

Digitizing Value Chain Finance for Smallholder Farmers

Agricultural value chains play an important role in providing financial services that help to reduce risk, improve crop yields, manage liquidity, and transact with markets. But for many of the world's smallholder farming households (smallholders), value chain financing remains either inadequate or entirely out of reach. In most markets, value chain financing arrangements are typically accessible only to smallholders who have very tight connections to value chains, such as a contract with a buyer. And even then, available services are often limited to one product (credit) for one purpose (inputs).

As agriculture and financial services move into the digital age, new technologies are emerging with the potential to extend the reach and product diversity of value chain finance to smallholders. From commitment savings accounts for inputs to receivables financing and warehouse receipts, the increasing prevalence of mobile devices is helping to unlock a range of new financial products and services that go beyond the traditional offerings available to participants in value chains. And while much of the innovation in this space focuses on smallholders with existing connections to buyers, digital technology is increasingly enabling outreach to smallholders who have only loose connections to value chains and who have until recently been largely excluded from the benefits of value chain financing.

However, the potential of technology to address financial needs along the value chain has yet to be fully realized. In some cases, the benefits of digital financial solutions flow largely to actors further downstream, such as traders and processors. In other cases, poor infrastructure and a nascent digital ecosystem, among other factors, make it difficult to provide and use digital services in rural areas.

Still, as more and more players begin to create and adopt digital tools to facilitate access to financial services along agricultural value chains, this trend has the potential to overcome some key constraints to smallholder families' agricultural livelihoods. This Focus Note aims to identify, analyze, and formulate potential development paths of efforts to digitize agricultural value chain finance.

We begin with an overview of value chain finance and the role of digital tools. Then we present three broad use cases for digital financial services (DFS) along value chains: overcoming barriers to providing financial services, improving the efficiency of financial transactions, and improving market opportunities. The paper also highlights the types of financial products and services that digital solutions enable and cites examples of models currently being implemented. It also analyzes the costs, benefits, and opportunities of various approaches to digitization, in an effort to help readers identify situations where digital tools can help solve key pain points along the value chain. The Focus Note concludes with a look toward the future of digital finance in agricultural value chains, and where promising opportunities for innovation lie.

The Role of DFS in Value Chains

As population growth, urbanization, and rising incomes continue to drive increased demand for agricultural commodities,¹ smallholder agricultural production can play an important role in supplying the world's food. Already, the Food and Agriculture Organization (FAO) of the United Nations estimates that smallholder farmers account for at least 70 percent of global food production (Maass Wolfenson 2012), and many agribusinesses have turned to smallholders as

¹ The Food and Agriculture Organization estimates that by 2050, the world's population will be 9.1 billion, with almost all growth occurring in developing countries. Urbanization will increase dramatically to 70 percent of the world's population, and income levels will be many multiples of what they are now. Feeding this population will require an estimated 70 percent increase in food production (FAO 2009).

suppliers in an effort to exploit newly emerging market opportunities (Carroll et al. 2012). Yet, despite the potential of smallholder producers, pain points along the value chain remain a significant obstacle to smallholders who are working to increase the quantity and quality of their yields and to channel their production to markets (see Figure 1).

To overcome some of these pain points, farmers and other value chain actors have traditionally looked to a category of financial services known as value chain finance. Defined as financial services that flow to or through any point in a value chain,

value chain finance plays an important role in providing actors with the working capital or investment financing necessary to improve returns and enhance the growth and competitiveness of the chain (Miller and Jones 2010). For example, savings and credit products can help smallholders invest in the inputs they need to improve quality and yields. In turn, insurance can reduce the risk of making these important investments. More efficient payments can also lower the costs and risks of distributing cash in rural areas. And post-harvest financing can reduce side-selling and allow smallholders to seek the best market opportunities available.²

Figure 1. Example of Pain Points along Agricultural Value Chains

| PRODUCTION | POST-HARVEST |
|--|---|
| <p>Smallholders</p> <ul style="list-style-type: none"> -Cannot access financing for high-quality inputs or working capital -Risk of crop losses hinders investments in productivity -Lack market opportunities needed to generate return | <p>Smallholders</p> <ul style="list-style-type: none"> -Lack of access to markets for crops -Liquidity constraints force smallholders to sell immediately after harvest when prices are lowest |
| <p>Input suppliers</p> <ul style="list-style-type: none"> -Many farmers cannot afford high-quality inputs -Unpredictable purchases by geographically dispersed farmers -Hard to finance farmers directly due to capital requirements | <p>Buyers</p> <ul style="list-style-type: none"> -Lack funds to pay smallholders quickly, leading to side-selling -High cost and risk of paying smallholders in cash -High cost of transportation to reach dispersed smallholders |
| <p>Buyers</p> <ul style="list-style-type: none"> -Struggle to ensure reliable supply of quality crops -Hard to finance farmers directly due to capital requirements, risk of side-selling | <p>Financial services providers</p> <ul style="list-style-type: none"> -Lack of reliable warehouse facilities prevents use of crops as loan collateral -Poor record-keeping makes it difficult to offer invoice discounting to buyers -High cost of serving geographically dispersed smallholders |
| <p>Financial services providers</p> <ul style="list-style-type: none"> -Hard to assess risk of financing farmers, lack of collateral -High cost of serving geographically dispersed smallholders | |

² Side-selling refers to a farmer who has a contractual relationship with a buyer instead selling his or her crops to a third-party in violation of the contract agreement with the buyer. It could also refer to farmers who have received inputs like seeds or fertilizer from a buyer with the expectation that repayment would be deducted from crop deliveries to the buyer, but who instead sell to a third party.

Given these clear use cases, value chains represent an ideal entry point for financial services for smallholders. However, financial services providers (FSPs) face constraints when attempting to engage with value chain actors. Lack of formal contracts, credit histories, production records, reliable storage facilities, and weather information services make it difficult to assess risk when making credit decisions. Moreover, with many smallholders geographically dispersed across vast rural areas, the cost of offering any financial product, including low-balance savings and insurance, is often simply too high.

In the absence of the formal financial sector, value chain actors have emerged as important providers of informal value chain finance. These actors (e.g., off-takers, input suppliers) have an intimate knowledge of smallholders in their value chain, and have an incentive to provide financial services that enable their suppliers to deliver consistent quality and quantity. Therefore, they may offer short-term financing for inputs, working capital, or advance payments for crop deliveries. However, these value chain actors also face constraints in providing adequate financial services. The cost of capital required to issue loans, side-selling by suppliers, and their own inability to access financing make

it difficult to provide credit on a large scale (see Figure 1). Furthermore, unlike formal FSPs, value chain actors typically do not provide financial services beyond credit, such as savings, insurance, and payments (FAO 2016).

Participating in value chains is in itself a challenge for many smallholders. Of the world's approximately 500 million smallholder households, an estimated 7 percent are tightly connected to value chains, 33 percent are only loosely connected to value chains, and 60 percent are noncommercial (see Box 1) (Christen and Anderson 2013). Without tight connections to value chains, smallholders are less likely to access informal value chain finance from buyers or input suppliers. They are also less likely to access financial services from formal financial institutions, which in many cases rely on value chain actors to reduce the risk of lending and act as aggregators and access points for products like savings, insurance, and payments.

If value chain finance is to truly make a dent in the number of smallholders without access to financial services, it is important to explore innovations that expand the reach of value chains themselves. This will require products and services that go beyond

Box 1. Segmenting Smallholders: Connections to Value Chains and Financial Access

Only a small minority (just 7 percent) of smallholders are estimated to be engaged in what CGAP refers to as "tight" value chain relationships, in which smallholders have a predetermined buyer for their agricultural outputs. While commercial smallholders in tight value chains are more likely to receive financing from buyers of their crops or leverage value chain relationships to access services from financial institutions, noncommercial smallholders and smallholders in loose value chains may have little to no opportunities to access financial services.

An appreciation of how smallholders engage with agricultural value chains is key to understanding their need for financial products and services in general, and value chain finance in particular. To that end, in 2013 CGAP proposed, based on a global desk review, that smallholders could be clustered into three broad segments depending on what they grow, how they engage with markets as buyers/sellers, and how those markets are organized (Christen and Anderson 2013):

- **Noncommercial smallholders (~300 million).** These smallholders are generally considered to

be subsistence farmers who are not linked to any structured value chains. They have few financial tools available to them, mostly informal mechanisms such as savings groups.

- **Commercial smallholders in loose value chains (~165 million).** These farmers have a surplus to sell in informal local or regional markets. They might have a relationship with one or more buyers and relationships in value chains, but they are not in a position to sell under contract and are more likely to engage in side-selling. This segment might have limited access to formal financial services, such as loans from microfinance institutions (MFIs).
- **Commercial smallholders in tight value chains (~35 million).** These smallholders produce enough quality and quantity to sell in structured value chains with clearly defined buyers. They are likely to have access to a greater variety of financial tools, including formal financial services and financing available through buyers and processors.

just finance to address the obstacles that prevent smallholders from accessing value chains in the first place, such as inconsistent quality and yields, poor storage infrastructure, inadequate transportation, and more.

Digital innovations offer an unprecedented opportunity to address many of the pain points faced by value chain actors and FSPs by reducing information asymmetries and transaction costs. For example, aggregation and analysis of digital data related to sales, payments, and seasonality of cash flows among value chain actors promise to overcome barriers to providing credit not only to smallholders, but also to traders, processors, and retailers. Additionally, branchless banking and the rise of mobile devices are making payments to and from smallholders more efficient, while reducing barriers to collecting deposits and offering affordable insurance products. Finally, connecting isolated smallholders to markets is becoming increasingly possible through new technologies that help them to aggregate their production and to develop commercial relationships with distant buyers.

While DFS include a broader set of technologies than just mobile phones, a rise in mobile connectivity among smallholders points to the increasing feasibility of digital approaches to value chain finance. For example, the 2016 CGAP National Survey and Segmentation of Smallholder Households in Tanzania found that 80 percent of smallholders in the country owned a mobile phone, and 49 percent had a mobile money account (Anderson et al. 2016). GSMA (2016) also notes that out of more than 750 million farmers in 69 selected countries, an estimated 295 million have a mobile phone and around 13 million have a phone and mobile money account. Interestingly, each study finds that, despite high rates of phone ownership, a much smaller share actually use DFS such as mobile money.

Digitizing value chain finance, when properly executed, could offer a compelling use case for

smallholders who have thus far been slow to adopt DFS. Furthermore, it represents a sizeable business opportunity for providers who wish to expand into new markets. Not only can digital tools help to deliver financial services more efficiently to smallholders already engaged in value chains, but they also have the potential to expand the reach of value chains themselves, and by extension the impact of value chain finance.

Recognizing this opportunity, this Focus Note seeks to identify digital innovations in value chain finance that provide the speed, security, transparency, and cost efficiency needed to promote financial inclusion of smallholders at scale. The focal point is on disruptive technology that is changing or has the potential to significantly change the availability and accessibility of financial services for smallholder farmers.

Emerging Approaches in Digital Value Chain Finance

With the advent of new technological innovations, a growing number of initiatives are changing how value chain finance can reach smallholders. Although digital value chain finance (DVCF) is still in its infancy, valuable insights are nonetheless emerging from this constantly evolving space.³ Moreover, there are clear patterns in how digital tools are being integrated into value chain finance. In particular, there are three broad use cases for digital tools in value chain finance for smallholders:

- Improving the efficiency of financial transactions.
- Overcoming barriers to providing financial services.
- Improving market opportunities.

For each use case, the following sections look at the financial products and services being digitized and provide examples of emerging models for implementing DVCF solutions. Each model is, in turn, analyzed with an eye toward the benefits, challenges, and opportunities they present for driving financial inclusion of smallholder farmers (see Table 1).

³ The analysis of the examples in DVCF included in this Focus Note comes primarily from a literature review and phone and in-person interviews.

Table 1. Overview of Approaches to Digitizing Value Chain Finance

| Use Case | Product Type | Key Pain Points Addressed | Role of Digital |
|---|---|--|--|
| Improving the Efficiency of Transactions | Digital Bulk Payments | Post-harvest: Buyers face high cost and risk when paying smallholders in cash | Reduces need for buyers to deliver and disburse cash in rural areas |
| | Digital Loan Disbursements and Repayments | Production and post-harvest: High cost to FSPs of serving geographically dispersed smallholders | Reduces need to establish branches or send loan officers to remote areas to disburse funds or collect repayments |
| Overcoming Barriers to Providing Financial Services | Digital Savings for Inputs | Production: Smallholders cannot access financing for high-quality inputs | <ul style="list-style-type: none"> • Reduces need for branches or staff in remote areas to collect savings • Allows for flexible payments • Aggregates demand for inputs |
| | Digital Agricultural Insurance | Production: Risk of crop losses hinders smallholder investments in productivity | Digital premium payments, automated monitoring of losses and payouts to mobile wallet reduce cost of providing insurance |
| | Digital Credit | Production: Smallholders cannot access financing for high-quality inputs or working capital | <ul style="list-style-type: none"> • Reduces need to establish branches or send loan officers to rural areas • Uses data to make lending decisions for smallholders lacking credit history • Speeds up decisions and disbursement |
| Improving Market Opportunities | Digital Trading Platforms | Post-harvest: Smallholders lack access to markets for crops | <ul style="list-style-type: none"> • Connects buyers and farmers to offer new, more transparent market opportunities • Aggregates farmer production to reduce procurement cost, maximize sale price |
| | Digital Invoice Discounting | Post-harvest: Buyers lack funds to pay smallholders quickly, leading to side-selling | <ul style="list-style-type: none"> • Uses data on production records to secure receivables financing for farmers • Allows payment to be made to farmer wallet/account upon delivery |
| | Digital Warehouse Receipts | Post-harvest: Liquidity constraints force smallholders to sell immediately after harvest when prices are lowest | <ul style="list-style-type: none"> • Digitized information on quantity/quality of stored crops used to determine value • Digital receipts representing value of stored crops used to secure financing |

Improving the efficiency of financial transactions

Financial transactions flowing through agricultural value chains, such as payments to and from farmers, traders, processors, or exporters for goods and services or loan disbursements and repayments, remain overwhelmingly cash-based. The process of handling, delivering, and collecting cash in rural areas is both slow and expensive; it is also subject to risks such as theft and loss. Digital payments that leverage services like mobile money promise

to reduce the costs and risks involved in cash-based transactions, while also generating a data trail on cash flows that can be used to assess credit risk. Approaches to digitizing payments along value chains include two prevailing product applications: digital bulk payments to suppliers, and digital loan disbursements and repayments (see Table 2).

Digital bulk payments

Bulk cash payments to a large number of farmers spread across remote, hard-to-reach areas is challenging. Because of this, many initiatives see

Table 2. Improving the Efficiency of Financial Transactions

| Product Type | Key Pain Points Addressed | Role of Digital |
|---|---|--|
| Digital Bulk Payments | Post-harvest: Buyers face high cost and risk when paying smallholders in cash | Reduces need for buyers to deliver and disburse cash in rural areas |
| Digital Loan Disbursements and Repayments | Production and post-harvest: High cost to FSPs of serving geographically dispersed smallholders | Reduces need to establish branches or send loan officers to remote areas to disburse funds or collect repayments |

digitizing payments from buyers to smallholder suppliers within value chains as a good starting point (see Box 2). According to GSMA, in 2016 there was an estimated US\$316 billion in cash payments from agricultural buyers that could have been shifted to digital channels—mobile money in particular. By 2020 this amount is expected to grow to US\$394 billion (GSMA 2016).

Mobile payments represent a compelling value proposition to buyers of agricultural commodities, who can shift the burden of payouts and cash-in-transit—which represent an important share of their operation costs—to mobile money services. This is the case for the Ghana Agricultural Development Company (GADCO), which determined that mobile payments were a financially efficient approach that could be integrated into its operations. Financial institutions, mobile network operators (MNOs), and others that provide digital payment services also have an interest in channeling these payments through their networks because of the fee revenue they generate from cash-out transactions. Furthermore, smallholder farmers are a mostly untapped market for banks and MNOs, and mobile payments have the potential to increase access and use of their services in this large market segment.⁴ Digitizing bulk payments provides significant benefits to smallholders as well by allowing them to receive their funds faster and more securely. Farmers often have to wait weeks for their payments or they have to travel far to receive them, contributing significantly to the transaction costs they face. With digital payment services, farmers can decide when and where to cash out their funds; this prevents the potential risk of theft from people who might find out when farmers are

getting paid. Additionally, when farmers receive payments digitally, they have the option to safely set aside some of those funds as a balance in their mobile wallet or linked savings account.

Still, without an adequate infrastructure and an extensive agent network, shifting from cash to digital payments requires a substantial upfront investment and can result in an additional burden on smallholders (see Box 2). If there are no agents nearby or agents do not have the liquidity to conduct cash-in/cash-out transactions, farmers might not be able to get their payments on a timely basis. This issue was highlighted in a CGAP-supported pilot in Uganda, where sugar and coffee farmers who were receiving mobile payments said that they had to wait an uncertain amount of time to receive their payments if agents did not have adequate liquidity. The pilot experience also highlighted that farmer profits are compromised if the transaction fee they have to pay to cash out is more than the direct and indirect costs of receiving cash payments (Lonie and Makin 2016).

Farmers often have limited mobile literacy and are not familiar with mobile money services. These challenges could dissuade them from taking up DFS unless appropriate training is provided. In addition, farmers might not trust receiving or sending money through an agent or they might not believe they can safely keep their cash in a mobile wallet. These factors could lead to side-selling by farmers who prefer cash payments, even if it means that they will not make as much money for their crops if they sell to informal traders who pay cash at the farm gate. For example, UNCDF explored a partnership around digitizing payments with a Ugandan tea

4 GSMA (2016) estimates that mobile operators could leverage bulk payments to open 357 million new mobile money accounts by 2020.

Box 2. Reaching Rural Areas with Digital Bulk Payments: UNCDF's Experience in Uganda

In Uganda, UNCDF's Mobile Money for the Poor Program partnered with Kyagalani Coffee Limited (KCL), a major coffee aggregator, to deliver mobile payments to over 10,000 of its coffee growers (UNCDF 2016). Besides finding that cash payments were costly and inefficient, UNCDF also quickly realized that shifting from cash to digital carried its own costs and challenges.

To prepare for the switch in payment delivery, UNCDF first needed to ensure that the necessary infrastructure was in place in Kapchorwa and Manafwa, rural areas where smallholders were to receive their payments. Because the regions had no mobile network coverage, UNCDF partnered with MNO MTN to install a mobile base transceiver station. But even then, only four in 10 farmers actually owned phones, and those who did struggled to obtain electricity to charge them. This led UNCDF to partner with solar energy provider Fenix International, which offered a pay-as-you-go product for smallholders where they could pay for phones and solar energy kits in small installments.

With the base station and phones in place, UNCDF brought in payments aggregator Yo! Uganda, which helped KCL redesign its internal systems to allow for bulk payments to be sent from KCL to farmers via MTN's mobile money network. Because the regions had no MTN agents where customers could cash in and out, Yo! Uganda also acted as a master agent for MTN, recruiting, training, and servicing local agents. Other key issues faced by UNCDF included high transaction costs and a low maximum transaction size allowed by MTN, which meant that farmers would need to pay high fees and receive their payments in tranches. Following negotiations with MTN, person-to-person transactions costs were discounted, and the maximum transaction size was increased to facilitate bulk payments to farmers.

Sources: Interviews with Joanne Oparo, knowledge management associate, UNCDF (April 2016); Amani Mbale, country technical specialist, UNCDF; and David Darkwa, consultant, Vital Wave (July 2016).

Even after all of this work, the results were somewhat disappointing. Farmers were initially given the choice of cash or digital payments, with the stipulation that cash payments would not be disbursed until the evening, whereas digital payments would be delivered in just one hour. However, only 10 out of the 1,380 transactions processed to farmers were digital. One significant obstacle UNCDF identified was farmer capacity. Approximately 80 percent of smallholders simply were not comfortable enough with their phones to use mobile money. This highlighted a need to train smallholders on how to navigate complex USSD menus and use financial products and services like mobile money.

Moving forward, UNCDF intends to continue to improve its offering to KCL farmers. It is working on building a network of merchants, including schools, that accept mobile money payments. UNCDF also supported MTN in rolling out its new MoCash product, which offers customers the option to deposit money in an interest-bearing savings account and access small loans using their mobile phones. The MoCash service will be available to all KCL farmers with an MTN mobile wallet.

Overall, the UNCDF experience in Uganda demonstrates the complexity of shifting from cash to digital bulk payments from agricultural buyers to smallholder farmers. The upfront investment cost can be high, and successful deployments require coordination among several disparate partners. It remains to be seen whether such an approach can be sustainable over the long term, but one notable success stands out: MTN was able to earn a profit on its base station within the first month of operation, as farmers in the area began using voice and data on their new phones.

processor that distributed cash to its tea estate by airdropping the cash every two weeks from an airplane. Despite the considerable costs involved, the tea processor turned down the opportunity to pilot mobile payments. The processor explained that the savings projected if it participated in the pilot would be small compared to its current system. It also felt that it risked losing its good reputation among smallholders by digitizing payments, because smallholders preferred cash (Oparo 2016).

Another concern is that bulk digital payments may not be an option for the many smallholders who sell their harvests to middlemen. To process

mobile payments, these middlemen and other intermediate actors need to have the capacity and systems in place. Without these two components, payments must be made in cash. For example, in Uganda, Kyagalani Coffee sources half of its coffee supply from traders. Farmers who supply these traders end up getting paid in cash because traders do not have a way to offer digital payments.

Another challenge with this digital approach is that the sustainability of mobile payments might be limited to value chains where there are frequent payments, as is the case with dairy, which features small, frequent payments throughout the year.

Box 3. Covering Cash-Out Fees to Spur Adoption of Digital Bulk Payments

In Ghana, there has been a significant increase in mobile penetration in recent years. A 2014 Financial Inclusion Insights (FI) survey found that 90 percent of adults owned a mobile phone, and 17 percent had a mobile money account in 2014, pointing to an emerging readiness to leverage mobile money to deliver bulk payments to smallholder farmers. In light of this trend, the Ghana Agricultural Development Corporation (GADCO) partnered with Tigo Cash to pilot mobile payments to rice farmers, with the expectation that digitized payments would be less costly than cash payments.

But while Tigo Cash generally charges a 0.5 percent fee to clients cashing out from their mobile money wallets, GADCO decided to cover this as part of the 1 percent commission it paid to Tigo. The off-taker

Source: Babcock (2015).

realized that the cost of these fees would be more than offset by savings from no longer needing to distribute cash in rural areas. This was seen as an important factor in motivating rice farmers to accept mobile payments.

Between September 2013 and June 2014, 722 rice farmers received US\$264,367 in mobile payments, and GADCO indicated a desire to eventually scale to 5,000 farmers. Although farmers noted a few difficulties using the system, including a need for Tigo to improve its network coverage, they were generally very positive about the new method for getting paid. Overall, this model offers an example of how reducing the financial burden of digital payments on smallholders can make these services more sustainable.

Because financial institutions and MNOs need to generate a steady stream of revenue to justify building and maintaining a network and agent infrastructure, value chains where payments are made seasonally during the harvest (e.g., grains) may not be attractive. Moreover, because most financial institutions and MNOs automatically close accounts after a period of inactivity, the rules need to be adapted to account for customers who use their wallets only during the short period around harvest.

To address some of these challenges, value chain actors and FSPs can adopt a strategy that gradually transitions smallholders to using digital services.

Some efforts, such as a mobile payment scheme led by MFI Advans in Côte d'Ivoire (see Box 4), offer farmers the option to receive blended payments, with a portion in cash and the rest as mobile money. Using this approach, farmers receive cash that they can readily use and can keep some of their money safely set aside in their mobile wallets.

This process eases farmers into using mobile money, while a broader digital ecosystem develops where clients can use their funds more extensively. In the Côte d'Ivoire case, the involvement of Advans as an MFI offers smallholders access to an interest-bearing savings account linked to their mobile wallet. This type of linkage could have

Box 4. Easing Smallholders into Digital Payments

When MFI Advans first approached cocoa traders and cooperatives in Côte d'Ivoire with a proposal to channel their payments through the MTN mobile money network and into mobile wallet-linked savings accounts, the number of cash-out points and merchants that accepted mobile payments were limited. Although the scheme offered many smallholders the opportunity to be linked to a formal financial institution for the first time, limits on their ability to access their funds and pay for goods and services meant that cash remained the preferred form of payment.

To address these limitations, Advans used a phased approach to digitizing payments to smallholders.

Source: Riquet (2016).

When farmers receive payment for their harvests, they have the option to choose a partial payment via mobile money and the rest in cash. This flexibility gives farmers an opportunity to try out the system first, without committing their entire payment to a digital system.

As of August 2016, more than 7,000 cocoa farmers from 58 cooperatives have subscribed to the service and now have a savings account with a formal financial institution. Among those, 2,700 accounts were active during the small cocoa harvest in April and May 2016.

positive implications for farmers, as there is some evidence that payments that are deposited directly into a bank account have resulted in an increased use of agricultural inputs (Brune et al. 2011).

Digital loan disbursements and repayments

Just as in bulk payments, digital disbursement and repayment of loans can result in cost savings and expedited processes for both the FSP and the client. In recognition of these advantages, FSPs are increasingly relying on digital tools for loan-related transactions. For instance, One Acre Fund, a nonprofit social enterprise in Kenya that provides inputs on credit, achieves significant savings by collecting repayments through mobile money, because field staff spend less time traveling to rural areas to collect cash payments from farmers. One Acre Fund staff can then spend more time training and educating farmers (see Box 5).

As with other mobile money transactions, farmers can benefit from the safety and convenience of digital payments. For example, for loan customers who would otherwise have to travel to a branch, making or receiving payments via mobile money saves them time and money.

But digital disbursement and repayment of loans also faces many of the same issues as bulk payments via mobile money. An inadequate agent network and insufficient available agent

float or liquidity can hinder farmers' ability to make repayments or withdraw disbursements, which in turn could result in delinquency or a delay in accessing their loan funds. Also, farmers who, in the past, were visited by loan officers for disbursements and collections might now have to travel to find a mobile money agent. Farmers may also incur costs to cash out their loan amounts, further adding to burdensome interest and fees. Faced with the choice between an FSP that offers disbursements and payments in cash and one that transacts only digitally, some farmers may decide to use the former over the latter if it is the cheaper option.

Overcoming Barriers to Providing Financial Services

All smallholder farmers, regardless of how they might engage with value chains, require relevant financial services to make investments in their agricultural activities. For commercial smallholder farmers, improved inputs—such as quality seeds and fertilizer—increase yields and crop quality, resulting in a greater amount sold to buyers, fewer rejected crops, and potential access to competitive but highly profitable agricultural markets. Even noncommercial farmers, who often consume much of what they produce, can benefit greatly from improved inputs that help them to generate the surplus required to begin selling into value chains.

Box 5. The Transition to Mobile Loan Repayments: One Acre Fund in Kenya

Although M-Pesa is now ubiquitous in Kenya, the decision by lender One Acre Fund to use the mobile money service to facilitate client repayments was approached with caution in years following M-Pesa's launch in 2007. In fact, it took five years before One Acre Fund would begin to explore the use of digital loan repayments.

When One Acre Fund looked into the possibility of having smallholder clients repay their input loans through M-Pesa, it found that many farmers did not own mobile phones, and that for those who did own a phone, they could not always charge them because of the poor electricity grid. Also, the agent network was insufficient, and transaction fees were high.

Source: Hanson (2014).

One Acre Fund thus decided to introduce M-Pesa as a pilot. Over time, many of the initial barriers began to ease. Mobile phone access increased, as did the availability of solar chargers, which One Acre Fund sold on credit to its customers. M-Pesa's agent network was also expanded in the areas where One Acre Fund operates, with 72 percent of One Acre Fund sites found to have three or more agents. M-Pesa also introduced a system that did not impose fees on customers for repayments, but rather charged One Acre Fund for use of the service. As a result, One Acre Fund began piloting mobile repayment with about 1,000 farmers in one district in mid-2013. Following its success, the pilot was scaled, and digital repayments are now used nationwide.

But farmers are hard pressed to invest in quality inputs if they run out of money by the time the planting season starts. While some commercial smallholders can obtain input loans from off-takers to meet these needs, this is not always the case for farmers in loose value chains. Many traders and processors are wary of financing farmers because of the upfront cost of procuring inputs and the risk that farmers might side-sell their crops, thereby reducing the chance of repayment.

Moreover, smallholder farmers without strong links to buyers have few financing options for purchasing inputs. Without credit histories or formal contracts that they can leverage as collateral for a loan, these smallholders may be limited to borrowing from middlemen, who can offer unfavorable loan terms. A recent CGAP study of the financial lives of smallholder farmers found that for 94 Pakistani farmers whose financial transactions were tracked over the course of a year, the only viable option to finance their agricultural inputs was through middlemen, who need to be repaid immediately after harvest when prices were at the lowest (Anderson and Ahmed 2016).⁵ Other farmers may attempt to borrow from savings and loan groups, but these loans tend to be small, too short-term relative to their crop cycles, and dependent on the group's available funds. The cost of these inputs can also be quite high, because smallholders purchasing small amounts of seeds and fertilizers are unable to take advantage of the high-volume discounts available to large agribusinesses.

The level of exposure to production risks related to weather, such as drought and flooding, also affects the extent to which farmers choose to invest in their agricultural production. If farmers perceive that any additional expenditure in their farms—whether quality inputs or other assets—could be lost, they might decide to forego the investment, especially if the investment requires going into debt. Formal risk management strategies, such as agricultural insurance products, can greatly mitigate agricultural risks and induce agricultural investments, but these are often unavailable or unaffordable to smallholders.

The lack of proper and diversified financial products not only negatively affects the investment in farm production, it also affects the extent to which farmers can maximize the income they derive from their harvests. And without investments in their farms that can increase the yields and quality of their crops, smallholders will not be seen as valuable commercial partners by value chain actors. By helping to overcome barriers, such as cost and information asymmetries, DFS can provide access to savings, insurance, and credit products that was previously unavailable to many smallholders (see Table 3).

Digital Savings for Inputs

Savings products offer an attractive means to acquire inputs because smallholders who do not have good options for credit (or who prefer not to become indebted) can plan ahead for input

Table 3. Overcoming Barriers to Providing Financial Services

| Product Type | Key Pain Points Addressed | Role of Digital |
|--------------------------------|--|--|
| Digital Savings for Inputs | Production: Smallholders cannot access financing for high-quality inputs | <ul style="list-style-type: none"> • Reduces need for branches or staff in remote areas to collect savings • Allows for flexible payments • Aggregates demand for inputs |
| Digital Agricultural Insurance | Production: Risk of crop losses hinders smallholder investments in productivity | Digital premium payments, automated monitoring of losses, and payouts to mobile wallets reduce cost of providing insurance |
| Digital Credit | Production: Smallholders cannot access financing for high-quality inputs or working capital | <ul style="list-style-type: none"> • Reduces need to establish branches or send loan officers to rural areas • Data used to make lending decisions for smallholders lacking credit history • Speeds up decisions and disbursement |

⁵ da Silva (2005) also acknowledges that farmers who borrow from buyers in exchange for a promise of future crop deliveries face potential drawbacks. He writes that the relationship between farmers and buyers is often uneven, with the buyer able to dictate the terms of the relationship.

purchases by setting aside small amounts of money over time. But because smallholder cash flows are unpredictable, they typically can save only in small amounts and at irregular times. For deposit-taking financial institutions, the small individual savings volume and the geographic dispersion of farmers may mean that traditional delivery channels, for example physical branches or field staff who travel to clients to collect savings, are unsustainable.

At the same time, supplying inputs to geographically dispersed, low-income smallholders is difficult and costly. For input providers, the challenge of selling small units of fertilizer per client to a large aggregate number of smallholders dispersed in vast areas is a logistical challenge for managing inventories and stocking rural distribution centers. As a result, smallholders rarely are able access the same bulk discounts that large buyers like cooperatives and large-scale farms enjoy.

Digital platforms are increasingly addressing many of these challenges by allowing smallholders to save

ahead for input purchases, which has the added benefit of aggregating demand and reducing the cost of seeds and fertilizers. For example, organizations like myAgro, which operates in Mali and Senegal, allow smallholders to make small, flexible payments over time; these payments are credited toward a package of inputs. myAgro uses a system of scratch cards that can be purchased from local myAgro vendors and credited to the smallholder's layaway balance by sending a secret code via SMS. The myAgro approach is particularly useful for consumers who are unfamiliar with mobile money, but who are used to the process of topping up airtime using the ubiquitous airtime scratch cards.⁶

In addition to myAgro, other organizations are beginning to test the viability of savings products for inputs. One prominent example is Esoko, which began as a digital agricultural information service provider and launched an input savings product in Ghana in late 2016 (see Box 6). Unlike myAgro, Esoko leverages mobile money networks to allow customers to contribute to a dedicated input

Box 6. Integrated Approach to Facilitating Access to Inputs

Esoko is one of a growing number of FinTech organizations that are using mobile wallets to give farmers a flexible way to save for input purchases. Esoko's model, named Fasiba, was launched as a pilot in Ghana in late 2016, with hopes of reaching 80,000 farmers in the first three years. In this model, farmers identify the package of inputs they would like to acquire, and the amount required to buy the package is set as the savings goal. Farmers can then contribute small amounts to their input wallet over time, with Esoko also offering rewards like airtime top-ups and souvenirs to help farmers achieve their goal. Upon reaching their savings goal, farmers authorize Esoko to remit payment from their input wallet to the input supplier, and farmers receive a voucher that allows them to redeem their inputs at a designated input vendor or aggregation point in their community.

Esoko also offers smallholders an integrated package of services. First, Esoko is helping to aggregate demand for inputs, which allows it to negotiate discounts for farmers. It complements this platform with its existing information services, which provide

agricultural tips and weather information to customers looking for guidance on how to best use their inputs.

By integrating multiple complementary services, Esoko's platform can address a variety of inefficiencies in agricultural value chains. By working with importers and distributors of inputs and aggregating demand on its platform, Esoko is able to offer inputs at a discount to farmers. For buyers and processors, the layaway scheme spares them from having to finance inputs to their suppliers. Input retailers might also benefit because the platform effectively connects them with new customers, which can increase the volume, stability, and predictability of sales. By aggregating demand from large numbers of farmers, the platform has the potential to enable participating input dealers to estimate the quantities they need to supply and lock in prices with greater precision, thereby avoiding spikes from limited supply or opportunistic margins during the planting season.

Because Fasiba is at a very early stage, it is hard to draw any conclusions as to its impact or sustainability. However, it demonstrates a new interest in exploring the potential of savings to finance input purchases among smallholders.

Source: Interview with Axel Stelk, vice president of Finance and Operations, Esoko (July 2016).

6 For more information on myAgro, see Mattern and Tarazi (2015).

layaway wallet, without the need to visit a bank branch or wait for a collector to come around (they do, however, need to add value to their mobile wallet via an agent or other channel).

Commitment savings for things like inputs can effectively drive good savings behavior by restricting access to funds, thereby mitigating the temptation to spend the money on many other needs (Ashraf, Karlan, and Yin 2004). This mechanism also benefits smallholders who may not qualify for loan funds or for whom loans may not be an appropriate option because of the cost or existing debt burden. By growing their savings and limiting indebtedness, farmers improve their capacity to invest in their farms through quality inputs.

Flexible savings for inputs also benefit other value chain actors. Collecting savings digitally is more cost effective for FSPs, and input providers benefit by generating additional sales. For buyers and processors, the savings mechanism helps to ensure that their suppliers have access to inputs without needing to provide financing themselves, and their funds can be used for their core agribusiness. Finally, MNOs can maintain their customer base in rural areas and increase use of mobile money services.

Yet, even with the flexibility offered by digital savings, smallholders are not always able to reach their savings goals before planting season arrives. Faced with multiple competing financial needs, farmers can struggle to make even small deposits, and sometimes they may need access to these funds to deal with an unexpected expense or an emergency. Another important challenge is ensuring that access points for depositing savings are available when smallholders have cash available. For example, myAgro in Senegal found that smallholders face numerous temptations to spend money on urgent, short-term needs. If there

is no available access point for making deposits when farmers have cash, the farmers may use the cash to pay for other expenses instead.⁷ To address this issue, myAgro in Mali and Senegal allows customers to adjust their chosen input package size at the end of the savings period if their goal has not been met. Esoko is also exploring this option, as well as the potential addition of a top-up loan that can cover the outstanding savings balance.

Finally, there is the issue of scale. Input discounts can be offered only when there is a critical mass of customers. This means that organizations that want to implement such digital input savings schemes will need to plan their outreach strategies carefully.

Digital Agricultural Insurance

Agricultural insurance products are largely unavailable to smallholder farmers because of the high costs of verifying loss claims in geographically dispersed areas, the relatively small size of individual policies that smallholders require, and the limited understanding of agricultural risks on the part of insurance providers.⁸ As a result, few providers have been willing to offer agricultural insurance policies that meet the needs of smallholders.

Digital technology can address some of the distinct challenges of offering agricultural insurance to smallholders by enhancing actuarial estimations and reducing the cost of delivering and monitoring insurance products. In the case of weather-index insurance, for example, registration by mobile phone allows customers to be geotagged, which when combined with automated weather stations and satellite imaging means that insurance providers do not have to conduct in-field loss assessments nor collect premiums or make payouts in person. The information captured can also reduce the risk of developing an index that does

7 CGAP found that with so many priorities competing for these customers' limited cash inflows, even a few hours' delay can mean the difference between making a deposit and "eating" the money—a term Senegalese smallholders use to describe their tendency to spend cash as soon as they received it (Mattern and Tarazi 2015).

8 About 198 million smallholders have some form of agricultural insurance policy. However, these are significantly concentrated in China, which has 160 million smallholder policies. In the rest of the developing world, smallholder agricultural insurance is less widespread, but growing (Hess and Hazel 2016). Of those policies, a very small share are digital. According to GSMA (2015), only 10 percent of mobile insurance products available so far are intended for agriculture.

not correlate well with actual losses incurred by smallholders—known as basis risk.

If the index defined in the policy—like rainfall, pasture coverage, or sea surface temperature correlated with smallholders’ losses—falls below or above a certain threshold, the agreed insurance payout is automatically issued to a customer’s mobile wallet, without farmers needing to submit an official claim or visit a branch. For insurance providers, the digital monitoring of weather information prevents fraudulent claims, while also reducing adverse selection and moral hazard.

Insurance products offered by Econet Wireless and ACRE Africa are based on similar, yet distinct models for offering mobile-enabled weather-index insurance to insure inputs bought or yield losses incurred due to weather events (see Box 7). Both services use mobile phones to process registrations and payouts to customers, and rely on remote monitoring via weather stations and satellites to

measure rainfall. In each case, smallholders buy a specific brand of seed that contains a code smallholders can use to register for the service using their mobile phone.

However, the two services differ in terms of their coverage and the cost of premiums. Whereas Econet’s EcoFarmer product requires customers to pay a premium to obtain coverage, the ACRE Africa model in Kenya offers a limited amount of coverage that is included with the purchase of a bag of seed from its partner seed company. The distinction is important, because even when the price of agricultural insurance is affordable, smallholders may not see or understand the value of these products, and as result they might be reluctant to take up insurance offers. According to IFAD (2011), weather-index insurance in particular may be seen as an unnecessary cost, especially given the fact that smallholders face a number of risks and productivity constraints that go beyond just weather events.

Box 7. Two Approaches to Digitally Insuring Farmers against Weather Risks

ACRE Africa in Kenya and Econet’s EcoFarmer product in Zimbabwe are both tackling the challenge of insuring smallholders against weather-related risks by offering insurance products tied to a rainfall index. However, each company has taken a distinct approach to marketing and selling its insurance products.

In ACRE Africa’s case, the seed company, Seed Co, pays the premium on behalf of farmers out of its marketing budget, which is included in the cost of a bag of seeds. This approach benefits both ACRE Africa and Seed Co, which offers coverage as a marketing tool to increase the attractiveness of its seeds in the competitive input market. Inside the bag of seeds is a code that farmers enter into their mobile phone to register their insurance policy. In this case, while farmers do not have a direct cost for the insurance, the coverage is limited to the cost of the seeds (approximately US\$5 for a 2 kilo bag, with smallholders typically buying one to two bags) within a short window of time (maximum 21 days after the first day of planting). While the coverage is limited, the subsidy allows skeptical smallholders who may not trust or understand insurance coverage to try the product with little risk. Seed Co recognizes smallholders as critical to expanding its input sales. In turn, ACRE Africa has taken a “freemium” approach

to insurance coverage. Even as it offers the subsidized coverage along with bags of seed, the company has begun to offer a range of additional paid insurance products for a number of crops, including coverage for yield losses, machinery, and livestock. By allowing smallholders to first build trust in the service, ACRE Africa hopes that its customers will begin to enroll in these other types of insurance coverage.

In Econet’s case, the insurance provider does not absorb the cost of the insurance. It instead relies on farmers to pay for the premium directly from their mobile wallet (either \$2.50 for \$25 in coverage or \$10 for \$100 in coverage). This coverage is more extensive than ACRE Africa’s subsidized coverage, because the payout can be triggered at any time during the growing season, and smallholders can choose to pay more for higher-level protection that goes beyond just the cost of the seeds. But uptake has so far been a challenge, because some smallholders are not confident that the insurance will pay out and are hesitant to pay even a small premium. However, Econet’s financial arm, Steward Bank, is now exploiting its position as a full-fledge bank and complementing the EcoFarmer strategy by linking the insurance product more systematically with other savings, payments, and credit products to better respond to the many financial needs smallholders face.

Sources: Interview with Wairimu Muthike, head of Business Development, ACRE Africa, July 2016; Econet (2016).

The fact that farmers face risks beyond weather is one of the fundamental shortcomings of strategies that offer only weather-index insurance to smallholders. Without more comprehensive coverage and access to other types of financial and nonfinancial services, smallholders are exposed to production risks (e.g., pests and spoilage) and market-related risks (e.g., price fluctuations) that can affect their bottom line. Additionally, the number of crops covered by such products remains limited to those for which quality historical rainfall and yield data are available.⁹

Finally, while the technology behind index insurance is fairly reliable, it is not error-proof. Satellites and weather stations are limited in their ability to predict precise rainfall levels at the individual farm level. And even when rainfall measurements are accurate, the models used by insurance companies to estimate losses at various rainfall levels may themselves be flawed. Therefore, basis risk is a distinct possibility. This means that some farmers who experience loss due to drought or flooding conditions may not receive a payout because the rainfall data were not accurately captured by weather stations or satellites. The opposite could also take place, where a payout is triggered in situations where farmers do not experience any yield loss (IFAD 2011).

Malawi's recent experience with national index insurance purchased through the African Union's African Risk Capacity initiative provides a cautionary example of how basis risk can affect payouts. Following a severe drought in 2016, ARC's software estimated that only 21,000 people were at risk—far below the threshold of 1.39 million required for a payout. However, a joint assessment by the Malawian government and international agencies put the number in need of assistance at 6.5 million. Such experiences can have a devastating effect on customer trust in insurance products, and may affect future enrollments (The Economist 2016).

Moving forward, there is some evidence that bundling digital insurance with a range of other products represents an important opportunity for FSPs.¹⁰ For example, rather than being sold as a standalone service, weather-index insurance could also be bundled with digital input savings to reduce exposure to weather events, and could also help to convince financial institutions to offer credit to top-up farmer balances by helping to de-risk lending.¹¹

Digital Credit

Traditionally, FSPs have struggled to offer credit products to smallholders because of the cost of serving remote areas and the lack of credit histories or collateral. But advances in data analytics and mobile technology are producing hopeful signs that FSPs may soon be able to overcome these barriers.

A recent study by the Rural & Agricultural Finance Learning Lab (2016) found that customer registration and application procedures are two of the most common forms of credit digitization among surveyed FSPs. For example, Kenyan MFI Musoni's loan officers use smartphones and tablets to take digital photos of their clients and their identification documents, which are in turn uploaded to headquarters along with other application information. This process reduces costs and expedites credit decisions, thereby boosting Musoni's capacity to issue a greater number of loans in a shorter amount of time. Farmers also benefit from quicker loan decisions and disbursements (made via M-Pesa), all without having to visit a branch or obtain documents such as a photo and copy of their identification.

However, digitization of the application process—while beneficial to creditworthy smallholders—does not address obstacles in the analysis used by the FSP to determine creditworthiness, which determines whether the client qualifies for credit in the first place. Moreover, in an era of products

9 The Global Index Insurance Facility (n.d.) notes that for ACRE Africa's weather-index insurance products to be affordable and accurate, 10–20 years of historical rainfall or yield data are required.

10 Bundling index insurance with a range of other risk-reducing interventions was a central recommendation in Hazel et al. (2010).

11 Weather-index insurance can be a key factor in helping farmers secure credit from financial institutions. For example, 177,782 farmers have received \$8.4 million in financing in part due to ACRE's index insurance products (GIIF 2012).

like Kenya's M-Shwari,¹² there is an increasing recognition of the potential of fully digital credit products.¹³ While CGAP's landscaping review did not find any existing credit deployments that have achieved full digitization, several organizations are working toward this vision.

In Colombia, Grameen Foundation partnered with the Andes Coffee Cooperative to build an innovative Agricultural Risk Evaluation Tool (ARET) that uses farm-level, nonfinancial data to build credit scores for coffee farmers. By analyzing the farm characteristics and repayment histories of a group of coffee farmers who had previously taken loans from the cooperative, Grameen was able to identify a handful of variables out of a total of 150 that predict the likelihood of a farmer defaulting on his or her loan. In turn, the cooperative was able to produce credit scores for member farmers who had no history of borrowing, thereby improving their ability to analyze the credit risk of farmers applying

for a loan for the first time. So far, the coffee cooperative has been cautious in applying the tool, preferring to use the scores as a complement to its manual underwriting process. However, ARET may eventually allow for instant, automated credit decisions for coffee farmers for whom data on these handful of variables are available (Tobias 2016).

A similar effort is underway in Kenya, where technology start-up FarmDrive is partnering with financial institutions to offer smallholders tailored digital credit products (see Box 8). But like ARET in Colombia, it will take time before lenders agree to automate their decisions completely. While the application process, credit analysis, disbursement, and repayment are all conducted remotely, the partner financial institution still has the final say on whether to approve the loan.

Despite the promise of digital credit for smallholders, there are also several challenges. These include

Box 8. FarmDrive in Kenya: Building toward Digital Credit for Smallholders

In Kenya, technology start-up FarmDrive has set out to overcome barriers to smallholder credit access by using data to develop credit profiles on smallholders and connect them to financial institutions. To access the service, smallholders can use either an Android application or SMS, which in turn prompts them to enter a range of agronomic, behavioral, and demographic information. Each farmer is also geotagged, and his or her personal information is matched against information such as soil data, weather data, historical crop production data, and more. Once farmers have entered their information into the system, an algorithm produces a credit score and provides loan recommendations to financial institutions. To lower the risk of lending, FarmDrive is also developing a hybrid index insurance that will be bundled with the credit.

Recently, FarmDrive partnered with MFI Musoni to pilot its credit-scoring algorithm with farmers in

Kenya. The partnership has grown its loan portfolio to over US\$130,000 and has allowed smallholders, some of whom did not previously have access to credit, to access financing in as little as 30 minutes.

Although this process can lead to rapid credit decisions, it also depends on risk-averse partner financial institutions to approve and disburse loan funds. But as FarmDrive continues to collect data on repayments and improve its algorithm, it might become easier to convince partners to increase lending based only on the credit profiles and loan recommendations it produces. While acknowledging this risk, FarmDrive describes its strategy as targeting financial institutions that are comfortable with technology and that have already committed to increasing their agriculture portfolios. It hopes that it can leverage initial successes to prove the bankability of smallholder farmers and drive engagement with a broader range of financial institutions.

Sources: Interviews with Alfred Iwasaki, COO, FarmDrive (July 2016); James Onyutta, CEO, Musoni (July 2016); and Mary Joseph, director of Partnerships and External Relations, FarmDrive (January 2017). Engineers Without Borders Canada (2016)

¹² M-Shwari is a digital credit product offered by Kenyan MNO Safaricom and Commercial Bank of Africa.

¹³ Digital credit is differentiated from conventional credit based on three key attributes: it is instant (decisions made in as little as seconds after application), automated (decisions on credit limits, customer management, and collections based on preset parameters), and remote (application, disbursement, repayment, and communications all conducted remotely, with no need to visit a branch or wait for a loan officer to arrive) (Chen and Mazer 2016).

Table 4. Improving Market Opportunities

| Product Type | Key Pain Points Addressed | Role of Digital |
|-----------------------------|--|---|
| Digital Trading Platforms | Post-harvest: Smallholders lack access to markets for crops | <ul style="list-style-type: none"> • Connects buyers and farmers to offer new, transparent market opportunities • Aggregates farmer production to reduce procurement cost, maximize sale price |
| Digital Invoice Discounting | Post-harvest: Buyers lack funds to pay smallholders quickly, leading to side-selling | <ul style="list-style-type: none"> • Data on production records used to secure receivables financing for farmers • Allows payment to be made to farmer wallet/account upon delivery |
| Digital Warehouse Receipts | Post-harvest: Liquidity constraints force smallholders to sell immediately after harvest when prices are lowest | <ul style="list-style-type: none"> • Digitized information on quantity/quality of stored crops used to determine value • Digital receipts representing value of stored crops used to secure financing |

the high initial investment required to develop and test algorithms, especially in light of providers' hesitance to serve a new client segment such as smallholders (RAFL 2016). Industry players are also raising concerns about the ownership and privacy of customer data. In many countries, regulatory frameworks have not caught up with innovations in the digital space. For example, some digital lenders in Kenya are operating outside of the regulation of any financial sector authority, and it can be difficult to hold them to account for misuse of customer data (Ombija and Chege 2016). Who owns the data is another important consideration. Data originators like MNOs are reluctant to share valuable data with partners, and some financial institutions do not trust the quality of data generated by third parties.¹⁴ Finally, it is important to note that existing digital credit deployments such as M-Shwari and M-Pawa are focused on short-term, high-cost consumer loans. Any attempts to develop digital credit products for investments in inputs or working capital need to be tailored to the agricultural cycle.

Improving market opportunities

Smallholder farmers often face difficult choices when seeking the best market price for their harvest. For smallholders with only loose connections to value chains, local traders and middlemen may offer lower prices than off-takers further up the value chain. Yet, these smallholders' low productivity and production volume and geographic isolation mean that connecting with better market opportunities is often out of reach. Even when smallholders

can get a better price for their crops by waiting to sell until commodity prices rise post-harvest, a need for liquidity forces many to sell immediately even though prices are at their lowest. Liquidity constraints also affect smallholders who participate in tight value chains; these smallholders sometimes side-sell to middlemen if an off-taker does not have enough capital to pay its farmers upon delivery. The availability of market opportunities is an important factor in smallholders' decision to invest in their agricultural activities. Without a clear outlet for their production, smallholders are less likely to make expensive investments in increasing production.

DFS can help to overcome these challenges in several ways (See Table 4). First, digital tools can be used to aggregate smallholder production and connect smallholders to buyers who offer better prices than those available in local markets. Second, digitized warehouse receipt systems can allow smallholders in loose value chains to safely store their crops and use them as loan collateral while waiting for market prices to rise. And third, the digitization of production and crop delivery records by aggregators and off-takers can help smallholders access financial services, such as receivables financing, that allow them to borrow based on payments owed to them by buyers further up the value chain, thereby providing the liquidity necessary to pay their suppliers on delivery.

Digital Trading Platforms

Market failures negatively impact players all along the value chain. Smallholders, who are typically

¹⁴ In conversations with providers, data quality and trust in algorithms to accurately predict repayment repeatedly emerged as a concern.

Box 9. TruTrade Africa Connects Smallholders to Agribusinesses

Despite a rising demand for agricultural commodities among agribusinesses and a ready supply available from smallholder farmers, connecting the two sides has always been a challenge. Local traders can sometimes play the role of intermediary, but even they face significant challenges in ensuring that they can affordably deliver high-quality produce to their buyers.

Recognizing an opportunity to make markets more efficient for everyone along the value chain, TruTrade Africa negotiates deals with buyers and procures supplies from a network of traders acting as franchisees. In this model, TruTrade identifies a buyer and negotiates a price for a specified quantity of a given commodity. The system then notifies its franchise network of local traders or farmer groups who are able to see the offered price and commission, and can then choose to accept the deal and collect crops from smallholders.

When procuring crops, TruTrade obtains financing to ensure that its franchisees can pay smallholders “cash on the bag.” Each farmer is offered a fixed price and given the choice to receive payment through mobile money, in which case TruTrade pays “cash-out” fees, or in cash. Unlike most middlemen, TruTrade and its franchisees have an incentive to offer smallholders the best price possible because their commission

(10 percent across the whole network) is based on the price paid to farmers, rather than what is paid by the end buyer. Farmers are able to see how much the end buyer is paid, the costs involved in intermediation (transport, storage, etc.), and the total commission paid to TruTrade. Deals that include value-added processing help TruTrade to fetch a higher price from buyers, which is passed along to the farmer. Furthermore, if the deal is completed successfully and the total profits exceed initial estimates, any additional profits are paid to the farmer.

Beyond helping smallholders get the best price for their crops, TruTrade also offers benefits for traders and buyers. Traders benefit from access to the financing required to pay farmers on delivery and do not need to negotiate deals and coordinate transportation. Buyers benefit from a more transparent supply chain in which they are able to trace commodities all the way to their origin, thereby facilitating certifications such as organic, fair trade, and more.

In the 2016 trading year in Uganda and Kenya, TruTrade traded 665 metric tonnes of produce across a variety of crops, with a total value nearing US\$500,000. Overall, the prices that smallholders obtain for their crops through the TruTrade system was on average 17 percent higher than the prevailing market rate.

Sources: TruTrade 2015, Self Help Africa 2016. Interview with Jenny Rafanomezana, CEO, TruTrade (January 2017)

far from markets, are often unaware of the prices being paid by agribusinesses, and the high cost of transportation makes it difficult to deliver their crops to these buyers in the first place. For agribusinesses, a lack of information on their suppliers and the high cost of aggregating produce of unknown quality from a large number of small producers makes connecting with these farmers difficult.

These information asymmetries and logistical constraints mean that both agribusinesses and smallholders often rely on local small-scale traders, or middlemen, to act as intermediaries. In this arrangement, the middleman is responsible for quality control, aggregation, and transportation to the buyer, thereby providing smallholders with access to markets and agribusinesses with a steady supply of crops.

However, using intermediaries can be far from efficient. Given the high costs of intermediation,

middlemen have an incentive to minimize the price they pay smallholders and maximize the price they get from buyers. With few options for selling their harvests and a pressing need for liquidity, smallholders are often forced to accept whatever price a middleman may offer at the farm gate. Buyers are also disadvantaged by this arrangement, because there is little transparency in terms of the origin of their supplies or the margin being charged by the middleman.

Digital trading platforms can help to address these market failures by connecting smallholders to a wider range of value chain actors seeking their product, contributing to more competitive rural markets, building transparency into the value chains, and adjusting the incentives for middlemen. One example is TruTrade Africa—a social enterprise operating in Uganda and Kenya—that uses a cloud-based digital platform to negotiate deals with buyers and procure crops from smallholders through a network of local traders (see Box 9).

The risks inherent in a digital trading platform like TruTrade are clear. First and foremost, commodities cannot be digitized, which means that even digital trading platforms need to rely on complex logistics required to transport crops from the point of sale to the ultimate buyer. This implies that middlemen are still likely to play a key role in last-mile sourcing of crops from smallholders, and any attempts to squeeze their margins may result in procurement issues. Moreover, the quality of crops procured by local traders is not guaranteed, and poor quality produce might not be accepted by the end buyer. Spoilage and other losses incurred between procurement and delivery to the buyer can also lead to lower revenues. Additionally, there is always the risk that a deal will fall through because franchisees are unable to source a sufficient volume from their smallholder suppliers.

Digital Invoice Discounting

Side-selling is one of the biggest challenges facing aggregators and processors like farmers groups and small and medium enterprises (SMEs) that procure from smallholders. Given logistical challenges and liquidity constraints, traders and processors sometimes take weeks to make payments to smallholders for their produce or to pay service suppliers like transporters or middlemen. This delay in payment can prompt smallholders to sell their produce to other buyers that may be able to offer immediate payment, even at the expense of a lower price.

Invoice discounting is one way aggregators and processors can ensure their suppliers are paid on time and reduce side-selling.¹⁵ Under this arrangement, the aggregator or processor helps farmers to access a loan from a financial institution based on the money owed to them for their crop deliveries, as per an existing contract. But because many farmers groups and SMEs do not have formal records that financial institutions would typically use to analyze their creditworthiness, obtaining financing can be difficult.

Digital production records that include, for example, quantity and quality of crops procured, sales to buyers, and information on smallholder suppliers, are bridging the information gap that made it difficult for SMEs and farmers groups to obtain financing from FSPs. For instance, Agrilife, a cloud-based technology platform owned by MobiPay Kenya Limited, allows dairy processors to digitize their records and use these records to secure invoice discounting services from financial institutions on behalf of their suppliers.¹⁶ Once loans are approved, funds are sent directly to the farmer's M-Pesa or bank account and are secured by the payment the processor owes the farmer (see Box 10). The service helps to address smallholders' urgent need for liquidity. Although side-selling is relatively rare in dairy value chains (because of a paucity of processors), such a scheme could help to reduce the possibility that farmers will engage in side-selling in looser value chains. As such, Agrilife is exploring ways to move into other value chains such as sorghum, maize, millet, and bananas.

However, uptake of digital platforms like Agrilife can be slow given the expense associated with acquiring the systems and a lack of capacity needed to manage them. Additionally, while data may give greater insight into the creditworthiness of informal processors and aggregators, partner FSPs might not trust these data fully and may insist on a formal contractual relationship between producers and buyers as a prerequisite to lending. Finally, because no data trails are generated for individual farmers, the data are of limited utility as an entry point for providing direct financial services to smallholders.

Digital Warehouse Receipts

At harvest time, when prices are at their lowest, many smallholders are forced to sell their crops to meet urgent household expenses. This urgent need for liquidity at the end of the growing season often prevents smallholder farmers from maximizing their profits.

¹⁵ Invoice discounting is the practice of using accounts receivable as collateral for a loan.

¹⁶ This financing mechanism is known as supply chain finance, a type of product-linked financing where farmers are the ones who borrow the funds, but the loan is initiated and guaranteed by the buyer or processor.

Box 10. Agrilife in Kenya Digitizes Production Records to Pay Dairy Producers on Delivery

A major challenge many processors face in highly competitive markets is securing a reliable supply of crops or raw materials to meet the needs of end buyers. This is certainly the case in Kenya, where dairy is a fast-growing sector that is facing fierce competition. Dairy processors in Kenya have a difficult time securing adequate supplies of raw milk because they typically pay their suppliers at the end of the month, whereas the informal market can pay cash on the spot. As a result, many dairy producers choose to side-sell to obtain payment on delivery.

Agrilife recognized that DFS could play a role in reducing side-selling in the dairy value chain. To test this approach, it partnered with the New Kenya Cooperative Creameries LTD (NKCC), which sources milk from over 150 dairy farmer groups totaling more than 50,000 smallholder farmers. With Agrilife's digital platform, NKCC registers farmer groups into

the system's database and collects contractual and production-level data. Using these digital data, NKCC sends a loan request to partner FSPs on behalf of the farmer groups. Farmers, in turn, receive the loan amount through M-Pesa or a bank account. Ownership of the farmers' accounts receivable for milk delivered is in turn transferred to the financial institution, and NKCC pays the financial institution once it has sold the milk to its end buyers (supermarkets or government agencies).

This system allows NKCC to maintain the loyalty of dairy producers and ensure a more reliable milk supply. At the same time, Agrilife generates a profit through a shared-revenue agreement with its partner financial institutions.

After nearly three years of operations, Agrilife is contemplating moving into other countries and value chains, including sorghum, bananas, and horticulture in Kenya, and maize and millet in Uganda.

Source: Interview with Charles Kiinde, director, Agrilife Limited (July 2016)

Digitized warehouse receipt systems are one way smallholders can access the post-harvest financing they need to smooth consumption, while also safely storing their crops for sale at a higher price later in the season. Warehouse receipts, also called warrants, are documents that prove the ownership of a specific amount and quality of a given commodity that is safely stored in a warehouse for a fee. A warehouse receipt system can help farmers secure financing from an FSP using the value of their stored crops as collateral, which in turn frees them to seek the best market opportunity for their harvest (Varangis and Larson 1996).

Yet, warehouse receipt systems typically require high-quality storage facilities and verifiable data on the quality and quantity of crops being stored—both of which are rarely available for smallholders in developing countries. But with the help of digital technology, innovative warehouse receipt systems are testing ways to make it possible for smallholders using more rudimentary storage facilities closer to home to obtain a digital receipt that allows them to access a post-harvest loan from a financial institution.

Grameen Foundation attempted such an approach when it piloted its e-Warehouse project in Kenya

(see Box 11). In this pilot, Grameen Foundation allowed smallholders to store their crops at home or in a central location in the village, with data on crop quantity and quality collected by local agents equipped with tablets known as Village Knowledge Workers. Each farmer participating in the scheme was provided with a digital warehouse receipt, which he or she could use to obtain financing worth up to 50 percent of the stored commodity.

Warehouse receipt systems can be difficult to manage and operate, even when integrated with appropriate technology. As the Grameen case highlights, inadequate storage methods and inaccurate data can lead to questions about the crops used to secure loans from financial institutions. Furthermore, any warehouse receipt system, digital or otherwise, is subject to market risks such as commodity price fluctuations. The business model depends on crop prices rising over time, but given the volatility of commodity markets, there is always the possibility that prices could drop, reducing the value of farmers' crops and leaving financial institutions exposed (Bass and Henderson 2000). In more developed markets, financial institutions have a range of tools, including forward contracts, to protect against this risk. But where commodity exchanges and legal and

Box 11. Digital Collection of Crop Data Enables e-Warehouse in Kenya

Grameen Foundation turned to technology to provide smallholders with access to post-harvest financing even though they had no access to formal warehouse facilities. By leveraging Farm Concern International's network of Village Knowledge Workers (VKWs), each of whom was equipped with a tablet running TaroWorks, Grameen Foundation was able to allow smallholders to store crops locally while also generating a digital receipt that could be used as collateral for a loan from a financial institution.

VKWs used TaroWorks to collect information on the location, quantity, and quality of crops without the need for a fixed storage facility or a visit from field staff. It also provided extension services focused on good crop storage practices to smallholders. The data and extension services were intended to give financial institutions confidence in the value of the stored commodities, which in turn allowed farmers to access loans worth up to 50 percent of the value of their crop.

During the storage period, farmers were provided with market information on their mobile phones to help them decide when to sell their crops. The data

collected through the TaroWorks program also allowed e-Warehouse to aggregate the stored crops and negotiate bulk deals with buyers. During the course of the pilot, 167 farmers applied for the loan, and 33 were approved to receive financing. Farmers participating in the pilot who waited 2–3 months to sell their crops saw on average an over 50 percent increase in the price they received.

Despite some promising results, bringing the pilot to scale proved difficult, and the pilot was discontinued in 2014. One of the key challenges faced by Grameen and its partners was ensuring that village-level data were accurate and up to date. Cost and time constraints meant VKWs could visit villages to check on stored crops only periodically, and local village groups were tasked with keeping records themselves. During loan monitoring visits to the villages, the participating financial institution found that local records did not match what had been entered in the system. Furthermore, there were cases when some stored crops had been sold, but it was unclear which farmers owned the missing crops.

Sources: Interview with Juan Guardado, country director, Tanzania and Kenya (July 2016). Ballard (2015).

regulatory frameworks are underdeveloped, volatile commodity prices can undermine warehouse receipt schemes. Financial institutions that have successfully developed nondigital warehouse receipts systems in developing countries, like Tanzania or Niger, base their success on a deep knowledge of and capacity to monitor agricultural markets and price fluctuations (Coulter 2014).

Looking Ahead to the Future of Digital Value Chain Finance for Smallholders

Research and analysis show the evolution and growth of DVCF. In some ways, this evolution is closely linked to developments in the broader DFS space. But digitizing financial services for agricultural value chains presents its own set of unique challenges and opportunities, especially in terms of their ability to overcome pain points along the value chain.

Looking across the various models highlighted in this study, it becomes clear that digital tools have

the potential to break down barriers to entry in value chain finance by doing the following:

- Allowing FSPs to eschew brick-and-mortar branches and full-time staff in favor of mobile phones and agent networks.
- Using digital technology to reduce the cost of serving smallholder farmers and bolster the business case for providers.
- Digitizing information on farmers and other actors to enhance providers' understanding of risk in agricultural value chains.

Overall, the promise of digital tools in agricultural value chain finance is apparent in the range of new savings, credit, insurance, and payment products being rolled out by organizations that previously had little to no involvement in agricultural finance, including commercial banks, MFIs, MNOs, and FinTechs. Many existing deployments are in the early stages, and the experiences documented in this analysis point to a number of obstacles that providers will need to overcome.

One key consideration moving forward will be the quality of mobile networks and agent infrastructures in rural areas. Because many new offerings rely on mobile network infrastructure, MNOs will need to make significant investments to extend network coverage to remote areas. At the same time, because these services often incorporate mobile payments, payment providers will need to recruit a greater number of agents and manage them more efficiently to ensure that customers in rural areas can cash in/out on demand.

Because investments in agent and network infrastructure cannot be made without a compelling business case, actors along the value chain will need to drive an increasing volume of digital transactions that helps to justify costly investments in infrastructure. One way to achieve this goal is to enhance the value proposition of digital payments by developing the broader ecosystem surrounding mobile payments, including the availability of merchants and other service providers (e.g., agridealers, energy companies, schools, etc.) that accept mobile payments. Moreover, payments providers should revisit their fee structures so as to encourage regular use of digital payments. In some cases, they may consider passing along fees to off-takers or agridealers, for which cost savings or increased sales might justify the expense.

Partnerships with value chain actors like farmer groups, traders, off-takers, processors, and agridealers can help FSPs to more easily reach the scale and volumes necessary to drive returns on their investments in rural infrastructure. Indeed, these actors can act as an entry point for the integration of digital finance into value chains, which can stimulate acceptance and uptake by farmers and other market actors. However, partnerships themselves can create headaches for FSPs, especially in a complex sector such as agriculture. From challenges in mobilizing and sensitizing farmers, to questions around the quality and reliability of data, several examples cited in this analysis point to both the promise and perils of partnering to deliver complicated financial services to smallholders in value chains.

In the long run, there is likely to be a shift in how smallholders gain access to DFS that can boost their incomes and make value chains more efficient and inclusive. While many early digital offerings tend to favor farmers who already have strong connections to value chain actors, a number of digital initiatives are targeting farmers with loose connections to value chains in an effort to increase their capacity and productivity. Digital credit and savings products that help smallholders who have only loose connections to value chains to access improved inputs can boost yields and overall crop quality, thereby allowing these farmers to sell more of what they produce at a higher price. Low-cost digital insurance, perhaps bundled with or tied to the purchase of inputs, can reduce the risk of making such a significant investment. With new digital services emerging that offer smallholders access to post-harvest financing and the ability to shop around for the best price for their crops, DVCF holds the promise to tightly integrate millions of smallholders into value chains.

The potential role DFS can play in boosting productivity and tightening value chains is a key motivation behind investments in DVCF. With a growing recognition of the importance of agricultural development to economic growth, and the emergence of new threats posed by climate change, leveraging financial services to strengthen value chains and boost smallholder production is increasingly a national priority for developing countries. While DVCF offers just one approach to achieving these goals, the potential impact of DVCF means that CGAP and its partners will be watching developments in the space closely in the years to come.

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