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Agricultural Input Markets in Sub-Saharan Africa: Theory and Evidence from the (Underappreciated) Supply Side

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Abstract

Economists have long studied the diffusion of improved agricultural technologies, often aiming to understand and relax the constraints that discourage their adoption among smallholder farmers. While this effort has documented and explored a long list of on-farm market constraints, the role of agrodealers in agricultural input markets has received far less attention—a critical blind spot. We review the empirical literature on input markets in low-income countries with a focus on Sub-Saharan Africa. We argue that the relative sparsity of this literature reflects limitations in our workhorse models of the household and the firm combined with a supply-side data gap due to infrequent systematic surveys of agrodealer firms. Consequently, we understand too little about the diverse input supply chains that culminate with agrodealers—large and small—marketing key inputs to farmers. We synthesize current findings and articulate a research agenda centered on agricultural input markets, including implications for research methods.

1. INTRODUCTION

A well-known joke among scientists illustrates how a search for things of value (e.g., insights, understanding, discoveries, and truth in the case of science) can be distorted by our limited capacity to attend to or measure relevant empirical realities. In the classic version, a policeman on night duty finds a man grappling on his hands and knees under a streetlight. The man explains that he dropped his keys. The policeman asks where he dropped his keys. The man points across the street and responds, "Over there." Confused, the policeman asks why in the world he is not looking over there then. "Oh, because the light is better here."

For more than 40 years, development economists have generated numerous insights and discoveries using household survey data to answer a wide range of demand-side technology adoption questions. Nationally representative household surveys have proved especially critical, representing "arguably among the most important innovations in social science research of the last century" (Meyer et al. 2015, p. 199). Development economists have adapted this potent data source to a range of uses including the analysis of program and policy impacts, the elicitation of critical behavioral parameters, the monitoring of food security status, the study of intrahousehold allocation and gender disparities, and the characterization of trends in agricultural investment and productivity.

While data from household surveys have provided innumerable insights, this important data source can shine such a bright light on households that it can distort how we frame research questions and where we look for answers. This streetlight effect can distort our perception of research priorities. In this review, we argue that there is an important research and data gap on the supply side of agricultural markets in Sub-Saharan Africa (SSA). This supply-side knowledge gap is driven by researcher inattention to supply-side questions about input markets, a need for supply-side theory about agrodealers' constrained optimization problem, and streetlight effects in which researchers use demand-side data because they are available and familiar, even in cases when the household is not the relevant unit of analysis. This current reality further reflects an important historical fact: The agricultural supply side in these contexts has been until relatively recently characterized primarily by heavy top-down parastatal involvement (Bates 2014), with limited scope for emergent dynamism or competition among agrodealers to attract the attention of applied researchers.

The structural transformation of low-income economies is driven by increasing agricultural productivity so that labor can flow to other sectors (Lewis 1954, Schultz 1964). For this reason, much of the study of agricultural transformation has been predicated on understanding technology adoption, primarily from the perspective of smallholder farmers. As the most recent installment in a long and historic survey of this literature (Feder et al. 1985, Foster & Rosenzweig 2010, Jack 2011, Magruder 2018), Suri & Udry (2022) review constraints to on-farm adoption of improved inputs in SSA and conclude that there is no single binding constraint; credit and liquidity, savings and insurance, information, infrastructure, transaction costs, and access to labor and land all affect input adoption and discourage investments that improve productivity.

This extensive literature on agricultural technology adoption largely takes rural households as the theoretical and empirical unit of analysis (Singh et al. 1986, de Janvry et al. 1991, de Janvry & Sadoulet 2006). The agricultural household model framing of these critical questions, however, risks shining a light so bright on demand-side questions that it inadvertently leads researchers and policymakers to overlook opportunities to better understand how supply-side actors promote technological diffusion and thereby contribute fundamentally to structural transformation.

Throughout SSA, many of these households have, in recent decades, become better connected to agricultural input and output markets. This market integration has been fueled by reforms in many countries' previously parastatal agricultural input and output markets, including economic

policies aimed at promoting market liberalization and reducing state involvement in the agricultural sector that have driven the privatization or closure of many once state-owned enterprises and created new opportunities for competition and private sector actors (Kherallah et al. 2002, Archibong et al. 2021). Consequently, the dynamics and interactions of agricultural market intermediaries have increasingly shaped on-farm decisions and outcomes, and the functioning of agricultural supply chains is now inseparable from the on-farm constraints that have structured generations of agricultural technology adoption research.

This neglect of supply-side actors in agricultural markets is inconsistent with the nonseparable agricultural household models so familiar to development economists. Those models identify missing markets as the key mechanism constraining households from optimizing, implicitly emphasizing their importance as a research and policy focus. However, understanding markets has been largely predicated on modeling the behavior of farmers, resulting in a rich demand-side understanding of farmer constraints, but an incomplete understanding of, for example, the functioning of input supply chains and agrodealer managers. Our objective in this review is to explore and discuss these blind spots using standard economic theory and empirical evidence.

Training our research focus on supply-side relationships in agricultural input markets may provide new understanding into the limitations and failures of interventions designed to increase demand among farmers for agricultural inputs, especially inputs with limited baseline use and availability. Two recent papers suggest that failing to ground microlevel studies and initiatives in a thorough understanding of their relation to supply-side dynamics can induce general equilibrium spillovers in input markets. First, Duflo et al. (2023b) evaluate a program to train Rwandan coffee farmers on the proper use of fertilizer in which extension efforts had negative spillovers on control farmers in the treatment communities because input (i.e., fertilizer) markets were not thick enough and fertilizer demand exceeded supply, crowding out control farmers who had been using the input at baseline.[1] Second, Ndegwa et al. (2024) conduct a randomized controlled trial (RCT) in Kenya to encourage farmer experimentation with new maize varieties and find increased farmer demand for the seeds one and two seasons after the intervention, but farmers were largely unable to locate the hybrid seeds in local agrodealer shops. In both cases, the supply side failed to respond to farmer demand, attenuating purchases, use, and adoption. Beyond these two examples, the impacts of other demand-focused interventions may have been limited in similar ways by slow, thin, or fragmented supply chains, resulting in missed opportunities for farmers to access the resources they need to improve productivity. Our collective inattention to the supply side can render these binding constraints invisible.

Ultimately, without a balanced approach that addresses both demand and supply constraints, agricultural interventions risk overlooking market dynamics as a driver of adoption decisions, instead attributing them solely to individual farmer preferences, failing to translate potential benefits into tangible outcomes for farmers, especially in regions where agricultural markets are still developing (de Janvry & Sadoulet 2020). Our argument emphasizes the importance of integrated strategies encompassing the behavioral, production, and risk aspects of farmers as well as the structural realities of the supply chain to foster sustainable agricultural growth—an importance that will only grow with continued market development and infrastructure improvements. Such strategies pertain to the design, implementation, and evaluation of research and interventions and of policy and private sector products and services.

In Section 2, we begin with a brief background to agricultural markets in SSA with a specific focus on agro-input markets and the critical role agrodealers play as the final, farmer-facing link in these supply chains. We then use a theoretical exercise in Section 3 to demonstrate the

[1]For discussion of these negative spillovers, see Duflo et al. (2023a).

limitations of current microlevel models when it comes to framing questions in the mesospace of input markets. Section 4 provides a structured review of existing empirical work related to agrodealers in SSA, an emerging literature that includes descriptive results focused on primary constraints and distinctive features of the sector. In this literature, many studies have addressed input subsidies, albeit with a typical farm-centric framing that generates limited insight on upstream agro-input markets. We review this literature through the specific lens of what current work on the topic addresses and misses in this regard. In Section 5, we return to our argument that the dominance and pervasiveness of household surveys can make it difficult to see and address important supply-side questions, and we discuss the methodological challenges that await any serious research agenda to directly address empirical questions related to agro-input markets and agrodealers. We conclude in Section 6 with a more forward-looking (and speculative) perspective on how SSA agro-input markets may evolve in the near and more distant future and what this may mean for research in this increasingly important and policy-relevant space.

2. AGRICULTURAL MARKETS AND AGRODEALERS IN SUB-SAHARAN AFRICA

Where agricultural markets exist and are well-integrated across space and time, they serve to sharpen on-farm incentives to invest in profitable technologies and to benefit consumers through efficient and timely provision of food and other products (Barrett 2008, Barrett & Mutambatsere 2008). These markets extend downstream of producers through points of aggregation, grading, transportation, processing, and distribution to final consumers. They also extend upstream of producers and consist of markets for key inputs, including land, labor, capital, and agro-inputs such as seed, fertilizer, and chemicals, as well as financial services including credit and insurance. In SSA, these output and input markets have traditionally been missing altogether in many places or, at best, have been present but poorly integrated and inefficient. Although this continues to be the reality for producers in especially remote and unconnected locations, many of these markets have changed considerably in the past 20 years (Zavale et al. 2020, Reardon et al. 2021, Barrett et al. 2022). As context and motivation for what follows, we provide in this section a brief description of agro-input markets in SSA.

Considerably more research attention has been paid to agricultural output markets than input markets in SSA. As data on market prices have improved in their quality, granularity, and accessibility and as researchers have become more innovative in their strategies to study and survey output market traders, work on agricultural output markets has transitioned from conceptual to empirical with increasingly rigorous research designs. This literature has addressed questions of market functioning and frictions, including key insights on competitiveness (Rashid & Minot 2010, Casaburi et al. 2013, Dillon & Dambro 2017, Newman et al. 2018, Bergquist & Dinerstein 2020), market integration and price transmission (Negassa & Myers 2007, Myers & Jayne 2012, Burke & Myers 2014, Bekkers et al. 2017), and the operations and roles of the agricultural midstream (Reardon et al. 2021, Macchiavello et al. 2022, Ambler et al. 2023, Reardon et al. 2024). While this empirical work (far) outweighs what has been done on agricultural input markets, this research is nonetheless subject to the streetlight effect of household surveys mentioned above. Barrett et al. (2022) argue that many of the dramatic changes (i.e., "revolutions") in agri-food value chains on the output side have been missed by researchers because the rapid emergence of actors, firms, and workers in these value chains is outside the sampling frame of household surveys.

As we shift our focus here to input markets, we note that both input and output markets in many parts of SSA are characterized by similar challenges and therefore raise similar questions for researchers, many with clear policy relevance. At the most fundamental level, these challenges

stem from the many on-farm constraints faced by smallholder producers or from common features of the context that give rise to both on-farm constraints and market-level complications. For example, weak and underdeveloped transportation infrastructure, along with limited access to logistics and financial services, results in high spatially and temporally variable transactions costs (Startz 2016, Bonilla Cedrez et al. 2020). Government price controls and weak institutions and enforcement capacity further complicate both input and output markets (Timmer 2010, Jayne 2012, Bonilla-Cedrez et al. 2021), as do information frictions (Allen 2014). Moreover, pronounced stochasticity and seasonality in production transmits significant risks through upstream and downstream market linkages, particularly when market intermediaries lack the scope of operations to diversify across agroecological zones and the scale to leverage efficiency gains. Some of these input and output similarities give rise to similar implications for researchers, especially related to measurement of profit and risk premia. Profit measures for (output) traders and (input) agrodealers are both subject to considerable measurement error for a host of reasons, including reporting sensitivities, recall periods, quantifying and valuing own labor, pricing search and fixed costs and risk, and assessing quality and quality premia.

Agricultural input markets have special features that distinguish their operations and frictions from output markets, however. Even many of the common features described above have distinctive implications for input markets. Seasonality of production, asymmetric information, limited or inconsistent government regulation, and risks related to product performance and availability all have quite different effects on input markets than they do on output markets. Combined with the fact that the market actors themselves are quite different, these distinguishing features and differential effects of common features imply that researchers need to take different empirical and theoretical approaches to studying and understanding input and output markets.

Agro-input markets are distinct from other input markets, such as land, labor, and capital, in several important ways that warrant mention. First, they have a special policy significance given that widespread adoption of enhanced agro-inputs could deliver significant productivity gains across much of SSA. When high-quality planting materials are paired with the appropriate amounts and types of high-quality fertilizer, they can dramatically boost on-farm productivity, making it crucial to understand how these markets operate and how they can be improved.

Second, while markets for agro-inputs continue to be entirely or partially missing from some rural parts of SSA, their penetration and connectedness have grown markedly in the past two decades. In contrast to markets for land and labor, which tend to be mostly informal and highly localized, and to markets for capital, which still mainly cater to large-scale, estate-style producers in SSA, agro-input markets include input suppliers that range from multinational corporations to large and medium-sized regional companies to a host of significantly smaller and sometimes seasonal enterprises. These suppliers are linked to farmers through a varied set of market relationships, some formalized through contracts but many governed by informal relational arrangements. These input supply chains may not yet have evolved as much as the so-called revolutions on the output side (Barrett et al. 2022), but they have changed, extended, and deepened in ways that have enhanced their spatial and temporal integration for many producers in SSA. In these emerging input supply chains, agrodealers are the final link and transact directly with farmers. As a result, they feature most frequently (and often implicitly) in empirical work in this area.

Agrodealers have a special importance in many low-income-country contexts, as they are often among a limited number of firms operating in rural areas, playing a crucial and farmer-facing role in supply chains that have regional and even global reach. Even so, they face challenges related to credit access, uninsured risk, technology and information constraints, and managing supply chains (Odame & Muange 2011, Benson & Mogues 2018). Describing and interrogating the risks that agrodealers manage through their market interactions can provide insights into resource

allocation, production efficiency, and technology adoption. Understanding these firms can improve the design and evaluation of policies to increase agricultural productivity and improve rural welfare.

Policymakers have expressed optimism that agrodealers will provide a missing link in agricultural information dissemination and technology diffusion; in some countries this role has historically been filled by public extension. In many regions of the world, however, public extension is now underfunded and largely absent in rural areas. The decline in public support for agricultural extension systems has coincided with the proliferation and penetration of agrodealers, making this emerging retail presence, which is a mix of formal and informal enterprises, a natural, if understudied, vehicle for advice and information alongside agro-inputs. Understanding the functioning and constraints of the sector is a prerequisite for accurately characterizing the current activities of agrodealers and for understanding the potential for agrodealers to provide information and facilitate technology adoption.

3. THEORETICAL MOTIVATION

As the workhorse of agricultural development economics, the agricultural household model represents the demand side of input and output markets: Households maximize utility subject to budget, labor, and technology constraints. Households face prices and wages set by external markets that are beyond their control. This price exogeneity implies that the behavior of suppliers and the interactions between agrodealers and farmers in markets, where equilibrium prices determine market clearance, remain unspecified, similar to general equilibrium models.

We can learn several things about agricultural markets from demand-side modeling. First, the main insight we gain from the agricultural household model about supply-side behavior is the potential response of farmers to changes in prices, which can affect agrodealer profitability. The elasticity of demand for inputs is central to an agrodealer's profit maximization problem. Empirical work rarely exploits variation in input prices because the research questions of interest typically focus on farmer's risk, endowment, or information constraints. We rarely elicit demand curves for new technologies because public sector strategies to diffuse new agricultural technologies are often predicated on subsidies without much consideration for private sector actors such as agrodealers.[2] More focus on demand elasticities in agricultural input markets could generate new insight and understanding, ultimately reducing uncertainty about market entry for agrodealers.

Second, theoretical predictions about how farmers manage risk and the large empirical literature on risk and technology adoption (e.g., Binswanger & McIntire 1987, Dercon & Christiaensen 2011, Karlan et al. 2014) underscore the uncertainty that agrodealers face when predicting demand and choosing which markets to enter. In the agricultural household model, a farmer's risk aversion or liquidity constraints lead to suboptimal demand for inputs. The implication for agrodealers is lower profits and potentially fewer entrants into rural markets. From a supply-side perspective, the effect of agricultural insurance or agricultural credit is rarely analyzed from the agrodealer's perspective despite it having a direct effect on the spatial and temporal distribution of input demand.

To better understand supply-side behavior, we summarize a model of firm behavior for a homogeneous good that provides some predictions about agrodealer choices and constraints. Following Bergquist & Dinerstein (2020), consider a set of households i in local market m in week w, which

[2] An exception is subsidies that aim to induce experimentation and learning and thereby increase farmer demand for improved inputs as the subsidy is phased out (e.g., Carter et al. 2021).

has market demand:

$$Q_{mw}(P_{mw}) = \sum_{i \in I} q_{imw}(P_{mw}). \quad 1.$$

Given this market setup, agrodealer *j*'s problem is to choose quantities in each weekly market to maximize profits subject to competition in the form of other agrodealer's profits, w, as follows:

$$\begin{aligned} \max\ \pi_{jmw} = & \textstyle\sum_{m \in M} P_{mw}(q_{jmw}) q_{jmw} - C_{jw}(q_{j1w}, \ldots, q_{jMw}) \\ & + \omega \left[\textstyle\sum_{m \in M} \sum_{k \neq j} P_{mw}(q_{jmw}) q_{kmw} - \sum_{k \neq j} C_{kw}(q_{j1w}, \ldots, q_{jMw}) \right], \end{aligned} \quad 2.$$

which results in the following first-order conditions:

$$P_{mw} = \frac{\partial C_{jw}}{\partial q_{jmw}} - \frac{\partial P_{mw}}{\partial q_{jmw}} \left(q_{jmw} + \omega \sum_{k \neq j} q_{kmw} \right). \quad 3.$$

This short sketch of the model illustrates several important points related to agrodealer behavior, each with implications for empirical measurement. We describe each of these implications in the remainder of this section.

Under certainty, agrodealers fix quantities to sell in a weekly market. In practice, rural markets are characterized by significant demand uncertainty over both quantities demanded and prices. This model assumes agrodealers observe both components of market demand. From empirical work, we know that mobile phone technology increases market efficiency (Aker 2010) and that agrodealers can provide information to farmers to increase demand, but also potentially benefit farmers (Dar et al. 2024).

Next, the model assumes that agrodealers have integrated supply chains or adequate stock management systems and that weekly demand is consistently satisfied. In practice, many agrodealers are small-scale re-sellers who may have multiple network links to reach fertilizer importers or wholesale agrodealers. Although these complex upstream supply chains can provide useful redundancy, they can nonetheless struggle to ensure the timely delivery of quality inputs, particularly to the smallest and most remote agrodealers.

Seasonality is captured well in this model. When market demand is low, agrodealers do not supply weekly markets. Perfect information assumptions are rejected in empirical papers like those by Fabregas et al. (2025) or Dillon & Tomaselli (2024), which clearly show markets could form earlier in the season because demand for inputs through forward contracts is strong in the postharvest period. This evidence rejects the perfect information assumption in this model because agrodealers could be more profitable if they organized postharvest markets, but in practice they rarely do.

The model has no spatial component, implicitly assuming spatial integration of markets is costless. In Mali and Ghana, household survey data indicate that agrodealers do not visit rural villages to sell inputs (Dillon & Tomaselli 2024). Many agrodealers build relationships with specific clients or cooperatives who visit the agrodealer in a secondary city rather than directly in rural villages. Market demand at the village level is not aggregated and is spatially distributed rather than clustered as in rural villages. Agrodealers do not travel to rural areas to sell to individual clients simply because it is not cost-effective.

A direct result of the model is that agrodealers observe the profits of other agrodealers in the market. When $w = 0$, the agrodealer's problem reduces to Cournot duopoly. When $w = 1$, the agrodealer's problem is that of a monopolist. The model thereby provides a direct test of the competitiveness of agricultural markets.

Finally, agrodealers may or may not be able to observe quality differences in the products they sell. There is no loss function implicitly integrated into the agrodealer's model, though larger

agrodealers normally have regular clients with whom they maintain long-term commercial relationships. It is unclear what motivates agrodealers to cheat in a multiperiod model or why all agrodealers do not cheat in a one period model.

4. EMPIRICAL EVIDENCE RELATED TO AGRODEALERS

Despite the methodological and measurement challenges, some research has begun to focus on the agrodealer sector. A small literature has emerged that explores various dimensions of agrodealer operations, including market access, entry and exit dynamics, and the effects of national policies on agrodealer functioning and performance. This work generally uses agrodealer surveys (sometimes in combination with other data collection methods) to focus on agrodealers as the unit of analysis and to address how they affect farmers' ability to sustainably adopt agricultural technologies distributed through private retail networks, such as for seeds, fertilizers, pesticides, and equipment. This work tends to explore the ways that agrodealer markets may fail to deliver reliable supply of agricultural technologies due to constraints highlighted above: spatial integration, demand uncertainty, financing, and quality/asymmetric information.

A second body of studies indirectly engages the supply side through analyzing the implementation and impacts of input subsidy programs. Some of this research implicitly engages the supply side, as in a number of countries (e.g., Malawi, Zambia, Tanzania, and Kenya), input vouchers were rolled out through private agrodealers as a means of strengthening the private sector—or at least not undermining it.

4.1. Supply-Side Challenges and Conditions

We begin this section with a brief review of the literature focused on agrodealers and their challenges related to supply-side conditions including market access, spatial market integration, demand uncertainty, financing, quality, and seed markets. We then discuss the literature on input subsidy programs, its supply-side engagement, and omissions.

4.1.1. Market access. Rutsaert et al. (2021a) use a census of agrodealers in Tanzania to analyze market access—input availability and prices—for farmers based on the spatial distribution of and local competition among agrodealers. Naugler et al. (2025) analyze a three-round panel in Tanzania to study high rates of agrodealer entry and exit and to estimate the effects of these high turnover rates on small farmer beliefs about fertilizer and information quality. Benson & Mogues (2018) survey samples of agrodealers and farmers in Tanzania, Uganda, and Mozambique and review policies related to agricultural input and output markets to identify primary factors associated with low use of fertilizer. They describe fertilizer supply chains in the three countries: how fertilizer moves from the point of import to rural retailers and how small input sellers organize their operations and investments. Odame & Muange (2011) document Kenyan government policies implemented with the objective to engage and equip agrodealers as agents to transform rural production through technology and information transfer to farmers. The authors describe constraints that frustrate these efforts, including weak government regulation, limited working capital, erratic demand, inadequate input supply, highly variable input prices, and high transaction and transport costs. Aker et al. (2023) find that exclusive importing and distribution rights during the initial introduction of improved storage bags induced long-lasting differences in take-up and willingness to pay.[3]

[3]A review by the Abdul Latif Jameel Poverty Action Lab (J-PAL) and the Center for Effective Global Action (CEGA) of evidence from recent RCTs related to small farmers and input and output market access (J-PAL

4.1.2. Spatial integration. Although the number of agrodealers has increased over time, many farmers have to travel to regional hubs to procure inputs (Rutsaert et al. 2021a). Minten et al. (2013) analyze the importance of the missing "last mile" in input markets for farmers and work through the effects of the high sourcing costs borne by farmers on fertilizer adoption. This study, like a handful of others (Liverpool-Tasie et al. 2017, Zavale et al. 2020), explores the importance of small agrodealers by analyzing the implications of their absence.

High transportation costs and poor road quality lower incentives to adopt inputs because the cost of travel may exceed the benefit in terms of higher yields or profits for some farmers (Suri 2011). Policies that lower transaction costs include improving road infrastructure, providing input subsidies that offset travel costs, and inducing market entry for input sellers in remote areas. Aggarwal et al. (2022) use structural modeling of fertilizer markets in Tanzania to show that decreasing travel costs by paving roads could double input adoption. Related work in Malawi shows that input subsidies can mitigate the effect of spatial inequality in transaction cost by reducing travel costs for remote farmers (Kumar et al. 2023). However, spot input markets alone do not address missing input markets, as shown in separate studies in Malawi and Mali (Aggarwal et al. 2022, 2024). Market timing and liquidity are important mechanisms for making markets (Dillon & Tomaselli 2024).

4.1.3. Demand uncertainty. From the farmers' perspective, interactions with agrodealers can be risky because farmers face an adoption decision that influences their potential returns to farming, which is typically an important source of consumption and income. Returns to agriculture are highly variable year to year, which can lower farmers' ability to learn the relative contribution of any single input (Marenya & Barrett 2009, Rosenzweig & Udry 2020). Ideally, input use lowers weather-related risks by supporting crop development at key stages regardless of soil fertility (fertilizer), disease outbreaks (pesticides), and downside risk of drought or floods (seeds) (Emerick et al. 2016, Boucher et al. 2024). In turn, technology adoption may vary year to year, which generates demand uncertainty for agrodealers who may reduce output, as suggested in the classic paper by Sandmo (1971) and explored with respect to farmers' production decisions related to output price uncertainty by Finkelshtain & Chalfant (1991).

The decision to purchase technology entails new types of risk, such as suitability- and quality-related risk. For example, farmers may purchase inputs that are not appropriate in their microclimate or geographic conditions (Bird et al. 2022, Moscona & Sastry 2022). Agrodealers decide which inputs to stock and may not have access to information about which types of seeds are appropriate for different types of farmers or geographies or new varietal releases or they may be unwilling to bear the risk of stocking unproven varieties (Kariuki et al. 2024). Data from the Africa Seed Access Index (**http://www.tasai.org**) shows that the number of maize varietal releases across SSA ranges substantially across countries, from 2.3 in Nigeria, 12–16 in East Africa, and up to 274 in Rwanda, when normalizing by the number of hectares under cultivation. At the same time, older input technologies persist in the market and in agrodealer shops (and continue to achieve significant market share) despite the availability of newer, higher-performing technologies (Abate et al. 2017, Rutsaert et al. 2021b). Seed supply chains are especially prone to spatial variability in performance—and therefore to demand uncertainty—as a result of pronounced heterogeneity in growing conditions due to soils and microclimates. Bird et al. (2022) discuss the supply-side implications of this heterogeneity and provide evidence that niche breeding by a medium-sized Kenyan

& CEGA 2024) discusses 16 RCTs and 13 quasi-experimental studies. Of these, only three focus on input market actors directly: Dar et al. (2024), Dillon & Tomaselli (2024), and Hsu & Wambugu (2024). A handful of others consider input investment as an outcome at the household level.

seed company with capacity to adapt publicly available germplasm to niche growing conditions can create important productivity and profitability gains on-farm.

Agrodealers are also constrained by demand uncertainty, particularly when they are marketing products to new markets. Dillon & Tomaselli (2025) use auctions to measure agrodealers' willingness to pay for licenses to supply rural villages using village input fairs. They find that open auctions, in which bidders implicitly share information with their peers, have up to 61% lower mean bid prices and up to 67% lower bid variance than closed auctions, in which bidders bid secretly. Given demand uncertainty, agrodealers rely on each others' assessments of market opportunities, which has strong implications for scaling innovation. In marketing urea deep placement technologies to farmers inexperienced with the climate-smart technology, Liverpool-Tasie et al. (2024) find that a potential marketing strategy to increase adoption, which offered price discounts to farmers, had limited effects on adoption (+8 percentage point increase) and were therefore not profitable for the agrodealer given farmer's demand elasticity.

4.1.4. Finance. Relatively few studies directly measure key financial features of agrodealer firms in terms of access to credit and financing, market churn, and firm size (Naugler et al. 2025). On the one hand, agrodealer firms may be informal and insecure, without access to credit or asset financing like many microenterprises through SSA (Kuntchev et al. 2013). In that case, firms may behave like risk averse agents with limited liquidity and capital to invest in stocking and verifying high-quality inputs. Markets may include many sellers, but then risks associated with quality verification might bind, lowering confidence and trust in market actors (Heiman et al. 2020). On the other hand, one consequence of demand uncertainty and low spatial integration is that only larger firms may be able to survive. As a result, firms may have more monopolistic pricing power and limited reach and scope in terms of input varieties stocked and offered. We characterize these markets as thin in the sense that farmers face few options when deciding what and where to make purchases. Input market failures described by Duflo et al. (2023b) and Ndegwa et al. (2024) are examples of both cases. Duflo et al. (2023b) showed that markets proved too thin to respond to a positive demand shock, and Ndegwa et al. (2024) showed that markets were too thick to learn quickly enough about demand for new varieties.

4.1.5. Quality. Policies and interventions that improve product quality in input supply chains have received increasing attention in recent years. Farmer perceptions that inputs are adulterated or deficient in quality lower adoption by decreasing expected returns to adoption, decreasing both trust in agrodealers and farmers' ability to learn about input performance (Bold et al. 2017, Michelson et al. 2021). Recent research suggests that the actual extent of quality deficiencies may be overstated by farmers and policymakers. The extent of the problem likely varies across products and contexts, but even relatively low rates of quality problems may contribute to widespread perceptions among farmers that the risk of purchasing low-quality inputs is too high to be worth the investment (Ashour et al. 2019, Hoel et al. 2024). Some research suggests that quality assurance programs administered through agrodealer shops and market clusters can help increase farmer confidence in the quality of inputs and increase technology adoption (Gilligan & Karachiwalla 2021, Hsu & Wambugu 2024, Michelson et al. 2024).

Research that uses DNA fingerprinting to identify seed varietals shows that farmers often make mistakes or have mistaken beliefs when reporting seed use and that these misperceptions are associated with suboptimal fertilizer use (Wossen et al. 2022, Bohr et al. 2024). Bulte et al. (2025) show that uncertainty about seed type significantly reduces complementary labor investment by farmers. The role of agrodealers in misrepresenting seeds is not known, but as a key point of contact with farmers, agrodealers are an important point of information transmission, including about how to

check for quality markers. Quality signaling through effective branding and marketing strategies is a critical feature in agro-input markets in many locations with more developed agricultural supply chains and is quickly emerging as an important dimension to agricultural technology adoption in SSA (Heiman et al. 2020).

4.2. Seed Markets as Distinct from Fertilizer and Phytosanitary Inputs

A small but active literature on seed systems emphasizes various features of the seed supply chain and their impact on farmers' technology adoption decisions. In SSA, much of this research has recently been motivated by the problem of low varietal turnover by farmers, that is, farmers generally continuing to grow older, established hybrid seeds when newer seed varieties are available in the market, offering the promise of higher yields and better protection from biotic and abiotic stressors (Abate et al. 2017, Obunyali et al. 2019, Almekinders et al. 2021, De Groote & Omondi 2023). In recent years, researchers concerned with this problem have begun to focus on agrodealers more specifically to address a host of questions: how they might best interact with and market to farmers (Rutsaert & Donovan 2020, Kitoto et al. 2024), how farmers interact within a manipulated commercial milieu of the agrodealer shop (Rutsaert et al. 2024), and how changing stocking and sales incentives for agrodealers can impact farmer purchasing and adoption (Kariuki et al. 2024).

4.3. Input Subsidy Programs

A common approach to promote input demand and leverage market incentives is to provide input subsidies to farmers. Subsidy design varies greatly and can range from point-of-sale discount vouchers to direct delivery of low-cost or free inputs. Publicly funded input subsidy program expenditure varies considerably year to year and across countries; from 2008 to 2014, input subsidies expenditure accounted for between 9% and 70% of agricultural budgets in 10 countries (Jayne & Rashid 2013, Jayne et al. 2018).

Research tends to focus on assessing the effects of these large, costly programs on input use and productivity. One important factor relevant to understanding this impact is determining their additionality on the extensive or intensive margin, i.e., whether they reach marginal farmers that otherwise would not purchase inputs or whether they tend to primarily benefit farmers who would buy inputs even without a subsidy (Gine et al. 2015). Some of these programs were designed to be supply-side smart subsidies, working through and thus helping to build the existing network of agrodealers (e.g., with vouchers). But much of the literature on these programs focuses instead on leakage, with little emphasis on the functioning of the supply side.

A second set of studies focusing on agricultural input subsidy programs analyzes whether short-run subsidies lead to persistent changes in input use and yields. Carter et al. (2021) find that a one-time fertilizer and seed voucher in Mozambique led to persistent adoption in the subsequent agricultural seasons, with strong positive spillovers to neighboring farmers, who also increased adoption and yields. Fishman et al. (2022) study the random phase-out of input subsidies and an extension program in Uganda and find that farmers persist in adoption by switching to purchasing inputs from market sources. The successful scaling of such demand-side subsidies would result in significant and sustained increases in input demand for agrodealers, but this potential outcome has yet to feature explicitly in research.

Relatively little research has focused on how agrodealers respond to subsidy programs. Do schemes offer a large enough demand shift to meaningfully change agrodealer behavior? In cases where agrodealers are free to set prices, do subsidies lead to other price distortions? Do subsidies lead to more or fewer purchases at agrodealers? In a survey of causal evaluations of input subsidies,

a systematic review that included 19 papers on input subsidies found mixed evidence on cost-effectiveness, targeting, take-up, and income (Murphy et al. 2024).[4]

5. METHODOLOGICAL CHALLENGES TO SUPPLY-SIDE RESEARCH

"Measure what matters" is a simple principle that can orient the agricultural input markets research agenda that we propose, which aims to complement much of the insightful work that has been going on under the familiar household survey streetlight. Simply put, we need to measure more of what matters on the supply side to better understand how agricultural markets form and function. The household survey streetlight effect has left us with less information about essential supply-side features: spatial market integration, market competition and structure, demand uncertainty (the risks and costs this uncertainty implies for agrodealers and their strategies to reduce these costs), finance, and quality investments and incentives to cheat or build reputation.

We highlight where methodological choices might expand the research frontier, including sample frames, measuring prices and market transactions, agrodealer enterprise data, and measuring input quality. Alternative data to complement and interlink with household surveys, such as administrative data, high-frequency collection efforts, or censuses, could facilitate analyses of firm operations, market structure, firm sourcing and stocking, profits, and margins.[5]

5.1. Sampling Frames

Researchers need to be able to link households and firms to transactions. In other words, we currently lack market-based sampling frames. An inherent challenge in developing market-based frames is that markets do not exist only in physical spaces, but they also arise seasonally. Surveying input market sellers, who are a mix of formal and informal, registered, and nonregistered with the government, can present challenges that are distinct from those characterizing the survey and study of small farm households. In this regard, input market sellers share similarities with traders in output markets. Some characteristics make them harder to find. Many operate informally without registration or licenses or have businesses that are mobile or seasonal in nature. Recent research has documented high rates of firm entry and exit in the sector (Naugler et al. 2025). One important consequence of collecting data on informality, nonregistered status, and high rates of entry and exit and seasonality is that reliable, comprehensive lists generally do not exist to serve as sampling frames, complicating efforts to gather representative data.

The cost of achieving a sufficient sample to provide insight that can be representative over space or time can therefore be significant. Panel sample frames, for example, are likely to be costly and resource intensive to establish and maintain. Additionally, the logistical challenges of accessing remote or dispersed markets can further complicate data collection efforts. As a result, researchers must carefully consider their sampling strategies and may need to employ innovative methods to balance cost and representativeness while ensuring that the diverse characteristics of sellers across different locations are adequately captured.

[4]Input subsidy schemes sometimes lead to other types of inefficiencies and externalities. Bernard et al. (2023) test a seed subsidy voucher in a context with weak input and output markets in rural DR Congo. Farmers were more likely to plant improved seeds without increasing deforestation overall. However, unmet demand for complementary inputs (fertilizer) caused farmers to clear primary forest instead of secondary forest to take advantage of higher soil fertility on newly cleared land.

[5]There are analogous discussions in the development economics literature on measurement complementarities and other considerations in the context of earth observation and household surveys (Burke et al. 2021, Porteous 2022).

5.2. Price and Transaction Data at the Right Resolution

We need data on market prices and seller transactions at the right spatial granularity and temporal frequency. For example, prices paid may not adequately characterize market prices or availability because household surveys do not generally ask respondents about discounts, subsidies, or purchases made on credit; household data will not provide insight into stockouts or into variability in prices and quantities by seller or season. Data on prices and seller transactions with both farmers and their upstream suppliers are required for empirical analysis about market structure and market power, and for quantifying the degree of competition, market integration. Such data can provide insight into market concentration and barriers to entry and also (along with seasonally relevant censusing of input sellers in operation) into where and why certain regions may lack access to inputs.

Prices and transactions are also required to quantify regional and temporal disparities in access to inputs. Input prices may climb during planting; they may change differentially over space and time. Improved price and transaction data can provide new insight into on-farm decision-making (e.g., by permitting analysis of input price volatility and its implications for farmer input investment). In particular, transaction data are required to understand spatial and temporal input demand patterns and to assess the responsiveness and delays in the input sector to new policies, to weather or geopolitical shocks, and to fluctuations in demand or supply.

Data challenges in this area also relate to problems with achieving a representative sample spatially and temporally, especially given a lack of reliable sampling frames. But methods used by central banks to collect consumer prices for consumer price index calculation may be relevant, along with high-frequency phone surveys with households (Carletto & Gourlay 2019, Gourlay et al. 2021, Abate et al. 2023). Challenges with input prices are akin to those for other consumer goods: Prices can vary based on the units sold (bulk discounts), brand, or quality differentials. Prices and transactions can also fluctuate seasonally and according to the macroeconomic environment, requiring relatively frequent data collection efforts to characterize trends. Some researchers have successfully used mystery shoppers with agrodealers or other small shop owners to gather information about seller behavior, information conveyance, and prices (Michelson et al. 2021, Fitzpatrick 2023, Kariuki et al. 2024). Other recent research is using transaction data from agrodealers to analyze spatial market integration and fertilizer price dynamics (Wilwerth et al. 2025).

5.3. Agrodealer Data

Agrodealer data requirements raise broader methodological challenges, namely, measuring profits and labor. Agrodealer profit margins themselves provide insight into market structure. Studying these margins over time can help researchers understand whether individual firms and the sector as a whole are growing or stagnating and why and to quantify the distribution of growth in the sector across firms in terms of sales and margins. These sorts of analyses identify the presence of incentives for firm growth, investment, and upgrading in the sector. Understanding firm profits, competition, and pass-through is important from a policy perspective, as it helps assess (perhaps even ex ante) the feasibility of programs designed to promote input adoption via price subsidies channeled through private sector sellers.

Calculating firm profits and margins requires measuring and tracking labor used by the firm, both owner labor as well as the costs of hired labor. Standard measurement challenges are relevant, including valuing the opportunity cost of the owner's time and in tracking and valuing labor hours by hired workers, especially in a business with a strongly seasonal demand. Even so, also like output market traders, input sellers may prove (at least in part because of their informal or nonregistered status) reluctant to participate in a survey or to provide details about their business operations due

to concerns about taxation or legal consequence. The diversity of their operations—that is, the number of products that they sell and the months over which they sell combined with their lack of record keeping on sales and inventories—can further complicate and compromise the quality of data they provide. As with price and transaction data, the seasonality of operations due to fluctuations in input demand in rainfed farming systems means that these data may vary importantly over time and space and that some thought should be devoted ex ante to the right temporal duration and sampling frequency.

5.4. Agro-Input Quality Measurement

The agronomic quality of agricultural inputs is difficult for both farmers and agrodealers to observe. The definition of agronomic input quality is somewhat input-dependent: for fertilizer, it is the content (by weight) of the active nutrients and the degree to which that content deviates from the advertised manufacturer standard; for agri-chemicals such as herbicides and pesticides, it is defined by the degree to which the active ingredient is present in the advertised concentration (by volume); and for seed, it is the germination rate and degree to which the seed sold is consistent with the genetic material of the advertised seed. Recent research indicates that quality issues are rare in fertilizer, especially urea (Michelson et al. 2021, 2023; Hoel et al. 2024), but that quality is more variable in seed (Bold et al. 2017) and agri-chemicals (Ashour et al. 2019; Haggblade et al. 2023, 2021). Research has documented suspicion among farmers about quality across inputs—even inputs such as urea fertilizer with no documented evidence of quality problems—and shows that such input quality uncertainty among farmers reduces farmers' complementary investment (Wossen et al. 2022, 2019; Bulte et al. 2025) and purchasing and use (Miehe et al. 2023, Michelson et al. 2024). Some research (Michelson et al. 2021) suggests that agrodealers themselves may have suspicions about the quality of inputs that they source and sell, i.e., that the presence of asymmetric information related to input quality could also be a critical factor in supply chain functioning and frictions.

Extant research has focused on quantifying beliefs about input quality at the farmer level, but much of the sampling of inputs for lab-based quality assessments[6] has been conducted at the agrodealer level. Regarding inputs for which quality issues are documented and prevalent, new methods for sampling along the supply chain are necessary to identify where quality problems originate and which actors have private information about quality. They are also necessary to understand, in combination with data on margins, prices, and market structure, the relative incentives to cheat versus to build reputation with customers.

6. CONCLUSIONS

This review aims to extend the research focus in agriculture and development economics toward agricultural markets, especially agro-input markets, on which agricultural households increasingly depend. Guided by a simple theoretical model, we have offered a review of recent empirical evidence on agrodealers as the most proximate link from households to agro-input markets. This review serves to showcase the methodological challenges of getting outside of the bright light of household surveys and designing empirical studies to inform our understanding of input markets more directly and intentionally. We conclude this article with broader reflections related to this aim.

First, it is worth revisiting one of our core motivations in writing this review: Agro-input markets offer a promising and cost-effective response to the staggering agricultural productivity gaps

[6]Best practices for sampling, measurement, and interpretation are described by Michelson et al. (2023).

that plague SSA. Persistently low and even falling agricultural productivity in SSA (Wollburg et al. 2024, 2023) has emerged as one of the major contemporary global challenges and one that grows in importance as Africa steadily makes up a larger share of global population. This lagging productivity has many explanations, but persistently low rates of adoption of agricultural inputs, including hybrid seed and mineral fertilizer in SSA, are critical contributors (Sheahan & Barrett 2017). Adaptation to climate change, rural household resilience, stability in agri-food markets in urban and periurban areas, and structural transformation in SSA all hinge importantly on improved agricultural productivity.

Second, while agro-input markets in SSA have extended their reach in remarkable ways and now reach into relatively remote corners of the region, these impressive gains are measured from a very low base, which included heavy-handed government control of output markets (and to a lesser extent, input markets). Market integration gains since 2000 are to be celebrated, but the markets still have a long way to go before they reap their full potential in scope, scale, and spatial reach. More than most regions of the world, agriculture in SSA is characterized by extreme heterogeneity in growing conditions, which implies extreme heterogeneity in input demand (Suri 2011, Newman & Tarp 2020). This feature emphasizes the need for agro-input markets that are nimble, responsive to highly specific needs, and well-integrated into existing research and development efforts. In this sense, the resilience of the input supply chain requires that each link in the chain be nimble, responsive, and well-integrated—from breeding and seed production to agrodealers.

Third, while household surveys have fueled our understanding of the microeconomics of development, their prominence as a research platform may have hampered our ability to see and answer relevant questions about agricultural markets that lay outside the household. These may not have been glaring blind spots in SSA in the 1980s and 1990s as household surveys arrived on the scene and started enabling and shaping empirical analyses. However, as rural agricultural households have become steadily more connected to markets and more dependent on these linkages for their livelihoods (and will continue on this path for the foreseeable future), these blind spots may significantly distort our understanding. These missing insights risk misguiding policy and interventions aimed at improving agricultural productivity and enhancing rural household resilience. This is ironic, because our focus as researchers has been so completely shifted to these households as our standard unit of analysis. Going forward, good research and smart policy will need both (*a*) rich household survey data (preferably panels) linking household welfare, agricultural production, and market participation and (*b*) information about the agro-dealer firms on the supply side.

Finally, any speculation about what the next decade might bring to or through agro-input markets in SSA must take into account three key forces.

1. Bilateral, multilateral, and private donor investments in input markets, especially seed systems. We claim no novelty in highlighting the importance of agro-input markets to smallholder agricultural productivity in SSA. This has long been recognized and, thankfully, has shaped at least some of the funding priorities for the region. The African-led organization AGRA (**https://www.agra.org/**), for example, has prioritized investments in agro-inputs and continues to influence national policy and capacity to regulate and support these markets. Of course, there is much more work to be done, especially because quality can be difficult measure and certify, and improved inputs are, therefore, are often targeted by counterfeiters and other malicious actors or perceived to be so.
2. The rise of regional private firms engaged as suppliers and intermediaries in agro-input markets. It is encouraging to see some medium-sized input suppliers in SSA extend their reach across national borders. In East Africa, it is common to find hybrid maize seeds from Kenyan

seed companies (e.g., Western Seed Company; **https://www.westernseedcompany.com**) competing in neighboring countries in these more integrated agro-input markets. Similarly, Seedco (**https://www.seedco.org**), based in Zimbabwe, has become major player in the East Africa seed market.

3. The vast potential for continued investment in these markets from India and China. As with so much in SSA, the future of agro-input markets will be increasingly influenced by the actions of India and especially China. Both of these countries have thriving agro-input suppliers that have started making inroads to the SSA market, and these firms know better than most Western firms how to mange operations in complex settings such as SSA. It is difficult to predict precisely how these forces will interact to shape the future of agro-input markets in SSA, but it seems very clear that these markets, including their actors, intermediaries and modalities, are set to evolve rapidly. These structural changes are almost certainly good news for on-farm productivity. They also underscore the importance of shifting our research focus and expanding our toolkit to better understand these dynamics, impacts, and implications for policy.

We conclude by highlighting the potential contributions of future research to the supply-side agenda we have laid out in this review. We advocate for greater research attention focused on the constraints and circumstances of agro-input markets that may be contributing to persistent low productivity. In particular, such research could benefit from new applications of existing data collection and sampling strategies but also from innovative methodologies for studying these markets. Key areas for research innovation could include the unique operational characteristics and challenges faced by agrodealers as compared to other small firms in these areas. This work should strive to evaluate which insights from related firm and industrial organization literatures are relevant to agrodealers and to broader input supply chains in SSA. By acknowledging how our collective achievements with household survey data may have simultaneously enriched us and blinded us to asking the right questions in this space, we will unleash a new wave of methodological creativity and innovation that will contribute to a deeper understanding of input markets, their impact on agricultural productivity, and how they can be tapped to build resilience of producers and consumers alike.

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