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Enabling the Environment for Private Sector Investment: Impact on Food Security and Poverty

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Abstract: Millions of people worldwide live in extreme poverty, which has an adverse effect on global food security. Research shows that growth in the agricultural labor sector has twice the impact on poverty compared to growth in other labor sectors. To that end, we examine some of the enabling factors of private sector investment to increase food security and reduce poverty: innovative output, intellectual property rights innovation, gender-sensitive land tenure, creation of new businesses, openness to trade, government institutional flexibility, access to credit, inclusion of new sectors, income diversification, public-private partnerships, infrastructure improvements, payments for eco-system services, and climate-smart innovation. Developing policies that improve food security will help to reduce poverty.

Keywords: food security, private sector investments, enabling environments, feed-the-future initiative, poverty, chronic hunger, rural, agriculture, global public health

JEL Classification: O31, O33, O34

1 Introduction

Shortages of food and water are a major threat to global health (Tripathi et al. 2019). Of the millions of people suffering from chronic hunger and unsafe water, 75% live in rural areas where they rely on agriculture for household income (Dunford and Lyng 2010; Hatab et al. 2019). While advances in the agricultural labor sector have been greater in reducing poverty than advances in other labor sectors (Ivanic and Martin 2018; Osabohien et al. 2019; Tomich et al. 2019).

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This paper focuses on enabling private sector investments in food-insecure countries such as those in Africa, where private investments to end food insecurity are limited. For example, roughly only 5% of investments in Uganda's agriculture is funded by the private sector (Bruce and Costa 2019). Strategies to stimulate private investment in agriculture can increase farm income and employment to guarantee global food security. Private sector investment in food-insecure countries has been limited for many reasons that we discuss that relate to agricultural enabling environments, innovative output, intellectual property rights innovation, gender-sensitive land tenure, creation of new businesses, openness to trade, government institutional flexibility, access to credit, inclusion of new sectors, income diversification, public–private partnerships, infrastructure improvements, and climate-smart innovation. This paper complements the research by Schmitz, Kennedy, and Schmitz (2015, 2016, 2017) on increasing food supplies and reducing food insecurity through public sector investments in new crop varieties.

2 Population Increases: Food and Water Demand

Projected population increases mean we must alter strategies to accommodate expected demand for the concomitant need of sufficient food and water for food-insecure populations, 98% of whom reside in developing countries (Abbade 2020; Boretti and Rosa 2019; Gouel and Guimbard 2018). The global population is projected to grow to 11 billion in 2100 and per-capita increase is expected to increase by 3%, leading to higher demand for food and water (Biswas and Tortajada 2016; Mountford and Rapoport 2015). Further, predictions are for a 100–110% increase from the 2005-level in global demand for food crops between 2020 and 2050 (Biswas and Tortajada 2016). Specifically, Alexandratos and Bruinsma (2012) estimate that by 2050, there will be large increases in demand for cereals (45.5%), sugar (74.9%), and meat (76.4%). To meet future food demand, the amount of cropped agricultural land will need to increase, in addition to increasing crop

productivity, to produce enough food to feed the world (Anseeuw et al. 2012; Kareem 2018; Timsina 2018).

In addition, anticipated increased water demand presents further obstacles (Figure 1) complicated by already existing issues with the quantity and quality of the water supply worldwide (Biswas and Tortajada 2016). If current policy and investment trends continue, 53% of the global population, along with 49% of grain production and 45% of the gross domestic production (GDP), will experience water shortages by 2050 (Ludwig et al. 2016).

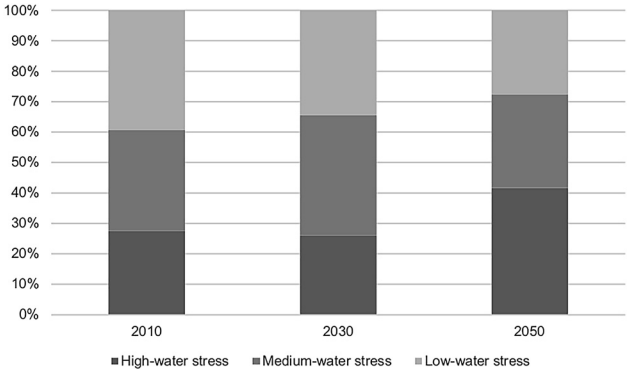

Figure 1: Share of people living under low-water (0–20%), medium-water (20–40%), and high-water (>40%) stress, estimated in 2010 and projected for 2030 and 2050 under the "business as usual" scenario.
Source: Ludwig et al. (2016).

3 Private Sector Investments

Private sector investments can play an important role in meeting current and future food and water needs (Negra et al. 2020). Evidence suggests that increased food production can decrease food insecurity if food dissemination is equitable (Pérez-Escamilla 2017). In the case of private sector investments, a systems approach (Riches 1997), rather than a disjointed process, should be used to facilitate improvements in global food security and human health in food-insecure countries.

African countries have infused both capital and technology into their agricultural sectors to improve agricultural productivity, food security, and rural livelihoods. However, research in selected Sub-Saharan African (SSA) countries indicates these agricultural investments typically have performed poorly or have ended prematurely (Lappé 2016). Investment performance (in terms of returns to capital) is influenced by macroeconomic, investment, trade, industrial, and agricultural policies (Pingali 2007).

Existing models of successful private sector agricultural investments show that when carried out correctly, private sector investments have improved farming techniques and technologies (Ruiters and Matji 2016; Mangeni 2019). Medium-scale to large-scale agricultural investments are also feasible (Mawoko, Hendriks, and Reys 2018). These successes are a strong basis for encouraging private sector agricultural investments.

4 Agricultural Enabling Environment

A deficient enabling environment has deterred private sector investment in agriculture (Bruce and Costa 2019). Improving the enabling environment for agricultural transformation involves addressing infrastructure issues, regulatory frameworks, financial access, and climate change (Cotula et al. 2009; Teng and Oliveros 2016). Deficient enabling environments normalize land degradation at the national frameworks, a phenomenon closely tied to food insecurity, poverty, and poor health outcomes (Viala 2008). Transforming the financial environment surrounding agriculture on a national level by promoting private sector investments means addressing relevant environmental aspects. In Africa, factors that would contribute to an increased market size are positively and significantly related to foreign direct investments ($p < 0.01$) (Amponsah, Garcia-Fuentes, and Smalley 2019).

5 Innovative Output

Agricultural development requires both institutional and technological innovation specific to a particular climate. What does not work is ignoring people in-country with specific knowledge about the local environment. Some African countries score comparatively low for innovative output (Dutta, Lanvin, and Wunsch-Vincent 2018; Masters, Ronsenblum, and Alemu 2018). Three strategies necessary to revitalize agricultural innovation in Africa have been argued to be (1) investment in the training and technical expertise relevant to agriculture; (2) investment in training farmers to adopt innovations; and (3) building networks between experts and users (Dinesh et al. 2017).

Many countries perform poorly in terms of their levels of corruption control (Zoogah 2018). Corruption in these countries is characterized by the creation of an ethical divide that hinders effective public administration (Downe, Cowell, and Morgan 2016). Further, countries with poor corruption control measures experience excessive public expenditures, a diversion of resources from social and

public goods, and an overall weakened public administration (Lassou, Hopper, and Soobaroyen 2020; Perry 2015).

6 Intellectual Property Rights Innovation

Intellectual property rights (IPR) for crops are critical, as they have a direct effect on innovation (Haugen 2020). This effect is modified by the economic state of the country (Zoogah, Peng, and Woldu 2015), with developed countries benefiting from tighter IPR compared to developing countries that often experience higher monopoly prices and lower welfare (Porter and Watts 2016). The relationship between IPR and innovation tends to follow an inverted U-shape. The optimal level lies in the center, within a tradeoff between a positive IPR that allows for higher research and development investment-based profits with larger mark-ups, and a negative IPR with less competition from increased blocking of rival entries into the market and higher costs for license transactions (Ager and Zarowsky 2015; Oluwatobi et al. 2015; Swanson et al. 2015). By modeling the relationship between innovation and IPR as modified by GDP, the innovation/IPR derivative increases when the per-capita GDP is above $4500. These effects can be mitigated by trade linked to foreign direct investments (FDI) and sufficient stock of human capital (Littlewood and Holt 2018; Oluwatobi et al. 2015). Human capital and secondary education are two important factors in a country's ability to absorb foreign innovation (Oluwatobi et al. 2016; Porter and Watts 2016).

Many examples show corrupt distribution of funds by African governments at all levels, such as the Fifth Burundian Five-Year Plan, which allocated 98% of its fixed gross capital to areas immediately surrounding the capital and to the home province of the country's elite (Kasara 2007). Local governments commonly allocate money to areas of personal investment (Oluwatobi et al. 2015). Private sector investments are an important tool to offset this negative force. To limit resistance to the changes necessary to foster innovation, the private sector must pressure government officials to pursue legislative reforms (Lassou, Hopper, and Soobaroyen 2020).

7 Gender-Sensitive Land Tenure

Although gendered differences occur in all aspects of business ownership, particularly in reference to credit access, there has been little progress in addressing the resultant lag for women in agricultural productivity due to empirically defined gender inequalities (Diiro et al. 2018; Kassie et al. 2015; Zereyesus 2017). Women have very little purchasing power, landownership, or land tenure. For example, in Kenya, only 0.5% of women have access to financial services and only 6% own land (Diiro et al. 2018). In addition to business constraints on landownership, traditional gender roles and associated discrimination limit a woman's ability to own land or have financial access, which presents significant barriers to women in the entrepreneurial space (Crick et al. 2018; Mori 2014; Mugabi 2014). A 2012 Women's Empowerment in Agriculture Index (WEAI) study measured female empowerment in agricultural settings in poor developing nations around the world (Alkire et al. 2013). The WEAI scores five domains of empowerment: decisions about agricultural production, access to and decision-making power about productive resources, control of use of income, leadership in the community, and time allocation. Based on these dimensions, despite their central role as farmers, more than half of the female population worldwide are disempowered (Cotula et al. 2009). For example, looking at domain scores on a global scale, 61.0% of female farmers in Bangladesh averaged 49.6%, 71.3% of female farmers in the western highlands of Guatemala averaged 43.5%, and 56.7% of female farmers in Uganda averaged 37.2%.

Along with an inability to own land, women also have limited access to technological advancements in agriculture (Peterman, Behman, and Quisumbing 2014). In Ghana, female farmers are associated with lower rates of organic fertilizer adoption ($p = 0.001$) and lower crop yields (Martey 2018). Addressing gender-based differences in agriculture is important because women tend to do the majority of the farm work despite their limited autonomy (Figure 2) (Gouse et al. 2016).

8 Creation of New Businesses

Multiple policy solutions could expedite the creation of new businesses. Agricultural enterprise promotion is a key development policy (Poulton and Macartney 2012). While increasing product protection based on geographical indications is a solution, this has been difficult to do because many of the countries within a specific geographical area grow the same crops (Atwood 1990).

Providing small business services has achieved variable success due to differences in design and implementation as needed (Antle 1983; Babcock 2015; Batra and Mahmood 2003). Entrepreneurial education, such as

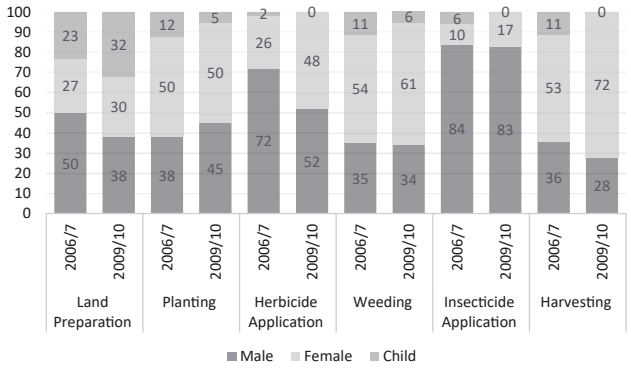

Figure 2: Male, female, and child maize production labor commitment indicated as share of total labor effort in South Africa. Source: Gouse et al. (2016).

programs to boost productivity for small household and micro-enterprises, is somewhat successful in the creation of new businesses. In different settings, entrepreneurship education comprises startup preparation, venture initiation preparation, and post-startup business management (Chipika and Wilson 2006). A survey of Kenyan female small-scale entrepreneurs reveals that education and business training are the most significant factors in attaining business success and accessing monetary financial institution (MFI) loans (Robson, Haugh, and Obeng 2009). For example, a 1.0 unit increase in education increases business success by 1.26 units, while a 1.0 unit increase in business training increases business success by 1.44 (Batra and Mahmood 2003). Business registration barriers must be addressed politically and must be culture-specific in order to succeed (Rogerson 2001). With more businesses comes a greater market size, and since market size is significantly and positively related to foreign direct investments ($p < 0.01$), creating new businesses is crucial (Amponsah, Garcia-Fuentes, and Smalley 2019).

9 Openness to Trade

Between 1995 and 2001, a country's openness to trade had a strong positive correlation with foreign direct investments (FDI) (Iamsiraroj 2016; Ronoh et al. 2014; Sabier, Rafique, and Abbas 2019). Across the developing world, Sabier, Rafique, and Abbas (2019) found that holding all other factors constant, a one-percentage point increase in trade openness leads to 3.7 and 2.1% increases in FDI inflows in low-income and lower-middle-income countries, respectively. Openness to trade has a slightly stronger effect in non-SSA countries compared to SSA countries: a 1% increase in openness corresponds to a 0.033% increase in FDI/GDP in non-SSA countries ($p < 0.01$) compared to a 0.028% increase in comparable SSA countries ($p < 0.01$) (Ronoh et al. 2014). Using two models – OLS and Fixed Effects – Kandiero and Chitiga (2006) found the economy-wide openness coefficient statistically significantly associated with FDI to GDP. The coefficients and p-values for the models were 0.0363 ($p = 0.0088$) and 0.0354 ($p = 0.0042$), respectively (Babcock 2015).

The Enabling the Business of Agriculture project (EBA) has provided case study findings on the relationship between FDI and development. Sierra Leone relied on FDI to develop its rural sectors using bioenergy (Batra and Mahmood 2003). The process evaluation revealed that countries need good governance to reap sustainable development benefits (Asiedu 2002). The institutions of Sierra Leone lacked the infrastructure to manage FDI and mobilize key partners and governance to improve agriculture. Moreover, investing time and know-how is a valuable path toward creating stronger governance that includes regulatory structures, technology, and effective coordination among key agencies (Asiedu 2002).

The relationship between financial aid and FDI is positive. When controlling for population growth, domestic savings, and initial per-capita GDP, the combined effects of complementary aid (education and health inputs) and physical aid (agriculture and trade inputs) have a stronger effect (Selaya and Sunesen 2012). This statistically significant relationship suggests that aid may be one way to increase FDI and private sector investments. As for the control variables, per-capita savings had a significant and negative effect on FDI while the effect of population growth was insignificant. Per-capita GDP had a positive and significant effect on FDI (Selaya and Sunesen 2012).

In another model, Iamsiraroj (2016) demonstrated the effects of domestic investment on FDI. Although domestic investment had a positive effect on economic growth, if it were considered in a silo, the total effect of domestic investment on economic growth would be negative. This is due to negative effects of domestic investment on FDI inflows into a country. For a developing nation, this creates more incentives to attract FDI to promote long-term economic growth than to expand domestic investment.

10 Government Institutional Flexibility

Without governmental enabling environments, countries are at risk of being excluded from resources and markets due

to globalization and competing uses of resources, which may lead to reduced resource productivity. A nation's institutions and its investment climate are strongly related in developing countries (Obeng and Blundel 2015). The task has been to reconcile the immediate needs of communities with international agreements focusing on the ecosystem. Governance of institutional enabling environments involves (1) setting management objectives, (2) defining and providing the knowledge base for management, and (3) ensuring implementation of management decisions.

An example of a successful institutional enabling environment is fisheries co-management between Southeast Asia and Southern Africa (Selaya and Sunesen 2012). The authors have researched various implementations of co-management arrangements in coastal and freshwater fisheries in Southeast Asia and Southern Africa to present a more comprehensive understanding of co-management and to summarize the experiences with both the positive outcomes and the problems in actual implementation.

Gutiérrez, Hilborn, and Defeo (2011) investigated 130 community-based co-management fisheries in 44 countries. Sustainable catches, referring to stock productivity, had a correlation of $r = 0.7$ for "Fishery Status" (denoting under-exploited, fully-exploited, and over-exploited fisheries). Sustainable catches were strongly correlated with increases in social welfare, referring to an increase in community welfare, income, and social equality ($r = 0.60$). Increased welfare and sustainability were positively correlated ($r = 0.5$) (Gutiérrez, Hilborn, and Defeo 2011). Co-management success differed across human development indices ($p < 0.05$). Industrial fishing sectors were more successful than artisanal fishing sectors ($p < 0.01$). Offshore ecosystems were more successful than both inland and coastal ecosystems ($p < 0.01$). Success also differed by resource type ($p < 0.05$). Governance attributes had a significantly stronger effect on success compared to user attributes ($p < 0.01$) (Gutiérrez, Hilborn, and Defeo 2011).

Another example of the creation of a successful enabling environment is the Senegalese approach to addressing and alleviating childhood undernutrition (Kampman et al. 2017). Gillespie and van de Bold (2017) describe an approach to evaluating systems of change through the guiding themes of commitment, coherence, and community. Particularly, in Senegal, they addressed the creation of strong coherence, both vertically – bridging national and local policies – and horizontally – bridging multiple sectors (Kampman et al. 2017). The Unit for the Fight Against Malnutrition that the government developed brought together the education, health, and agriculture sectors; different types of organizations (government, non-government, and international); and academia. The body of the different types of organizations produced critical reviews of local governments' failures to adopt nutrition reform to provide structure for future nutrition development policies. Collaboration among different actors promotes an environment of re-evaluation and progress, while also aiding the monitoring and collation of nutritional data for public and private sectors.

Recurring political, economic, and environmental crises require re-evaluating dominant pathways of food security that meet resistance to fundamental changes. Rather than preserving conventional patterns and focusing on continuity, crises could be an opportunity for adopting more sustainable pathways. By focusing on institutions, we illustrate the tension between the concepts of continuity and change, along with how they interact and how they build or degrade institutional resilience (Selaya and Sunesen 2012). While Uzbekistan has chosen to preserve key institutions, maintaining social memory, and providing transparency of reform processes, South Africa has opted to create comprehensive reforms resulting in a higher level of change, including flexible legislation, regular reviews, and adaptation of legislation during and after implementation.

11 Access to Credit

Access to credit and use of financial loans can advance small business producer groups (SBPG). These loans can be created by developing economic policies, loan packages, and strategies to make certain that access to credit is available to those in need (Cotula et al. 2009; Di Mario, Rao, and Drechsel 2018). Inadequate agricultural finance limits production, investments, and value chain activities in the sector as well (Berg and Fuchs 2013). It is estimated that the overall investment gap for rural development and agriculture needs in Africa is US$20–40 million annually (Page and Shimeles 2015).

Korir (2015) analyzed the factors affecting access to credit by the SBPGs in Kenya based on what influences credit access, how farmers choose their credit source, and the role of credit facilities (Cotula et al. 2009). Credit access was influenced by inconsistent information, potential risks, lack of collateral, lender-borrower distance, income level, distance to credit sources, past credit participation, and assets owned (Cotula et al. 2009). Credit source was determined by proximity to financial institutions, credit processing time, all times access, repayment flexibility, and lower transaction costs (Global Mechanism 2008). Smallholder farmers gained the attention of large buyers by jointly storing, grading, and selling their produce (Global Mechanism 2008). Governments helped establish

private sector-led deals through equity participation such as through soft loans or insurance schemes (Taj et al. 2012). In a Nigerian case study, Okon and Osaniuma (2017) reviewed the impact of interest rates on small and medium enterprises (SMEs). Using a chi-squared analysis, they showed that high interest rates crowd out SMEs; therefore, they recommended that Nigerian banks set aside a portion of profits for low-interest-rate soft loans and interest-free loans to stimulate private sector involvement.

Those who provided loans from banks in African countries and those who drove banks' involvement in Kenya, Nigeria, Rwanda, South Africa, and Tanzania between 2010 and 2012 showed that the share of lending for agriculture in the overall loan portfolios of banks varied 5–20%. The key contributing factors included the structure and size of the economy, the extent of government borrowing, the degree of innovation (mostly introduced by foreign lenders to financial sectors), and the state of the financial sector infrastructure and enabling environment (Korir 2015). To encourage private sector investment, micro-investments became popular, lending as much as US $100 to micro-entrepreneurs (Taj et al. 2012).

Increasing capital – especially external capital in the form of FDI – in SSA economies is vital to their expansion, given their extremely low income levels and domestic savings (Munguti 2014). One significant barrier to FDI in Africa is geographical location. Being an African nation has a significant negative effect on FDI (Ronoh et al. 2014). Higher return on capital has no significant effect on FDI flows to SSA countries, despite its significant and positive effects on FDI flows to non-SSA countries (Nhyamah 2013). Similarly, infrastructure development promotes FDI in non-SSA countries but has no significant effect on FDI in SSA countries (Atwood 1990). The implemented policies to better the enabling environment for private sector investments should perhaps reflect the differences that these findings indicate between African and other developing nations.

Small-scale studies reflect that with proper support, if the investments were to reach SSA countries, they would significantly increase profits for farmers and agribusinesses. A case study in Malawi shows that farm profits of women who received grants supplemented by loans from micro-financial institutions increased 10% more compared to those of women in villages who received grants without loans (Asiedu 2002). The smallholders bought fertilizer and seeds, hired more labor, and increased their use of tractors. The increases in profit from the grants and loans combined persisted for more than two years, and the results were statistically significant (Asiedu 2002). However, grant money alone is insufficient; there must be infrastructure in place to provide loans on an individual scale.

12 Inclusion of New Sectors

In rural African landscapes, investment is increasing in agriculture and food security, poverty alleviation, climate change adaptation, and ecosystem conservation. Historically, investments corresponded with new sectoral programs (Milder et al. 2014). Times are changing, with the latest trend being investment in integrated landscape initiatives (ILIs) to improve management of rural landscapes (Asiedu 2002). Milder et al. (2014) conducted a survey of leaders and managers of 87 ILIs in 33 African countries, which revealed that 63% of the ILIs reported at least one positive outcome in all domains and 72% in at least three. The correlation between the investment and outcome indices was both significant and positive (r = 0.45) ($p < 0.001$). The survey also measured motivations, design, participation, and outcomes of initiatives. The results suggest that ILIs succeed at promoting multi-functionality of rural regions. Similarly, van Zanten and van Tulder (2018) found that multi-national enterprises must develop multi-sectorial partnerships in order to take on a more proactive role in achieving sustainable development goals.

13 Income Diversification

The income source of smallholder investors is an important component of improving enabling environments. Diversifying one's income sources mitigates the risk of losing assets (Waage et al. 2016). For example, an Ethiopian case study showed that on average, a 10% increase in the crop diversity index reduces the probability of being in poverty by 17.5% (Michler and Josephson 2017). Moreover, increasing crop diversification by 10% was associated with a 16.9% reduction in the risk of falling into poverty and an 18.3% reduction in the probability of remaining in poverty for those already under the poverty line (Michler and Josephson 2017). With greater revenues from other markets, farmers have capital they can depend on while they invest in their smallholdings. This provides more stability in the financial framework surrounding agricultural transformation, thereby stabilizing enabling environments (Waage et al. 2016).

Diversification of income can also arise from family members migrating to different locations to engage in different industries. Beegle, De Weerdt, and Dercon (2011) revealed significant decreases in poverty and consumption resulting from migration in Kagera, Tanzania, a predominantly rural region where exported coffee is the primary source of income in the region. A case study on migration in

Oromin, Ethiopia revealed that the average change in consumption and poverty by head count showed a significantly greater decrease in poverty among those who migrated compared to those who remained ($p < 0.0001$) (Van Den Berg and Kumbi 2006).

Policies to reduce poverty must address the type of migration that is taking place (Beegle, De Weerdt and Dercon 2011). Migration into non-agricultural sectors may increase food security (Waage et al. 2016). In addition, migration to non-agricultural rural settings has a more significant effect on poverty reduction ($p < 0.05$) compared to migration to strictly urban settings ($p > 0.1$) (Beegle, De Weerdt, and Dercon 2011).

To maintain rural agricultural communities, agriculture must become a more sustainable, lucrative, and attractive sector. The private sector has a unique opportunity to invest and provide incentives. Thus, addressing the other elements of enabling environment for private sector investments, such as credit access and government institutional flexibility, is critical.

14 Public–Private Partnerships

Public–private partnerships (PPPs) may increase the level of private sector investment into poorly performing agricultural value chains. Private investors may perceive less risk if the initiative has public funding. Poulton and Macartney (2012) considered a range of PPP mechanisms that respond to different market failures affecting economic chains, along with common patterns associated with implementing PPPs in Africa. They found that even though some positive impacts on investment may exist, state failures undermined PPP effectiveness (Poulton and Macartney 2012).

Researchers are mostly interested in the ability of public and private entities to collaborate (Börzel and Risse 2005; Kampman et al. 2017; Poulton and Macartney 2012; Ulbert 2008). The analysis by Ulbert (2008) reveals that the first mark of the effectiveness of a PPP is the establishment of a working relationship between the private and public entities. Many attempts to understand PPPs have shown that their effectiveness is extremely variable (Table 1) (Börzel and Risse 2005). Ruiters and Matji (2016) report that barriers to PPP success include a lack of technical skills and the failure to monitor the operators. PPP models can be successful, but the contract must suit all the involved parties. Further, addressing the lack of technical, management, and legal capacities of local municipalities is important for successful PPPs in the industry (Ruiters and Matji 2016).

15 Infrastructure

15.1 Local Infrastructure and Technological Advances

Enabling infrastructure includes insurance, public utilities, public works, transportation, and research facilities, all of which are essential for agricultural development. Infrastructures defined as facilities include structures, associated equipment, services, and institutional arrangements that facilitate the flow of agricultural goods, services, and ideas (Christiaensen, De Weerdt, and Todo 2013). Deficiencies in these enabling infrastructures and in available local technologies pose major constraints to the development and innovation of formal and informal SMEs in Africa (Crick et al. 2018, Di Mario, Rao, and Drechsel 2018). In a joint study by the World Bank and the Africa Development Bank, electricity was determined to be the largest failure in infrastructure, with 30 nations reportedly experiencing regular extended power shortages (Adenle, Manning, and Azadi 2017). Poor quality roads have a negative impact on the adoption of non-traditional agricultural practices and create a high cost of transportation from the farm to the primary and secondary markets (Page and Shimeles 2015). Further, low fertilizer usage is attributable to high prices and far distances from manufacturers (Cotula et al. 2009).

Many countries view foreign investment in agriculture as an opportunity to introduce new technologies that are increasingly complex and area-specific (Reardon et al. 2019). The private sector has been argued to be more involved in funding technology research and development (R&D) than in purchasing the technologies (Cotula et al. 2009). Agricultural technologies require huge investments in R&D, yet most countries in Africa spend an average of 0.7% of their agricultural GDP on R&D compared to nearly 3% in developed countries (Udry 2015).

While overall agricultural R&D is dominated by the public sector, private sector research has shown higher annual growth rates in Kenya, Mexico, and Zimbabwe (Cotula et al. 2009). On a global scale, between 1981 and 2000, the increase in absolute private sector agricultural R&D spending in OECD countries tripled compared to the increase in public sector R&D (Pray and Fuglie 2001). For example, private sector investments in soil biotechnology innovations include plant growth-promoting rhizobacteria (PGPR), which can increase crop yields by as much as 60% (Cotula et al. 2009). Azogreen-m, containing *Azospirillum*

Table 1: Sources of failure in agricultural markets.

Market failure source	Private sector involvement constraints	Agricultural examples	PPP solutions
1. Lack of enabling environment	Unstable macro-economic environment		
	Inadequate physical infrastructure	Rural roads, irrigation infrastructure	Provision and/or maintenance of infrastructure
	Weak property rights and/or contract enforcement		
	State as problem (crowding out, unpredictable policies)		
2. Public or merit goods	Market under-provides due to:		
	Nonexcludability, nonsubtractability	OPV seed research	Contracting out service delivery
	Social benefits exceed private benefits	Fertilizer (e.g., if food price falls)	Voucher schemes
	Lack of effective demand	Extension	
3. Barriers to entry	Lack of access to:		
	Capital Technical knowledge Market information	Stock lists, seed companies	Loan guarantees
	High fixed costs/risks	Biotechnology research, credit, smallholder engagement in high value commodity chains	Risk sharing schemes
4. Coordination failures	Asymmetric information, no mechanism to enforce commitments; lack of trust	Complementary investments in service provision to smallholders or along value chain	Deliberative fora

Source: Antle (1983).

lipoferum CRT1, promotes maize growth by significantly increasing the root length of inoculated plants compared to non-inoculated plants ($p < 0.05$) (Cotula et al. 2009). Other species of PGPRs have significantly suppressed plant diseases such as cucumber mosaic virus ($p \leq 0.05$), damping off disease ($p \leq 0.05$), wilt disease ($p \leq 0.05$), and Anthracose disease ($p \leq 0.01$) (Jetiyanon and Kloepper 2002). Advancements in technology between 2020 and 2050 would help to reach crop demands to feed the ever-growing global population, while reducing the amount of land needed to meet current yields. For this to happen with maximum effect, technological advances must be coupled with technology transfer to developing nations (Page and Shimeles 2015).

Between 1996 and 1998, the United States Department of Agriculture (USDA) conducted a survey and interview-based study in Asia to analyze the influence of private sector research on international agriculture and the private technology transfer business. One of the primary objectives was to assess the impact of private investments on agricultural businesses in the low-income, midsize economy countries of Indonesia, Pakistan, and the Philippines (Cotula et al. 2009). Investigators found that investing in private research contributed significantly to increasing agricultural productivity and output, while increasing income for farmers and reducing food costs of consumers (Abbade 2020). For example, allowing for private research led to increased sugarcane yields in the Philippines and reduced banana production costs; privately funded research also led to control of pests that are unique to the Philippines while reducing the number of fungicidal applications necessary to grow banana crops (Juma 2015). Ultimately, privatized agricultural research led to improved income distribution, primarily benefiting food crop production of smallholders and low-income consumers (Cotula et al. 2009).

15.2 Payments for Eco-System Services

Despite the knowledge that conservation agriculture is likely to improve poor crop production and soil quality in Sub-Saharan Africa (Keesstra et al. 2016), conservation agriculture is not prioritized in funding due to the limited amount of agricultural investments available. Payments for ecosystem services (PES) offer a new approach to securing revenue streams for the maintenance, conservation, and restoration of ecological structures and functions globally (Waage et al. 2016). This new approach is still in the early stages of development.

Studies on PES present qualitative findings (Corbera, Kosoy, and Tuna 2007; Waage et al. 2016). Corbera, Kosey, and Tune (2007) found that payments channeled directly to non-governmental organizations for the protection and management of protected areas only partially compensate for management costs, while payments allocated to individual farmers and rural communities barely compensate for local opportunity costs or fair prices. Regardless, they found that the payments contribute to household and community well-being by providing material household needs and collective benefits (Corbera, Kosoy, and Tuna 2007).

15.3 Climate Smart Innovation

Effective responses to climate change require innovation. Africa, purported to be one of the most vulnerable regions in the world to climate change, could experience enormous crop losses due to increased vector-borne diseases and pests in the future, leading to a large number of deaths due to food insecurity (Adenle, Manning, and Azadi 2017). Given the role that innovation plays as an engine for economic development, we examined the collective enabling factor of institutions in Africa (Pray and Fuglie 2001). Applying the system generalized method of moments (SGMM) estimation technique (Cotula et al. 2009) to a sample of 40 African countries over the period 1996–2012 revealed that the institutional measures with the most equivalent impact on innovation are government effectiveness and regulatory quality. Many SMEs face barriers in developing both short- and long-term climate adaptations, especially due to the high upfront required capital costs (Crick et al. 2018). SMEs also face significant tradeoffs in short-term growth optimization compared to long-term climate adaptation. Short-term investments have an impact on the development of products or services that are climate-smart, especially if they are not directly at high exposure to immediate climate risk.

International investments in farmland are occurring where land had previously been of little interest (Pray and Fuglie 2001). Evidence from examples such as the Mali Biocarburant biodiesel project in Koulikoro, Mali suggests that carbon market considerations play a role as complementary sources of market profits. The development of biofuels has the potential to influence both agricultural development and environmental conservation. However, promoting the oil-bearing, non-edible tree *Jatropha curcas* (Jatropha) as a sustainable development tool in Mali creates the risk of shifting land-use from the production of food toward biofuels (Cotula et al. 2009). To control this, "improved cooperation and coordination among state departments, enhanced monitoring of programmes and projects, as well as the establishment of adequate regulatory and fiscal frameworks governing private biofuel investments are needed to achieve sustainable outcomes" (Hacihasanoglu 2013).

Transgenic crops offer important benefits toward sustainable agriculture for developing countries in which malnutrition and starvation are common. Transgenic crops allow for more flexible crop management and higher productivity, along with environmental benefits from decreased use of pesticides (Cross and Adam 2007). Transgenic crops developed by the private sector are most common in industrialized nations (Page and Shimeles 2015). Only a small number of SMEs in Africa have adopted the use of drought-resistant crop varieties or have access to improved seeds (Page and Shimeles 2015). Private investments in agriculture would facilitate the adoption of transgenic crops, thus providing much needed benefits to developing nations with high rates of food insecurity.

Importantly, studies show that transgenic crops influence labor use differently than conventional crops. For example, Gouse et al. (2016) found the amount of farm labor time by smallholder maize farmers in South Africa differed between those who grew insect-resistant and conventional maize and those who grew insect-resistant and herbicide-tolerant maize: land preparation and planning ($p = 0.01$), herbicide application ($p = 0.00$), manual weeding ($p = 0.00$), harvesting ($p = 0.07$), and total family labor ($p = 0.00$).

16 Limitations and Conclusions

In the recent past, calls for action to address undernutrition have resulted in investments in Africa by international governments and organizations and private donors, yet many of these efforts have fallen short of international best practices (Page and Shimeles 2015). While campaigns have successfully communicated to investors a common understanding of what malnutrition is and how to address it, the following more complex questions persist:

> How can enabling environments and processes be cultivated, sustained, and ultimately translated into results on the ground? How has high-level political momentum been generated? What needs to happen to turn this momentum into results? How can we ensure that high-quality, well-resourced interventions for nutrition are available to those who need them, and that agriculture, social protection, and water and sanitation systems and programs are proactively reoriented to support nutrition goals? (Hacihasanoglu 2013: 552).

To fully comprehend how to create enabling environments for private sector investments, a better understanding is needed of farmland data and how to secure local land rights within the context of agriculture investment projects (Atwood 1990). Generally, the conversation needs to be broadened thematically since factors such as environmental standards and commercial pressures from land usage outside of agriculture (i.e., tourism, mining, etc.) have not yet been explored (Poulton and Macartney 2012).

A significant limitation of this research is that Africa is less monolithic than other developing areas (Giller et al. 2009). Even within the continent, Sub-Saharan Africa does not respond as well to typically successful strategies for increased FDI. Approaches to increasing available capital in other areas of the world cannot necessarily be applied broadly to Africa, which makes creating enabling environments for private sector investments even more challenging.

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