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Finance Needs of the Agricultural Midstream and the Prospects for Digital Financial Services

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Abstract

Recent literature suggests that agricultural value chains are changing rapidly and places an increasing focus on the importance of actors and activities taking place in the "midstream" of these value chains, after production and prior to final sale. This article discusses the financial needs of midstream actors in agricultural value chains, emphasizing differences across midstream activities and highlighting how value chain characteristics can influence both financial needs and potential remedies. The paper concludes with a discussion of the prospects of digital financial services to alleviate financial needs of midstream actors.

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I. Background and motivation

Agricultural economics research in developing countries has traditionally centered on smallholder farmers and on-farm production. Smallholders constitute a majority of the world's poor, and a long-standing (though highly debated) view in development economics suggests that increasing smallholder productivity is essential for poverty reduction (e.g. Johnston and Mellor, 1961) and possibly for broader economic growth as well (Timmer, 2002).[1] The central role of smallholder farmers was reinforced by the 2008 World Development Report and the concurrent food price crisis (World Bank, 2007), catalyzing a renewed focus on international aid directed towards agriculture. Despite these more recent efforts and generally strong economic growth throughout the developing world prior to the COVID-19 pandemic, rural poverty remains a persistent challenge. This reality has highlighted a broader need for thinking beyond the farm and more holistically about rent distribution along the entirety of agricultural value chains. Large gaps between the prices paid to producers and those paid by final consumers suggest an inequitable distribution of these profits and allude to the importance of actors in the middle of agricultural value chains (e.g., Yi et al., 2021; de Brauw and Bulte, 2021, Bellemare et al., 2021b). Ultimately, for agricultural development to become a more effective poverty reduction tool, a deeper understanding of the behaviors, constraints, and interlinkages of value chain actors is needed.

A growing body of research suggests that the composition, roles, and services taking place in the agricultural sector are rapidly changing (Barrett et al., 2022). These changes are particularly pronounced in the "midstream" of agricultural value chains, encompassing all activities that occur after on-farm production and before retail. This evolution is simultaneously leading to emergent opportunities as well as new challenges (Reardon, 2015). And yet, the research base on these actors and their activities remains limited (Bellemare et al., 2021b; Barrett et al., 2022).

Wherever new economic opportunities emerge, suitable financial services and capabilities play a critical role in both facilitating investments in those opportunities and determining who is (and who is not) able to take advantage of them. Access to credit, secure saving methods, and reduced exposure to risk can facilitate investments while low-cost modes of payment and market coordination services have the potential to reduce transaction costs, creating greater surplus and potential efficiency gains. To meet their

[1] Whether improved performance of smallholders can both drive poverty reduction and long run economic growth is a disputed claim within the literature. At some point in the development process, some farm consolidation is necessary to reduce costs of marketing surplus through value chains (Collier and Dercon, 2014). Dercon and Gollin (2014) further note that the sheer number of smallholders within a country does not guarantee investments targeting them will have high returns in terms of poverty reduction or growth; agricultural productivity gains may also be easier to attain with larger farms. Nonetheless, an important constraint can be the size and development level of markets in which farmers sell their surplus.

financial needs, midstream actors use a wide range of both formal and informal services, but many gaps and inefficiencies remain. While many of these needs are similar to those facing actors in other sectors of the economy, the agricultural context can also introduce idiosyncrasies and constraints that undermine the suitability of established financial services and products for agricultural value chain actors. These differences can vary greatly across countries, across value chains within the same country, and across actors at different nodes within the same value chain.

Recently emerging digital financial services (DFS) may be able to fill some of these gaps in agricultural midstream financing. These new technologies have the potential to be more adaptable and better tailored to the unmet needs of midstream actors that are either unmet by the formal financial sector or costly when provided through the informal sector. Digital transfer systems, digital marketplaces, mobile based credit, savings, and loan products all may lead to increased efficiency and growth in the midstream itself with the potential for additional up and downstream benefits. In particular, DFS adoption among midstream actors, especially transfer systems, may offer an inroad to improving financial inclusion among smallholders who have been difficult to reach. However, constraints and low uptake by smallholders may also hinder DFS adoption and benefits among midstream actors, resulting in a low-adoption equilibrium in need of a subsidy or nudge to escape. Alternatively, increasing technological requirements of participation in high-value value chains could create a further barrier to income earning opportunities for the most marginalized farmers. While growing grey literature promoting the potential and benefits of DFS in the midstream exists, peer-reviewed research on these topics remains sparse.

In this paper we consider the financial needs of midstream actors working within agricultural value chains. We first provide a broad categorization of midstream actors, sketching their main activities and financial needs. We then detail a set of important value chain features along with a brief discussion of their implications for financial needs of midstream actors. We then discuss the limited existing research on financial needs and services for these actors. And finally, we discuss the potential for DFS to help meet these needs.

II. Who or what is the "midstream"?

Research in the past ten years has highlighted a number of recent trends and changes in agricultural value chains in developing countries. Rising income levels, changing relative prices of different foods, urbanization, changing demographics, shifts in trade patterns, and evolving technology are all cited as important drivers of these changes (AGRA, 2019; Reardon et al., 2012; Barrett et al., 2022). Acceleration of these shifts has led to assertions that rapid midstream growth is creating new economic opportunities (Minten et al., 2014b; Reardon, 2015; Hernandez et al., 2018). Widespread data limitations make clear

documentation of the scale of these opportunities a challenge, but many claim that the midstream constitutes a critical growth area of employment and income-generating opportunities in rural areas (Yeboah and Jayne, 2018; Dolislager et al., 2021; Reardon and Minten, 2021). Beyond income generation for midstream actors themselves, the functioning of the midstream has implications that extend to the ends of the value chain, affecting both the incomes of small-scale producers as well as the budgets and nutrition of consumers (Liverpool-Tasie et al., 2020; Yi et al., 2021).

The midstream of agricultural value chains can be divided into three broad phases: aggregation, value addition, and distribution. The composition of activities included in these phases depend on the country context and agricultural product, but typically include transport, trading and wholesaling, processing, and packaging, and storage. Businesses in the midstream can take on a wide variety of forms, from formal to informal, and while businesses often center on a specific midstream activity, some midstream actors may perform more than one role.[2] In some contexts, services such as transport or storage may be provided across value chains or even across sectors. The specific geographic context and agricultural product matter greatly, reflected in different value chain structures, activities, and participants, and further making broad generalizations difficult. Despite these challenges, we offer a stylized characterization of the main activities based on a range of academic and gray literature.[3] Table 1 summarizes these core activities, providing their source of profits, phase of the value chain, long-run credit and short-run liquidity needs, risk exposure, and other financial considerations.

[2] For some products, agricultural producers may do some activities themselves, particularly related to value addition or preservation, before sale.

[3] We provide an acknowledgment of a number of these studies and reports drawn on in this paper in Appendix Table 1.

Table 1. Value Chain Activities

Activity	Source of Profits	Phase of Value Chain	Long-Run (LR) Credit and Short-Run (SR) Liquidity Needs	Risk Exposure	Other Financial Considerations
Transportation	Spatial arbitrage	Aggregation and Distribution	SR: Liquidity for purchase of commodities from producers LR: Purchase of transport equipment	1. Damage to capital from bad infrastructure 2. Uncertain supply 3. Theft of cash	1. Search costs 2. Principal-agent misalignment of incentives
Trading and Wholesaling	Price mark-ups	Aggregation and Distribution	SR/LR: Rent or buy commercial space LR: Credit to purchase produce post-harvest at low prices, repay over time/later when prices rise	*1. Spoilage* *2. Uncertain supply/demand* *3. Theft* *4. Side selling*	*1. Delivery commitment* *2. Transaction costs* *3. Liquidity needs*
Processing and Packaging	Value addition	Value Addition	SR: Liquidity needs to pay for labor LR: Investment in processing/packaging equipment	1. Irregular supply 2. Low quality supply 3. Uncertain input prices 4. Uncertain global prices	1. Domestic/ international ownership 2. Export orientation
Storage	Inter-temporal arbitrage; Value preservation	All	LR: Investment in storage facilities LR: Capital to purchase goods while waiting for arbitrage opportunity (or timing of production)	1. Spoilage 2. Pests 3. Theft 4. Uncertain long-term prices 5. Electricity supply (cold storage)	*1. Delivery commitment* *2. Transaction costs* *3. Liquidity needs*

Source: Authors

Trading and wholesaling are frequently linked with transportation services. In many cases, traders expend energy identifying sellers and use their own vehicles to arrange transport. After accumulating sufficient volumes, larger traders may take the form of wholesalers who establish their presence in urban centers or rotate through local markets, letting nearby farmers bring their produce to them. Both frequently play an important role in aggregation of products as they move towards processors, exporters, or in preparation for within-country distribution to local consumer markets. Both trading and wholesaling require short-term liquidity for high transaction volumes, and improved access to short-term credit can assist small traders in buying larger quantities and growing their businesses. Longer-run credit needs may be required to acquire retail space or to accommodate the seasonality of buying large quantities at harvest and recouping the investment later in the year.

Processing activities include any activities occurring post-harvest that add value to a product. In the context of midstream activities, milling grains, drying coffee, treating milk, or more broadly the conversion of raw commodities into saleable or consumable products fall under processing. Some activities face low levels of risk after production and require minimal up-front costs, such as a simple tarp or a mortar and pestle. Small-scale local mills may require slightly more capital investment with rural entrepreneurs purchasing gas operated grinders to service the needs of local farmers, while taking on additional uncertainty and risk of theft, damage, breakdowns, and reliance on fluctuating local production and demand for the service. At the top end, large-scale factories may be involved with production of more

heavily processed goods, such as biscuits or yogurt that require substantial amounts of capital in the form of industrial mixers, ovens, and conveyors. These investments typically have high overhead costs making them more vulnerable to risks from unreliable input sourcing or access to labor. Large capital investments require higher production volumes to recoup investments while loss or spoilage can pose additional risks when any part of the production process is out of sync with the rest.

Packaging is needed to preserve the quality of most processed goods. For example, packaging is needed to preserve the freshness of recently produced yogurt, freshly roasted coffee, or canned foods; packaging can also be used to make fresh fruits and vegetables more attractive for the purpose of better marketing and higher retail prices. It can further serve an important role in reducing the risk of damage during transport that would otherwise cut into profits.

Next, storage is important for commodities with highly seasonal production. Wide variation in pre- versus post-harvest prices allow for potential profits from storage or may be conducted by processors themselves who want to ensure a steady supply of inputs needed to meet year-round demand. These activities frequently require access to credit to fund payment of post-harvest prices and accommodate delayed repayment from later sales. Additionally, storage faces risks of spoilage and uncertain later prices which may undercut anticipated profits. Storage occurs across the value chain, by farmers, midstream actors, and retailers. A variant of conventional storage is cold storage which combines standard storage dynamics with the specific climate requirements for preservation of perishable products. Capital requirements such as refrigerating facilities can be very expensive and require substantial access to credit. Further, cold storage requires a reliable source of electricity, so that outages do not lead to spoilage and lost produce.

Midstream actors also face different degrees of price and upstream production risk in varying forms. While production risk is faced most-directly by farmers and producers, risk in the form of inconsistent supply is also transmitted to midstream actors, particularly those who have made large capital investments and for whom profitability depends on maintaining a minimal productive capacity. Bad harvests lead to high post-harvest prices and cut into midstream actors' profits. Where substantial investments have been made anticipating a lower price and broader source of supply, this can constitute meaningful risk for these midstream actors. Some countries do have formal insurance products targeting production risk for small scale producers such as index insurance, but these products typically suffer from very low take-up unless they are heavily subsidized. To our knowledge, no similar viable product exists designed to serve the needs of midstream actors. Instead, midstream actors must adapt and adjust their business strategies when unexpected upstream shocks take place. On the other end, global price

fluctuations are also rarely covered by insurance products, can move unpredictably, and result in one year's profitable businesses becoming unprofitable the next.[4]

This list and discussion serve as a starting point for how to think about some of the main activities present in most value chains. Not all activities are present in all value chains and the sequence of steps may similarly follow different paths. Different actors may perform different combinations of activities depending on the context. While this characterization of different midstream activities is intended to anchor initial intuition, the context and structure of a given value chain are critical for anticipating how constraints or financial challenges facing midstream actors, such as a lack of credit or exposure to risk, will or will not affect them and be transferred to other actors at other nodes, both up and down stream.

III. Value Chain Heterogeneity

The previous section outlined how different midstream activities have their own inherent sources of risk and capital needs. However, a range of additional value chain characteristics also influence these financial needs as well as the set of options available for meeting them. Many of these contextual factors tend to vary along with a value chain's degree of modernization, while others may be inherent to the country context or characteristics of a given product.[5]

A handful of recent papers have described this evolution of value chain modernization and delineated three broad stages of development. We reference the main observations here, but recommend referring to the citations themselves for a complete discussion and set of references underpinning these groupings.[6] In their forthcoming article in the *Journal of Economic Literature*, Chris Barrett, Thomas Reardon, Johan Swinnen, and David Zilberman argue that agricultural value chains in low and middle-income countries are undergoing a "revolution". They characterize this revolution as a series of stages of modernity where important value chain features vary as they progress from traditional, to transitional, to modern. As value chains become more modern, the nature of midstream activities evolves as well. We adapt and expand on their framework to match our categories, summarized in Table 2.

As value chains modernize, transport and logistics progress from own transport and small brokers to third party logistics services, and eventually large companies and freight forwarders in modern value chains. Trading and wholesaling progresses from locally-based brokers, to urban based markets in transitional

[4] Very large business may find other ways of hedging on these prices and mitigating risk exposure, but SMEs in the midstream of most transitional value chains are unlikely to have this capacity.

[5] For example, products that spoil easily or require stricter quality controls may have a different structure than chains for products that are more stable or require less regulation.

[6] See Reardon et al. (2021a), Reardon and Minten (2021), and Barrett et al. (2022) for their rich discussions and examples of the progression of agricultural value chain modernization.

markets, and off-market distribution companies in modern value chains. Traditional value chains have little or no processing and packaging, in transitional value chains processing and packaging begins to be done by local SMEs, and in modern value chains it is largely done by large scale processors and manufacturers. Finally, storage is done at home or locally in traditional value chains, in central locations for transitional value chains, and in improved and centralized facilities in modern value chains. Across all these activities, the capital requirements and scope of activities generally expand. This changing nature of activities is both a response to and an enabling factor contributing to value chain evolution. Understanding where a specific value chain is in its development/transition speaks to both the financial needs of the midstream actors and the type of financial solution that is appropriate.

Table 2. Midstream Activities by Stage of Value Chain Modernization

	Traditional	Transitional	Modern
Transportation and Logistics	Own transport and logistics by small brokers	SMEs in third party logistics (3PLS)	Large companies and freight forwarders
Trading and Wholesaling	Brokers based in rural villages	Wholesalers based in urban markets	Off-market distribution companies
Processing and Packaging	None (home-processing)	SMEs such as small mills	Large processors and food manufacturers
Storage	In home or village	Central locations with improved facilities	Central locations with improved facilities (incl. cold storage)

Source: Authors

We next consider eight characteristics of value chains and how they differ as value chains modernize, which are further adapted from Barrett et al. (2022), making additions to help focus on the midstream. This is presented in Table 3. The first four characteristics relate broadly to the logistical structure of the value chain: value chain length, the end market, spatial dispersion, and the influence of seasonality. The second four relate broadly to market structure and relationships: market power, midstream entry costs, apex actors, and exchange relationships. Below we discuss these characteristics and how they relate to the midstream and their financial needs.

Table 3. Value Chain Characteristics by Stages of Modernization

	Traditional	Transitional	Modern
Logistical Structure:			
Value chain length	Short	Medium	Long
Spatial dispersion	Local	Rural-urban	Rural-urban, international
End market	Local	Regional/National	National/International
Influence of seasonality	Very High	High	Medium

Market Structure:			
Market power	Local	Local/Regional	Local/Regional/Global
Midstream entry costs	Low	Moderate	High
Apex Actors	None	Some	Prevalent
Exchange relationships	No or informal contracts and few standards	Informal and formalizing contracts, public standards, some vertical integration	Emerging contracts, private standards, vertical integration

Source: Authors

Logistical Structure

The logistical structure of a value chain has a major role in determining financial needs of midstream actors as well as shaping the space in which they act. First, value chains can be characterized by their length, or the number of nodes through which an agricultural product passes before reaching the consumer. Length therefore relates directly to the number of midstream activities contained in a value chain. Whereas a short value chain could be as simple as a smallholder walking to a local market and selling their produce to nearby villagers, value chains tend to lengthen as they modernize, passing through a larger number of intermediaries transporting, aggregating, storing, and adding value before reaching final consumers. In the former example in the absence of intermediaries, the price paid by the final consumer is the same as that received by the producer. More typically, each step in a value chain requires its own payments and markup, creating a wedge between prices at farm gate and final vendors. Longer value chains also create wider spans of vertical inter-dependency. While value chain length may not directly determine need for finance or credit, it can influence the type of financial services needed. For example, financial services that provide vertical linkages between actors for sales, credit provision, insurance, or other services, are all affected by the length of a value chain and the range and organization of actors present.

Next, related to but distinct from value chain length, the extent of a value chain's spatial dispersion can affect search costs, transportation costs, logistics procedures, and aggregation challenges facing these actors. As value chains modernize, lengthening chains may introduce greater exposure to specific risks, such as theft of cash, damage to capital, or principal-agent issues between value chain business owners and employees. Financial services could help mitigate some of these risks by allowing for more secure forms of transactions, improving coordination, and reducing search costs, and insuring or distributing

more of these potential risks. As value chains expand over space, financial transaction costs can grow, necessitating modern services to reduce those costs in transitioning value chains.[7]

As value chains modernize, they tend to serve larger and more distant end markets. This tendency is again linked with both chain length and spatial dispersion, but the type of end market creates unique requirements. While traditional value chains generally serve local markets, they often expand to serve regional, national, and eventually international markets as they modernize. National and international markets may require different quality standards that both necessitate increased investments and better record keeping, both of which require expanded financial services.

Finally, the seasonality of agricultural production and timing of harvest in many value chains have direct implications for the timing of the logistical needs of the value chain. It additionally affects the risk exposure and credit needs of producers as well as midstream actors who rely on their products as inputs. Rain-fed agricultural systems are, of course, more directly affected by seasonality whereas animal products typically have smoother production cycles. While most value chains remain dependent on the natural growing season, creating irrigation systems or greenhouses can extend or add growing seasons to production as value chains modernize.

Most rain-fed agricultural systems have relatively synchronized harvests of primary grains and legumes that can create increased short-term credit needs for midstream actors focused on purchasing, distributing, and processing these products. Where robust warehousing systems are missing, the greater the volume of a country's agricultural production that is harvested at or near the same time, the greater will be the seasonal liquidity needs of traders and transporters in the months following harvest. Where possible, some midstream actors may work across multiple value chains with different seasonal patterns so that their capital investments are used at higher capacity throughout the year. This may have an additional benefit of spreading risk in the case of a bad growing season for a particular crop. These challenges are less relevant in less-seasonal (typically non-rain dependent) value chains, such as milk, eggs, meat, or aquaculture, making financial needs of such firms more closely resemble those of other non-agricultural businesses. Loan products in highly seasonal value chains will need to accommodate the lags between purchase and eventual resale for these midstream actors and where a rush on credit occurs during specific, post-harvest seasons, liquidity may be scarce throughout the entire financial system. More

[7] On the production side of the value chain, products that need more specialized agroecological conditions, such as vegetables which require a lot of water, may be more concentrated in specific areas, whereas staple crops can be spread over wider portions of a country. These varying geographic structures also have implications for the types of financial services that midstream actors require.

broadly, the availability of suitable financial products for entrants offering feasible repayment schedules and non-prohibitive interest rates are central to competition at these nodes of the value chain.

Market Structure

Market structure may further affect the functioning and financial needs of midstream actors within value chains. Here, we highlight four components. First, concentration of market power is often observed at midstream value chain nodes. For example, there might be one processor making chili paste in a specific region or country; that processor would then have monopsonist power within the chili pepper value chain. Value chains serving international markets typically have a limited number of final buyers in the distribution phase, shipping either raw commodities or processed goods abroad. High entry costs of serving international markets frequently lead to monopsony or oligopsony power among a single or a small number of international exporters able to access international markets. In contrast, distribution within value chains for domestic staples is typically more diffuse and thus may have more potential entrants among buyers in agricultural markets. However, regionally the midstream may again be vulnerable to locally monopsonistic buyers when transport and search costs are high for smallholders in remote areas, and barriers to entry exist.

The presence of market power at a given node of a value chain can inflate the rents of dominant actors while marginalizing smaller actors and prospective entrants. The distribution of market power could affect vertical relationships and arrangements, manifesting itself in negotiated prices, contracts, and distribution of risk in favor of those with greater market power and thus, leverage. As a result, returns to investment among smaller actors can be reduced, along with a banks' willingness to lend to those actors or willingness of new potential entrants to invest. However, especially in modernizing value chains where a high initial investment is essential, the presence of less-competitive actors may serve a helpful or even essential role; the entire value chain might not exist without, for example, a local processing plant. Additionally, these larger scale actors may also be able to reduce risk exposure of other actors in the chain by providing a guaranteed market for farmers or traders. They may further have both the incentive and capability of providing needed credit and liquidity to other actors by themselves borrowing formally from banks and passing loans to farmers as in an agricultural value chain finance scheme or providing that liquidity directly from their own reserves. The role of market power in any given value chain will be an important component of designing appropriate financial products.

Second, many midstream activities require substantial lumpy fixed-cost investments for new entrants. Transporters may need trucks, cold storage requires cold rooms and power sources to cool them, and grain processing may require a mill. The specific requirements will depend on the value chain and the

technology needed to perform the given task. In highly mechanized value chains these costs may be very high whereas in others, a midstream activity may only require additional labor and minimal additional financing. The higher the start-up capital needs and the more expensive these items, the more likely that the level of competition at a specific value chain node will depend on access to finance. Lack of competition at a given node may also be the result of only certain actors being able to operate at a sufficient scale to achieve low marginal costs such as established distribution or supply networks and infrastructure (Williamson, 1995). Other related services may also act to lower these barriers. For example, digital platforms that allow for equipment rental could make initial entry more feasible or provide additional income sources for equipment owners.

Third, market orientation towards domestic or international markets can directly affect value chain structure. Value chains serving international markets typically have a limited number of final buyers in the distribution phase, shipping either raw commodities or processed goods abroad. High setup and marginal costs of serving international markets frequently leads to monopsony power among a small number of international exporters able to access higher global prices. In contrast, the distribution phase of domestic oriented value chains is typically more diffuse and thus may have more potential entrants among buyers in agricultural markets. For both types, the midstream may again be vulnerable to locally monopsonistic buyers when transport and search costs are high for small-scale producing farmers and barriers to entry exist.

These factors also closely relate to the presence of dominant market players, or “apex actors”. Whether these apex actors are large-scale exporters, monopsonistic wholesalers, or monopolistic processors, their presence can affect the financing ecosystem of a value chain. International exporters or large-scale domestic distributors frequently have better access to capital. In these instances, seeking to establish stable sources of supply, large private actors may be able to use their own resources to feed liquidity into their supply chains, meeting the needs of other midstream actors or even small-scale producers where local financial institutions are unable. Apex actors (or otherwise large actors) are also better positioned to absorb price risk than smaller actors in the value chain.

Finally, we consider the type of exchange relationships featured in different value chains. While contracts of some type are a feature of relationships between buyers and sellers and input providers across all commodities, traditional value chains may feature more relational contract structures which become formalized as value chains modernize (Michler and Wu, 2020). More formal contracts may carry more regulation and quality standards.

Altogether these different market dynamics, value chain structures, and balances of power are likely to manifest themselves in the form of relationships between value chain actors. As mentioned earlier, the presence of market power among different actors will influence division of surplus. In so much as vertical dependencies are created, relationships may also include financial arrangements where larger actors help smaller ones, either up or downstream, by offering credit or contracts with lower risk exposure. The degree of formality in these relationships can, however, vary greatly. In traditional value chains, most relationships are informal and transactional. As value chains modernize, these become more routinized and formalized, leading to more formal contracting arrangements. In the most extreme manifestation, vertical integration of value chain activities can dispel entirely with the needs for contracting as larger range of activities are incorporated under the same operational umbrella.

IV. Evidence on Financial Constraints and Needs of Midstream Actors

In the previous section we provided a framework for thinking about midstream actors and their roles in modernizing value chains. As we consider how financial services might be adapted to serve their needs, we first review the research on existing financial services that relate to the agricultural midstream. In general, there is limited work that addresses this specific question, and much of what has been studied focuses principally on smallholders, with midstream actors as a secondary factor. We consider credit and insurance needs as well as contract farming and vertical linkages.

Credit and insurance needs in the midstream

Where available, well-designed financial instruments offered by banks and MFIs tailored to the needs of a specific midstream activity may be the first-best financial solution for that actor. Formal insurance, credit, transfer and payment services, savings vehicles, and market platforms all may, at times serve these roles. However, information asymmetries, moral hazard, and limited liability frequently impede the functioning of insurance and credit markets while idiosyncratic needs of diverse midstream actors may lead to poorly matched needs and available financial products. Unmet financial needs may therefore manifest themselves in other ways along value chains such as when risk exposure and credit needs affect prices, forms of contracting, and vertical relationships more broadly. Financial challenges facing smallholder farmers can therefore directly affect the availability of needed inputs for midstream actors. In this section we focus on access to credit and risk exposure as key areas where financial services can affect the overall function of agricultural value chains, emphasizing their implications for midstream activities. We include both formal and informal approaches for addressing these financial constraints as they influence midstream actors' behaviors.

Credit needs among midstream actors can vary widely. While large-scale private actors in value chains may be able to satisfy their own credit needs, by self-financing, accessing formal finance in the existing banking system, or by accessing international investment and financing (e.g., Van Campenhout et al., 2020), less formal SMEs or individual actors in the midstream are less likely to have ready access to affordable credit. The broader literature in developing countries suggests that SMEs across all sectors are frequently credit constrained and that there may be substantial returns for many of these actors to additional credit.[8] Most of these studies are based in urban samples, targeted towards non-agricultural activities, and thus may miss the particular credit needs and returns relevant to midstream agricultural SMEs.

A notable exception comes from Lauren Bergquist and Michael Dinerstein's (2020) paper on market power among maize traders in Kenya. The authors find low take up of subsidized entry into trading, suggesting high unmet credit needs in this midstream segment of the maize value chain. However, they also find that randomly induced entry into local markets does not affect local prices over the course of the study, attributing this non-response to collusion among traders. Expanding credit may therefore not be sufficient for reducing rents taken by large scale actors in non-competitive value chain nodes. In another paper also within the maize value chain in Kenya, Burke et al. (2019) use a randomized control trial to show that lean season liquidity and credit constraints impede farmers' ability to store their produce. Those provided with harvest time loans are able to store and delay sale of their output at better prices later in the year. In light of these credit constraints, storage activities are more frequently conducted by large-scale actors who are then able to exert monopolistic power in lean season.

Credit needs can also affect midstream activities indirectly by hindering supply of agricultural inputs from smallholder farmers, either in terms of having reliable and sufficient quantity or quality. Smallholder credit constraints are well documented in existing literature suggesting that many farmers could, indeed, improve their productivity and reduce their vulnerability to shocks by adopting improved agricultural technologies and inputs. Where smallholders' credit needs are unmet, midstream actors may in turn have inconsistent supply, and therefore they have an incentive to provide credit to farmers themselves. Credit arrangements can take place through contract farming, provision of inputs on credit by buyers (e.g.,

[8] De Mel et al. (2008) use randomized grants for microenterprises in Sri Lanka and find average real returns to capital of 4.6% to 5.3% per month, above the actual market interest rates; these returns are lasting (De Mel et al., 2012). Fafchamps et al. (2014) give cash and in-kind grants to firms in Ghana, finding the in-kind grants lead to higher returns particularly female entrepreneurs, suggesting self-control problems with cash. Blattman et al. (2014) found grants to youth led to 38 percent gains in income; nine years later those impacts had dissipated (Blattman et al., 2020). McKenzie (2017) further shows high returns gained by winners of a randomized business plan competition in Nigeria.

relational contracting), or through agricultural value chain finance as mentioned above and discussed below.

Second, exposure to uninsured risk has the potential to deter or distort investments. It may further lead to inflated prices to compensate for risk exposure and exclude would-be entrants who are risk averse. Ideally, insurance markets could directly cover the different sources of risk facing midstream actors while offering them suitable and fairly priced insurance products. In some (probably rare) instances that may be the case, such as for car insurance, insurance from theft, or some forms of agricultural production or livestock insurance. Some of these markets are also boosted, especially in more developed countries, by laws requiring that everyone participate in a given insurance market, thus avoiding issues of selection. But a large literature on risk and agricultural production in developing countries suggests potentially meaningful gains from reducing risk, but also substantial barriers to adoption.[9] Again, rigorous studies assessing the impact of uninsured risk on productivity of midstream actors is missing. Here the broader literature on SMEs is also virtually empty. More often, exposure to risk instead either gets priced into negotiated contracts or informal agreements and may lead to activities being non-profitable (Michler and Wu, 2020).

Vertical Linkages and Contract Farming

Exposure to uninsured risk and unmet credit needs of value chain participants will affect both their upstream suppliers and downstream buyers. These vertical linkages may also lead to alternative financing strategies, that leverage these linkages, both formal and informal. This is especially important for midstream activities in agricultural value chains that depend on smallholder farmers for their main source of raw produce and inputs since these producers are most likely to face credit constraints and be exposed to uninsured risk. Where these needs go unmet, the supply and quality of inputs for midstream actors further downstream will suffer. Midstream actors may therefore have an interest in relieving these constraints among their small-scale suppliers, which can occur through contracting relationships of varying degrees of formality. And when other methods fail, uninsured risk will likely get priced into

[9] Cole et al. (2017) in India, and Karlan et al. (2014) in Ghana, show similar evidence of shifts in investment towards higher return products and greater profits in RCTs randomly providing free rainfall-linked insurance to smallholder farmers. In another RCT, Lane (2020) shows that offering loans conditional on experiencing bad weather outcomes in Bangladesh also leads to shifts in investment towards more profitable commodities. In tension with these positive returns, Giné and Yang (2009) explore the interactions between credit and insurance markets and find that offering bundled insurance along with credit reduces take-up of credit, suggesting negative willingness to pay for risk reduction. Barriers to adoption of agricultural index insurance are widespread and further explored in papers by Cole et al. (2013) and Casaburi and Willis (2018).

different services and goods, or willingness to enter at all among exposed midstream actors. Despite a general lack of research on financial needs in the midstream, contract farming is one form of these vertical relationships that has been relatively well studied.

Formal contracting between value chain actors can come in many forms, and (as discussed in the previous section) will vary based on the type of value chain. Contracts are typically defined by type of product or service, quantity, price, quality, and timing of delivery and payment. Stipulations may further either directly or implicitly target financial needs of one or both actors. Smallholder farmers with unmet credit needs may be offered free inputs with repayment factored into prices or shares of yields given to the buyer at harvest. A guaranteed price can inherently reduce exposure to price risk for smallholder farmers.[10] On the other hand, contracts may allow for transaction prices to be linked to the prevailing market prices, reducing the risk exposure of the buyer or alternatively reducing the incentive for farmers to side sell and renege on their contracts. Farmers are also frequently provided with extension services to ensure that their produce meets the processor's or exporter's product standards. In return, buyers gain access to a more suitable and reliable set of inputs in terms of quality and quantity which they can then either sell on or process for later sale (Minot and Sawyer, 2016). Details of these arrangements therefore have potential for gains among both partners with a reallocation of ex-ante risk between buyer and seller along with prices and, where relevant, terms of credit that are more optimal for both parties.[11]

In theory, formalized contract farming has the potential to raise farmer income and enable them to shift into higher value crops despite lack of access to formal credit or insurance, while buyers can expand their businesses and profit from processing, distributing, or exporting with a more stable supply of inputs. The evidence on contract farming has focused predominantly on the impacts on smallholder farmers; literature reviews on contract farming include those by Glover (1984), Bellemare and Bloem (2018), and Otsuka et al. (2016). Summarizing, the expected positive returns for farmers are not consistently found, as increased costs of compliance may match increased revenues from the contracted crop. These findings are further clouded by identification challenges that inhibit the causal interpretation of the effects of contract farming participation on farmer outcomes.[12] More broadly, research has found that whether

[10] Bellemare et al. (2021a) show that fixed-price contracts —which transfer risk from the farmers to the midstream processors who purchase their produce— lead to an approximately 0.2 standard deviation decrease in farmers' income variability. Guo and Jolly (2008) find that floor pricing, valued as a form of risk reduction, can improve contract fulfillment rates.

[11] See Ashraf et al. (2009) for an example of contract farming to ensure a steady supply of products for processing between Kenyan green bean growers and an international exporter serving the European market. See Ambler et al., (2018) for an example of a domestic contract scheme for sugarcane producers**.**

[12] Arouna et al. (2021) provide one exception using an RCT to show that a price guarantee for farmers in Benin reduced their exposure to risk and enabled them to diversify into other investments.

contract farming meaningfully improves welfare among farmers, the profit incentive of buyers may lead to the exclusion of poorer farmers or those from more marginalized groups (Ton et al., 2018; Minot and Sawyer, 2016).

The existence of contract farming suggests that processors or exporters, willing to engage farmers on these terms, must be profiting for it to be worth their efforts. However, a more nuanced understanding of their returns and effects of particular terms and conditions for different contracts are relatively underdeveloped. Contract farming appears to be an important and widespread arrangement in developing, transitional value chains in particular, it is also not a silver bullet for poverty alleviation or for solving financial needs in the midstream or in the agriculture sector more broadly.

An alternative is for contractual arrangements to occur through producer organizations, which sometimes help farmers access extension services, access to inputs, or credit, but most commonly provide services related to output for their members (de Brauw and Bulte, 2021). Such services include grading, bulking, and storage, and at their best producer organizations can help processors access smallholder output at a lower cost by contracting with the producer organization. At their best, producer organizations can bond smaller farmers together to "act" like a large farm. However, they frequently lack good management, which can affect their performance in a number of different ways, and can make them riskier to deal with from a midstream or finance perspective (Kahsay and Bulte, 2021).

A major issue in the sustainability of contract farming schemes, whether with individual farmers or producer organizations, is contract enforceability. Buyers tend to emphasize hold-up risk, or the risk that farmers will take the inputs on credit and, at the time of harvest, instead sell their products to other buyers offering a better price.[13] In their review, Reardon et al. (2021a) cite a number of studies suggesting that "tied output-credit" arrangements between SME wholesalers and farmers have been on the decline. They attribute this shift to value chain modernization whereby improved infrastructure leads to competition among buyers, and the possibility of side selling damages the sustainability of contracts. On the other side, farmers may not always have confidence that buyers will, in fact, deliver a promised price if market prices are below that offered in the contract, that quality standards will be fairly applied when they are

[13] Fafchamps (2003) use data from Benin, Madagascar, and Malawi, and argue that contract renegotiation is common, especially on the farmer's side. Macchiavello and Morjaria (2021) observe that in Rwanda, coffee mills must rely on a "legally unenforceable provision of services before, during and after harvest" to source coffee cherries from farmers. de Brauw and Bulte (2021) describe hold up risk from the farmers' perspective in relational contracting; if farmers make investments in quality without investment from the trader, they face risk that the trader will only purchase a share of their crop. This pattern is found in certified coffee markets in Kenya (Van Rijsbergen et al., 2016).

ready for sale, or that all their product will be purchased (e.g., Fafchamps, 2003; Saenger et al., 2014; Van Rijsbergen et al., 2016).[14]

These inter-linkages between small-scale producers and midstream actors are not always formalized in contracts but may still manifest themselves in negotiated agreements between value chain actors. Using an instrumental variables approach, Macchiavello and Morjaria (2021) find that even informal relational contracts between Rwandan coffee growers and mills improve farmer productivity. However, these benefits are diminished by side selling in areas with greater competition among mills damaging both farmer and mills' profits. In another paper, Casaburi and Reed (2020) show a different form of interlinked transaction between cocoa traders and growers in Sierra Leone. In their experiment, the authors show that traders compete with one another both on price as well as provision of credit (advance payments) in pursuit of cocoa growers' output. In Kenya, Casaburi and Macchiavello (2019) show that farmers' unmet liquidity needs and lack of options for effective savings lead them to value *infrequent* payment from milk traders and processors as a form of commitment savings. A final example, from Ghani and Reed (2022), shows that ice suppliers compete for fishermen's business and needs for cold storage by giving them preferential supply when market-wide supply is scarce, and offering better terms for credit when supply in the market is relatively abundant.

A variant of contract farming is agricultural value chain finance (AVCF). AVCF are forms of financial service schemes that leverage the inter-linked roles between value chain actors to extend financial services (usually credit) to otherwise non-creditworthy smallholder farmers while improving the reliability of midstream actors. AVCF blends some aspects of relational contracting with more formal contracting that is observed in modern value chains (Michler and Wu, 2020; Liverpool-Tasie et al., 2020; Barrett et al., 2022). A standard AVCF scheme allows a formal lender (e.g., a bank) to lend to a single enterprise (e.g., a processor), which then buys commodities from individual farmers. The relationship between the enterprise and farmers can act as a substitute for more formal collateral provided by the farmers. The enterprise can more effectively monitor and screen farmers and provide the individualized loans that banks find too costly to make, while the bank retains the ability to make a formal loan to an enterprise that has business that is easier to understand for its loan officers. Where direct provision of credit to smallholder farmers from FSPs is not viable or too risky, an alternative model leverages midstream buyers as price guarantors for farmers. With this promise of a buying price and reduced exposure to price risk, these smallholder farmers become less risky borrowers for FSPs. Conceptually, AVCF can involve credit,

[14] Saenger et al. (2014) use an experiment with Vietnamese dairy farmers to show that threat of independent verification of milk quality increases confidence among farmers in the fairness of quality assessment at sale and leads to increased investments and profits among farmers.

insurance, or a blend of both (Miller and Da Silva, 2007; Miller and Jones, 2010). Liverpool-Tasie et al. (2020) review the evidence on market links between value chain actors and small-scale producers finding that larger scale actors are most likely to offer producers complementary services, including credit and further find that these benefits are frequently extended to midstream SMEs as well.

In descriptive work in South America, Gonzalez-Vega et al. (2007) find that existing value chain relationships between farmers and an international wholesaler facilitated farmers' access to formal financial services. However, in a comparison of three different value chains in Uganda, Johnston and Meyer (2008) suggest that the success of AVCF was dependent on the value-chain structure where the ability of firms to monitor the behaviors of farmers was a key determinant of the scheme's viability. Ultimately, the literature shows that solutions like contracts that provide for stable vertical linkages are an important component of developing value chains. However, more evidence on how it benefits both smallholders and midstream actors, particularly smaller ones, is needed.

V. Emergent Digital Financial Services and Evidence

The recent and rapid expansion of mobile phone availability and the accompanying emergence of DFS are creating new forms of financial services. There are many reasons why DFS have the potential to expand financial offerings in agriculture. Low marginal cost of service expansion may allow digital services to penetrate into markets where conventional reliance on brick-and-mortar presence is financially infeasible. Low marginal costs of service provision may also result in lower usage costs or better terms for adopters when services have reached scale. In addition to low service fees, mobile based services can reduce shoe-leather costs and processing delays that frequently accompany formal services. Digital platforms also have the potential to take more innovative forms, offering more adaptable and tailored services where standardized products and existing services may not have been well matched to users' needs.[15]

However, DFS adoption requires a number of important prerequisites. Most mobile-based digital services require network coverage and connectivity. Second, although dependence on physical infrastructure is reduced, an accessible agent network is still necessary for many services so that users can deposit and withdraw cash from their mobile-based accounts. Third, DFS require a means of accessing the new services, typically through mobile phones. Some services are SMS based and can therefore be accessed

[15] Aker and Mbiti (2010) provide a review of the potential benefits of expanding access to mobile phones across Africa, highlighting lower search costs, greater arbitrage opportunities, and welfare improvements while providing a platform for future digital services.

with feature phones, though others require more complete smart phone functionality so that barriers to technology adoption (e.g., cost and learning) may impede take-up, particularly among marginalized groups.[16] Broad trends suggest widespread expansion in access to reliable network service as well as mobile phones (Fabregas et al., 2019; GSMA 2020b). While midstream actors themselves may be more likely to have the education and resources to overcome these technological barriers, issues of unequal access and returns may persist, and services based on linkages between midstream and upstream small-scale producers may be further hindered by technology adoption related challenges as these services evolve and expand.

While DFS have the potential to catalyze major changes in peoples' financial capabilities, evidence on the actual impacts of DFS is only beginning to emerge. In the remainder of this section, we discuss the potential for digital payment systems, credit, insurance, and marketplaces for addressing financial needs of midstream actors, along with the existing relevant evidence. The focus of many existing studies of DFS in agriculture is on smallholder needs and experiences. However, for a range of reasons midstream actors, even small ones, may be more likely to have reliable access to digital infrastructure (Denyes et al., 2019). As such, they have potential to benefit more initially, and catalyze greater use of DFS upstream in the value chain.

Digital Transfer/Storage Systems

Digital transfer, payment, and money storage or "mobile money" systems are the most mature and widely adopted mobile-based financial services. While the extent of adoption is inconsistent across developing country contexts, these basic services are currently available almost everywhere (Demirguç-Kunt et al., 2018; GSMA, 2020b). Mobile money can offer a safe alternative to cash savings, reducing exposure to theft or pressures to spend (Aker and Mbiti, 2010). The transfer feature can greatly reduce transaction costs that accompany cash payments or remittances, especially those occurring across large distances (Jack and Suri, 2014). In addition to these benefits, advocates argue that mobile money can serve as a required first step in gaining access to a broader set of DFS (BTCA, 2016).

In countries where mobile money has achieved wide penetration, its emergence has constituted a particularly important change in the financial ecosystem. Suri and Jack (2016) argue that adoption of mobile money technologies in Kenya lifted 2% of the country's population out of poverty, driven by

[16] A report by the International Finance Corporation (IFC) draws from survey data and administrative records on mobile transactions to show the persisting gender differences in financial inclusion and behavior in Sub-Saharan Africa. In Zambia, for instance, the report finds that usage of mobile money is negatively correlated with being a woman; and that 33% of women report little or no knowledge about mobile money, compared to 14% of men. These informational barriers towards women also occur in countries like Senegal and Uganda (Denyes et al., 2019).

decreased vulnerability to shocks, increased savings, and better labor market outcomes.[17] Digital transfer systems in a wide range of settings may have the potential to increase traceability and reliability of payments and transfers.[18] Outside Kenya, within the agricultural sector and among rural populations likely to be late adopters, cash-based payment systems remain most common for all but the largest actors. While the impact of mobile money on households has been studied, there is little evidence on the impacts of mobile money adoption explicitly targeting the agriculture sector or its midstream actors.

However, many claim that the agriculture sector is on the brink of change. The Global Findex Database covers financial behavior of individual economies around the world with data on how adults save, borrow, make payments, and manage risk. Mobile money accounts have been spreading widely —especially in Sub-Saharan Africa. There appears to be considerable untapped potential for digital payments in agriculture, where about 235 million unbanked farmers and actors receive agricultural payments in cash, and 59% of those own a mobile phone (Demirguç-Kunt et al., 2018). Ultimately, gains from adoption of digital transfer systems are likely to depend on the structure of the given value chain.[19] Initial costs of adoption may need to be initially subsidized, either by external sources (government or aid) or by large scale actors whose market power allows them to incur short-run losses.

Digital transfer systems have the potential to reduce transaction costs and create greater efficiency for transacting partners. They may additionally lower exposure to theft or loss that would result from holding large amounts of money needed for cash-based transactions. Digital transactions also generate verifiable records of past activities that can increase accountability and traceability of past transactions. Midstream exporters or processors who source their inputs from a recurrent set of suppliers, with high numbers of transactions, are likely to have the greatest returns to lowering transaction costs and (depending on the accompanying service fees) adopting digital payment systems (GSMA, 2021). In their report on Ghana's Cocoa Sector, the Better Than Cash Alliance calculate that cash-based payment systems cost businesses 19% of their total revenue (BTCA, 2020). These losses are calculated as resulting from foregone interest on estimated payment delays, additional transportation and transaction fees, losses from theft, and additional bureaucratic fees. These large potential gains suggest that digitization could lead to benefits

[17] Using a natural experiment from the expansion of mobile money in Kenya, Jack and Suri (2014) find that mobile money adoption eliminates vulnerability to negative household shocks by increasing remittances from their social networks.

[18] The Better Than Cash Alliance (BTCA) provides a range of references for early DFS use cases here: https://www.betterthancash.org/why-digital-payments.

[19] GSMA (2021) presents a value chain assessment tool to determine the suitability of different agricultural value chains for digitization highlighting the value of agricultural formal sector procurement, volume of production, size of transactions, frequency of transactions, and interlinkages of value chain actors as key considerations.

for actors all along the value chain. World Bank (2020)'s report on the digitization of agribusiness payments in Africa offers a case study of VegPro, one of the largest producers/exporters of fresh produce in Kenya, transitioning to digital payments and reducing transaction costs for participating farmers (minimum deposit requirements, deposit fees). Causal evidence remains sparse, however, on the effects of the adoption of digitized payment systems, whether these potential gains would manifest, or if other challenges and bottlenecks would emerge. Whether adoption of digital payment systems is a necessary pre-requisite for the use of higher value services or if these services are critical to stimulate adoption remains an unresolved question where there may prove to be circumstances supporting each model.

Digital Credit Services

Second, digital credit services may be able to create borrowing opportunities among potential borrowers presently excluded from formal markets. In particular, digital data sources, including the type of transaction histories generated from the use of digital payment systems may be used for digital credit scoring and assessments of creditworthiness (Bjorkegren and Grissen, 2020). These scores may, in turn, circumvent the need for prohibitive collateral requirements frequently required as part of conventional loans or the high coordination costs that accompany microcredit.[20] BTCA (2020) provide an example of these new services in Ghana where mobile service providers partner with local banks to offer short-term loans that can be accessed strictly through SMS based interactions.

The flexibility of mobile-based lending has further potential to be paired with input products so that credit offerings are more closely paired with the actual credit needs and feasible repayment schedules of borrowers. Again, these new services may be most relevant to smallholder farmers and small-scale vendors, but relieving their credit needs can, in turn, benefit midstream actors by improving the reliability and quantity of their supply of inputs or demand for their post-value addition products. Though midstream actors may be less likely than farmers to lack access to formal credit, their access is by no means universal, and small-scale firms like transporters or traders may benefit from the expanded availability of digital credit offerings.

Digital credit services have generally been slow to catch on in agricultural value chains, even in countries with high general rates of mobile money adoption. Efforts to spur digital credit take-up have been hindered by high default rates.[21] These high default rates are suggestive of potential deeper and more

[20] Tsan et al. (2019) argue this in a CTA/Dalberg report on the digitization of African agriculture, making the case that digital credit can boost financial inclusion by allowing farmers to access previously unattainable financial services. This is also claimed in the GSMA report (2020b).

[21] One example is provided in Kenya in CEGA (2021) here https://cega.berkeley.edu/research/digital-credit-for-agriculture/

troubling issues with digital credit. Lower barriers to access credit may create the potential for substantial gains, but there are meaningful risks as well. Recent media coverage suggests that low levels of financial literacy and aggressive salesmanship by service providers can lead some borrowers to take on risky loans and find themselves in cycles of debt.[22] A more recent working paper, Brailovskaya et al. (2021) also suggests widespread misunderstanding of loan terms and hidden fees and penalties in digital microloans in Malawi. A recent CGAP blog post based on newly collected data from Kenya and Tanzania reports that more than 50% of borrowers had repaid loans late (incurring late fees), 12 and 31 percent (respectively) had defaulted on loans, and 20 and 9 percent (respectively) reported reducing food consumption in order to repay loans.[23] Consumer protection remains an important area of future research as digital services, of all forms, continue to grow. Strategies that focus on introducing digital credit to midstream actors could promote AVCF-type models that mitigate default among smallholders.

Digital Insurance and Risk Reduction Services

As discussed, insurance products covering agricultural production have faced low adoption rates. Digital based insurance may prove to be a more appealing product if costs can be reduced and products can become better tailored to specific individual needs. A recent report from GSMA asserts that a shift away from indemnity-based insurance towards index-based insurance is generating new opportunities for mobile based insurance provision to reach smallholder farmers, even while adoption remains low (GSMA, 2020a). Another effort to improve monitoring with lower field costs is to use picture-based whereby farmers take and send pictures with a mobile phone to document crop losses instead of relying on physical inspections or index insurance options (Ceballos et al., 2019). However, few if any of these innovations are tailored to midstream actors.

Digital farming advisory services offer an alternative digital service that can help reduce risk exposure among smallholder farmers. In fact, advisory services make up the majority of digital services in the agricultural space (Tsan et al., 2019). Improved farming practices as well as advice that incorporates weather forecasts and individual plot attributes may, in practice, reduce farmers *ex ante* exposure to negative shocks while improving expected overall yields. A 2019 report from the Technical Centre for Agricultural and Rural Cooperation (CTA) highlights digital solutions for risk-assessment and insurance

[22] "Kenya outrage over debt collectors' shaming tactics" https://www.bbc.com/news/world-africa-57985667 and "Mobile-based lending is a double-edged sword in Kenya—helping but also spiking personal debt" https://qz.com/africa/1722613/mobile-money-lending-in-kenya-helps-but-also-spikes-debt/

[23] See Izaguirre et al. (2018)'s blog post: "It's Time to Slow Digital Credit's Growth in East Africa" https://www.cgap.org/blog/its-time-slow-digital-credits-growth-east-africa

(e.g., digitally enabled index, weather, precipitation, and pest insurance).[24] Advisory services are again targeted towards smallholders, but there is a role for platforms that include midstream actors that may benefit from better and quicker information.

Market Platforms

Driven by the wide geographic coverage of production for many commodities in the agricultural sector, search, transaction, and coordination costs can be especially high. Digital marketplaces or platforms have evolved as a solution to these high costs. In their simplest form, these platforms seek to connect buyers and sellers and may add on payments or other features. This is one of the most relevant services for the midstream as it can serve to connect them more efficiently to farmers or to other midstream actors further downstream. Market platforms have the potential to reduce search costs along with information asymmetries endemic in spot market interactions and non-repeated transactions more broadly. Market platforms have the potential to reduce costs and challenges facing midstream buyers facing unknown quality, unreliable suppliers, and uncertain prices. Producers can benefit from better prices and timing of sales and can make locally monopsonistic markets more competitive by offering credible outside offers to small scale farmers.

Fueled by venture capital, digital platforms to buy and sell agricultural products have been growing rapidly in recent years. In a report from the Rural & Agricultural Finance Learning Lab, the authors summarize the state of digital agricultural platforms.[25] In summary they find that although there has been an explosion of these services, half are concentrated in India and Kenya while 75% are being run by tech startups and have not reached sustainable scale. Among the obstacles flagged by the authors, digital marketplaces in the agricultural sector are especially challenging because high upfront costs and barriers to technology adoption inhibit farmer participation and systems risk being bypassed by participants.

Despite these challenges, these platforms still carry potential and, at scale, may prove sustainable drivers of further gains in the agricultural sector. In the only study directly testing the impacts of participation in these nascent digital marketplaces, Bergquist and McIntosh (2021) show substantial evidence of spatial arbitrage and welfare gains. However, gains appeared concentrated among the largest of smallholders who themselves engaged in midstream aggregation and trading on the platform, both buying and selling maize. Digital marketplaces may improve the performance and ability to transact for midstream actors,

[24] Fabregas et al. (2019) argue that given large returns to smallholder farmers, but with very low ability or willingness to pay among those who would benefit most, this is a critical area for public subsidy to stimulate growth until service providers have reached sufficient scale as to be profitable.

[25] Full report: https://isfadvisors.org/wp-content/uploads/2021/03/ISF_RAFLL_Agricultural_Platforms_Report.pdf

but technology adoption costs may still prevent smallholders from sharing in these benefits. In general, these platforms face a challenging landscape when considering how to scale and monetize their services. The margins earned from participating smallholders are generally too small to profit buyers, sellers, and the platform. As such, work remains to find the right service delivery model (ISF, 2021). One promising possibility are "super platforms" that combine market linkages other financial and advisory services to appeal to a greater group of customers. The effects of forced lock downs and limited mobility resulting from COVID-19 restrictions over the past two years may have further shifted the equilibrium of technology adoption and digital market usage, but is still not fully documented or understood at this point.

The broad menu of ever evolving digital services carries great potential for impact across many agricultural value chains. However, technical capabilities seem to be ahead of the necessary environmental conditions such as human capital and digital literacy in many circumstances (Tsan et al., 2019). As such, midstream actors may be an attractive entry point for such services as they are likely to have higher digital literacy, access, and connectivity (Denyes et al., 2019). Another challenge is that outside of a few leading countries (India and Kenya provide notable exceptions), investments by the private sector remain low and successful products have been mostly donor driven. Where tech start-up firms are involved, reach is often low and financial sustainability has not been achieved (Tsan et al., 2019). However, as value chains modernize, midstream actors in value chains close to or in the transitional phase are poised to benefit from such products. The features of these chains, such as longer midstream, diverse end markets, more formal contracting, greater credit demands, and possibly higher exposure to price risk, suggests that digital solutions could have great impact. At the same time, the enabling environment is evolving, suggesting that these actors may also be ready to take advantage of the right service.

VI. Conclusion

Agricultural value chains are rapidly changing in low- and middle-income countries, and that reorganization has implications for how income and welfare are shared throughout the value chain. This is altering and creating new midstream activities, post-production and prior to arriving at the final vendors. Useful financial services are essential for people to be able to seize these new opportunities. However, idiosyncrasies of different value chains, including spatial dispersion and seasonality may make conventional financial services ill-suited for their specific needs and influence the value proposition of different alternatives. These challenges may in turn hinder entry into this sector and contribute to lack of competitiveness at certain nodes of value chains. Further, although midstream actors may have greater access to finance than upstream smallholders, they still rely on these upstream actors for their inputs.

Where smallholders' financial needs are not being met, this will damage midstream actors' supply and profitability.

Digital services provide a wide number of theoretical avenues for improving finance for midstream actors and the essential background conditions (e.g., access to mobile technologies and consistent network coverage) are broadly improving. However, technology adoption is always a challenging process especially when network effects are central to their profitability. Although powerful actors in value chains may be able to provide public goods for others in the value chain or facilitate adoption of new technologies, this may also come at the cost of market power and lead to an inequitable share of surplus along the value chain. Potential gains to digital transfer systems, marketplaces, or cheaper forms of mobile-based credit or insurance are all large. With only a few notable exceptions, rigorous evidence on their impacts, especially among the agricultural producers and midstream actors, remains largely missing from the existing literature.

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APPENDIX

Table A1. Papers Focused on Midstream Activities

Midstream Activity	Value Chain	Area	Reference
Transport			
	Potato	India	Mitra et al. (2018)
	Vegetables and Fruits	Colombia	McKenzie and Iacovone (2019)
	Multiple	Uganda	Mutumba, Banadda, and Kiggundu (2020)
	Dairy	Uganda	Campenhout et al. (2021)
	Multiple	India and Nigeria	Daum et al. (2021)
Storage			
	Maize	Kenya	Burke, Bergquist, and Miguel (2019)
	Vegetables and Fruits	Colombia	McKenzie and Iacovone (2019)
Cold Storage			
	Potato	India	Mitra et al. (2018)
	Potato	Asia	Reardon et al. (2012)
	Potato	Asia	Minten et al. (2014)
Processing			
	Rice	Asia	Reardon et al. (2012)
	All	Global	Barrett et al. (2022)
	Coffee	Ethiopia	Minten et al. (2019)
	Coffee	Rwanda	Macchiavello and Morjaria (2021)
	Multiple	China	Guo and Jolly (2008)
	Coffee	Colombia	Macchiavello and Miquel-Florensa (2019)
	Dairy	Uganda	Campenhout et al. (2021)
	Mango, tomato, potato, turmeric, maize	India	Fafchamps et al. (2008)
	Multiple	Africa	Reardon et al. (2021b)
Trading/ Wholesaling			
	Maize	Uganda	Bergquist and McIntosh (2021)
	Ice	Sierra Leone	Ghani and Reed (2022)
	Cocoa	Sierra Leone	Casaburi and Reed (2020)
	Dairy	Vietnam	Saenger, Torero, and Qaim (2014)
	Groundnut	Senegal	Deutschmann, Bernard, and Yameogo (2021)
	Dairy	Uganda	Campenhout et al. (2021)
	Maize	Zambia	Burke, Jayne, and Sitko (2020)
	Mango, tomato, potato, turmeric, maize	India	Fafchamps et al. (2008)
	Multiple	Nigeria	Startz (2016)
	Multiple	Multiple	Ferreira, Goh, and Valavi (2017)

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