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Leveraging Private Sector Innovation to Generate Evidence on Farmers' Productivity, Profitability, and Food Security in Africa

Framing a Research Agenda for the UM6P-J-PAL Agricultural Lab for Africa (UJALA)

UJALA
UM6P-J-PAL Agricultural Lab for Africa

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I. Motivating a new agricultural lab to study small-scale farmers' food security, productivity, and profitability in Africa

Supporting small-scale agriculture remains critical to reducing extreme hunger and poverty in low- and middle-income countries (LMICs). The prevalence of moderate and severe food insecurity in Africa is immense—at over 60 percent or more than twice the global level of 29.6 percent (FAO et al. 2023). Despite having over 65 percent of the world's uncultivated land, Africa is a net food importer, and as such, has been severely impacted by the rise of global food prices (Yohannes-Kassahun 2023). Food insecurity has worsened substantially on the continent over the last few years, with the Covid-19 pandemic and political conflicts that have disrupted agricultural supply chains.[1] For example, the Russo-Ukrainian War triggered a shortage of about 30 million tons of grains on the African continent and a sharp rise in fertilizer prices, which resulted in a sharp increase in the costs of food imports further exacerbating food insecurity. Climate change is another factor intensifying food insecurity as more frequent and intense weather shocks affect production. Climate change is expected to reduce yields of staple crops by up to 30 percent due to lower productivity and higher likelihood of crop failure (Jain et al. 2015).

Given this complex environment, improving the agricultural productivity of small-scale farmers, who dominate Africa's agriculture sector, is a critical objective to improve global food security. Evidence suggests that a primary way to increase productivity is through the adoption of agricultural technologies, of which fertilizer, more resilient and/or higher productivity seeds, and irrigation equipment are prime examples (J-PAL 2019). However, technology adoption in sub-Saharan Africa remains disproportionately low. For example, the average fertilizer application rate in Africa is 22 kilograms per hectare compared to a world average that is seven times higher (146 kilograms per hectare) (Bridle et al. 2019).

A robust evidence base, some of which was funded through the Agricultural Technology Adoption Initiative, has demonstrated that alleviating the constraints that farmers face to adopting new technologies, like access to credit and savings, information, and inputs, among others, can help improve farmer productivity (Jack 2013; Suri and Udry 2024). However, evidence also suggests that technology adoption is not the only factor hindering productivity, nor should productivity be the only goal. Supporting farmers' profitability and transition out of subsistence farming is another key step to improve farmers' welfare. This body of literature focuses on connecting farmers to input and output markets, developing contracts, supporting value-added activities, and the diversification of production (J-PAL 2019).

[1] Compared to 2019, an estimated additional 37 million people in 2020, 26 million in 2021, and 11 million in 2022 were severely food insecure in Africa—an increase of about 74 million people in three years (Headey and Ruel 2024).

Despite growing evidence on the conditions for agricultural technology adoption and market access, there are gaps in the evidence particularly around strategies to improve food security. There is a unique opportunity for the private sector to support evidence-informed business development that aims to support farmers' agricultural productivity and profitability as a tool for combating global food insecurity. For example, due to the private sectors' operational scale and incentives to quickly respond to market changes, the sector is uniquely positioned to support farmers to tailor and distribute high-quality inputs. In addition, complex challenges related to providing access to training for farmers on best agricultural practices for sustainable fertilization, disease and/or pest management, facilitating market linkages, and integrating domestic supply chains create an opportunity for the private sector to collaborate with researchers to design evidence-informed programming.

A. Introduction to the UM6P-J-PAL Agricultural Lab for Africa (UJALA)

The UM6P-J-PAL Agricultural Lab for Africa (UJALA) will generate a rigorous evidence base on improving farmers' food security, productivity, environmental sustainability, and profitability in sub-Saharan Africa. Primarily, UJALA will fund grants for full-scale randomized evaluations and pilot studies. A randomized evaluation can be a powerful tool for testing specific components of a program's theory of change and identifying the mechanisms behind the success of specific interventions. This methodology will be applied to timely/critical questions from the research agenda and UJALA's policy partners; examples of these are elucidated below.

II. Framing a research agenda for UJALA

In this section, we outline some open questions and the areas of focus under UJALA's five key priority areas.

A. Subsidy schemes to improve food security

Given the low adoption of agricultural technologies in sub-Saharan Africa compared to other parts of the globe, various policies have been applied to facilitate uptake. One such policy is input subsidy programs (ISPs), which provide technologies (mainly fertilizer and improved seeds) at below-market prices. Many sub-Saharan African countries have some variation of agricultural subsidies in place, making up a large portion of each government's public spending (1.5 percent of each country's total GDP on average) (Baptista 2022). They are meant to support farmers' productivity, increase yields, and, ultimately, reduce food insecurity.

However, there is little rigorous evidence that has shown the link between agricultural subsidies, productivity, and improved food security. Some countries in sub-Saharan Africa that have implemented input subsidy programs have experienced higher growth in aggregate yields (Carter et al. 2021). However, there is mixed evidence showing that ISPs led to increases in yields. For example, a study of Malawi's fertilizer subsidy program that uses panel data found that the program had no enduring effects on small-scale farmers' maize production (Ricker-Gilbert et al. 2017). In a randomized evaluation of a government-implemented ISP in Mozambique, a temporary subsidy for maize farmers stimulated fertilizer adoption and led to increased maize yields (Carter et al. 2021). The subsidy was provided via vouchers to be redeemed at private agricultural dealers for a single input package in one agricultural season and was targeted to farmers thought to have high potential gains from the inputs due to substantial learning effects and spillovers. These factors (e.g., involving the private sector, targeting, etc.), often referred to as characteristics of "smart subsidies," may have contributed to the persistence in use of fertilizer in later, unsubsidized years (Carter et al. 2021). Instruments proposed for implementing "smart subsidies" include demonstration packs, vouchers, rationing, targeting, and matching grants; however, these techniques remain under-evaluated (Hemming et al. 2018).

There is potential for temporary subsidies to have lasting impacts on adoption; however, more rigorous research is needed to understand the specific design and conditions under which they may or may not work.

Some relevant questions include:

- What are the effects of agricultural input subsidies (ISPs) on agricultural productivity?
    - What characteristics of ISPs are most effective in realizing productivity gains?
- What types of subsidy schemes can improve food security?
    - What sort of targeting is effective? Subsidies targeting agricultural productivity? Or, income support, as cash transfers often do? Or, new targeting mechanisms, like targeting the adoption of more nutritious crops?
    - What is the mechanism behind why they work?
- What is the optimal design for subsidy schemes? How do conditional and unconditional schemes compare?
- How do in-kind schemes compare to cash transfers, including in cost effectiveness?
    - Under which conditions and for which technologies is each method more effective?
- How can digital tools be used to leverage agricultural subsidies?
    - How can digital tools be used beyond targeting?

- Who should subsidies be targeted to?
    - What are the effects on non-targeted farmers and other rural and urban households? How can these spillover or general equilibrium effects be captured?
- How long do subsidies need to be in place to have lasting impacts on technology adoption and, ultimately, productivity?
    - How do we determine when a subsidy is ready to be lifted?
    - Does the optimal duration of the subsidy depend on the complexity of the technology and the related learning process?
    - Are there technologies where an upfront subsidy is needed to offset upfront costs, and if so, how do we optimally design those subsidies?

B. Reducing the reliance of low-income households on imported food

Although Africa has 60 percent of the world's unexploited arable land, the continent spent US$78 billion of foreign currency on food imports in 2023, which is predicted to rise to US$110 billion by 2025 (Hodder and Migwalla 2023). Low agricultural productivity and low rates of fertilizer application and other productive inputs are some of the factors that contribute to food import dependency. The region is also increasingly susceptible to global supply shocks as witnessed through disruptions caused by the Covid-19 pandemic and the Russo-Ukrainian War. Food prices in sub-Saharan Africa of cereals, such as wheat, maize, rice, and cassava, surged by a combined average of 23.9 percent between 2020 and 2022 (Okou et al. 2022). Under these global conditions, increasing countries' food sovereignty—the ability of a country to feed itself—is challenging. Imports can be necessary and valuable when economies specialize to their advantage or when there is limited available water and land resources to grow resource-intensive staples, particularly in the context of more frequent climate shocks, political instability, and conflict across the region (d'Amour and Anderson 2020). The availability of food imports also allows countries to diversify risk associated with poor and seasonal harvests. On the other hand, the availability of low-priced imports reduces a farmer's own incentives to cultivate staples, which in turn lowers the natural insurance provided by staple production. When there are no suitable instruments to smooth global price risks, a lack of food sovereignty can leave farmers exposed to these substantial price changes.

Research has pointed to various strategies to reduce sub-Saharan Africa's reliance on food imports. One strategy is to improve small-scale farmers' agricultural productivity to compete effectively against low-cost imports from the international market (Rakotoarisoa et al 2011; Arment 2020). Encouraging farmers to adopt productive technologies is a well-researched topic and covered in the next section of the research agenda (de Janvry et al. 2009; de Janvry and Sadoulet 2020; Bridle et al. 2019). Research also highlights the importance of integrating

small-scale farmers into domestic value chains (de Janvry and Sadoulet 2020). There are a host of open questions about how to best facilitate market linkages from developing post-harvest storage and value-additional opportunities, to developing rural infrastructure to facilitate regional food trade (see subsection D. Improving access to markets). Promoting inter-regional agricultural trade presents another opportunity (FAO and AUC 2021). Digital technology may help facilitate these pathways by modernizing payments and allowing small-scale farmers to better participate in value chains (see J-PAL 2022).

In light of all the factors that contribute to reliance on food imports, there are many areas for further research, in partnership with private sector innovation, on how to best reduce risks associated with reliance on food imports.

Some relevant questions include:

- What factors cause small-scale farmers to depend on food imports?
    - How can small-scale farmers protect themselves against sudden increases in imported food prices exacerbated by factors like political instability and conflict?
    - How do climate shocks and environmental degradation affect small-scale farmers' production and what adaptation strategies can be implemented to build resilience in agricultural systems?
    - Which characteristics make countries and communities most dependent on food imports? Which interventions might work to help them overcome those factors without limiting the realized gains from food trade?
- How can small-scale farmers mitigate some of the risks from reliance on imported foods?
    - When can improved post-harvest storage or better financial inclusion reduce consumption volatility associated with changing food prices?
    - Are farmers under-investing in staple production in communities that are most exposed to food price risk? Which instruments and incentives would encourage additional staple production in these communities?
    - What technologies can be leveraged to boost staple productivity and insure against food price risk?
    - Do post-harvest storage facilities support farmers to increase their production and opportunities to sell their crops? How can they be optimized to do this better?

    - How can digital technology be effectively utilized to modernize payment systems and facilitate the participation of small-scale farmers in value chains, to enhance their integration into domestic and international markets?
- How can regional food trade be facilitated to improve food security in the region?
    - What are the potential benefits and drawbacks of promoting inter-regional agricultural trade in sub-Saharan Africa?
    - Which trading patterns and barriers reduce or enhance food price volatility?
    - How can rural infrastructure be developed to support inter-regional trade?

C. Overcoming farmers' constraints to technology adoption

Agricultural productivity and adoption of yield-improving technologies in sub-Saharan Africa lags behind those of other regions of the world (Suri and Udry 2024). There is a vast body of rigorous research focused on both identifying the constraints farmers in low- and middle-income countries face when making a decision about whether to adopt a new technology or practice and designing appropriate interventions to help farmers' overcome any barriers they face in making productivity-increasing investments (de Janvry 2009; de Janvry and Sadoulet 2020; Bridle et al. 2019).

Common constraints identified in the literature include information, credit, savings, risk and insurance, input/output market access, access to land, access to labor, and other externalities (Jack 2013; Suri and Udry 2024). In recent years, research has also addressed constraints, such as gender-specific barriers, infrastructure, institutional and regulatory barriers, transaction and search costs, and variable climate. This research, however, has found mixed results on some topics, revealing new, important challenges and questions yet to be answered (Suri and Udry 2024). For instance, research on agricultural information provision or extension services shows that the transfer of information can be improved when leveraging tools like information and communication technologies, incentivizing trainers or information providers, or facilitating social learning between neighbors (J-PAL 2023). However, many of these studies either did not collect data on or were unable to detect an effect on yields or profits after farmers adopted and used the new technology promoted through the information shared.

Building on this existing evidence base, UJALA is interested in further understanding farmers' constraints, how the private sector can be a partner in removing them, and how to facilitate and incentivize investment when barriers are overcome.

Some relevant questions include:

- What are the constraints to farmers using improved practices and/or inputs?
    - For instance, are technologies available in the market, but not well-tailored to local conditions?
    - Do farmers face multiple constraints that equally affect their decisions and investments?
- What interventions are needed to alleviate these constraints?
    - Which training programs are effective?
    - How much do liquidity (or credit/financing) constraints matter? For example, would tailored credit products that span the agricultural cycle help to facilitate investment in agriculture by small-scale farmers?
    - How could bundling technologies or services affect take-up and long-term adoption?
- What are the tradeoffs between ex ante (e.g., drought resistant crops) and ex post (e.g., weather insurance) adaptation strategies on farmers' resilience?
- How can programs be designed to encourage willingness to pay for and take-up risk-protecting products and technologies, such as stress-tolerant crops, index insurance, or climate-sensitive agricultural practices?
- Are there technologies that can really move the needle on climate adaptation? If so, how do we trial/test and adapt them to local contexts?

D. Improving access to input and output markets

Addressing questions of output quality and ensuring the existence of competitive or functioning markets is equally important as increasing productivity to improve the overall welfare of agricultural households. Input markets do not often reach farmers in their villages so understanding where and under what conditions farmers are able to purchase inputs and interact with input dealers is important. Not all farmers, especially women, can travel out of villages to access inputs; therefore, understanding these constraints and how to alleviate them is crucial.

Not only must markets exist, but the timing and structure of markets is also critical for farmers' production process. Input markets, on one hand, must be accessible at the time farmers need to make investments and are especially useful when these markets carry high-quality inputs (Hsu and Wambugu 2023; Deutschmann et al. 2023), offer flexible financing options (Casaburi and Reed 2022), and connect farmers with post-harvest buyers. Ag-input dealers may organize markets in advance of the planting season, as liquidity and commitment contracts organized in

the post-harvest period have similar effects on farmer input demand (Dillon and Tomaselli 2022). On the other hand, output markets, which are physical and digital spaces where farmers and sellers meet to negotiate prices for the exchange of agricultural goods, must also exist and be physically accessible and navigable by farmers (e.g., farmers have the right level of price and market information to engage, they know who the buyers are and can choose among options, etc.). Small-scale farmers in low- and middle-income countries often lack access to profitable markets and value chains for many reasons, such as high search costs, lack of information, and inaccessibility due to inadequate road and bridge infrastructure, distance to urban centers, and lack of transport options (de Janvry and Sadoulet 2020).

When farmers are unable to access markets or if the markets to which they have access face low prices despite high demand, farmers do not profit from increasing yields. Making investments in inputs, when available, or adopting new practices or technologies that enable farmers to grow higher volumes or higher quality crops for local or export markets will therefore not be worthwhile to farmers, potentially reducing their incentives to adopt improved technologies that may increase production, maximize profits, and improve their welfare. As such, understanding market dynamics, structures, costs, and flows are critical to improving farming households' well-being. There are myriad open questions related to market access.

Some relevant questions include:

- How can the integration of rural and urban markets in Africa support farmers?
- To what extent does market access matter on both the input and output side? How can we best improve market access?
- Does improving farmers' access to input sellers and markets affect farmers' food security and profitability? To what extent?
- What are the sources of input dealer's business growth? Why do input dealers or other supply-side actors not sell/purchase from farmers? What prevents them from selling in rural villages?
- What is inhibiting output dealers/traders from aggregating in rural areas if farmers are interested in selling?
- Which characteristics determine the market structure, efficiency, and profitability of input sellers and buyers? Which interventions help these firms deliver services that benefit farmers?
- How does facilitating connections within the value chain affect buyer trust and stability at harvest?
- What are effective ways to organize input and output markets?

E. Fertilizer customization and small-scale farmer outcomes

The decision between adopting and using customized fertilizers and blanket formulas is pivotal for small-scale farmers in sub-Saharan Africa. Customized fertilizers, tailored to local soil conditions and crop requirements through soil testing and agronomic expertise, offer a precise approach to address nutrient deficiencies and enhance crop yields (Vanlauwe et al. 2019). Conversely, blanket formulas represent generic fertilizers lacking specificity to the unique soil characteristics and crop demands of individual farming contexts. Research indicates that the utilization of blanket formulas may lead to suboptimal nutrient application, resulting in ineffective resource utilization and decreased agricultural productivity (Kassam 2018).

While the potential advantages of customized fertilizers for small-scale farmer productivity and profitability are apparent, substantial knowledge gaps persist. Despite initial evidence suggesting the effectiveness of customized fertilizer recommendations based on soil testing (Tittonell 2020), the translation of these findings into practical strategies for small-scale farmers in resource-limited settings remains limited. Further research is imperative to comprehensively understand the socio-economic determinants that influence the adoption of customized fertilizers in order to devise effective strategies for surmounting adoption barriers among small-scale farmers.

Some relevant questions include:

- What are the primary constraints hindering small-scale farmers from adopting and utilizing customized fertilizer solutions, and to what extent do they differ across contexts?
- Do farmers make their own customized blends and how effective are these?
- What interventions are needed to address these constraints effectively, and how can tailored training programs enhance adoption rates?
- How can customized fertilizer solutions contribute to climate resilience and adaptation in the face of increasing weather variability and extreme events?
- What are the most effective strategies for mitigating climate-related risks and promoting the uptake of climate-smart agricultural practices among small-scale farmers?
- What are the most effective approaches for scaling up the dissemination of customized fertilizer recommendations to reach a broader population of small-scale farmers?
- How can policy frameworks and institutional support facilitate the adoption and diffusion of customized fertilizer solutions and generally improved practices at scale, and what are the key considerations for sustainable implementation?

III. Partner Landscape

Introduction

OCP Africa is a subsidiary of OCP Group responsible for developing and providing customized fertilizer solutions and agronomic services in Africa. It operates through twelve subsidiaries and two representative offices, covering more than sixteen African countries. OCP Group, a Moroccan State-owned company for 94 percent of its shares, is a leading global provider of phosphate and its derivatives, with access to over 70 percent of global phosphate reserves.

OCP Africa is the largest player in the African fertilizer sector with over 25 percent market share. Since 2016, OCP Africa has supported over 3.2 million farmers through its various initiatives, including a relief campaign in the wake of the 2022 food security crisis with over 500,000 tons of free and discounted fertilizers to aid farmers across the continent. It also runs a range of programs aimed at supporting small-scale farmers and the development of the African agriculture sector more broadly. The following sections provide details on each of these programs (note that these programs vary by country).[2]

I. Agribooster

The Agribooster program provides farmers with fertilizers, hybrid seeds, and training in good agricultural practices (GAP) and soil fertility management. In its extended model, Agribooster includes a full range of inputs (seeds, fertilizer, agrochemicals, etc.), farmer organization support, digital platform assistance, micro-financial services, and mechanization. It aims to enhance productivity through agricultural extension services, soil testing, and customized fertilizer recommendations. The program facilitates market linkages, helping farmers connect with reliable buyers, and involves practical training sessions and demonstrations of modern farming techniques to improve farming practices. Agribooster is run alongside OCP School Lab (see Table 1) in some countries.

[2] The sections aim to give an overview of the programs. The list of implementation countries and the list of partners are not exhaustive and presented here for indication only.

Table 1

Implementation countries	**Partners** (Indicative list)	**Scale** (Total across countries)
• Côte d'Ivoire • Ghana • Kenya • Nigeria • Senegal	• National/regional governments • Local universities • USAID • Cereal Growers Association (CGA) • Ghana Cocoa Board (Cocobod) • Financial Institutions (primarily for microfinance)	1,200,000+ farmers reached (lifetime) and 200,000+ in 2023

II. OCP School Lab (OSL)

The OSL program provides agricultural extension and support to farmers through mobile laboratories to conduct soil testing and field schools. The labs travel to remote areas to conduct soil analysis and deliver tailored recommendations to improve farming practices and productivity in regions where soils were tested. The soil testing is complemented by trainings on good agricultural practices (GAP) and soil fertility management. The program has reached hundreds of thousands of farmers across multiple countries.

Table 2

Implementation countries	**Partners** (Indicative list)	**Scale** (Total across countries)
• Burkina Faso • Cameroon • Côte d'Ivoire • Ghana • Kenya • Nigeria • Rwanda • Senegal • Tanzania	• National/regional governments • Local universities • Institut Agricole d'Obala • Cultivating New Frontiers in Agriculture (CNFA) • Tanzania Agricultural Research Institute (TARI)	900,000+ farmers participated (lifetime), of which 116,000+ received soil tests in 2023 and 341,065+ trained on GAP in 2023

III. Farmer Houses

Farmer Houses (aka Farmer Hubs) establish physical centers in underserved agrarian communities to provide farmers with essential agricultural inputs and services. These hubs stock high-quality fertilizers, seeds, and phytosanitary products for sale, and provide access to training on GAP, soil analysis, financial services, market connections, and mechanization support. Products sold through the Farmer Houses are not limited to OCP products as there are multiple partners involved. Farmer Houses aim to improve the distribution of agricultural resources and enhance the productivity and livelihoods of farming communities while operating like a business.

Table 3

Implementation countries	**Partners** (Indicative list)	**Scale** (Total across countries)
• Cameroon • Ghana • Kenya • Nigeria • Rwanda • Senegal • Tanzania • Togo	• National/regional governments • Local universities • Syngenta Foundation for Sustainable Agriculture (SFSA) • L'Agence Nationale de Conseil Agricole et Rural (ANCAR) • The World Bank • USAID	900,000+ farmers reached (lifetime) and 47 Hubs launched in 2023.

IV. Demonstration Plots

Demonstration plots (aka demo plots) are small, managed pieces of agricultural land used to showcase specific farming techniques, crop varieties, or agricultural practices. OCP-managed plots provide practical examples for farmers to observe the benefits and outcomes of new technologies or methods in real-world settings. Key activities include the application of customized fertilizers, precision planting, conservation tillage, and soil management techniques. Interactive field days and hands-on training sessions are conducted to demonstrate these practices directly to farmers. In some countries, these are held on the side of the road for farmers to more easily see input performance; in other places, the demo plots are held on lead farmers' land.

Table 4

Implementation countries	**Partners** (Indicative list)	**Scale** (Total across countries)
• Burkina Faso • Cameroon • Côte d'Ivoire • Ghana • Kenya • Nigeria • Rwanda • Senegal • Tanzania	• National/regional governments • Local universities • Kenya Agricultural and Livestock Research Organization (KALRO) • Coffee and Cocoa Board of Côte d'Ivoire • National Agricultural Extension and Research Liaison Services (NAERLS)	5,000+ demonstrations conducted in 2023

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