half. Tactics in the bottom half of the table are causally a step removed from the impact they have on quantity, quality, and/or price. Asterisks (*) indicate that no direct link exists between a given tactic or strategy and that commodity attribute.

Second, within these various roles, traders grow their businesses by increasing the quantity sold, improving
CHAPTER 4. TRADER BUSINESS STRATEGIES

Figure 4-1: Diagram depicting the complex relationship between quantity, quality, and price. Traders describe the activities they undertake to affect one or more of these dimensions, which ultimately affect the others directly or indirectly.

quality, and increasing prices. Yet, the relationships between quantity, quality, and price are complex. Efforts to change one of these attributes almost always affects the others. Traders tended to rationalize the use of a strategy based on one perceived effect or another, but intuitively seem to realize that effects on other attributes may be indirect or delayed. The tables and diagrams presented in this analysis aim to bring to light the pathways by which indirect effects are realized.

Third, of the strategies and tactics that traders use to grow their businesses, farmers are most directly affected by training, the provision of agricultural services, and credit provided by traders. Individual traders typically presented these tactics as ways to increase either quantity, quality, or price, but it is clear that the effects of said tactics indirectly affect all three.

The analysis presented here sets the stage for modeling the complex effects of actions taken by traders. Chapter 5 further examines the framework presented here in an attempt to understand why strategies affect business growth and better articulate how these effects manifest.

4.6 Enablers and Barriers to Economic Growth in Uganda

Traders spoke about a number of phenomena that can be described as enablers and barriers to change. These include social, environmental, political, and technological factors, described in this section. The Market System Monitoring Activity has developed a framework for discussing system conditions, colloquially called 4A. The four As are Availability, Accessibility, Affordability, and Acceptability. In the context of agriculture, goods and services can be described as 4A if they meet these criteria. A good or service is acceptable if it is of sufficient quality and affordable if it is priced appropriately for the target customers, typically smallholder farmers. The distinction between availability and accessibility is more subtle. A good or service that is available, provided by an actor in an area, may not be accessible due to socio-cultural or political barriers, lack of transportation, time constraints, or unawareness. The 4A framework is useful for thinking about the barriers and enablers traders face in the course of running a business.

Traders identified a variety of challenges. From the trader perspective, barriers to increasing quantity, improving quality, and getting better prices are interconnected. Each trader had a unique story to tell on how these barriers manifest. Some are challenges that the trader has overcome. Some were framed as requests. In understanding the
challenges and enablers of quality differentiated pricing, it is essential that challenges are approached with the knowledge that they affect people in ways as varied and multitudinous as personalities. Though a full explanation of barriers and enablers identified through interviews is included in Appendix A, notable ones have been reiterated here:

• The political climate must be amenable to commerce and private enterprise. Regulations for seed and crop quality must exist and be enforced.

• Effective and affordable financial services support private enterprise by providing means for investment in capital and assets that expedite growth. Consistent access to financial services would allow both farmers and traders to engage in practices that improve crop quality. However, financial services are expensive or simply non-existent in many parts of Uganda.

• Farmer adoption of good agricultural and processing practices was an issue identified by most of the traders. When asked why this was the case, traders gave different answers. “it is human nature to resist change...farmers feel they do not have time to employ new practices, that they are inconvenient, and that they are satisfied with their current harvests.

• Traders face difficulties in receiving and distributing price information among farmers and in traveling to farmers to teach and guide them. Poor roads and lack of vehicles make it difficult to keep in touch with farmers and monitor progress. For traders who help farmers know when the right time to harvest is, for example, and mostly travel by foot or bicycle. Cell phones and improving telecommunications infrastructure facilitate communications, but have unreliable service in many areas.

• Several traders mentioned that counterfeit inputs are still a problem that their farmers face. Distinct from the emphasis on using quality inputs that farmers cited as a good agricultural practice improving quality, the presence of counterfeit inputs was also identified as a challenge to be overcome.

• Finally, traders commented on the impacts of climate change and weather. Weather, more simply, impacts day to day operations. It is more difficult to dry crops thoroughly when it rains, for example. However, climate change is affecting seasonal patterns and harvest times. Crops must be sown at particular times; if too early or too late, harvests are sub-optimal. The timing is becoming unpredictable as a result of climate change, leaving agricultural market actors vulnerable. Farmers have the option to use climate-smart agricultural technologies where available, including resilient crop breeds.

Though this list is likely not exhaustive, fortifying these institutions will help create a market environment conducive to increasing quantity, quality, and price.
Chapter 5
System Dynamics Modeling and Analysis

The third research question on how mutually beneficial behavior comes about is inherently a question of system structure, an inquiry into the feedback loops that characterize the relationship between trader and farmer activities. As described in Section 2.3, System Dynamics is a method of modeling and analyzing feedback structures and delays in a system. System dynamics modeling begins with reference modes, observed trends that raise interesting and difficult questions about causal events. Reference modes are used as a compass during model-building, a pattern against which simulated system behavior can be compared and validated. Data on individual trader and farmer incomes is scarce. However, within this data-poor context, narrative evidence describes volatility in farmer cashflows that leads to unstable, vulnerable farmer livelihoods and, consequently, trader income.

Most crops take three to four months to mature. Consequently, farmers are subject concentrated expenses at the beginning of the growing season that are not recuperated until harvest. Figure 5-1 offers a simplistic view of this pattern. During the growing season, farmers have ongoing living expenses. Financial shocks, such as school fees or medical expenses, could bankrupt a farmer or leave them with less cash to invest in production. As discussed in Section 4.2, formal financial services are lacking in Uganda and are often prohibitively expensive for smallholder farmers to utilize. Thus, subsistence smallholder farmers risk getting caught in a degenerative cycle where they cannot afford to plant and consequently have reduced income. The effects trickle down to traders, who rely on farmers for supply. If farmers can not reliably produce, traders are left with a vulnerable supply chain.

![Figure 5-1: Farmer cash reference mode](image)

**Figure 5-1: Farmer cash reference mode.** Seasonal fluctuations in farmer cash are evidence of vulnerable livelihoods. Smallholder farmers spend and earn cash in concentrated spurts on either end of the growing season. Stabilizing these fluctuations would improve resilience.
This chapter uses system dynamics modeling to shed light on the causal structure that underlies how trader business strategies affect observed patterns of instability in farmer livelihoods. Three business strategies, identified in Chapter 4 from empirical evidence, were selected for further analysis through the model:

1. **Inputs Financing**: Trader provides farmers with inputs, or cash to purchase inputs, at the beginning of the growing season. The farmer pays back the loan over time or at harvest.
2. **Trader Storage**: Trader invests in crop storage so that commodities can be bought at harvest, when prices are low, and sold during the off-season, when supply shrinks and prices rise.
3. **Increasing Farmer Yield**: A variety of trader business strategies all have the effect of increasing farmer yields, the ratio of actual production per acre to theoretical production per acre. Tactics include training farmers in good agricultural practices and post-harvest handling; providing agricultural services like spraying and pruning; and helping farmers access quality inputs.

First, a base model was created as a platform on which these business strategies could be implemented and tested. Second, feedback structures for each strategy were built or identified within the base model. Analysis of simulations from the base case and the emulated business strategies gives rise to an explanation of how business strategies affect farmer and trader cashflows.

### 5.1 Base Model Design

The base model was designed to simulate the outcomes of a transactional relationship between a single farmer and trader. Initialization parameters for the base model are based on real data. Through sensitivity analysis, assumptions were relaxed one at a time to assess the influence of each variable and delay. A logical starting point was to represent cashflows for both traders and farmers using a causal loop diagram (CLD). Farmers and traders both make money through sales. The basic causal structure, seen in Figure 5-2, is a second order positive feedback loop referred to as the *cash conversion cycle*. Cash is used to purchase or produce crops; once stocked, these crops are sold to earn revenue, which in turn enables further procurement. Sale price directly affects the rate at which

![Figure 5-2: Cash conversion causal loop diagram](#) This causal loop diagram portrays the basic sequence of events by which a farmer or business earns income.
revenue is earned. At the same time, purchases deplete cash according to commodity cost. The cash conversion cycle is a strong reinforcing loop, the main driver of business growth and farmer income. Exponential growth is limited by two first order negative feedback loops imposing the assumptions that an actor cannot purchase more inventory than they have cash for and cannot sell more crops than are in stock. Sale price and production or procurement costs directly affect the rate at which revenue is earned.

Expanding on the basic structure, Figure 5-3 presents a more detailed causal loop diagram that connects the trader and farmer cash conversion cycles. Notably, there is another reinforcing loop here: as the farmer increases crop production, more crops are available for the trader to purchase. As the trader increases the quantity purchased, the farmer earns more income and can invest in further crop production. Though exogenous to this model, parallel positive feedback loops exist between traders and their downstream customers, including exporters, other traders, and entities like the World Food Programme.

![Figure 5-3: Transactional causal loop diagram.](image)

The CLD in Figure 5-3 was the starting point for building the base model. In converting the CLD to an operational differential equations model, several points merit attention. Essentially all business strategies intended to increase business growth focus on reducing the influence of the various balancing loops and strengthen the reinforcing loops. Yet, there is a significant delay in the farmer reinforcing loop due to the time needed to grow crops. As the model behavior and sensitivity analysis below show, this delay is the primary cause of oscillations in farmer livelihoods.

### 5.1.1 Assumptions and Limitations

Inevitably, assumptions were made in building the base model from the CLD. First, a number of factors went unaccounted for, including price negotiations, weather variability, incidence of fake chemicals or bad seeds, interactions with other farmers and cooperatives, diversification of crops and revenue streams, and experience.

Second, I assume that purchase costs are the trader's only expenditures and that sales are the only source of revenue. In a more complex model, there are other operating expenses (e.g. transportation, marketing and promotion, electricity, salaries) and other sources of cash (e.g. loans, equity). Many traders also deal in multiple commodities, each bought and sold at a different price and slightly different time.
5.1. BASE MODEL DESIGN

Third, I ignore the complex dynamics that govern supply and demand, market power, and nuanced price-setting. I assume that demand exceeds a trader's purchase capacity and that all commodities bought in a month are also sold. Since agricultural commodities are highly seasonal, trader businesses tend to be constrained by limited supply, rather than limited demand. During the off-season, in particular, demand is much higher than supply, causing prices to rise. For market prices, I use fixed values, past commodity prices published by Infotrade. In reality, prices fluctuate with market supply and demand, seasonality, quality, and negotiations. I chose to omit market forces from the model since the traders I interviewed primarily said that business growth was limited by the quantity they could procure, implying that they are able to sell all inventory they hold. Since these are relatively small mid-supply chain actors, I assume that they are price takers, not market makers. This is an opportunity for further study.

Fourth, in this case, I only explore the dynamics between a single farmer and trader who exclusively buy from and sell to the other. While farmers may have only one buyer, traders procure from a multitude of farmers and other traders. Influences from large buyers, such as exporters or organizations that run school feeding programs, are also ignored. Expanding the model to account for pressures from other actors would provide further insight on the dynamics of the broader market system.

Fifth, many decision-making policies are modeled simplistically. In this model, a trader buys as much inventory as they think they have room to store. However, since there is a time delay in procurement, the trader's storage capacity is never fully utilized. In reality, traders likely have more sophisticated, though possibly informal, inventory review and order-up-to policies that govern the quantity they choose to purchase. Similarly, a simple heuristic is used to govern a farmer's decision to plant (is it the right season? Is there space in the field? Will there be enough money to cover expected costs?) The model could be expanded to include more sophisticated inventory management policies for both actors.

5.1.2 Modeling Trader Business Operations

The next two sections provide a detailed description of the model structure and the differential equations that govern system behavior. Stock and flow structures created in Vensim are included in Figures 5-4 and 5-5.

A trader's cash increases when revenue is earned and decreases via expenditures. The Revenue rate depends on the price of goods and the quantity sold. The rate of expenditures depends on the farm gate price, the amount a trader pays a farmer to acquire inventory, and is formulated as Farmer Cash at time \( t \) divided by a Minimum Expenditure Time. In the model, if the farm gate price is high, the trader will not spend in deficit.

Trader inventory increases when goods are purchased and depletes when they are sold. Purchase Rate depends on the quantity purchased and the time it takes to make a purchase, constrained by the rate at which farmers are willing to sell. The trader's Sales Rate depends on current inventory levels and the average time a trader holds crops before selling. Two first order negative feedback loops respectively prevent cash and inventory from becoming negative by dividing the current state of the stocks over the time it takes a trader to complete the respective transaction. A trader will not spend more money or sell more inventory than they have.

Conversely, the trader's purchasing policy generates a third negative feedback loop: the trader will buy as much inventory as possible, given sufficient storage space, cash, and available crops. In this model, inventory storage capacity is a constant, though a more detailed formulation might look like the Capacity Utilization structure of the Market Growth Model (Sterman, 2000). In rural Uganda, traders typically buy and sell within a short amount
CHAPTER 5. SYSTEM DYNAMICS MODELING AND ANALYSIS

Figure 5-4: Trader stock and flow diagram. Produced in Vensim, this diagram captures the stock and flow model used to simulate trader business operations.

\[ \text{Cash}_T(t) = \int_0^t \text{Revenue}_T(t) - \text{Expenditures}_T(t) \, dt + \text{Cash}_{T,i} \]  
\[ \text{Revenue}_T(t) = \text{SalesRate}_T(t) \times \text{MarketPrice}(t) \]  
\[ \text{Expenditures}_T(t) = \text{MIN} \left( \text{FarmGatePrice}(t) \times \text{PurchaseRate}_T(t), \frac{\text{Cash}_T(t)}{\text{Exp.Time}_T} \right) \]  
\[ \text{Inventory}_T(t) = \int_0^t \text{PurchaseRate}_T(t) - \text{SalesRate}_T(t) \, dt + \text{Inventory}_{T,i} \]  
\[ \text{PurchaseRate}_T(t) = \text{MIN} \left( \frac{\text{PurchaseQuantity}_T(t)}{\text{TransactionTime}}, \frac{\text{WillingnessToSell}_T(t)}{} \right) \]  
\[ \text{SalesRate}_T(t) = \frac{\text{Inventory}_T(t)}{\text{TimeToSell}_T} \]  
\[ \text{PurchaseQty}_T(t) = \text{MIN}(\text{DesiredPurchaseQty}_T(t), \text{MaxPurchaseQty}_T(t)) \]  
\[ \text{DesiredPurchaseQty}_T(t) = \text{InventoryCapacity}_T - \text{Inventory}_T(t) \]  
\[ \text{MaxPurchaseQty}_T(t) = \frac{\text{Cash}_T(t)}{\text{FarmGatePrice}(t)} \]
If time unless they use a business strategy where crops are intentionally stored for several months. In the absence of significant delays, auxiliary variables limit exponential growth in trader revenue. Relevant balancing feedback loops are tied to storage capacity, cash, crops available for purchase, and sale price.

### 5.1.3 Modeling Farmer Livelihoods

The farmer livelihoods component of the model (Figure 5-5) is similar to that of the trader. The main difference is that there are two material stocks to model crop production, and the first of these introduces a significant delay. Crops In Fields is the stock of crops that are currently growing. Typically, fields are sown and harvested in discrete blocks of time (rather than continuously over time). Thus, the planting rate is modeled as the ratio of area cultivated to the time needed to plant, and harvesting is modeled as a pipe delay that depends on the time needed to grow crops.

![Farmer Livelihoods](image)

**Figure 5-5:** Farmer stock and flow diagram. This stock and flow diagram, produced in Vensim, depicts the model used to simulate dynamics that affect farmer livelihoods.
Farmers decide when and how much area to cultivate as a function of the land available, current cash, expected costs, and time of year. If it is an appropriate time for planting, the farmer will cultivate the maximum area available and affordable. Land Available to Cultivate is the difference between land under cultivation and total area owned. If land currently has crops growing on it, no additional crops can be planted there. Land Affordable to Cultivate is the number of acres a farmer could plant with the cash available. It is calculated as the difference between current cash and expected expenses, divided over the expected total cost of cultivating one acre. Expected expenses are the monthly cost of living times the number of months it takes to grow crops. Farmers need at least this much cash to avoid going broke during the growing season. Land Available and Land Affordable must always be positive values, unless a farmer plans to take out a loan to plant crops.

Farmers can only plant during certain times of the year. The model imposes this restriction by formulating the farmer's decision to plant as a function of available land, available cash, and appropriate season. The Planting Season variable is a binary indicator of whether it is an appropriate time to sow seeds. A table function indicates the months in which crops should be planted (March and August, in this case) and Planting Season is calculated as a function of the current month. Detail on how months are indicated is included in Section 5.1.4 below.

The second material stock relevant to farmers is Crops In Stock. This is the quantity a farmer accumulates after harvesting and can sell. During Post-Harvest Handling (PHH), farmers take measures to prepare crops for storage or sale. PHH includes drying, removing contaminants, and packaging crops. Typically, this process happens concurrent with or immediately following harvest. In the model, PHH occurs at the same rate as harvesting and accounts for farmer yield, the ratio of quantity reaped to area sown.

\[
\text{CropsInFields}_{F}(t) = \int_0^t \text{Planting}(t) - \text{Harvest}(t) \, dt + \text{CropsInFields}_{F,i}
\]  

(5-10)

\[
\text{Planting}(t) = \frac{\text{AreaCultivated}(t)}{\text{TimeNeededtoPlantCrops}}
\]  

(5-11)

\[
\text{Harvest}(t) = \text{DELAYFIXED}(\text{Planting}(t), \text{TimeToGrowCrops}, 0)
\]  

(5-12)

\[
\text{AreaCultivated}(t) = \text{MIN}(\text{LandAvailable}(t), \text{LandAffordable}(t)) \times \text{PlantingSeason}(t)
\]  

(5-13)

\[
\text{LandAvailable}(t) = \text{MAX}(\text{LandOwned} - \text{CropsInFields}_{F}(t), 0)
\]  

(5-14)

\[
\text{LandAffordable}(t) = \text{MAX}\left(\frac{\text{Cash}_{F}(t) - \text{CostOfLiving}}{\text{TotalCostPerAcre}} \times \text{TimeToGrow}, 0\right)
\]  

(5-15)

\[
\text{PlantingSeason}(t) = f(\text{Month})
\]  

(5-16)

\[
\text{CropsInStock}_{F}(t) = \int_0^t \text{PHH}_{F}(t) - \text{SalesRate}_{F}(t) \, dt + \text{CropsInStock}_{F,i}
\]  

(5-17)

\[
\text{PHH}_{F}(t) = \text{Harvest}(t) \times \text{FarmerYield}
\]  

(5-18)

\[
\text{FarmerYield} = \text{TheoreticalYield} \times (1 + \text{FarmerProductionEfficiency})
\]  

(5-19)

\[
\text{SalesRate}_{F}(t) = \text{PurchaseRate}_{T}(t)
\]  

(5-20)

\[
\text{WillingnessToSell}_{F}(t) = \frac{\text{CropsInStock}_{F}(t)}{\text{TransactionTime}}
\]  

(5-21)

Farmer sales are directly tied to trader purchases via a first order balancing feedback loop that prevents Crops In Stock from becoming negative. A trader can only purchase if crops are available, but the farmer can only sell if a trader has sufficient cash and storage capacity to make the purchase. Crop are available if farmer is willing to sell. There is a certain amount of time needed for transactions to take place. The rate at which a farmer is
5.1. BASE MODEL DESIGN

willing to sell is equal to Crops in Stock divided by transaction time.

The final element of the Farmer Livelihoods cash conversion cycle is the farmer's cashflow. For farmers, income depends on the Farm Gate Price, the same price traders pay to procure goods, and the sales rate. Farmer Spending is, again, limited by a first order negative feedback loop to impose the assumption that farmers cannot spend more money than they currently have. Spending is the sum of the Cost of Living and Production Expenditures, which vary significantly over the growing season. Cost of Living is modeled as a constant but can also include pulse, step, or random noise input to simulate financial shocks. The Production Expenditures variable combines expenditures from planting, crop maturation, and post-harvest handling, which depend on the Area cultivated, crops in fields, and post-harvest handling rate respectively.

\[ Cash_F(t) = \int_0^t Earning_F(t) - Spending_F(t) \, dt + Cash_{F,i} \] (5-22)

\[ Earning_F(t) = SalesRate_F(t) \times FarmGatePrice \] (5-23)

\[ Spending_F(t) = \min(ProductionExpenditures_F(t) + CostOfLiving, MaxExpenditureRate_F) \] (5-24)

\[ ProductionExpenditures_F(t) = PlantingExpenditures_F(t) + CropGrowthExpenditures_F(t) + PHHExpenditures_F(t) \] (5-25)

\[ PlantingExpenditures_F(t) = \frac{CostToPlantPerAcre}{TimeToPlantPerAcre} \times AreaCultivated(t) \] (5-26)

\[ CropGrowthExpenditures_F(t) = \frac{CostToTendPerAcre}{TimeToGrowCrops} \times CropsInField_F(t) \] (5-27)

\[ PHHExpenditures_F(t) = CostOfPHHPerKilo \times PHH_F(t) \] (5-28)

5.1.4 Monthly Prices

The last element of the model is a construct to indicate months of the year. In Vensim, the Get Time Value function can return a month numbered 1 through 12 that corresponds with the current simulation time\(^1\). Indicated Month can be used to simulate annual or otherwise cyclical patterns. This value is used as an input in several parts of the model. The Planting Season variable is a function of Month Index that indicates whether a given month is an appropriate time to plant crops. Similarly, the Month Index is used to incorporate real data for market prices and farm gate prices. Monthly prices, indicated by table functions, can be switched on or off, giving the option to simulate with static prices and markup percentages instead.

Capturing price seasonality is important for reflecting business strategies that rely on buying when prices are low, storing grain, and selling when prices are high again. In order to make the model as accurate as possible, I decided to use real price data for commodities in Uganda. Specifically, I chose to use prices for maize in Iganga district, where forty interviews were held in 2017. Maize was selected because prices are available longitudinally for both the processed and unprocessed forms.

\(^1\)Vensim documentation provides more detail on the Get Time Value function at https://www.vensim.com/documentation/index.html?fn_get_time_value.htm
Historical commodity price data was obtained from the World Food Programme Global Food Prices database (World Food Programme, 2017). Using R, monthly prices for whole kernel white maize and maize flour in Iganga district were averaged from April 2011 to September 2017. Plotted in Figure 5-6, five-year average monthly prices were used to represent typical price changes over time. These values were included in the model as table functions to indicate monthly prices.

![Average Monthly Prices for Maize and Maize Flour in Iganga](image)

**Figure 5-6:** Average monthly prices in Iganga district. Data are from the WFP Global Food Prices database.

### 5.2 Base Model Behavior and Sensitivity Analysis

This section ties the base model behavior to farmers' oscillating cashflows depicted in Figure 5-1, the reference mode. In the base case simulation, auxiliary variable parameters were populated with real data and reasonable estimates. The equations 5-35 to 5-47 list the values used in the base case simulation.

Data on crop production costs and yields were obtained from a study published by the United Nations Food and Agriculture Organization through their information repository of technologies and practices for small agricultural producers (UN Food and Agriculture Organization, 2017). Specifically, the Cost of Planting maize (55,000 UGX/acre), Farmer Yield (0.1), and Theoretical Yield (3600 kg/acre) were offered by this study as conservative estimates for smallholder farmers who do not use improved agricultural technologies (e.g. drought resistant varieties). For the base case, farmer Land Owned was set to one acre for simplicity, though many smallholder
farmers cultivate up to two acres. For simplicity, the Cost to Tend Crops and Cost of PHH were set at low, nominal values. PHH was set to 100 UGX to approximate the cost of drying crops. The Cost of Living was set at a high enough value to observe the expected behavior, but low enough so as not to cause immediate bankruptcy.

**Base Case Expenditures and Land Use Variables**

\[
\begin{align*}
\text{Farmer Production Efficiency} & = 0.1 \\
\text{Land Owned} & = 1 \text{ acre} \\
\text{Theoretical Yield} & = 3600 \text{ kilos/acre} \\
\text{Cost of Living} & = 15000 \text{ Shillings/Month} \\
\text{Cost of Planting per Acre} & = 55000 \text{ Shillings/acre} \\
\text{Cost of PHH per kilo} & = 100 \text{ Shillings/kilo} \\
\text{Cost to Tend Crops per Acre} & = 0 \text{ Shillings/acre}
\end{align*}
\]

Other conditions were selected based on realistic values that produced the expected reference mode. The farmer's Initial Cash was set to 200,000 UGX and Initial Stock was set to 0 kg. Initial Crops in Fields was set to 0 acres out of necessity; the model was actually not robust enough to simulate crop growth if the planting time was unknown. Since Harvesting is formulated as a pipe delay of Planting, crops that start off in the fields are never harvested since the time at which they were planted is undefined. Initial Trader Cash was set to 1,000,000 UGX, an order of magnitude higher than the farmer's initial cash. Like the farmer, the trader also has no initial inventory. However, the trader does have an inventory capacity of 1000kg. This value is low, but not unrealistic for a small business; grain is typically sold in 50kg or 100kg bags, and some small silos hold as little as 1000kg.

**Base Case Initial Conditions and Time Intervals**

\[
\begin{align*}
\text{Initial Farmer Cash} & = 200000 \text{ Shillings} \\
\text{Initial Farmer Crops} & = 0 \text{ acres} \\
\text{Initial Farmer Stock} & = 0 \text{ kilos} \\
\text{Initial Trader Cash} & = 1e + 06 \text{ Shillings} \\
\text{Trader Initial Inventory} & = 0 \text{ kilos} \\
\text{Trader Inventory Capacity} & = 1000 \text{ kilos} \\
\text{Normal Transaction Time} & = 1 \text{ Month} \\
\text{Time Needed to Plant an Acre} & = 0.25 \text{ Months} \\
\text{Time to Grow Crops} & = 3 \text{ Months}
\end{align*}
\]

Depending on the variety, maize takes two to three months to mature. Conversations with acquaintances and interviewees who farm revealed that it can take several days to a week to prepare and plant a field. Thus in the base case simulation, Time Needed to Plant an Acre was estimated as 0.25 months and Time to Grow Crops was set to 3 months. Additionally, it may take a day or two for traders and farmers to coordinate and complete transactions, including transportation time. Originally, the Normal Transaction Time was set to 0.25 months, but extending the time to one month allowed for closer inspection of changes in cashflow and transaction rates.

A dashboard in the model provides graphs of Farmer Cash, Trader Cash, Farmer and Trader Stock, Farmer Expenditures, and Trader Expenditures over time. The base case simulation produces expected peaks and valleys
in Farmer Cash levels that correspond with the growing seasons (Figure 5-7). Concurrent oscillations in Trader Cash are due to limited availability of crops during the off-season. Figure 5-8 shows how the rates of expenditures and earnings correspond with oscillations in cash levels.

**Figure 5-7:** Farmer Cash (left) and Trader Cash (right) under Base Case conditions. The farmer spends at the beginning of the growing season and recovers expenses at harvest. However, the cost of living is a constant drain on farmer cash. Trader cash is similarly cyclical according to the growing season.

**Figure 5-8:** Farmer and Trader expenditures and earnings under base case conditions. Farmer Expenditures (left) occur at the time of planting. Farmer earnings, also showed, are offset by the Time to Grow Crops. Trader Expenditures and Earnings (right) occur simultaneously when crops are available.

The base case simulation results in a transactional relationship where both the farmer and trader increase their income. In contrast, Figure 5-9 shows a simulation initialized with lower Initial Farmer Cash (140,000 UGX instead of 200,000 UGX). The farmer runs out of money within a few seasons. The trader consequently ceases to generate income and a market failure ensues because the farmer can no longer afford to produce. What is interesting here is that the trader does still have cash—certainly sufficient cash to fund crop production and restart the reinforcing cash conversion cycle. This concept surfaces again in Section 5.3 where provision of credit is modeled on the premise that financing can stabilize farmer production.
Sensitivity analysis was conducted to observe the effects of each variable on the model. Sensitivity analysis begins with initializing the model in equilibrium, a scenario where nothing happens to either farmer or trader cash over time. The model can be initialized in equilibrium (Figure 5-10) if all expenses (planting, growing, PHH, cost of living) and payments are set to 0, seasonality is turned off, rate times are set to 1 Month, and the trader has no initial cash. Values carried over from the base case include Theoretical Yield, Production Efficiency, Land Owned, and Trader Inventory Capacity. Without these values, simulations will not initialize. Additionally, since the farmer decides to plant based on the minimum of expected costs and land available, there must be some nominal cost to production to avoid a floating point error. The equilibrium simulation was therefore initialized with a nominal Cost of Planting of 1 UGX. Under equilibrium conditions, reducing farmer or trader cash either changed the level of the overall trend or prevented the model from initializing with informative behavior.

Sensitivity analysis involves adjusting variables that disrupt the equilibrium of a system. In Figure 5-11, the model has been initialized with Trader Cash reinstated at 1,000,000 UGX and farm gate price of 700 UGX/kg. A new equilibrium is achieved after 6 months—the first full growing season—when farmer and trader expenditures...
Figure 5-11: Simulating crop production in equilibrium. When traders have cash to buy crops and a Farm Gate Price is established, transactions occur and farmer income grows. Rather than producing and selling in equilibrium from the outset, there is an adjustment period wherein goal-seeking behavior leads to steady purchase and sales rates.

Figure 5-12: Simulating production costs. Farmer and trader cash and expenditures begin to show oscillating behavior when costs are imposed for Planting and Post-Harvest Handling.
5.2. BASE MODEL BEHAVIOR AND SENSITIVITY ANALYSIS

Figure 5-13: **Simulating production delays.** Farmer and trader cash and expenditures oscillate when Time to Grow Crops is increased, Time to Plant is reduced, and Planting and Harvesting costs are non-zero. In particular, Time to Grow Crops affects the period of oscillations, while planting and harvesting costs affect the amplitude.

Oscillations begin to appear in cash levels when production costs are added to the simulation. Planting and Post-Harvest Handling expenses, 55,000 UGX and 100 UGX respectively, cause dips in cash. Figure 5-12 shows the beginning of these oscillations, which become more prominent when time delays change. Increasing the Time To Grow Crops and decreasing the Time To Plant lengthens the period of oscillations in farmer expenditures and earnings, which are reflected in farmer cash levels and captured in Figure 5-13. Time To Grow Crops affects the period of oscillations, while Time to Plant affects amplitude inversely. When planting takes longer, crops are harvested over a longer period of time. When planting happens instantaneously, costs of planting and post-harvest handling become concentrated.

The key takeaway here is that **cashflow oscillations are a product of the underlying system structure.** While the shape of the oscillations is different from the reference mode in Figure 5-1 and corresponding base casebe-
behavior in Figure 5-7, the fundamental behavior of the system is the same. Through this analysis, we can isolate Time to Grow Crops as the key variable that causes oscillations in cashflow. In general, farmer expenditures are concentrated at planting and revenues peak three months (Time to Grow Crops) later. Trader expenditures are offset from those of farmers by the Time to Grow Crops, and trader revenue peaks one month (Trader Time To Sell) after purchase. Additional volatility emerges as a result of the other model variables. When the Planting Time variable is removed, oscillations occur because of limited land and cash, not because of seasonal changes. Similarly, the rate at which farmer cash grows is determined by the farm gate price, and the trader's cash grows according to the markup percentage. Using real market price data affects the level of income and adds noise to the oscillations, but does not change the overall pattern of behavior.

5.3 Inputs Financing

As seen in the sensitivity analysis, the time it takes crops to mature is a major delay that accounts for fluctuations in farmer cash when paired with costs of production and costs of living. Again, Figure 5-9 shows a farmer who becomes bankrupt and is unable to sow the fields. As discussed in Section 4.5, a trader can prevent farmer bankruptcy by financing inputs, effectively offsetting costs and extending the time over which payments are made.

In practice, there are numerous ways traders provide financing to farmers. One generic strategy was selected for modeling and analysis. The following assumptions framed changes made to the model:

1. The trader provides inputs or cash to offset the farmer's planting expenses.
2. Trader financing occurs for all seasons in a given simulation run, regardless of whether a farmer would otherwise run out of money.
3. The farmer accrues debt at the same rate as the trader spends money on planting.
4. The farmer makes debt payments only when they have sufficient cash to meet anticipated expenses over a forecast horizon.
5. Farmer debt payments increase the rate of farmer expenditures and the rate of trader revenue, a transfer from farmer cash to trader cash.

In order to implement these assumptions and simulate inputs financing, the structure presented in Figure 5-14 was added to the model. Farmer debt was modeled as a stock that grows over time as a farmer accrues debt and is reduced when the farmer pays the trader back. Per the second assumption listed above, debt accrues for each season. The debt accrual rate is a function of the cost of inputs per acre, area cultivated, and time over which debt is accrued. For simplicity, debt is accrued at the same rate as planting occurs and the value of inputs provided by the trader is equal to the cost of planting.

The rate at which the farmer pays off debt is based on a flexible policy, as articulated by a few traders in interviews: the farmer pays back credit when they have sufficient money to do so. If there is a bad season, the trader may grant the farmer an extension. In the model, payback rate is based on a simple decision heuristic that mimics the process a farmer might go through if a trader grants them agency to decide how debts will be paid. The farmer makes a payment only if they expect to have excess cash over the forecast horizon after expected production costs and living expenses. If the forecast horizon is set to three months, the farmer will consider the expected costs of planting (55,000 UGX * AreaPlanted), living (15,000 UGX * NumberOfmonths), and PHH
(100 * \textit{AreaPlanted} * \textit{Yield}). Payments will be made only if current cash is higher than expected expenses; the farmer will pay either the amount owed or the amount of surplus cash they have, whichever is less.

\[
\text{MoneyOwedToTrader}_F(t) = \int_0^t \text{AccruingDebt}_F(t) - \text{CreditPayments}_F(t) \, dt \tag{5-48}
\]

\[
\text{AccruingDebt}_F(t) = \frac{\text{Value of Inputs Provided by Trader}}{\text{Time to Accrue Debt}} \cdot \text{AreaCultivated}(t) \tag{5-49}
\]

\[
\text{CreditPayments}_F(t) = \max \left( \frac{\text{MIN(MoneyOwedToTrader}_F(t), ExpectedCashSurplus}_F(t))}{\text{AverageTime to Pay off debt}}, 0 \right) \tag{5-50}
\]

\[
\text{ExpectedCashSurplus} = \text{Cash}_F(t) - \text{ExpectedExpenditures}_F(t) \tag{5-51}
\]

\[
\text{ExpectedExpenditures}_F(t) = \text{Cost of Living} \cdot \text{Forecast Horizon} + \text{TotalCostPerAcre}_F \cdot \text{AreaCultivated}(t) \tag{5-52}
\]

Figure 5-14: Stock and flow diagram of inputs financing. With additional structure, traders can offset the cost of planting, allowing farmers to extend the time over which they pay planting expenses.

Since the farmer's planting costs are offset by the trader, a new variable for Value of Inputs Provided by Trader was added to the model. In simulations, the Value of Inputs Provided by Trader was set equal to the cost of planting (55,000 UGX/acre). The function governing a farmer's planting costs was updated to subtract the value provided by traders from the base cost to plant per acre. Another variable was added for Trader Planting Expenditures, a function of area cultivated, time needed to plant, and value of inputs provided by the trader. Updates to functions for trader expenditures, farmer expenditures, and trader revenue were also made.

Several simulations were run to test the effects of an Inputs Financing business strategy. Figure 5-15 compares the scenario where a farmer becomes bankrupt to the same scenario where the cost of inputs is offset by the trader. In the right hand image, rather than facing bankruptcy, the farmer is able to plant and continue production. Inputs
CHAPTER 5. SYSTEM DYNAMICS MODELING AND ANALYSIS

\[
\text{CostToPlantPerAcre}_T(t) = \text{BaseCost of Planting} - \text{Value of Inputs Provided by Trader} \\
\text{PlantingExpenditures}_T(t) = \frac{\text{AreaCultivated}(t) \times \text{Value of Inputs Provided by Trader}}{\text{Time to Plant an Acre}} \\
\text{Spending}_T(t) = \text{MIN}(\text{ProductionExpenditures}_T(t) + \text{CreditPayments}_T(t) + \text{Cost of Living}, \text{MaxExpenditureRate}_T) \\
\text{Revenue}_T(t) = \text{SalesRate}_T(t) \times \text{MarketPrice}(t) + \text{CreditPayments}_T(t) \\
\text{Expenditures}_T(t) = \text{MIN}((\text{FarmGatePrice}(t) \times \text{PurchaseRate}) - r(t) + \text{PlantingExpenditures}_T(t), \frac{\text{Cash}_T(t)}{\text{ExpenditureTime}_T})
\]

Figure 5-15: Comparative outcomes of inputs financing. A farmer who would otherwise go bankrupt (left) is able to continue production when the trader provides financing for inputs.

financing creates resilience by offsetting concentrated expenses. By offering credit for inputs or, by extension, for other concentrated expenses, the trader builds resilience into the supply chain, avoiding seasons without production. At the same time, the farmer benefits from less volatile cashflow. When traders have lenient payback policies, farmers also benefit from inputs financing as a type of informal insurance against a bad season.

5.4 Trader Storage

Traders say that they sometimes store grain to reap higher sale prices in the off-season. This second strategy theoretically capitalizes on market price fluctuations driven by changes in supply and demand that correlate with the growing seasons. Prices are low around the harvest and highest when crops are growing. A second approach to increasing profit through the use of storage is to establish purchase contracts wherein the trader agrees to provide reliable supply to a buyer. For example, a trader may sign a contract with the World Food Programme or a government-run school, agreeing to supply a certain quantity of a commodity each month for
5.4. TRADER STORAGE

school feeding programs. Analysis of these strategies reveals that decision heuristics offered by traders are naive. In reality, it seems, traders who maximize profit actually employ more complex conditional storage policies than they articulate.

Several variables affect a trader's crop storage policy: quantity of crops available for purchase, time it takes to make the purchase, storage capacity, demand, average time to sell, and price. The structure of the current model implicitly assumes that the trader has no market power, that demand, price, and production by other farmers are exogenous, and that storage capacity is fixed. Though these assumptions are rigid and not necessarily realistic for all traders, they enable us to carefully inspect the relationship between storage time and income.

First, let us inspect what happens when a trader increases average storage time. The rationale behind this policy is that increased storage time enables a trader to get higher prices in the off season. The effect of increasing average storage time can be assessed without structural changes to the model. Increasing the Trader's Minimum Time to Sell from one month to three months, we can simulate the effects of a trader's decision to store grain for a longer time on average. Figure 5-16 compares Trader Cash in the base case simulation, where the average holding time is one month, with a situation where the average holding time is three months. Note that in Figure 5-17 below, Time to Sell has been renamed Trader Storage Time. They are equivalent.

The results are unimpressive. In these simulations, increasing average storage time has minimal effect on income. Upon closer inspection, the reason for this is quite clear and intuitive: the model simulates average storage time, using this variable as a differential time horizon over which sales are normally distributed. In effect, the same number of goods are bought and sold within each time step, shifting earnings instead of increasing them.

Alternatively, a trader could develop a storage utilization policy based on sales rate. If sales rate is the objective variable, storage utilization will change with grain availability. To test this approach, the model was modified to articulate the structure for a target sales rate, such as what a trader might agree to if supplying for a school feeding program. As seen in Figure 5-17, a variable for Desired Trader Sales Rate was added to the model. When this feature is switched on, the formulas for Trader Sales Rate and Trader Purchase Rate prioritize the Desired Sales Rate above other decision criteria. The trader will purchase at the Desired Sales Rate if the desired rate is
less than rate at which the trader would purchase otherwise. For selling, the trader will sell at the desired rate if it is less than the trader's maximum sales rate (restricted by the time it takes to make a transaction).

\[
PurchaseRate_T = \min(DesiredSalesRate_T, \min(\frac{PurchaseQuantity_T}{ActualTransactionTime}, \text{RateAtWhichFarmerisWillingToSell}))
\]

\[
SalesRate_T = \min(DesiredTraderSalesRate, TraderMaximumSalesRate)
\]

When a trader has a target sales rate and limited storage capacity, there are three scenarios that can occur:

1. The trader may have much more capacity to store grain than the desired amount sold per time period. For example, the trader may have a desired sales rate of 500kg/month and space to store 1000kg.

2. The trader may have storage capacity equal to the desired amount sold per time period. For example, the trader may have a desired sales rate of 500kg/month and exactly 500kg of storage space.

3. The trader may have less storage capacity than the desired amount sold each time period. For example, the trader may have a desired sales rate of 500kg/month and only space to store 250kg.

Simulations for each of these scenarios used base case conditions, a farmer-trader transaction time of 0.1 months, and a maximum trader sales time of one month. To isolate the effect of having a target sales rate in simulations, farmer yield was increased to 100% of the theoretical yield (Farmer Yield = 1.0). With this modification, supply was large enough to mimic conditions in which a trader procures from many farmers and is no longer a constraint. The three scenarios were modeled with a desired sales rate of 500kg/month and storage capacities of 1000kg, 500kg, and 250kg respectively. Results from the simulations are presented in Figure 5-18. During the first 6 months of the simulation, trends are clouded by disequilibrium in the system. After month 12, the effects of storage size are clear.

Scenario 1 was the only one in which the trader was able to meet the desired demand. Under Scenario 2, the trader sales rate was slightly less than the desired sales rate. This is because the trader's decision on how much
5.4. TRADER STORAGE

Figure 5-18: Effect of storage capacity with a desired sales rate. Traders

To purchase is determined by the current amount of space available, but does not account for future sales over lead time (the time it takes to complete a transaction, in this case). Thus, the trader never maximizes storage capacity. This is a classic inventory management problem. In practice, this gap might be remedied by forecasting demand and purchasing additional inventory per an order-up-to inventory management strategy.

Scenario 3 mimics Scenario 2 in that the trader is constantly selling less than the storage capacity since procurement decisions neglect anticipated sales over lead time. However, the trader, constrained by limited storage space, is far from meeting the desired demand. Thus, it is clear that when a simple ordering policy is employed, traders will only be able to achieve a desired sales rate if their storage capacity is sufficiently large to accommodate the desired sales rate and the procurement delay.

From modeling these two approaches to inventory management—the first based on average storage time and the second based on desired sales rate—it becomes clear that neither actually optimizes profit by using storage. In fact, the two approaches are in some ways contradictory. To optimize profit by changing average storage time, the trader needs to move as much inventory as possible. To optimize under a desired sales rate, the trader needs to have more storage capacity than is ever filled, an inefficient solution that limits the amount purchased during the harvest season.

It can then be deduced that in order to optimize profit among changing rates of production and changing prices, a trader instead needs to use a dynamic or conditional policy and vary the sales rate in accordance with projected supply and prices. Based on this analysis, the optimal policy would be to buy and sell as much as possible (at the highest rate possible) during the harvest time when grain is amply available from farms. Once prices are at their lowest, the trader would be wise to sell at a lower rate or store until prices are higher. In other words, the trader would likely make the most money if they moved as much inventory as possible during the harvest season, and then, as produce from farms became unavailable, reduced the sales rate to benefit from higher prices later in the season. When these two approaches are combined, additional storage capacity enables a trader to maximize inventory moved during the harvest time and also save a large amount of inventory to sell in the off-season. Such a conditional policy as this is subtle and difficult to recreate with differential equations modeling. Discrete event models or agent-based modeling methods may be more appropriate for simulating storage policies in future work.
Traders did not articulate this nuance when interviewed, though they seem to understand the principle intuitively—after all, no traders said they only use naive sales and storage policies as they purported that these tactics are useful. Some traders asserted that business growth is limited primarily by the quantity available, that they "need more farmers." With more farmers and more crops available for purchase, traders can make more money by moving more inventory, even with limited storage capacity. Thus, this analysis sheds light on the complexity underlying trader storage policies.

5.5 Increasing Farmer Yields

The third business strategy investigated with the system dynamics model was the suite of activities that traders undertake to help farmers increase yields, discussed at length in Section 4.2. Sensitivity analysis showed production efficiency to have a strong direct effect on trader and farmer cash. To observe the effect of production efficiency on cash, Farmer Yield was adjusted in the base case simulation. In the base case, farmer yield is 1% of the theoretical maximum yield. Results from simulations with yields set to 20%, 50%, and 100% of the theoretical are compared in Figure 5-19.

![Figure 5-19: Effect of yield on farmer and trader cash. These graphs show the effect of farmer yield on farmer cash (left) and trader cash (right). As yield increases, cash increases for both actors.](image)

Predictably, increased yield leads to increased income. Of all the causal links and feedback loops explored in this modeling exercise, the relationship between yields and cash is perhaps the least complex. As described by traders in interviews, more quantity leads to more income. When farmers have higher yields, both farmers and traders benefit. Incentives are aligned for traders to help farmers.

However, the mechanisms by which traders influence farmer yields proved difficult to model. Several unsuccessful attempts were made to add structure for training, adoption of methods, and provision of quality inputs and services. Insufficient data and time constraints prevented full development of the appropriate model structures. Further empirical evidence is needed to model how traders provide these benefits to farmers and then benefit in return. Herein lies a great opportunity for future work in applications of system dynamics modeling.
Chapter 6
Discussion

Market systems are complex. The analysis presented here offers evidence and explanations of the mechanisms by which traders intuitively navigate—and thrive in—Uganda’s agricultural commodity markets. This chapter recapitulates and synthesizes the main findings from the analyses presented and offers suggestions for how USAID might leverage this knowledge. In addition, I discuss how the pairing of qualitative data analysis and system dynamics modeling can generate an epistemological basis upon which future market facilitation interventions might be grounded.

6.1 Summary of Findings

At a high level, it is easy and obvious to say that market systems are complex. It is another to explain that complexity. To reiterate, three research questions guided the data collection, modeling, and analysis presented in this thesis:

1. What business strategies are used by traders in Uganda?
2. How do these strategies affect farmers, and
3. What is the structure of the underlying system that governs mutually beneficial behavior?

Findings shed light on ways commodity traders and smallholder farmers interact within a complex economic system and reveal causal loops of the underlying system structure.

Finding 1: Traders use business strategies that cut across roles to improve quality, increase quantity, and get better prices.

As the qualitative analysis in Chapter 4 shows, trader business strategies can be defined in two dimensions. First, strategies can be categorized by role; second, they can be described by intended effect on commodity attributes: quantity, quality, and price. Both elements relate to what traders do. Traders opportunistically take on additional roles when those roles provide options for improving quantity, quality, or price. In essence, traders have strategic goals for improving commodity attributes (quantity, quality, price) that they pursue through the various roles they play. Beyond the high level strategy, traders achieve strategic goals by employing a variety of tactics, many of which affect multiple commodity attributes simultaneously. Through these tactics, traders end up playing roles with which they may not immediately identify.

Finding 2: When traders fill roles in which they directly interact with farmers, their efforts to improve quantity and quality may provide long-term mutual benefits.

Traders who also act as collectors (or behave in other capacities in which they interact with farmers) strengthen supply chain links and can provide smallholder farmers with access to knowledge, goods, and services. Clear examples were traders who provide trainings to improve farmer productivity, offer agricultural services (either free or for a fee), or give inputs or tools to farmers at the beginning of the growing season. In all of these cases, the trader is able to procure more quantity and better quality goods as a result of providing goods, services, and
knowledge to smallholder farmers. Farmers benefit from selling more and better produce in turn. In these cases, a trader’s decision to develop relationships with farmers is mutually beneficial.

**Finding 3: Credit policies like inputs financing reduce volatility in cashflow and commodity supply chains.**

It is well-known that farmers experience variable cashflows that align with the growing season and that financial services provide stability in agricultural production. The subtlety exposed by the analysis here is that traders—who have no obligation to offer financial services and do not have the security of a financial institution—can create stability for themselves and their suppliers, and in some cases initiate production, by offering small amounts of credit or credit in-kind. Through credit, traders can empower farmers to produce in seasons when it would have been financially impossible otherwise.

**Finding 4: Traders appear to intuit complexity and make decisions accordingly, but do not necessarily articulate or formalize these mental models.**

Finally, through analysis of traders’ stated and implied storage policies, it seems that naive policies are simplifications of what traders actually do. Neither a constant storage time nor a constant sales rate capture the financial benefit traders say they receive from storage. Rather, it seems that traders actually employ conditional or dynamic policies that change according to the season, prices, and supply.

The dynamics that govern this behavior were not captured by the model described in this paper. Dynamic storage policies are highly dependent on supply, demand, prices, and predictions. Given a fixed storage capacity, traders make the most money by maximizing the number of sales when supply is plentiful. This understanding is captured by the strategy to focus on quantity. However, when prices drop and supply simultaneously becomes scarce, traders are wise to store grain until prices rise and supply is hard to come by. Arbitrage is a basic economic principle, but the delays between changes in supply, changes in price, and grain spoilage make it difficult to predict the optimal time to begin storing and the optimal time to sell. Traders seem to intuit these dynamics; even though they articulated only naive policies, their actual behavior is evidenced by the fact that they see storage as profitable. Herein lies an opportunity for further modeling work that can explain the dynamic market environment in which traders are enacting storage policies.

### 6.2 Methodological Contribution

Over the past half-century, system dynamics has been widely applied to shed light on social phenomena in fields as diverse as management science and environmental studies. System dynamics applies where complex systems thrive; socio-economic development is, perhaps, one of the most complex systems. The theoretical dynamics that govern macro and microeconomic growth are well-documented in economics literature, many of which uses econometrics and causal inference to derive meaning from observation and experiments.

However, these studies often rely on quantitative data. Despite growing efforts from organizations like AID Data, the Humanitarian Data Exchange, and USAID’s own data repository, country-specific data is still wanting. In our experience, even data sets provided by USAID/Uganda activities lack longitudinal continuity, completeness, a representative sample, and accuracy, especially when it comes to monetary values and business transactions.

Thus, this thesis offers an alternative methodology for assessing causal relationships in Uganda’s agricultural market system using qualitative data. Explanatory models can be used to explore reasons for the emergence of patterns of behavior, even when said patterns are qualitative in nature. What makes explanatory modeling different from explanatory diagramming (e.g. results chains, theory of change diagrams, the Market System...
Monitoring Behaviors-Relationships-Conditions map) is its ability to validate the model structure by using known inputs to generate known behavior. Through this validation process, conceptual diagrams can be converted to more precise causal models. Epistemologically, modeling is used to infer causal gaps in qualitative data, and quantitative data is used to validate the model's output.

The intention, of course, is to create a model that is useful with the understanding that, as the saying goes, all models are wrong. This model and modeling technique are not meant to predict the future of agricultural development, nor to offer a general theory of how all agribusinesses are managed and interact with farmers. Surely another researcher would construct the model differently, call the variables by other names, explain the outcomes with different insight. Yet, this analysis provides in-depth, formal explanations for how trades run their businesses where current understanding is simplistic.

Conveying quality, quantity, and price in mathematical terms gives the impression that these attributes of sales are governed by an exact science, which certainly is not the case. Rather, the beauty of the mathematical statements and differential equations employed here is that they can succinctly articulate complex relationships among social phenomena. In a system where causality is nearly impossible to isolate and allocate, mathematical expressions can summarily capture the complexity, interdependence, and inseparability of commodity attributes.

6.3 Remaining Gaps and Opportunities

Pairing qualitative data analysis with quantitative modeling can be a useful tool for explaining causal feedback structures in the economic development context. With increasing attention to the systems that underlie wide-reaching social problems, pairing system dynamics or similar modeling techniques with qualitative analysis of empirical evidence offers an opportunity to develop and validate deeper understanding of complex systems. There are ample opportunities to expand upon this research and to put findings into practice.

1. Collect additional qualitative and quantitative data. One of the limitations of this study is the scope of qualitative evidence. The sample of interviewees is small and geographically concentrated. These results speak to the experience of traders in Iganga district, but are not necessarily generalizable to other parts of Uganda. Additional interviews or surveys of traders throughout the country may reveal whether the causal structures presented here are applicable and more universally valid. Similarly, the lack of quantitative data for validation reveals opportunities for future work. Even within data collected by USAID/Uganda, holes in the data made it impossible to simulate the experience of any given trader. In particular, collecting complete longitudinal data on price and quantity for purchases and sales would enable developing a deeper understanding of causal structure.

2. Continue modeling and explore other modeling methods. Modeling is important for confirming and updating current mental models. The model presented in this paper, while useful, lacks detail in a few notable areas. Future iterations should incorporate structure for market dynamics, information stocks like utilization of storage capacity, more robust decision-making formulations such as a trader's storage policies, additional business strategies, and the ability to simulate interactions among multiple farmers and traders. For example, including another downstream buyer, such as an exporter, would add an interesting layer of complexity. In addition, other modeling methodologies may be useful. In particular, agent-based modeling could offer another perspective on how different types of actors interact.

3. Use participatory modeling to engage actors in developing and using mutually beneficial business strategies by helping them better understand their role(s) in the system. Development organizations should continue to promote mutually beneficial practices and use participatory modeling to engage traders in developing
informed strategies. This thesis provides additional empirical support for USAID's market facilitation approach; there are strategies that benefit both farmers and traders, and some traders are using them.

In addition to trainings, there may be opportunities to engage traders and other stakeholders in the modeling process. Participatory modeling has been effectively used to develop accurate and robust models. Rather than extracting information to build a model, analyzing the outputs, and returning findings, participants are inherently involved. The benefit of this process is that stakeholders also gain insight from the modeling process and may be able to derive individual insight from using the model. In such a scenario, development organizations like USAID could work with traders to develop individualized plans for business growth using model outputs. Facilitators likely have better models as a result, and benefits are returned directly to stakeholders.
Chapter 7

Conclusion

This thesis combines qualitative analysis with quantitative modeling to identify business strategies used by agricultural commodity traders in Uganda and explain the underlying system structure that leads to growth for both traders and farmers when these strategies are employed. In summary, traders use business strategies that cut across roles to improve quality, increase quantity, and get better prices. As the evidence and analysis presented here have shown, traders who fill roles in which they directly interact with farmers are able to tailor their business strategies to improve quantity and quality, while providing long-term benefits for themselves and farmers. Credit policies, like inputs financing, reduce volatility in cashflow and commodity supply chains. Regarding storage policies and provision of agricultural knowledge and services, traders appear to intuit systemic complexity and make decisions accordingly, but do not necessarily articulate or formalize these mental models.

Stories connect us, bring us together. As a researcher, as a human being, if there is any way to truly know another person, it must begin with an experience, a thread, bridging cultural and geographic canyons, connecting people together. In this study, pairing qualitative analysis with system dynamics modeling offers robust explanations that draw on both the stories shared by individuals and the simulations that imply generality and objectivity. This methodology unites the specific and the generic in order to derive a nuanced understanding of why business strategies work, offering an example of how quantitative modeling might be used in the future to triangulate qualitative observations with other data. There is a clear need for additional data—both quantitative and qualitative—that would enable the creation of different types of explanatory simulation models while continuing to shed light on the realities of agriculture-derived livelihoods in Uganda. Additionally, this methodology lends itself to participatory modeling, highlighting opportunities to further engage stakeholders in research and agenda-setting for economic development.


Appendices
Appendix A

Quality-Differentiated Pricing Study

This document was first released in May 2017. The original version is available at http://humanitarian.mit.edu/projects/feed-the-future-uganda.

Introduction

The Market System Monitoring activity's goals are to develop new approaches that assess the impact of market facilitation activities in the USAID/Uganda Feed the Future Value Chain (FTF-VC) project and to assess systemic change in markets in cooperation with the relevant partners. This effort should complement monitoring and evaluation efforts of individual activities with methods to assess how the combination of activities in the project portfolio is enabling systemic change in markets. This report describes the findings of an in-depth study of one part of the market system: quality-differentiated pricing in the agricultural outputs value chain.

Background: Market System Monitoring Activity approach

To address the difficulty of monitoring outcomes for a portfolio of market facilitation activities, the team conducts analysis on two levels: the entire market system and subsets of components in the market system (subsystems). At the market system level, we aim to identify, understand, and analyze the relationships among the system components. Based on this understanding, we can identify key parts of the system that may be measured to assess systemic changes. At the market subsystem level, we aim to analyze key dynamics, actors, supply chains, and other interacting components to refine the indicators identified at the market system level. To do so, we will develop subsystem models, using methodologies appropriate to the unique characteristics of each subsystem and aligned with the purpose of the analysis. Our approach is to iterate between these two levels with methodological development, data acquisition, and analysis at each level (depicted in Figure 1). For example, we would begin at the market system level of analysis by developing a conceptual map of the market system and use it to identify potential systemic change indicators. Next, we would select some of these potential indicators for further study at the subsystem level of analysis. We would identify a subsystem for which indicator(s) have been proposed, and begin to study it more deeply. To do so, we would identify data that exist or can be collected, model the subsystem, and analyze the data and models in order to formalize methodologies for measuring change in the subsystem. In this manner, we would refine the proposed indicators and develop a method for measuring them. Finally, the insights from this deeper study would be captured at the market system level of analysis, by updating the market system maps and the systemic change indicators. Further analysis at the market system level would enable identification of additional indicators and selection of additional subsystems. This iterative approach invites collaboration, learning and adaption across activities.
Goals of this report

One way small-holder farmers can improve their livelihoods is through practices that increase profits. In a system where downstream actors value quality and are willing to pay more for better products, farmers have incentive to engage in practices to improve crop quality. In order to achieve a market for quality product, it is important that actors throughout the VC offer and have access to quality-differentiated pricing (QDP). In some cases, QDP does exist, but we do not fully understand what enables or blocks access to and willingness to extend quality-differentiated pricing. By exploring experiences of traders, this subsystem study aims to elucidate changes in the market system that enable or inhibit value chain (VC) actor access to quality-differentiated prices. Findings from this study will be used to improve understanding of the causal relationships in Uganda's agricultural market system and to inform USAID/Uganda's FTF-VC activities.

This study is exploratory in nature, designed to generate hypotheses and ideas for measuring systemic change. It is intended to identify system components and dynamics not previously understood. The overarching goal is to understand the nature of agricultural commodity quality and pricing in Uganda and identify indicators for measuring change in the market system.

The following research questions frame the scope of the study:

1. Quality: According to traders, has crop quality improved? How and why? Where are steps taken? and by whom? to improve crop quality?
2. Prices: Do traders buy and sell crops at higher prices than in the past? Is this change due to improved quality? What are the mechanisms by which prices change? How do traders make decisions in buying and selling?
3. Quality-Differentiated Pricing: What is the nature of quality-differentiated pricing that traders observe in the outputs subsector? What factors have enabled QDP to become an institution?
4. Challenges: What challenges must traders overcome to achieve better quality, prices, and quality-differentiated prices? How easily are these challenges overcome? How frequently are they insurmountable?

These questions were approached from the perspective of the trader. Through the USAID/Uganda Commodity Production and Marketing Activity (CPM), we are able to connect with and access data on traders from various parts of Uganda who have had varied experiences with quality and pricing in CPM's model, discussed briefly
in Section 3. The study does not aim to confirm existing hypotheses and is not solely focused on CPM interventions. It is not meant to evaluate success of market facilitation activities nor develop recommendations for traders.

**OUTPUTS VALUE CHAIN**

The Market System Monitoring Activity developed two maps as part of the effort to analyze the whole supply chains for maize, corn and beans. The first map is the Supply Chain Role (SCR) map. The second map, the Behaviors-relationships-conditions (BRC) map, is described more in section 7.2. The SCR is useful as an introduction as it sets a common terminology and scope of the value chain analysis. Since there are as many interpretations of a market system as there are people analyzing it, using the SCR as a reference ensures that knowledge is easily transferable and exchangeable.

The SCR map (Figure 2) brings clarity around the roles of actors in the value chain; this study focuses on the outputs side of the map. The terminology that the Market System Monitoring Activity is using differs from that of other FTF-VC activities in a few ways. The Market System Monitoring Activity considers any person or group of people that buy agricultural goods directly from farmers as playing the role of a collector. Other FTF-VC activities refer to collectors who buy outputs from farmers as village agents (VAs). Moving further down the value chain, a trader is a company or person that buys agricultural goods from collectors, but not farmers.

In a value chain as complex as this, there are numerous business models in which actors participate. As an example, village agents can also offer privatized, mobile extension services and provide financing or other services to farmers. These additional roles taken on by the VA are represented by the various service providers on the SCR map. If a VA also sells agricultural inputs to farmers, a role also undertaken by stockists and agrodealers, they assume the role of a dealer on the SCR map. This results in the ability to describe an actor, not just with a name that could entail various roles and business models, but by exactly the roles that they fill. For example, a VA could act as a collector-dealer.

**FTF-VC INTERVENTION: COMMODITY PRODUCTION AND MARKETING (CPM) ACTIVITY**

In Uganda, 85 percent of the people earn their income through farming. Farms are mostly smallholder farmers producing small amounts of produce. The FTF-VC activities all work to reduce poverty by increasing the quantity and quality of smallholder crops. One effort focused on youth in agriculture and the enabling environment for agriculture. Another focuses on strengthening the agricultural inputs subsystem. This study primarily worked with the Feed the Future Uganda Commodity Production and Marketing Activity (CPM) to gather data and explore quality-differentiated pricing in the outputs subsystem.

CPM is a five-year program (2013-2018) also using a market facilitation approach. They are working across FTF-VC target districts with middle value chain actors, such as traders, processors, and cooperatives, to increase incomes through the production of higher quality commodities in larger quantities. CPM focuses on boosting crop productivity, encouraging support services for farmers, strengthening relationships between buyers and sellers, and creating ties between traders and exporters. Their goal is to improve domestic production in such a way that they export market grows and increases farmer income.
RESEARCH DESIGN AND DATA COLLECTION

With little study of QDP in the Uganda market, the team took an inductive approach to generate new theory based on qualitative analysis using a multiple case study approach. We explored the experiences of several traders who were selected to represent variety in location, size, level of success in providing and accessing quality-differentiated pricing, commodity, and organizational structure. We then answered the research questions using qualitative analysis methods to interpret information from the traders and compare both within and across cases.

Research support was provided by the Feed the Future Uganda Commodity Production and Marketing Activity (CPM). CPM selected six traders that met the selection criteria regarding geography and success with quality-differentiated pricing. Table 1 summarizes notable demographics of each trader. P1 and P2 were the pilot cases while C1-C4 were interviewed with an updated interview guide. While several traders worked with more than one commodity, the interviews tended to focus on only one. Secondary commodities are noted in parentheses.

An interview guide was developed to conduct semi-structured interviews with the traders. Two interviews were used as pilot studies. The interview guide was revised after reviewing transcripts and initial learnings from the pilots, and four additional interviews were held using the revised version. The pilot questions and revised interview guide can be found in Appendix A: Pilot Interview Guide and Appendix B: Revised Interview Guide respectively. The updated interview guide broke the discussion into four parts:

- Background: general information about what crops traders deal in, the numbers of farmers and village agents they work with, and who they sell to.
- Buying: learn about how traders have improved the quality of crops they are able to buy; how they set their prices and purchase crops; and how they interact with village agents and farmers.
- Selling: learn how traders access markets and provide high-quality products to achieve good market prices;
APPENDIX A. QUALITY-DIFFERENTIATED PRICING STUDY

Table 1: Overview of traders interviewed

<table>
<thead>
<tr>
<th>Trader</th>
<th>Region</th>
<th>Organization</th>
<th>Commodity</th>
<th>Annual Production</th>
<th>Storage Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Central</td>
<td>Multiple collectors, sells domestically</td>
<td>Bean Seed</td>
<td>300-500 MT</td>
<td>566 MT</td>
</tr>
<tr>
<td>P2</td>
<td>Central</td>
<td>Multiple collectors</td>
<td>Coffee</td>
<td>730 MT</td>
<td>100 MT</td>
</tr>
<tr>
<td>C1</td>
<td>Central</td>
<td>Multiple collectors</td>
<td>Maize (some Coffee)</td>
<td>500-1000 MT maize</td>
<td>100 MT</td>
</tr>
<tr>
<td>C2</td>
<td>Central</td>
<td>Multiple collectors</td>
<td>Maize (some Beans)</td>
<td>700-1000 MT maize &amp; beans</td>
<td>250 MT</td>
</tr>
<tr>
<td>C3</td>
<td>Western</td>
<td>Cooperative; farmers sell directly</td>
<td>Coffee</td>
<td>280 MT</td>
<td>unknown</td>
</tr>
<tr>
<td>C4</td>
<td>Western</td>
<td>Multiple collectors and distributors</td>
<td>Maize</td>
<td>7,200 MT</td>
<td>10,300 MT</td>
</tr>
</tbody>
</table>

learn about the challenges they face in accessing markets and good prices.
- Business practices: learn about how changes in business practices have affected quality and prices; learn about traders' goals for the future and barriers to progress.

All six interviews were included in the analysis with nomenclature to distinguish between pilot (P) interviews and case study (C) interviews: P1, P2 for interviews using the pilot guide; C1 to C4 for interviews using the updated guide. Interviews were facilitated by CPM staff who accompanied the the Market System Monitoring Activity team. The CPM staff, with knowledge of the local markets and language, helped clarify questions and answers as necessary during interviews. In total, five Market System Monitoring Activity team members were involved in the interview process. Interviews were captured with an audio recorder and later transcribed. Field notes and short summaries were also recorded electronically. Data collection methods received approval from university Institutional Review Boards to ensure appropriate handling of human subjects information.

ANALYSIS METHODS

We primarily used coding and pattern matching in our case-based qualitative analyses. First, interview recordings were transcribed and the data were reviewed. Important themes were identified via a deep reading of one transcript (C2). These themes were compared to the research questions and used to construct preliminary codes. Codes are like tags used to annotate and draw connections among different parts of transcripts. Coding allowed the researcher to systematically compare and contrast trader experiences. Atlas.ti was used to code the various documents and aid in analysis. The preliminary codes are listed here:

1.1 Quality perception
1.2 Quality change
1.3 Action taken to improve quality
1.4 Driver of quality change
2.1 Price perception
2.2 Price change
2.3 Action taken to improve price
2.4 Driver of price change
3.1 Price based on quality
3.2 Driver of QDP
RESULTS

Results are organized by the research questions stated in Section 1.2. Findings reflect the experiences of six traders who have been working with the Commodity Production and Marketing Activity (CPM). Findings are not meant to be representative of the typical Ugandan trader or even of traders working with CPM. This research aims to develop theories regarding enablers of quality, pricing, and quality differentiated pricing (QDP) based on a variety of trader experiences.

Changes in Quality

Quality is multi-dimensional. While quality standards are not always employed, many traders consider similar crop attributes when evaluating quality. Table 2 briefly describes a number of quality attributes that traders frequently mentioned.

Traders perceive that crop quality is improving. The four case study traders were asked whether their crop quality has been improving; this question was not explicit in the pilot interviews. Each of the four traders who were asked [C1, C2, C3, C4] said their crop quality was improving. All six traders expressed positive perceptions of their crop quality, captured in Table 3.

Upon being asked, C1, C2, and C3 said that they were happy with their crop quality. While C4, P1, and P2 were not explicitly asked the same question, they did imply that they buy and sell what they consider to be good...
Table 2: Common quality attributes noted by traders

<table>
<thead>
<tr>
<th>Quality Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture content</td>
<td>The percentage of water in a product; generally, drier products are considered higher quality.</td>
</tr>
<tr>
<td>Foreign matter</td>
<td>Rocks and other inedible objects reduce the quality of goods and must be removed.</td>
</tr>
<tr>
<td>Spoilage</td>
<td>Molds and bacteria can cause crops to spoil. In maize, aflatoxins are harmful metabolites present in spoiled crops; in coffee, Ochratoxin-A is a similar byproduct.</td>
</tr>
<tr>
<td>Roughage</td>
<td>Coffee and maize have hulls-roughage-around the seed and grain, respectively, that are removed during post-harvest processing. Crops with hulls intact are considered lower quality.</td>
</tr>
<tr>
<td>Size and shape</td>
<td>Small and/or deformed crops may be indicative of poor agricultural practices or poor growing conditions. Traders use screens of different mesh size to sort crops by size.</td>
</tr>
<tr>
<td>Color</td>
<td>In the case of coffee, the color of the hull indicates maturity. When coffee berries are red (cherries) they are ready for harvest.</td>
</tr>
</tbody>
</table>

Table 3: Traders' perceptions of crop quality

<table>
<thead>
<tr>
<th>Trader Perception of Crop Quality</th>
<th>C1 (M/C)</th>
<th>C2 (M/B)</th>
<th>C3 (C)</th>
<th>C4 (M)</th>
<th>P1 (B)</th>
<th>P2 (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>They are happy with the current quality of the crops they buy</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop quality has been improving</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>They are selective about the quality of crops they buy</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>They reference a grading/classification system in buying and selling</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
quality products. These three traders were also more precise in defining a system for classification or grading. C4 identified five grades of maize, and P1 noted three different grades of beans. In the case of coffee, P2 distinguished between kiboko and Fairly Average Quality (FAQ), the former of which is dry, unprocessed coffee cherries and the latter is hulled. All three said that different grades or classes fetch different prices.

Traders attribute improved crop quality to using good agricultural practices (GAP) and good post-harvest handling (PHH) practices. Table 4 lists agricultural practices that traders are encouraging farmers to use. Traders also mentioned processing and preservation practices that are important for improving or maintaining quality, listed in Table 5. All traders acknowledge the value of having high quality inputs, and three [C1, C2, C4] related the benefits of using good quality inputs to the benefits of using good quality seeds, discussing them in similar ways. As a seed dealer, P1 had a different view on the use of good seeds, emphasizing their importance in more depth. C3 and P2 work in coffee, a woody perennial crop for which the quality of the seed used is less important than the practices used to germinate and care for the plants. By extension, since coffee is a tree, it is not unexpected that C3 was the only trader who acknowledged the value of pruning and identified it as most important for improving crop quality.

<table>
<thead>
<tr>
<th>Good Agricultural Practices</th>
<th>C1 (M/C)</th>
<th>C2 (M/B)</th>
<th>C3 (C)</th>
<th>C4 (M)</th>
<th>P1 (B)</th>
<th>P2 (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use good inputs</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Use good seeds</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvesting ripe products</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Pruning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Spraying</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

P1 deals in beans, both ?grain? and ?seed.? P1 acknowledged the importance of producing good quality seed for buyers and also discussed how different varieties have different value. Similarly, P1 explained that certain varieties were more valuable since they have higher yields. Here, quality and volume were not conflated, but P1 did imply that quality and yield are dependent on overlapping sets of factors.

It should be noted that Table 4 considers spraying separately from the use of good inputs?despite potential redundancy?for three reasons. First, spraying was a specific application of inputs singled out by half of the traders interviewed. Second, the activity of spraying is distinct from using good quality spray; one could spray using good quality or poor quality chemicals. Third, spraying can be done by multiple actors and requires special equipment, as opposed to fertilizer or other agrochemicals that are mixed into the soil and primarily used by farmers. Village Agents sometimes offer spraying services, or spray equipment is purchased communally.

Table 5 similarly compares the processing and preservation practices that traders use and promote to improve quality. Good processing and preservation practices are distinct from good agricultural practices: agricultural practices are explicitly employed by farmers to produce crops, while post-harvest processing and preservation practices can be used by any actor in the value chain to improve quality.

Sorting and drying do not require (but can be expedited with) machinery and can easily be accomplished by any actor. Both drying and sorting contribute to the perceived quality: dry products are less perishable; contaminants should not be consumed. Drying and sorting apply to all three commodities. On the other hand, fumigation is not usually used to process coffee and hulling is less intensive for beans. Fumigation was only mentioned by one maize trader and one bean trader and not across the board. The most frequently mentioned post-harvest practices were drying and the use of adequate post-harvest storage facilities, which prevent spoilage from molds and insects. In particular, emphasis was placed on the use of tarps for drying to prevent contamination and
Table 5: Processing and preservation practices that traders attribute to improved quality

<table>
<thead>
<tr>
<th>Processing and Preservation Practices</th>
<th>C1 (M/C)</th>
<th>C2 (M/B)</th>
<th>C3 (C)</th>
<th>C4 (M)</th>
<th>P1 (B)</th>
<th>P2 (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorting (size, shape, foreign material)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Hulling</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Drying</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Fumigation</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Post-harvest storage</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

achieve lower moisture content. For maize, different levels of hulling help determine different quality grades. In Uganda, according to C4, less roughage is considered higher quality. Hulling is particularly important for coffee quality. There are two methods of hulling, dry and wet. Typically, Arabica coffee is hulled wet before the beans are dried while Robusta is hulled by mechanically shaking off the shells after drying.

Traders attribute improved crop quality to training and knowledge dissemination. Table 6 shows four of the modes by which traders access and disseminate knowledge about improving the good practices mentioned above.

Table 6: Modes of knowledge transfer identified by traders

<table>
<thead>
<tr>
<th>Modes of Knowledge Transfer</th>
<th>C1 (M/C)</th>
<th>C2 (M/B)</th>
<th>C3 (C)</th>
<th>C4 (M)</th>
<th>P1 (B)</th>
<th>P2 (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trainings from CPM or other organiza-</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>tions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VAs train farmers</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Demonstrations</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Communication technology</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Training, not unexpectedly, was identified by all traders as a key mode of knowledge transfer. Several traders requested more trainings, asking if we could provide resources for further learning on ways to improve crop quality and yield. More interesting are the nuances surrounding the ways traders explained knowledge transfer between their village agents and farmers. For C3, for example, village agents primarily act as extension and service providers. They sell pruning and spraying services to farmers and help them know when the right times are to harvest. Unlike C4, whose village agents additionally buy crops from farmers to sell to C4 and also have outlet stores for selling posho (milled corn) and inputs, C3's village agents are not involved in transactions with farmers. Village agents play many roles, many of which include aspects of knowledge transfer touched on in these interviews. Among them:

- Extension providers teach farmers good agricultural practices; advise on planting and harvest timing; advise on treating crop illnesses
- Service providers spraying and pruning services were primarily identified
- Collectors either collect and transport or buy and sell crops from farmers to traders
- Dealers sell agro-inputs; alternatively, may act as a liaison between farmers and dealers

Four of the traders mentioned demonstrations as valuable ways of transferring knowledge. Across the four traders, we heard about different ways to conduct demonstrations. Some talked about the value of demos for sharing ideas and learning techniques among farmers, while others focused on the persuasive nature of seeing improvements in crops. Some traders discussed field days where farmers come together to practice techniques, share ideas,
and show their wares. Other times, farmers work with village agents to set up demo plots where techniques are tested. After a season, farmers can see the difference that improved agricultural practices have on yield and crop quality.

Telecommunications technology has provided an important platform for sharing information among exporters, traders, collectors, and farmers. C2 and P1 were the only two traders who discussed the use of cell phones and the internet, but CPM has been promoting and subsidizing smart phones to help all actors better access extension services and data on current prices. Phones help strengthen relationships among farmers and village agents, village agents and traders, traders and exporters. Improved communication allows actors to make better-informed production and business decisions.

**Changes in Pricing**

**Traders report that they buy and sell at higher prices than in the past.** Three traders [C1, C2, C3] directly indicated that prices have changed, that they fetch better prices for their crops than in the past. Table 7 is included for visual continuity. It should be noted that only these three traders were explicitly asked whether their prices have changed over time; the question was articulated when the interview guide was modified between the pilot and case interviews, and the question was overlooked in the C4 interview, which was pressed for time.

<table>
<thead>
<tr>
<th>Price Perception</th>
<th>C1 (M/C)</th>
<th>C2 (M/B)</th>
<th>C3 (C)</th>
<th>C4 (M)</th>
<th>P1 (B)</th>
<th>P2 (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prices have improved because of</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>quality change</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All three traders said that they have indeed seen price changes, and they attributed those changes to improvements in crop quality.

- C1 briefly mentioned that prices have changed in recent years and that quality and quantity have also changed.
- C2 talked about changes in quality over the past three years, explaining that the price they sold maize increased from 250-500 to over 800 UGX/kg. In a different part of the interview, C2 explained that the change in quality allowed them to access more markets; new exporters began buying their crops and were willing to pay more for them.
- C3 echoed that the general increase in quality has led to an increase in price. Interestingly, C3 implied that he perceived this change happening at a national level.

While the evidence suggests that prices have changed for these traders, it is not sufficient to conclude that changes in quality are the singular cause of price changes. While traders did not identify other reasons that prices have changed, they did comment on the criteria that they use to set prices and on actions they take to fetch higher prices, both of which are described further below.

**When buying, traders set prices based on exporter prices, record keeping, and quality.** Distinct from whether or not traders buy and sell at higher prices, Table 8 shows the three main factors that traders claim they consider when setting prices.

Export prices drive the market. It was clear from interviews that these traders work primarily with exporters and rely on competition among exporters to fetch good prices. Few traders discussed domestic markets, which
Table 8: Factors traders consider when setting prices

<table>
<thead>
<tr>
<th>Factors Traders Consider When Setting Prices</th>
<th>C1 (M/C)</th>
<th>C2 (M/B)</th>
<th>C3 (C)</th>
<th>C4 (M)</th>
<th>P1 (B)</th>
<th>P2 (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exporter Prices</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Business Records</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Quality</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

may indicate that domestic markets are not as stable or reliable as export markets. Two traders also said that they would like to become exporters themselves, seeing that as a path forward for earning higher incomes. Most traders kept records of goods purchased and sold and used those records to make business decisions. C1 astutely stated that they use records to track the quantities of goods they buy and sell and the profits of their transactions because, If the business does not bring a profit it is not a business. C2 decides what to pay farmers by deducting their transportation costs and profit from the revenue they project based on export prices. Some traders, like C4, indicated that they learned the importance of improved record keeping through CPM. It is worth noting that P2 did not discuss record keeping during the interview, but neither claimed nor denied whether they do. C3 mentioned record keeping and using records to make business decisions, but did not directly tie this to setting prices. Rather, C3 is a cooperative that uses records to see when they have surplus income that they can invest in machinery and other physical capital to improve services for members. Finally, all traders except for P1 indicated that they set prices based on quality. The mechanisms of this process are described in more detail in the next section on Quality-Differentiated Pricing. P1, as a dealer of bean seed, discussed the relationship between quality and yield in the context of improved varieties and multiplication of seed.

When selling, traders fetch higher prices by negotiating, comparing offers, selling seeds and premium varieties, waiting for market prices to rise, and building a reputation for quality. Before discussing the specific actions that traders identified for fetching higher prices, it is important to mention that some traders did not clearly distinguish between price and revenue. That is, when asked what they do to fetch higher prices, some answers were framed as what traders do to make more money. While increased crop prices lead to traders generating higher revenue, many actions to increase revenue do not necessarily include fetching higher prices for the same goods. While the distinction was not always clear, the results here aim to reflect actions taken to obtain higher prices per goods sold, rather than overall revenue. Table 9 summarizes these categories of actions traders take.

Table 9: Action traders take to fetch higher prices

<table>
<thead>
<tr>
<th>Actions Taken to Fetch Higher Prices</th>
<th>C1 (M/C)</th>
<th>C2 (M/B)</th>
<th>C3 (C)</th>
<th>C4 (M)</th>
<th>P1 (B)</th>
<th>P2 (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negotiating</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selling to highest offer (access to markets)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Store crops when prices are low, sell when high</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Exporting directly</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Selling seed and premium varieties</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advertising</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Most of the traders either negotiate with exporters, select where to sell based on prices advertised, or both. In selling to the highest offer, traders emphasized the importance of having access to a number of exporters.
When they are connected to more exporters, they have more options and can see who is offering the highest price. Most traders either call ahead to see what prices are offered on a given day or they access the prices over the internet. Once they know the prices offered at each location, they can use those prices to negotiate higher prices at a preferred exporter. Traders may prefer one exporter over another because of proximity. Length or reliability of relationship can also motivate traders to prefer one exporter over another for reasons other than price offered.

Negotiating and selecting the market to sell to, collectively mentioned by five of the traders, are essential mechanisms for determining the value of goods. These two methods for fetching higher prices can be thought of as types of auctions where exporters bid on the goods traders are auctioning. In each transaction where negotiating takes place or traders choose one exporter over another, the parties are mutually agreeing on the value of the goods.

Market price fluctuations (described in Section 6.3 as a challenge traders face) increase the importance of having adequate storage facilities that prevent crops from spoiling. When market prices are low, traders prefer to store their crops until prices rise again. Without appropriate post-harvest storage facilities, crops are susceptible to mold and insect damage. If traders store crops until the main harvest has passed—that is, until those who lack storage facilities have sold their produce—they can fetch higher prices when prices rise again in the off season. Additionally, P2 explained that weather can have an effect on prices: when there is rain, coffee, for example, does not dry as well. If P2 has silos to keep coffee dry, they can sell at a higher price after the rain. Therefore, storage facilities can help traders fetch higher prices when they strategize based on reasonably predictable market price fluctuations.

When traders have access directly to export markets, they say they are able to fetch higher prices than selling domestically. Only C4 mentioned that they sell to domestic markets, and even then, they were selling and aiming to sell to specialty buyers (e.g., schools, refugee camps). The four traders who identified exporting directly as a way to increase prices indicated that, while becoming an exporter requires physical and financial capital, they dream of exporting directly to reach new markets that offer higher prices.

In terms of the value of goods, only P1 directly discussed the value of certain varieties in detail, but the importance of variety was backed up through discussions with CPM members and was mentioned by C1 and C3. For producers who grow seed stock, P1 said, certain varieties fetch higher prices. Similarly, some varieties have higher yields or are genetically engineered to grow under difficult conditions. Better seeds are associated with larger yields, larger yields bring in more income overall. Thus, for some, high yield is considered a ?good? quality attribute.

As discussed in the previous section, use of good business practices came up several times in the discussions on price setting. All traders except P2 mentioned keeping records of quantities bought and sold and using that information to make business decisions. In terms of fetching higher prices, P1 also advertises and has a team that works on marketing strategy. C2 and C4 alluded to the importance of reputation, explaining that buyers know their company name and know that their products are high quality. Reputation and advertising help build trust among buyers and sellers, creating positive feedback that facilitates quality differentiated pricing. Traders? explanations of their actions taken to improve prices indicate that the upward trend in pricing identified in the first part of this section is inconsistent and heavily dependent on factors that traders perceive as external. Almost all of these actions (with the exception of selling premium seeds or varieties) depend on exporters being willing to pay more for higher quality or trusting the exporter enough to pay a higher price. It is interesting that traders did not say ?I improved my quality in order to fetch higher prices? but did correlate the improvement in quality with increased prices. Causality was implied, though not explicit.
Quality-Differentiated Pricing

It is difficult to determine the catalyst for QDP, and thus challenging to identify where to initiate interventions. Buyers are only willing to pay more when better quality goods are available, but sellers only have the incentive to produce better quality goods when they know the extra effort will be rewarded. This type of dynamic is a "reinforcing loop" in which an action produces a result that enables more of the same action, and on and on. This results in something of a paradox: better quality goods must be available for a buyer to pay more for them, but better quality goods will only be produced if a buyer is willing to pay more for them. Initiating this reinforcing loop requires both changes to happen together.

Two approaches for quality-differentiated pricing are prices based on quality grade and prices based on adjusted weight. In one way or another, all traders agreed that higher quality crops fetch higher prices than lower quality crops. However, as implied by Table 10 price setting is complicated, multifaceted, and done in different ways, even when based on quality.

**Table 10: Evidence that traders offer and obtain quality-differentiated pricing**

<table>
<thead>
<tr>
<th>Evidence of Quality-Differentiated Pricing</th>
<th>C1 (M/C)</th>
<th>C2 (M/B)</th>
<th>C3 (C)</th>
<th>C4 (M)</th>
<th>P1 (B)</th>
<th>P2 (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher quality fetches a higher price</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>We do not buy bad quality</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced kilograms for lower quality</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price by grade or level of processing</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Among these traders, there are two distinct approaches to QDP:

1) Price based on quality grade? actors use distinct pricing brackets for different grades determined by common perceptions of specific quality characteristics.

2) Price based on adjusted weight? certain quality attributes (e.g. moisture content, presence of foreign matter) affect the weight of a given quantity purchased; many buyers perform secondary processing that results in weight reduction. Therefore, they may ?reduce the kilograms? purchased in a transaction to account for reduced revenue potential.

Grading is clearly employed by C4 and P1 and to some extent by P2. C4 listed five grades of posho (corn flour) and explained that they differ based on the level of processing. P1 explained that there are three grades of beans. Both traders also said that different grades fetch different prices. P2 was less clear about a grading system, but noted that hulled coffee (known as FAQ, Fairly Average Quality) is bought and sold at a higher price than unhulled coffee (kiboko). Again, quality is added through processing and higher prices are paid for higher levels of processing.

Traders that do not distinguish quality grades typically employ a method known as reducing the kilograms. Basically, they publicize a nominal price for ?good? quality and pay for fewer kilograms than the scale measures when the quality is substandard, though the process for ascertaining quality is not standardized and the adjustment may be arbitrary. Traders explained that they use this method to account for mass lost after processing and described three ways that happens. First, one of the hallmarks of poor quality that warrants reducing the kilograms is the presence of foreign objects (e.g. stones). Traders will sort the products again to remove these
contaminants, physically reducing the weight of the goods. While C4 does not claim to use the "reducing the kilograms? method, they explained that up to 10% of the weight of poorly-sorted maize may be comprised of stones and other foreign matter. Second, a similar situation occurs when crops are not thoroughly dried. Traders will dry the crops again, and as water is removed, the crops weigh less. So, some traders will reduce the kilograms to account for the extra weight of water. In C3's case, a machine sorts dry coffee from the un-dry and C3 purchases the dry coffee only. The third scenario in which this makes sense is when crops are not hulled?hulling removes weight.

Enablers and barriers to QDP As seen in Table 11, traders identified a wide variety of challenges. In the interviews, it was difficult to specify and tease out the differences among challenges to improving quality, challenges to fetching higher prices, and challenges to QDP. From the trader perspective, they are all interconnected. Additionally, traders sometimes discussed the challenges farmers, village agents, and exporters face as distinct from their own; sometimes challenges were discussed broadly. Each trader had a unique story to tell on how these challenges were presented. Some are challenges that the trader has overcome. Some were framed as requests. In understanding the challenges and enablers of quality differentiated pricing, it is essential that challenges are approached with the knowledge that they affect people in ways as varied and multitudinous as personalities.

Table 11: Challenges that value chain actors face as identified by traders

<table>
<thead>
<tr>
<th>Challenges</th>
<th>C1 (M/C)</th>
<th>C2 (M/B)</th>
<th>C3 (C)</th>
<th>C4 (M)</th>
<th>P1 (B)</th>
<th>P2 (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers adopt practices slowly</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telecommunications</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication/transportation</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[infrastructure]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to markets</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Yields/volume of produce</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Lack of storage facilities</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Counterfeit inputs</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finance</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate change/weather</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price fluctuations</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Farmer adoption of good agricultural and processing practices was an issue identified by most of the traders. When asked why this was the case, traders gave different answers. C3 explained that it is "human nature? to resist change. He says that farmers feel they do not have time to employ new practices, that they are inconvenient, and that they are satisfied with their current harvests. As explained in Section 6.1, demonstrations have been effective in encouraging farmers to adopt more quickly. Yet, despite demonstrations, trainings, and testaments, traders can expect that adoption will remain an obstacle to be overcome with each farmer.

Communication and transportation, combined here, include difficulties that traders face in receiving and distributing price information among farmers, and challenges that village agents face in traveling to farmers to teach and guide them. Poor roads and lack of vehicles were mentioned by C1, C2, and P1. Village agents, they say, have difficulty keeping in touch with farmers and monitoring their progress. Village agents help farmers know when the right time to harvest is, for example, and mostly travel by foot or bicycle. As C2 says, even if they all had motorcycles, it would make a big difference. Many traders, village agents, and farmers also rely on cellular telecommunications, which as C2 and P2 point out, is sometimes out of service.

The importance of access to export markets, lack of storage facilities, and price fluctuations are discussed previously in the context of actions traders take to fetch higher prices. C2 and C3 particularly emphasized that limited
access to export markets is one of the greatest challenges they face and a main limitation to growth. While price fluctuations were frequently identified as a difficulty, P1 made a call for government intervention and price fixing.

Almost all the traders, at one point or another, commented that their businesses are limited by the current yields and volumes of crops they trade. This sentiment was sometimes framed as a request for further trainings that would help them increase yields. Sometimes, as in the case of C2 and C4, it was a lament that volume is preventing them from becoming exporters themselves. Either way, it was clear that quantity is a significant obstacle in the minds of the traders, though this is tangentially related to the use of quality differentiated pricing.

Several traders mentioned that counterfeit inputs are still a problem that their farmers face. Distinct from the emphasis on using quality inputs that farmers cited as a good agricultural practice improving quality, the presence of counterfeit inputs was also identified as a challenge to be overcome. With the introduction of the Agricultural Inputs Activity’s e-verification system, some of the issues with counterfeit inputs are being addressed.

Access to finance is a challenge that comes in many flavors. Traders may take out commercial loans or make use of payment plans when purchasing processing equipment, silos, or trucks, for example (mentioned by C2 and C4). C3 discussed how other traders take out loans to pay farmers advances, enabling them to purchase inputs. C3 explained that this is a risky move since harvests are not always as expected and farmers could sell to other traders instead. Looking at finance from a different angle, C4 discussed how their village agents are better able to access loans since they are affiliated with C4 and are considered part of an association. Village agents and cooperatives are sometimes able to purchase equipment like sprayers via cost sharing (C3). Farmers have opportunities to purchase tractors through similar payment plan programs (C4). Consistent access to financial services would allow both farmers and traders to engage in practices that improve crop quality.

Finally, traders commented on the impacts of climate change and weather. Weather, more simply, impacts day to day operations. It is more difficult to dry crops thoroughly when it rains, for example. However, climate change is affecting seasonal patterns and harvest times. Crops must be sown at particular times; if too early or too late, harvests are sub-optimal. The timing is becoming unpredictable as a result of climate change.

Traders identified various QDP enabling conditions that are established or developing:

- access to good inputs, seeds, and varieties
- use of good agricultural practices
- use of good processing and storage practices
- promulgation of knowledge through trainings and demonstrations
- provision of services (spraying, pruning)
- improved communication and transportation infrastructure
- access to numerous markets (competition)
- negotiation for, advertising for, and reliably providing quality to achieve higher prices
- use of transaction records to make business decisions
- ownership of assets for processing and storage
- access to finance to grow a business and take risks

Though this list may not be comprehensive, fortifying these institutions will help create the environment conducive to provision of QDP. CPM’s interventions have been addressing many of these issues, and our results suggest they have met with some success, though its extent remains to be determined. From our data, it is hard
to see the perspectives of village agents, farmers, and exporters, but we can extrapolate the findings to predict their points of view.

DISCUSSION

One key finding is that quality-differentiated pricing (QDP) can be propagated in the value chain through synergistic relationships. When some actors offer QDP, they create incentives for other actors to improve the quality of their goods; actors who provide high-quality goods, in turn, create an incentive for buyers to offer QDP. This reinforcing loop, in which an action produces a result that enables more of the same action, is a foundational structure within systems thinking. A second key finding is that QDP exists but is implemented informally and not yet well-established. Quality is slowly improving through efforts to disseminate knowledge about quality improvement techniques and prices are slowly rising through improving quality and better market knowledge and relationships.

The Nature of QDP

The relationship between quality and price and quantity is complex. Traders emphasized the importance of quality at just about every point of production; however, they also implied that quality, quantity, and price are three dimensions of goods sold that are distinct, yet interdependent. For example, price is a function of both quality and quantity. One reason buyers are willing to pay more for better quality is because several quality attributes are dependent on the removal of physical substances (water, stones, husks), and so buyers are paying for more quantity when they pay more for higher quality.

Quality and quantity are inherently related, and sometimes conflated, by actors in the commodity distribution supply chain. For example, traders frequently linked the use of quality inputs to increased yields. When traders have more goods to sell, they make more money. Similarly, the use of good quality inputs protects crops from insect damage and produces large grains, both traits of quality that can help traders fetch higher prices. It becomes easy to make fallacious assumptions that the use of good inputs leads to higher incomes only because use of good inputs leads to higher yields, and thus, higher incomes; it is similarly true that the use of good inputs leads to better quality crops, which fetch higher prices when QDP is offered. The use of good inputs leads to both higher yields and better quality crops, both of which are dimensions that fetch better prices.

A similar story can be told with respect to pruning, sowing and harvesting seeds at appropriate times, and other good agricultural practices. These actions enable large harvests (quantity) while improving quality characteristics of crops (size, shape, color). While traders loosely acknowledged that quantity and quality are both dependent on use of good practices, and that prices are set based on both dimensions, they did not differentiate or explain price setting in this more nuanced way. It is unclear, for example, the extent to which price varies with quantity?whether this occurs solely in the context of reducing the kilograms?, or whether some traders also offer higher prices for bulk quantities of crops.

QDP in the Behaviors-Relationships-Conditions (BRC) Framework

The reinforcing loop for quality differentiated pricing can be depicted in the style of the Market Systems Monitoring Activity's Behaviors-Relationships-Conditions (BRC) map. The BRC map depicts key concepts in market sys-
tems, including behavior changes by actors, relationship changes among actors, and enabling conditions.

The framework behind the BRC map is depicted in Figure 3. It is based on a "theory of change" for the facilitative market interventions carried out by Feed the Future Activities. These interventions enable the existence of conditions within the market system that further enable behavior changes by and relationships among market actors. When behavior and relationship changes occur together at some scale, system level results are affected, generating project impact. The BRC map framework connects key concepts to each other by showing which behaviors, relationships, and conditions enable other behaviors, relationships, and conditions, without claiming causality. In other words, an arrow from A to B indicates that A enables B, even if A may not cause B. Some arrows are bi-directional; the enabling can occur in either direction. Feedback arrows in Figure 3 demonstrate that system level results can enable relationship and behavior changes, as well as changes to conditions. The feedback arrows also demonstrate that relationships and behavior changes can enable conditions.

Figure 3: BRC map framework

Figure 4: demonstrates how this framework is translated into a BRC map. Magenta circles represent relationships, blue squares represent behavior changes, items in black letters with no outline are enabling conditions, and green ovals represent interventions by activities. The arrows indicate which map element enables another. In this case, an intervention enables two conditions, each of which enables a behavior change. A relationship between actors enables a behavior change of one actor to affect the behavior of the other.

In Figure 5, the behaviors, relationships, and conditions involved in the QDP reinforcing loop are represented using the BRC system mapping approach. In general, QDP is offered by a Buyer (an Exporter, Trader, or Collector) and quality goods are provided by Sellers (Traders, Collectors, and Farmers, respectively). This Buyer-Seller relationship is used in Figure 5 as a placeholder to represent the other dyad relationships (Exporter-Trader, Trader-Collector, and Collector-Farmer). Figure 5 portrays the QDP loop in generic Buyer-Seller terminology, where the behavior changes and enabling conditions relating to Buyers are surrounded by green background, and those relating to Sellers are surrounded by orange. As described above, this is a positive feedback cycle—the arrows from behaviors to conditions form a continuous loop. Once initiated, the cycle is self-reinforcing.

When interpreting the QDP loop, a logical place to begin is with the behavior change "Buyer offers QDP." When a Buyer offers QDP, they create an incentive (a condition) for a Seller to stock quality goods. This condition enables two behavior changes a Seller can make to improve the quality of goods they stock. First, they can increase their quality standards for what they purchase: they can purchase better quality goods. Second, a Seller can process
Figure 4: Translating BRC framework into a map

Figure 5: QDP loop depicted with Buyer and Seller placeholders
goods to improve quality. For example, milling, hulling, and drying are three ways middle value chain actors can increase the quality of the goods they sell; farmers can use good agricultural practices and buy quality inputs to produce better quality crops. As a result of procuring higher quality goods and processing goods to improve quality, Sellers have better quality goods in stock. "Sellers stocking quality goods" is a behavior that can take place regardless of whether or not Buyers offer QDP, but one way to enable this behavior is through making QDP available.

When Sellers have better quality goods in stock, Buyers have incentive to offer QDP, and the cycle continues. The incentives for Buyers and Sellers to respectively offer QDP and stock quality goods are the factors that drive the reinforcing loop and are enabled by each actor taking the initiative to stock quality goods and offer QDP respectively.

There is another nuance here: a single actor typically plays the role of both the Seller and Buyer. A trader, for example, is a Buyer with respect to collectors and a Seller with respect to exporters. We have attempted to capture this complexity with the behavior "Seller becomes Buyer with formal quality differentiation."

To fully map the pathways that enable QDP in the market system, the BRC map must also include the processes that determine the quality and quantity of produce. In Figure 6, quality, quantity, and price settling are represented in the BRC map as three parallel subsystems that all enable increased profit for the Seller.

Depicting quality, quantity, and price setting separately, it becomes clear that there are behavior changes that affect quality and quantity independently, but that increased quantity and increased quality both lead to higher profits. Price settling is complex, and while prices are impacted by both quantity and quality, data from this study shows that negotiations, reputation, and competition are relevant. The prices for quality differentiated products are also influenced by prevailing international market prices, particularly when there are exporters in the value chain. Discerning the economic and psychological drivers behind price settling is outside the scope of this study, but presents opportunities for future work.

In Figure 6, the dyad relationships (Exporter-Trader, Trader-Collector, and Collector-Farmer) are summarized with the token Buyer-Seller terminology except where Exporters and Farmers act differently from the other middle value chain actors. Figure 7 further expands the BRC map to show how the Buyer-Seller dyads cascade, how each tier relies on QDP being offered by sellers of the higher tier, and higher quality goods being provided by actors in the lower tier.

**QDP exists in the value chain**

Our findings indicate that the reinforcing loop has been initiated but that QDP is largely informal. The traders that we interviewed observed that the quality of products is improving (see Table 3). Since we spoke only to traders who have been working with CPM and their insights were varied, it is unclear whether these results reflect the broader market system.

To a certain extent, quality-differentiated pricing is available. Quality affects how traders set prices (see Table 8), and most of the traders we interviewed offer better prices for better quality, even though not all use formal grading systems to do so (see Table 10). Furthermore, the traders we interviewed feel that they are accessing better prices because the quality of the crops they sell has improved (see Table 7). With QDP available, farmers and traders have the incentive to produce, through good agricultural and processing practices, high quality crops.

Despite the clarity brought by the relationships and enabling conditions shown in the BRC map, we return to the question, "What initiates QDP?" Why is a trader (or farmer, or village agent) willing to invest in quality
Figure 6: Quantity and Quality in the outputs subsystem
Figure 7: Expanded quality and quantity BRC map for outputs subsystem actors
before QDP is offered? Why would a trader (or village agent, or exporter) seek a buyer offering QDP before good quality goods are available? Once enabling conditions are in place, how can actors be coordinated to provide better quality and QDP simultaneously?

QDP requires a set of coordinated and interacting changes by multiple actors.

One way to initiate QDP is to strengthen relationships among actors in order to promote transactions that optimize income across the value chain, rather than each actor operating solely in self-interest. For example, traders can initiate the positive feedback cycle of change by providing information about quality-differentiated pricing to farmers, and helping farmers improve their products through training on good agricultural and processing practices. Traders will not see this as worthwhile unless they see the bigger picture: that investing in quality production at the beginning of each season will increase everyone’s incomes at harvest time. Before this can happen, traders need confidence in that bigger picture and the resources to carry it out. Throughout the value chain, sellers must have the skills, knowledge, and equipment to improve quality, while buyers must have the finances and market access to offer higher prices.

Discussion around price-setting revealed a process-oriented approach to QDP where each actor relies on the actions of other actors. For example, traders place a high importance on the prices they get from their buyers. As shown in Section 6.2, traders set prices based on export prices and proactively take ownership of the process through negotiations and competitive selling to get better prices, rather than just sitting and waiting for better prices to appear. Simultaneously, exporters must be willing to pay more, and are sometimes open to negotiations or building relationships with traders they procure goods from. On the other end, village agents and farmers must work with traders to arbitrate fair prices. In order for any actor to receive quality-differentiated prices, ostensibly all actors must be willing to offer and receive QDP; when all actors offer and receive QDP, it becomes a common phenomenon. Increasing the number of relationships among actors enables better coordination as QDP becomes further institutionalized.

Indicators of systemic changes related to QDP

As seen above, behaviors, relationships, and conditions enable QDP in a complex way. In this section, we aim to identify key aspects that should be tracked in order to see whether and how the system is changing, and how those changes relate to QDP. The key dynamics in this system revolve around quality and pricing. Of particular interest is the problem of identifying where to start: a quality-differentiated price is necessary to incentivize improvements in quality, but improvements in quality are necessary before quality-differentiated pricing is relevant. The first set of indicators investigate these dynamics directly.

- Existence of quality-differentiated pricing for farmers. Pricing that differs based on the quality of the product (whether formally or informally graded) is a necessary condition for incentivizing the improvement of product quality by farmers. This can be measured with a survey, but needs to take into account all of the methods, both informal and formal, by which traders set a price based on quality (see Table 10). For example, even if a trader does not offer two different prices for two different grades, he or she may take quality into account in setting the price.

- Existence of quality-differentiated pricing for traders. Before traders can offer quality-differentiated pricing to farmers, they need incentives for better quality from their customers. This could be measured with a survey of traders or of the major buyers in the marketplace.
• Use of formal quality grading systems. As the more formal and transparent of the methods for determining quality, use of a grading system and confirmation of prices associated with grades is a clear indicator of institutionalizing QDP and placing value on quality. This should be measured at both interfaces: farmers-to-traders and traders-to-buyers.

• Changes in available product quality. If quality-differentiated pricing is successfully incentivizing farmers to improve quality, the general quality of products available for traders and buyers to purchase should be improving. This could be measured with a survey of traders and buyers, but it would need to be designed carefully.

In addition to the key dynamics identified above, the study revealed several other factors as relevant to enabling the reinforcing loop that drives improvements in quality and pricing. These include:

• Access to and use of finance. Finance seems to be a key enabler for farmer, village agent, and trader productivity. Actors who can access and choose to use banks and loans can make better-informed business decisions and scale production and profits. An actor receiving a loan or taking advantage of a payment plan is likely to be sufficiently financially confident to engage in risk sharing activities. They can invest in activities that improve quality and, ultimately, reap the benefits of improved quality when QDP is available, contributing to the reinforcing loop described above. Indicator could include prevalence of loans and payment plans used, counts of bank accounts opened and closed by actors, and number of institutions (banks, microfinance agencies) that offer financial assistance.

• Investment in physical capital. Similarly, the purchase of equipment (silos, processing machinery, vehicles, etc.) indicates that actors have the financial capacity to invest in improving quality. Good agricultural, processing, and storage practices improve quality. These activities can be facilitated and expedited by equipment (machinery, silos, sprayers, tools). The ability to invest in equipment indicates business growth and surplus. Investments in physical capital that improve quality also show movement toward increased emphasis on the importance of quality. It is possible that this metric could be used to observe changes in perception of the importance of quality at scale.

• Use of communication technology. Communication is important for coordination of supply chains. Use of communication technology could be relatively easy to track, if farmers/traders are willing to share their internet and cellular use data (could be self-reported). Increases in ICT use may show strengthening relationships among actors, improved access to information used in making business decisions, and improved access to knowledge on good agricultural practices. While not directly an indicator of QDP, improved communication enables actors to coordinate decisions on quality and pricing.

• Trader access to markets. Access to better prices for traders seems to depend on their ability to access markets, including information and negotiation of prices across buyers, ability to export directly, etc. (see Table 8 and Table 9). Better prices for traders are, in turn, necessary for them to offer better (and quality-dependent) prices to farmers. Measuring access to markets is complex because of the variety of ways in which it is manifested, but indicators could be developed based on surveys of price-setting practices, measures of the actual prices paid compared to those available in the market, relationships among traders and buyers, or other similar concepts. A related indicator would measure whether traders are taking actions to increase their access to markets, indicating they are taking ownership of the issue.
RECOMMENDATIONS

Recommendations for future work

The qualitative methods used in this case study were effective for gaining deep insight into the experiences of six traders. From their perspective, market facilitation has led to positive changes. However, these traders are not necessarily representative of Ugandan traders. The limitations of this study dovetail with recommendations for the next steps in pursuing quality-differentiated pricing.

**Strengthen QDP through future interventions.** Our results suggest that QDP is critical to improving livelihoods, but that it is implemented informally and therefore remains underdeveloped. Future interventions should aim to strengthen the reinforcing loop of actions described above. We propose that the BRC maps and relationship maps may be useful tools for identifying intervention opportunities. The challenges and enablers listed in Section 6.3 may also provide starting points for designing new interventions.

**Explore QDP from the perspective of other actors.** This study observed QDP solely through the lens of six traders. While looking deeply at the cases of six traders provides insights into the variety of experiences and a general perspective of the relationships among actors and factors that affect quality-differentiate pricing, it is by no means comprehensive. Future studies that look at a larger number of traders may be able to use statistical analyses to evaluate trends and correlations among factors that enable QDP. The traders interviewed in this study were not representative. All six have been through CPM trainings and are continuously monitored by CPM. All six have had some level of success improving quality and seeing subsequent price increases. Interviewing traders who have not worked with CPM may paint a broader picture of the state of QDP.

While studying the middle value chain actor (traders) gives insight into both upstream and downstream actors’ experiences, interviewing exporters and farmers directly will help verify and validate the complex relationship between quality, pricing, and QDP. Additionally, exploring the experiences of producer organizations (like P1 and C3) may provide further insight into the role that groups play in decision making and pricing advocacy. Finally, understanding how the exporters? business partners and major buyers approach QDP could reveal important market-shaping behavior by significant actors in the market.

**Study QDP for domestic markets.** The traders interviewed in this study (except for C4) all sell explicitly to export markets. It is unclear whether QDP is driven by domestic markets. Further study should be initiated through engagement with significant actors in domestic food commodity markets.

**Study correlation between knowledge of a grading system and incentive for improved quality.** It is clear from this study that offering QDP creates incentive for other actors to provide better quality. A question that remains is whether the use of a transparent and formal grading systems creates more incentive for providing quality goods than the use of informal approaches like “reduce the kilograms”. Does the transparent quantification of quality create more incentive to meet standards? Does knowledge of a grading system increase a buyer’s purchasing standards?

**Requests from traders**

During interviews, traders expressed their gratitude to USAID Feed the Future for current interventions. They made several requests and suggestions for future facilitation initiatives and government interventions. Specifically, traders would like help with:
• Providing more trainings for farmers on using good agricultural practices to improve quality and quantity of crops, and building relationships with other groups that provide trainings.
• Continuing to learn good business practices.
• Connecting with more farmers, exporters, and external markets to expand business.
• Accessing finance to buy processing and storage equipment.
• Mitigating fluctuations in market prices.
• Accessing certifications for quality seed and crop providers.
• Improving transportation and telecommunication infrastructure

CONCLUSION

This subsystem study aimed to explore factors that enable quality-differentiated pricing (QDP) in the agricultural market system. Interviews with six traders of maize, beans, and coffee, revealed that quality and pricing are separate but interrelated aspects of transactions. Overall, these traders perceive that quality is improving through use of good agricultural, processing, and preservation practices, and that quality has improved as knowledge of these practices has spread. These traders also report buying and selling crops at higher prices than in the past. When buying, they set prices based on expected resale value, expected profit, and perceived quality. When selling, they negotiate with and compare prices among buyers, take actions to improve the quality of their goods, wait for market prices to change, and build reputations for having good quality. Quality-differentiated pricing exists in the market, but seems to manifest in two different ways. Some traders use a formal grading system. Others adjust the total price paid based on the expected quantity of high-quality crops in a given amount purchased. Traders also identified several challenges that must be overcome to improve the quality and prices of goods. At the most fundamental level, QDP is propagated by reinforcing feedback: when some actors offer QDP, they create incentives for other actors to improve the quality of their goods and, in turn, offer QDP. Actors who provide high-quality goods create an incentive for buyers to offer quality-differentiated prices. Throughout the value chain, sellers must have the skills, knowledge, and equipment to improve quality, while buyers must have the finances and a market to offer higher prices. The institution of QDP may be fortified by increasing the number and strength of relationships between downstream and upstream VC actors so that they can coordinate their activities to improve the quality and price of goods. Opportunities exist for facilitative interventions that promote quality-differentiated pricing throughout the supply chain.

CONTACT

The Feed the Future Uganda Market System Monitoring activity welcomes feedback. Please contact us at msm.uganda@mit.edu.
Appendix B

2016 Interview Guide on Quality-Differentiated Pricing

Introduction

- Introduce ourselves: names and affiliations. I am professor, they are students.
- Why we are here: learn about your experience with improving the quality of the products you are able to purchase and sell. Part of a research project funded by USAID.
- How this will work: Talk for one hour. First, basic background, then about buying quality products, then about selling, and finally more generally about your business and your goals. I will ask the questions, and they will take notes.
- Consent and recording: We would like to use this as part of our research on change in agricultural markets, and we would like to record the interview. Explain form. Are you willing to participate?
- Do you have any questions for me?

SECTION I: Background

1. What crops do you trade?
2. Do you work with agents and/or farmers? How many? What proportion of your purchases are from farmers vs agents?
3. How many different organizations do you sell to? Are they exporters, processors, a local market, or what else?
4. How long have you been in business?

SECTION II: Buying Now, I want to ask you about improving the quality of the products you are able to buy.

1. Are you happy with the quality you receive? How do you rate quality? Where and when is quality assessed, and by whom?
2. Do you offer a different price for higher-quality products?
   (a) How do you implement this differentiated pricing? Who does this [stage in VC]?
   (b) How do you set the price?
   (c) How do your agents and farmers know what your price is?
   (d) When are your agents and farmers paid? How are they paid?
3. You have good quality now. 5 years ago, did you have the same quality or was it worse?
4. What have you done in the last several years to ensure better quality is available to you to purchase?
   (a) What are the steps you took to encourage better quality? Prompt for all activities with farmers, then with agents, then your own [trader] activities
   (b) If needed, prompt with examples to make sure we cover: Incentives (financial, including pricing), Relationships developed, Providing information and training to farmers, Providing goods and services
(c) Did you try anything that did not work? Why did it not work? Did you figure out a way to make it work?
(d) How fast did quality improve? When did it start to improve? What changed first?
5. What were the challenges, i.e. what was difficult in doing these things?
6. Did your relationships with other actors change? How? (contracts, informal agreements, incentives, etc.)
7. How will you expand this approach to more agents/farmers? Have you already expanded beyond your initial group?
8. What resources would/did it require to expand the approach? What relationships would be required?
9. What are the challenges to expanding the approach?
10. What’s stopping you from reaching your goal? [answer] What’s stopping you from doing that?

Section III: Selling

1. Do you sell more than one quality grade, at different prices? Where and when is quality assessed, and by whom? How do you decide where to sell (e.g. how do you know what the prices are)? When are you paid? How?
2. Do you now get a better price than you did 5 years ago? What have you done to improve the price you get from exporters? Examples: working with different exporters, negotiating with exporters, attending trade fairs, accessing foreign markets
3. Have you developed any new relationships in the last few years that help with this access to better pricing?
4. What are the challenges? i.e., what makes it difficult to get good prices for your products?
5. How quickly did these steps lead to better pricing for you? What changed first? What took time? (e.g. trust developing over time)

SECTION IV: Business and Future Goals

1. How do you manage your business?
2. How do you do your finances? Do you use financial information to determine your profit, set prices, or make other business decisions?
3. How do you manage your agents and farmers? Exporters?
4. Do you employ other people? What do you look for when you hire, e.g. skills?
5. What are the key relationships enabling or blocking you from success? For example, do you have relationships with people you sell to, e.g. exporters? People you buy from, e.g. agents and farmers?
6. What are your goals for the next few years for the business?
7. What are your major challenges to overcome? What’s stopping you from reaching your goal? What’s stopping you from doing that?

Wrap-Up

• If there is time, ask for a tour
• Do you have any questions for us?
• Thank you very much for your time!
Appendix C

Preliminary Findings From Agribusiness Interviews

This memo was originally produced for USAID/Uganda Feed the Future in October, 2017. The original can be found online at http://humanitarian.mit.edu/projects/feed-the-future-uganda.

To complement survey data collected in the forthcoming Farmer Market Engagement Study, the USAID/Uganda Feed the Future Market System Monitoring Activity (MSM) completed a series of in-depth interviews with agribusinesses in Iganga District. This document presents preliminary observations based on the interviews and potential opportunities for USAID to engage with agribusinesses through its market facilitation activities. Deeper and more thorough analysis will follow with the results of the Farmer Market Engagement Study.

OVERVIEW OF METHODS

In August 2017, we completed 40 semi-structured interviews with agribusinesses in Iganga district. The objectives were to profile agribusinesses who interact with smallholder farmers and to understand their business models, sources of information, and access to finance. Using a snowball sampling approach, we targeted agribusinesses filling a variety of market system roles: brokers, traders, dealers, and processors. The interviews were conducted in the trading centers of Busembatya, Namirembe, Idudi, and Iganga Town. Five interviews were also held in villages 10-15 kilometers away from trading centers. Interviews lasted 45-90 minutes and were primarily conducted in Lusoga with the assistance of translators.

OBSERVATION 1: SMALL AGribusinesses HAVE ADOPTED FLEXIBLE BUSINESS MODELS THAT CAN FILL MULTIPLE ROLES

The interviews demonstrated that small agribusinesses cannot always easily be categorized. Many offered more than one type of product or service to the community; in other words, they played more than one role in the supply chain. Previously, using our system mapping methodology, we identified roles that businesses can play, each representing a distinct activity in the supply chain. The main roles we observed in Iganga are illustrated in Figure 1:

These roles can be loosely categorized as pre- and post-cultivation, and are described below:

- Pre-cultivation:
  - Wholesaler: produces or buys agricultural inputs and sells to Dealers
  - Dealer: buys wholesale agricultural inputs and sells retail to Farmers
- Post-cultivation:
APPENDIX C. PRELIMINARY FINDINGS FROM AGROBUSINESS INTERVIEWS

Figure 1: Roles filled by agribusinesses in Iganga District

- Collector: collects (buys) harvested crops directly from Farmers and sells to Traders
- Processor: provides value-added services to crops, usually through grain cleaning, hulling or threshing, milling, or a combination of these
- Trader: buys agricultural goods from Collectors or smaller Traders and sells to Exporters or Retailers
- Exporter: buys agricultural goods wholesale and sells to export markets
- Retailer: buys agricultural goods wholesale and sells at retail prices for consumption

Agribusiness activities often spanned several roles. For example, a business that operates a milling machine may also buy and sell grain at the wholesale level, acting as both a Processor and a Trader. Some businesses that identify as Traders also have storefronts where they sell grain at the retail level. Many of the business owners interviewed started out playing a single role in the market, usually one that required low startup capital such as using a bicycle to collect and sell grain, and then diversified to take advantage of new opportunities. Therefore, although we can describe the supply chain using these different roles, the roles do not clearly define market actors or describe their business models.

This observation has two implications for USAID market facilitation projects. First, activities that target specific types of market actors may be relevant to others who fill but do not identify with the same role. For example, trainings on crop quality standards may target Traders but also pertain to Collectors and Processors. Second, by targeting businesses that fill multiple roles, it is possible to multiply the effect of an intervention. For example, in disseminating information (elaborated upon in the next section), an agribusiness that fills many roles is likely to have relationships with multiple types of market actors, leading to a broader impact.

OBSERVATION 2: INFORMATION DISSEMINATION FOLLOWS BUSINESS RELATIONSHIPS AMONG MARKET ACTORS

One critical component of our study is to understand the types of information that are available to farmers, and the role that agribusinesses play in providing access to information. Table 1 summarizes information sources and types of information that were available to the agribusinesses we interviewed.

Approximately half of businesses had worked with a government or a development partner, including OWC, WFP, and Feed the Future, and considered them a source of information. Word of mouth was the most common way to obtain and share information with market actors. Two observations about this informal behavior have implications on information dissemination efforts.
There was financial incentive for agribusinesses to provide information to farmers and other market actors. Market actors who had repeat transactions with suppliers or customers seemed more likely to share information, especially when it benefited both actors. For example, customer-service focused Dealers instructed clients on proper use of inputs to increase yield. Similarly, Collectors and Traders recognized that they can reduce losses and increase profits by instructing farmers on improved post-harvest handling techniques, such as drying crops thoroughly and removing stones. Collectors who visited the same farmers seasonally seemed more likely to provide this information, sometimes referring farmers to successful neighbors for advice. This financial incentive should be leveraged to encourage productive behaviors.

Lateral relationships among actors playing the same role contributed to the spread of information. Some Traders relied on other Traders to learn current market prices. Some Dealers consulted other Dealers about new product offerings, input certifications, and safe use practices. Interviews offered evidence that UNADA facilitated the transfer of information among Dealers by organizing trainings (e.g., on safe use of chemicals). Larger organizations might play a role in encouraging lateral transfer of information among actors, e.g., an industry association of Traders might make information on quality-differentiated pricing more accessible.

**OBSERVATION 3: MANY ACTORS RELY ON PERSONAL CONNECTIONS FOR CREDIT, GIVEN DISTRUST OF FORMAL FINANCIAL INSTITUTIONS**

Access to finance is vital for small agribusinesses to grow, and was a recurring topic in our interviews. While nearly all business owners had access to formal financing (including physical proximity to financial institutions), very few were actually leveraging it for agricultural productivity. The following observations identify opportunities to better understand perceptions and behaviors regarding formal and informal channels for accessing finance.

Many small business owners, particularly Collectors and smaller Processors, indicated that they do not trust banks, SACCOS, and other formal financial institutions. Many who had taken out a bank loan in the past had a bad experience. The interest rates at banks were perceived to be unaffordable. Those who distrusted SACCOS and VSLAs had lost money due to poor management of the savings group. Businesses most likely to utilize formal financial institutions were larger and had capital investments. Though a number of Dealers, Processors, and Traders indicated that they purchase inventory and assets using savings, these were the only roles for which business owners spoke about utilizing loans from formal financial institutions.

Many business owners accessed credit informally through personal connections, such as from friends or family
members, where social capital is the collateral. Informal loans offered a vital pathway to credit for many small business owners. As the strength of relationships increased, the formality of agreements seemed to decrease. Only rarely were agreements written or witnessed by a third party, and only in situations where personal connections were weak.

Finally, the primary reason business owners cited for borrowing money was to pay school fees. This is an issue at the intersection of agriculture and education: school fees are expected to be paid during the growing season, the time when small businesses have the least amount of cash on hand. Payment of school fees affects agricultural productivity when farmers harvest prematurely in order to raise cash. Adjustment in the timing for school fees or introduction of payment plans could have an impact on agricultural output, and flexibility may become increasingly important as changing rainfall patterns affect the traditional harvest calendar.

ADDITIONAL OBSERVATIONS

Advertising: Radio and television advertisements for certified inputs have been effective in some areas. In fact, several dealers cited a problem where farmers who were aware of verification entities became wary of products that were not certified, even though certifications do not yet exist for many inputs. This anecdotal feedback suggested that the certification programs are generating demand for certified products among farmers, as intended.

Village Retail Agents: Several input Dealers reported that they recruit Village Retail Agents to act as local representatives and distributors. Most of these agents were selected from farmer groups in order to collect bulk orders from farmers for the input Dealer. Stories from two Dealers in Iganga Town who had used this model highlight potential pitfalls of working with such agents.

1. Training: A key agent role is to share product information directly with farmers. However, with new products and information regularly released, dealers reported that it was difficult, time consuming, and expensive to keep the agents up to date. In addition, there was a high cost to adding and training new agents, so the positions were often left unfilled.

2. Competition: Village Retail Agents enable input dealers to increase their sales in more rural areas. However, smaller input Dealers who already exist in these areas might be unable to compete. One Dealer deliberately ended their Village Retail Agent operation after realizing that smaller local Dealers (some of whom were customers) were losing business.

Quality-Differentiated Pricing: While quality is important to many actors, crop quality standards were not widely known, especially among Collectors. Because many Collectors did not differentiate their stock by quality, very few Processors and Traders offered different prices for varying quality. When the only quality options offered by collectors are 'acceptable' and 'unacceptable', Traders simply bought everything of acceptable quality at the same price. Traders who were willing to pay more for higher quality crops were undercut by Collectors who were not willing or aware of the opportunity. This phenomenon is self-reinforcing.
Appendix D
August 2017 Agribusiness Interview Guide

1. INTRODUCTION: BASIC BUSINESS INFORMATION

1.1. Name of interviewee:
1.2. Gender:
1.3. Level of education
1.4. Name of business:
1.5. Year business started:
1.6. Number of employees:
1.7. E-mail/phone or business card
1.8. Does the business have a physical location?
1.9. District: IGANGA
1.10. Village:
1.11. Coordinates:
1.12. Have you worked with any development partners? (NGOs, USAID, etc.) When? What was the content?
1.13. Have you had any engagement with government officials with regard to your business? When? What was the content?
1.14. Have you completed interviews or surveys for any of these USAID Feed the Future organizations?

2. BUSINESS MODEL:

2.1. Who are your customers (focus on farmers/types of farmers) Ex: smallholder farmers, commercial farms, cooperatives, NGOs, companies etc.
   - How many customers do you have?
   - How do you meet them? Do you advertise? How? (see section 3)
   - How often do they come back to buy from you again?
   - How do you communicate with customers? (ex: phone calls, SMS messages, e-mail, Facebook/social media)
   - Do you have contracts or formal agreements? How do you enforce them?
   - Do you trust them?

2.2. Who are your Suppliers? (focus on farmers/types of farmers) Ex: smallholder farmers, commercial farms, cooperatives, NGOs, companies etc.
   - How many suppliers do you have?
   - How do you meet them?
• How often do they come back or sell to you again?
• How do you communicate with suppliers? (ex: phone calls, SMS messages, e-mail, Facebook/social media)
• Do you have contracts or formal agreements? How do you enforce them?
• Do you trust them?

2.3. Do you have agents who work with farmers?
• Do they work exclusively for you?
• What do your agents do?
• How many agents do you have?
• Do you give your agents advance cash or inputs? For how many agents?
• Do you provide/help agents purchase bicycles, motorcycles, cell phones or other equipment? For how many agents?
• How do you recruit new ones?

3. FARMER ENGAGEMENT

3.1. What are the ways you communicate with farmers? (ex: phone calls, SMS messages, e-mail, Facebook/social media)
3.2. Do you provide any benefits to farmers you work with? (ex: discounts, product delivery, after sales follow up, trainings or product information, extension services)
3.3. How do you make agreements with farmers? (ex: contracts, cash receipts, verbal agreements)
What do you do to ensure that farmers keep their end of the bargain?
3.4. Do you help farmers develop relationships with other farmers? How?
3.5. Do you help farmers develop relationships with other market actors/businesses/service providers? ?

4. PRIMARY BUSINESS ACTIVITIES

4.1. What do you buy or sell? What services do you provide? How did you choose those products/services?
• Sell agricultural inputs [Wholesale, Retail]
• Buy produce [Wholesale, Retail]
• Sell produce [Wholesale, Retail]
• Involved in an outgrower arrangement/contract farming
• Pre-production services: Rent out equipment, Lease land or help farmers access land, Digital profiling services, Seed multiplication, Soil testing, Tilling/Plowing
• Production services: Planting, Irrigation, Weeding, Spraying, Pruning (coffee), Harvesting
• Post-Harvest Handling: Drying, Storage services/sell improved storage equipment, Packaging
• Transportation
• Bulking/aggregating
• Marketing services
• Processing: Shelling/threshing/hulling, Milling, Grain cleaning
• Provide trainings for a fee
• Other

4.2. Transportation

• Where do products come from? How do you get them?
• How do you deliver products/services to customers?
• Who pays for transportation?

4.3. Inventory Management: Do you keep inventory or sales records? How do you decide when/how much to buy? Do you ever run out?

4.4. Do you have other locations? (List quantity and locations)

4.5. Are you planning to open new locations? Where?

4.6. Do you have any certifications? What for?

4.7. Business registration: Is your business registered?

4.8. Do you know your sub-county chief?

4.9. Do you know your agricultural extension worker?

5. INFORMATION

5.1. What kind of information do you receive that is crucial to running your business? Where do you get it from?

5.2. Did you get any training/help on how to run your business? What was the nature of the training? From whom? When?

5.3. What kind of agricultural related information does the government provide? How do you access this information?

5.4. Do you provide information on any of the following topics to customers or suppliers?

• Prices for inputs and crops
• Weather/climate information
• Local and national ordinances (Seed and input standards, Crop quality standards)
• Business registration and management
• Opportunities for government engagement

5.5. Do you offer information/trainings/extension on any of the following topics? To whom? Who does the trainings?

• Product knowledge: Genuine input awareness, Safe use of chemicals and herbicides
• Business Practices: Record keeping for inventory/sales, Farming as a family business, Leadership, Entrepreneurship, Business Plan development, Literacy, Numeracy, Marketing, Pricing, Business registration
• Financial management practices: Bookkeeping, Saving, e-payments, Credit access, Insurance
• Post-harvest handling and production practices: Harvesting, Post-harvest handling techniques, Grading, Quality control?
6. COST STRUCTURE AND REVENUE STREAMS

6.1. How do you set prices?
6.1. Does your business use mobile money?
6.2. Receiving Payment
   • How are you paid? (ex: cash, mobile money, credit, in-kind)
   • Are you paid in full or in part?
   • What is the timing of the payment? (advance, at time of transaction, over time, end of season)
6.3. Do you provide credit/financing or other financial services to your customers?
   • Credit/loans/cash advances
   • Crop insurance inspection services
   • Digital financial services (Mobile Money, Other e-payment, Other DFS)
   • Auditing
   • Bookkeeping assistance
6.4. Paying
   • How do you pay suppliers? (ex: cash, mobile money, credit, in-kind)
   • Do you pay in full or in part?
   • What is the timing of the payment? (advance, at time of transaction, over time, end of season)
   • Do you receive credit or financing from partners?
6.5. Is there a bank or MFI where you could get a loan if you wanted one?
6.6. Do you belong to a VSLA or a SACCO?
6.7. Have you received any type of credit, financing, or loan from a financial institution in the past year? If so, What for? From whom?
6.8. There must be times of year when cash flow is tight? how do you manage that?
6.9. Do you have insurance? What have you insured?

7. ADDITIONAL QUESTIONS (IF TIME ALLOWS)

7.1. Why did you decide to start this business?
7.2. How did you initiate it?
7.3. What do you do differently to gain an advantage over the competition? What is your niche?
7.4. Is this a family business? What percentage of your income comes from this business?
Appendix E

Market System Monitoring Activity Maps

Text and images in this appendix are borrowed from the release notes that accompany the Market System Monitoring Activity’s maps. The Market System Monitoring team proposes two types of system maps as a starting point: a supply chain role (SCR) map and a behaviors-relationships-conditions (BRC) map. The original release notes and more readable versions of the maps can be found online at http://humanitarian.mit.edu/projects/feed-the-future-uganda.

E.1 Supply Chain Role Map

The SCR mapping approach could be applied to mapping any supply chain system where it is beneficial to depict different types of flows and roles. MSM’s map may be modified, or new maps drawn for application in other contexts.

Often supply chain maps concentrate on specific actors in a value chain. Based on observations that specific actors can play several roles in agricultural value chains, the SCR map focuses on the key roles in the value chain and the material, financial, and service provision flows that connect them. This effort enables characterization of actors’ activities and helps to visualize and simplify complex relationships across the value chain.

To begin using this type of map, depict roles in a value chain (for example, sequencing by time or phase). Then think about other roles that will be necessary to depict, and categorize them by type if necessary. Drawing black arrows to represent product or material first is recommended, followed by other types of arrows. Material and financial flows represent transactions; this may be enough, or one may want to add another type. One could delete these and/or add other types of arrows, such as actors or signals that contain a specific type of information. We use de facto swim lanes in our SCR map for roles that transform products (e.g., manufacturing, milling), move products, and provide services. Drawing swim lanes on a map may be the right approach if there is value in explicitly categorizing actors by type. If it is beneficial to present types of roles along one swim lane, one may depict these in another color or shape. If the type of role is relatively unimportant with regard to other map content, perhaps swim lanes are not useful. If swim lanes are useful and stage of process is also important, one could introduce vertical swim lanes to depict supply chain phase.

There are as many interpretations of a market system as there are people analyzing it. The SCR is useful as an introduction into an existing analysis of a value chain. It aligns participants considering a value chain on a common terminology and scope of the value chain analysis. This ensures that knowledge is easily transferable and exchangeable.

In presenting this type of map, we suggest first presenting the core supply chain or set of processes, then adding roles or boxes throughout the discussion. It can also be helpful to introduce one type of arrow at a time. If one portion of this map is of particular interest, one may choose to focus on this without losing the rest of the system’s content with clouds on either side.
The resulting SCR map clearly communicates the roles and linkages of interest to your analysis and supports the terminology and methodology to be used in further discussions.

This SCR map highlights the roles in the value chains for maize, beans, and coffee in Uganda. In these value chains actors play multiple roles, actors are called by different names, and overlapping definitions exist for common actors. By focusing on the flows between the roles, the SCR map allows for discussion of all the types of roles that actors play in the value chain.

To capture the interactions on the map, we use different arrows for these flows from one role player to another.

- **Material**: movement of raw materials, inputs, processed products, and finished goods along the value chain.
- **Financial**: both flows of cash to pay for goods and services or financial products that enable investment.
- **Service Provision**: tasks performed along a value chain to increase knowledge, quality/quantity of finished goods, or to enable investment. Often these tasks are performed in exchange for compensation. These types of flows are used to connect the roles played along the value chain.

Roles in value chain (see Figure 4):

- **Transformation of products**
  - Manufacturer: a company or person that creates goods for sale (e.g. producing seeds, making equipment).
  - Processor: a company or person that transforms agricultural commodities for consumption (e.g. grain milling or packaging).
- **Movement of products**
  - Importer: a company or person that imports finished goods for sale.
  - Wholesaler: a company or person that sells agricultural inputs to other businesses.
  - Dealer: a company or person that sells agricultural inputs to farmers.
  - Collector: a person or group of people that buy agricultural goods directly from farmers.
  - Farmer: a person or group of people who own or manage farms.
  - Trader: a company or person that buys agricultural goods from collectors, but not farmers.

- **Service Provision**
  - Certification: an entity, either governmental or non-governmental, that evaluates if goods (e.g. seeds) or individuals (e.g. dealers) are recognized as meeting certain predetermined standards.
  - Extension: a provider of agricultural information and expertise (e.g. DLG extension agents or input dealers).
  - Production: a provider of pre-harvest production services (e.g. planting, weeding, or spraying).
  - Marketing: a provider of post-harvest marketing services (e.g. drying, sorting, or storage).
  - Financial: an entity such as banks, VLSAs, SACCOS,
producer organizations, collectors, traders, or dealers that provides or facilitates financing.

The farmer is centered in the map at the boundary between the input and output sides of the value chain. Inputs flow from the left to right. After harvest, product continues to flow to the right from the farmer to markets. Roles that transform goods are located above the main product flow. Service providers are below the product flow and are connected with service and financial arrows. The financial service provider is of note as it shows a connection to a cloud. If every financial service linkage was shown on this map, the map would be unreadable. These linkages are shown using the "business entity" cloud to represent the many linkages present and still capture the importance of financial service provision.

The SCR map brings clarity around the roles of actors in the value chain. In a value chain as complex as this, there are numerous business models in which actors participate. As an example, Village Agents (VAs) are actors in the value chain that buy crops from farmers. This is represented as "collector" on the SCR map. A VA can also offer privatized, mobile extension services and provide financing or other services to farmers. These additional roles taken on by the VA are represented by the various "service providers" on the SCR map. If a VA also sells agricultural inputs to farmers, a role also undertaken by stockists and agrodealers, they assume the role of a "dealer" on the SCR map. This results in the ability to describe an actor, not just with a name that could entail various roles and business models, but by exactly the roles that they fill. For example, a VA could act as a "collector-dealer" or a "collector-production service provider".

In another example, the term agrodealer can encompass several different business models. An agrodealer in a town center may act as both a "wholesaler" and a "dealer". In the countryside, agrodealers, also known as stockists or retailers, may only sell to farmers as a "dealer". Separating these roles enables the SCR map to capture ways importers and manufacturers may market direct to "dealers" in the countryside thereby bypassing "wholesalers".

E.2 Behaviors, Relationships, and Conditions Map

The BRC map depicts key concepts in market systems, including behavior changes by actors, relationship changes among actors, and enabling conditions. This map connects key concepts to each other by showing what enables what, without claiming causality. In other words, an arrow from A to B indicates that A enables B, even if A may not cause B.

The framework used for the BRC map is depicted in Figure 6. This is based on a theory that facilitative interventions by activities enable existence of conditions within the market system that further enable behavior changes by and relationships among actors. When behavior and relationship changes occur together at some scale, system level results are affected that result in project impact. Feedback arrows exist from system level results to relationship and behavior changes, as well as to conditions. A feedback arrow also exists from relationships and behavior changes to conditions. Feedback means that the enabling can occur in either direction.

The next figure demonstrates how the above framework becomes a map. Magenta circles represent relationships, blue squares represent behavior changes, items in black letters with no shape outline are enabling conditions, and green ovals represent interventions by activities. In this case, an intervention enables two conditions, each of which in turn enables a behavior change. In addition, a relationship between actors enables a behavior change of one actor to affect the behavior of the other.

An example of the above mapping approach is shown in Figure 8. A rolex is a food item sold on the street
Figure 2: BRC map framework

Figure 3: Translating BRC framework into a map
in Uganda. Different vendors use different types of packaging. Starting at the top of the map, a relationship between a newspaper and a rolex vendor enables a condition: a newspaper is less expensive than a plastic bag. This, along with no customer preference for the type of bag, enables a behavior change: the rolex vendor uses fewer plastic bags. The cloud enabling this behavior change represents many other things going on in the market system that also enable the behavior change.

![Figure 4: Rolex Example](image)

Next we consider an example from the BRC map? starting with the desired behavior of ?Farmers buying quality inputs? there are two enabling conditions. Both ?4A retail input markets? and ?Farmer sees value in quality inputs? enable farmers to buy quality inputs, but they are not the end of the story (see Figure 9).

Finally, in Figure 12, we draw subsystem boundaries around related behaviors and conditions. The boundaries of these subsystems are not hard or fixed and can overlap each other. It is important to remember that these boundaries do not change the relationships in the map, but only serve to group items and facilitate discussion.

The BRC map has many potential uses. A BRC map is generally useful whenever a complex and dynamic (changing) system must be depicted. It is particularly designed to enable visualization of ?pathways? by which changes can be enabled or blocked. Such visualization would be useful in many situations, such as:

? Capturing an understanding of a changing system; ? Connecting multiple theories about change, such as results chains, to see their interactions and/or conflicts; ? Coordinating activities with multiple stakeholders who can point to where they fit in the larger system, identify who is doing what where, etc.; ? Identifying gaps and designing interventions: areas where no one is working but change leverage appears to be strong, for example; and ? Identifying useful ?measurement points? in the system that could be tracked as indicators.

The map may be modified, or an entirely new map created for a different context, using this mapping framework and its mechanisms for representation of system features. If changes, such as intervention in a system, create conditions to enable changes in behavior or relationships, then further map creation may be applied using the approach outlined in this release.
Figure 5: Enabling conditions and relationships for “farmer sees value in quality inputs”

Figure 6: Subsystem delineations
It may be helpful to begin mapping by identifying an important behavior change; then, ask the question, “What enables this behavior change?” Remember arrows mean “A” enables “B”, and not causes, or affects. Stated differently, arrows mean “A” is necessary for “B”, but perhaps not sufficient (i.e. a system must have “A” if it is to have “B”, but “B” may require more than “A”). Behavior changes should contain a verb, and enabling conditions should be a noun. To continue building out the map, for each new element added, ask the question “What enables this?” For example, if “availability of affordable inputs” is an enabling condition, one may want to think about what conditions enable affordability. Any one of these features (behaviors changes, relationships, conditions) can enable any other feature (i.e. there are no rules for what enables what).

Drawing a boundary around the system map can be difficult. A mapmaker should consider all the behavior changes she has depicted, and ask whether or not these are all she cares about. The same question may be asked about conditions and relationships. The same question can be asked in terms of subsystems: “Have all the necessary subsystems been captured in sufficient detail?” In order to keep the map manageable as possible, one should not add features to the map that are not necessary. Clouds may be used to depict a boundary: clouds indicate that there is more going on here? even though it is not included on the map.

One could even expand the mapping framework. It may be necessary to make distinctions among types of market conditions: for example, distinction between macro- or micro-conditions, or between conditions representing technology, policy, training or finance. Distinction could be made with different colors.

It may be useful, especially when presenting the map, to highlight specific pathways to behavior changes or relationships. This could be done by walking through the chain of behaviors, relationships and conditions individually, using a circle to encompass the chain or highlighting them with different font attributes. If a subsystem is of particular importance, one may depict it alone without sacrificing other important content in the map by using clouds as the boundary.

Other examples of modification may be deletion of one feature or addition of another: for example, if relationships between actors are unimportant, but an enabling information technology system or policy is very important to depict. These could be depicted in different shapes and colors. If enabling arrows are still very appropriate, but another type of arrow such as information flow is important, it could be added to this type of map.

The complete BRC map shown in Figure 14 is large and dense, reflecting the broad and complex market system it represents. It is best viewed when printed on a large paper size. Below we provide narrative to navigate through the subsystems.

Input Subsystem: The input subsystem describes four supplier behavior changes and one private sector behavior change. Suppliers in the BRC map are an aggregate term comprised of the roles of manufacturer, importer and wholesaler. This simplification is used to reduce complexity and concentrate on key behaviors and relations. The first two supplier behaviors are related to e-verification and quality inputs. The second two concern the use of good business practices (GBP). Both of these enable 4A wholesale input markets. 4A is the condition that states inputs are acceptable, available in the market, accessible, and affordable. In addition, there are two enabling conditions and a behavior change: incentive to produce agricultural technology marketing of technology to farmers and private sector produces technology. These enable 4A retail input markets that farmers access.

Seed Subsystem: Some of the market conditions in this subsystem are enabled by interventions of the FTF-VC activity AgInputs. Conditions enabled by AgInputs include AgVerify and e-verification. Since the behavior changes in this subsystem are relevant to production of quality seed and verification of quality, it should follow that these three structures enable the subsystem’s conditions. These behavior changes then enable other conditions or behavior changes. For example, AgInputs is enabling the existence of AgVerify Limited, which is necessary (but not
Figure 7: Behaviors-relationships-conditions map
sufficient) for seed companies to sign up for AgVerify. This behavior change enables another: seed companies produce quality seed. Seed companies producing quality seed enables 4A wholesale markets in the distribution subsystem.

**Commodity Distribution Subsystem:** The distribution subsystem contains six behavior changes, four of which are relevant to dealer business practices, and two relevant to the sale of quality inputs. 4A wholesale markets enable the sale of quality inputs. The remaining three enabling conditions concern compliance with regulations and the fact that compliant dealers that use GBP succeed in the market while others that do not will exit the market. The other enabling arrows come from the input, seed, finance, regulatory, and extension subsystems. For example, the enforcement of regulations is necessary for there to be certified dealers.

**Financial Subsystem:** In the financial subsystem, we see AgInputs and CPM interventions. An activity may intervene to enable one or several market conditions in a subsystem. CPM enables the existence of entrepreneurship training, incentives to keep business records and e-wallet ownership. An incentive to keep business records, leads to the use of financial management that enables the financing of farmers.

**Farmer Practices Subsystem:** This subsystem is surrounded by the others. Smallholder farmer behavior is important to the system. Facilitative market intervention indicates we are intervening to enable conditions surrounding the farmer. Activities do not directly enable any conditions, behavior changes or relationships inside this subsystem. The behavior changes here deal with good agricultural practices (GAP), good marketing practices (GMP), or the market for agricultural commodities. Most of the enabling conditions on the left side deal with inputs, and they are enabled by the input or distribution subsystems. The conditions on the right side deal with market incentives and access to market information; these are enabled by the output subsystem.

**Output Subsystem:** The output subsystem contains many of the three elements of our map: behavior changes, relationships and enabling conditions. It also contains a cloud: this cloud contains everything else going on in the system that is currently outside of our boundary. Trust is very meaningful in this subsystem.

**Processing Subsystem:** In the processing subsystem, we have only one of each behavior change, condition and intervention. CPM is creating incentive to produce value added agricultural commodities, and this enables the behavior change where the private sector produces value-added commodities. An enabling arrow, married women pursue agriculture, connects to this behavior change from the human resources subsystem.

**Services Subsystem:** The services subsystem contains behavior changes that enable the delivery of services to farmers. These changes are enabled by many connections from outside the services subsystem. For example, the recognition of quality and incentive to grow quantity conditions found in the output subsystem enable the facilitation of service provision. The farmer practices subsystem enables service delivery by supporting the demand for services condition. Additional connections outside this subsystem are to the human resources subsystem where training in services enables skills and competencies and youth pursue work in agriculture enables service providers to deliver professional services to farmers.

**Regulatory Subsystem:** The regulatory system also has many behavior changes and conditions, with one relationship. It is highly connected to the seed subsystem. EEA is enabling many of these conditions. For example, EEA works with the Ministry of Agriculture to support seed policy strategy, which enables trust between EEA and the government of Uganda. This relationship enables something else: government consults EEA for seed policy is a behavior change, which enables another: government invests resources in seed certification program. The relationship between government and EEA does not enable either of these behavior changes, but it does enable the “enabling.”

**Extension Subsystem:** The extension subsystem contains mostly behavior changes, around traders and agents
primarily. The private sector is also important. This behavior change enables one in the final subsystem: human resources.

**Human Resources Subsystem:** The Human resources subsystem concerns three areas: interest in agriculture work, skills and competencies, and business models. All three of these areas feed into the behavior change where individuals choose to pursue agricultural work. From there two behavior changes further characterize the choice of work into a choice by youth / single women or married women. This distinguishes which group?s choice to work enables other parts of the map as they often choose different kinds of agricultural work.

**System Indicators:** Near the human resources subsystem is the condition ?Higher household income?. We placed this indicator on the map to serve as an example of how system indicators can be incorporated into a BRC map. It is enabled by the condition ?farmers able to provide increased quantity? and the behavior changes ?Youth and single women pursue agriculture? and ?Married women pursue agriculture?. This can be measured and its enabling behaviors, relationships, and conditions can be mapped.

**Practices:** To capture a set of practices common to multiple roles in the BRC map, a set of practices and their enabling conditions were summarized at the top right of the map. This simplifies the map by not repeating practices in each place they occur in the map.