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Key Messages

- Sub-Saharan Africa is one of the world's poorest regions. Its comparatively low land productivity, which results from both farming practices and physical features, exacerbates local households' uncertainty regarding livelihood and food security.
- Other areas of the world that successfully lifted their agricultural productivity did so by relying on improved seeds and fertilizers. Despite efforts in this direction, this has not occurred in SSA.
- Farmers' adoption of such technologies can be constrained by poor access to credit and insurance, and by behavioral barriers such as lack of information and present-bias.
- Long-term climatic shifts and the increased likelihood of weather shocks make implementing adaptation and mitigation policies for agriculture imperative in this region.
- Land productivity boosts can lead to lasting effects only if coupled with improvements in security, political stability and effective health systems.

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A “Green Revolution” for Sub-Saharan Africa? Challenges and Opportunities

Michael Bernardi, Christa Hainz, Paulina Maier, Maria Waldinger[*]

Sub-Saharan Africa (SSA) ranks as one of the world’s poorest regions. The causes of this are exceptionally complex, with political instability, lack of security, low levels of education, poor access to infrastructure and lack of integration into global trade networks as the leading explanations, among others. In addition, a large part of the population still depends economically on agriculture (Suri and Udry 2022). Agricultural productivity, however, is very low and is regularly further reduced by political or climatic shocks, such as wars, terrorism and extreme droughts or floods (Addae-Korankye 2014, Bulte et al. 2022, Hübsch et al. 2022).

Several developmental policy initiatives of the international community, together with domestic policy efforts within SSA countries, try to counteract this phenomenon, for instance through direct investments in education, health, infrastructure or promotion of private investment and trade partnerships. A complementary approach focuses on agricultural productivity. The logic behind this approach acknowledges that actual agricultural productivity in sub-Saharan Africa lags far behind its potential, even though it could be within reach using modern farming methods (Lobell et al. 2009). While countries in Asia and South America have been able to greatly increase their agricultural yields since the 1960s through improved seeds and chemical fertilisers, this development has been far weaker in sub-Saharan Africa: no "Green Revolution" has taken place here.[1]

This is a cause for concern, firstly because low domestic agricultural production is one of the reasons for the lack of food security. Secondly, because SSA is being, and will continue to be, particularly affected by climate change. If average temperatures and the risk of weather extremes continue to increase (Milly et al. 2002), agricultural

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[1] The “Green Revolution” denotes the use of improved seeds in combination with chemical fertilizers, which have greatly increased agricultural yields in South America and Asia (Evenson and Gollin 2003). However, the Green Revolution is also associated with severe environmental problems.

productivity in SSA will deteriorate further, increasing food insecurity and poverty (IPPC 2022).

In recent decades, economists and agricultural development experts have been looking for ways to increase agricultural productivity in SSA through improved seeds, fertilisers and more modern farming technologies. In this article, we look at the measures in question, what has been done so far, and how scientists assess the effectiveness of these measures on agricultural productivity and poverty reduction. Finally, we present concrete recommendations.

Background: The Green Revolution

In Asia and Latin America, a "Green Revolution" that started in 1960 has already taken hold. Grain yields have quadrupled, thanks to the spread of chemical fertilisers and high-yield seeds (Carter et al. 2021). The latter have been qualitatively improved to better withstand droughts or floods, and are adapted to local conditions (Bulte et al. 2022, Emerick et al. 2016).

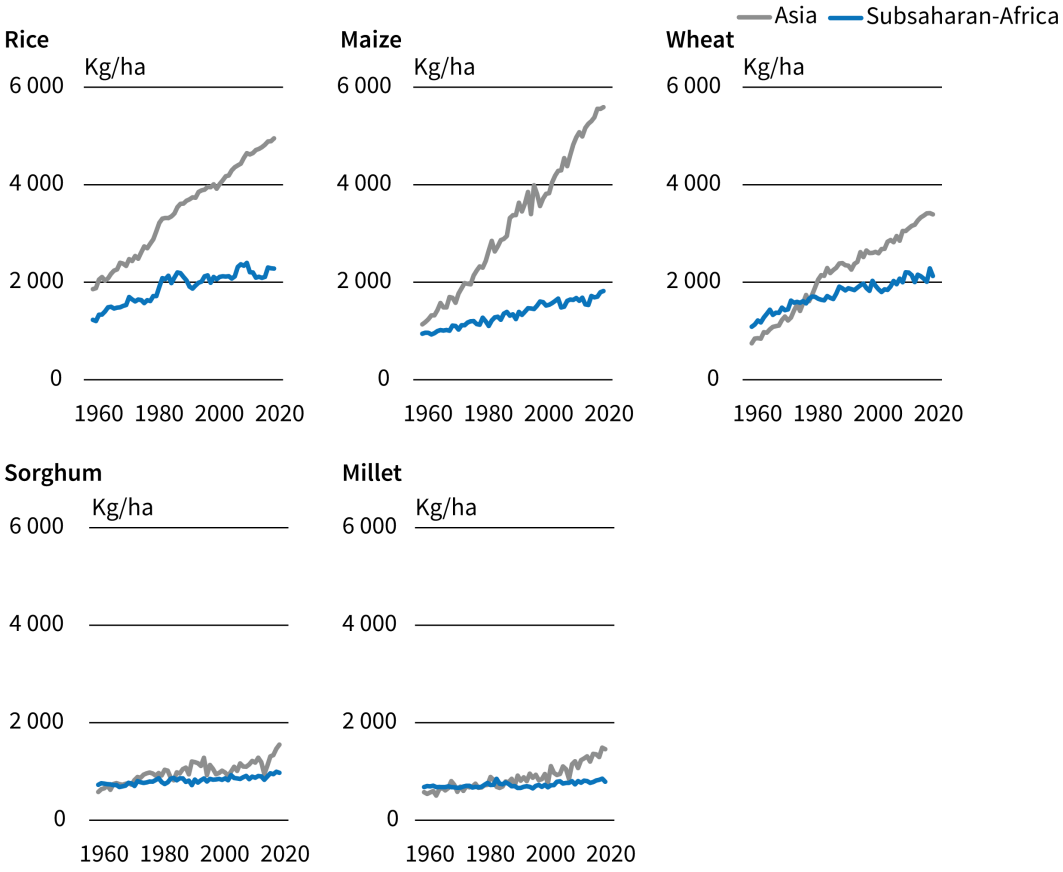
In a large-scale study, Gollin et al. (2021) show that increased agricultural productivity also had positive effects on important development indicators, such as gross domestic product.[2] Alongside the positive economic effects, however, there have also been some negative effects, for example on the environment (Pingali 2012, World Bank 2007).

Stock-Taking in Sub-Saharan Africa: What Has Been Done So Far?

While agricultural productivity in SSA has improved slightly over the past decades, Figure 1 shows that it continues to lag behind yields attained in other regions of the world (Suri and Udry, 2022). One of the determinants of this is the shortfall in the adoption of agricultural methods that could be within reach, due to factors such as lack of savings, credit or insurance, high risk (especially in the early years), lack of access to outlets, poor infrastructure, and socio-economic or cultural barriers (Bridle et al., 2019; Suri, 2022).

[2] A 10-percentage-point increase in the cultivation of high-yield varieties leads to an increase in per capita GDP of about 15%. The authors attribute 60% of the GDP increase to an increase in agricultural productivity and the remaining 40% to a reorientation of workers from agriculture to other economic activities.

Figure 1
Agricultural Productivity Divergence between Sub-Saharan Africa and Asia



Note: The figure shows how the evolution of land productivity evolved over time in the two regions.
Source: FAOSTAT and World Bank (2007). © ifo Institute

Various current initiatives are aimed at facilitating the introduction of modern agricultural methods. Ten countries in SSA have been subsidising agricultural inputs since 2003 with the aim of providing improved seeds and chemical fertilisers at lower prices (Carter et al. 2021).

The Consultative Group on International Agricultural Research (CGIAR) has developed over 200 improved and climate-tolerant maize varieties that yield about a quarter more than conventional varieties in drought-prone areas (CGIAR 2023a). A 2017 study found that the dissemination of improved rice varieties has increased food security for over 7 million inhabitants in 16 countries in SSA (Renkow et al., 2010; CGIAR 2023b).

High-yield varieties are already being used in sub-Saharan Africa, albeit with varying frequency. Data from a randomised control trial in Mozambique in 2010 shows that about 54% of farmers were already using improved seed (Carter et al. 2021). For maize farmers in Uganda, the figure was 36% (Sheahan et al. 2014).

Factors Holding Farmers Back

Although local markets offer fertilizers and improved seeds, only a minority of SSA farmers choose to invest in such products. For instance, in Nigeria, Duflo et al. (2008) found that only 37% of farmers used fertilizers and 37.5% hybrid seeds, even though the annual return on such investments exceeds 69%. Studies that shed light on the reasons for this low adoption have found several sources of friction.

Firstly, Bridle et al. (2020) point out how farmers are exposed to sparse cash flows during the year before they can sell their harvest. This makes it comparatively harder for them to finance their investment in agricultural productivity and to cope with the financing constraints.

Secondly, SSA is characterised by small farm sizes, leading to a plethora of microfinance instruments, which have been shown by Brune et al. (2016) to increase agricultural input expenditures by 13% and output by 24%. Credit markets with small private borrowers are nonetheless characterised by adverse selection, as first shown by Stiglitz and Weiss (1981). Farmers in this case face higher interest rates from lenders, leading some to be selected out of the credit market. An experiment carried out in Mali by Beaman et al. (2014) shows evidence that microcredit handed out to farmers increase investment. Among less poor farmers, farmers with high returns select into credit uptake. Among very poor households with potentially high returns, however, do not borrow due to borrowing frictions such as higher risk aversion.

A prominent line of the literature concerns itself with the behavioural factors behind farmers' decisions to invest. These range from present-bias to ambiguity aversion and choice overload. Duflo et al. (2011) found that small discounts on fertilizer, timed after harvesting, help farmers in Kenya make more rational investment decisions by overcoming present-bias. Similar studies assess the social dimensions, as farmers react to economic incentives and are influenced by their community. Bandiera and Rasul (2006) find that in Mozambique networks of friends and family help spread adoption of more efficient crops, especially for those with less information about the new crops, while Conley et al. (2004) demonstrate that individuals learn from well-performing input adopted by people in their informational neighbourhood.

It is important to note that this is a non-exhaustive review, as further limiting factors are at play, concerning for instance the management of risk and the fluid access to input and output markets (Emerick et al. 2016).

The Role of Better Financing for New Technologies

Increasing agricultural yields in the face of the above-mentioned challenges requires the provision of finance in several areas.

Firstly, international institutions could provide targeted support to farmers by increasing the availability of credit to farmers from local banks (Foster and Rosenzweig 2010). Credit is needed to help bridge the time between the purchase of seeds and the sale of the harvest. However, this requires access to the formal financial sector, which is often lacking in SSA in general and in rural areas in particular (World Bank 2023). Alternatively, Carter et al. (2021) suggest providing short-term input subsidies.

Secondly, it makes sense for development aid institutions to support the funding of research and the development of improved seeds. Assuming that research on and development of improved seeds is a public good, private investors have little incentive to invest (Pingali 2012). Therefore, opportunities to finance these efforts through development assistance should be explored.

Finally, these institutions could finance complementary structures, such as irrigation systems or better infrastructure to reduce transportation costs (Otsuka and Larson 2013, Suri and Udry 2022).

Recommendations for Policymakers and Academics

In SSA, agricultural productivity has so far been low and is also threatened by extreme weather events induced by climate change. The development of improved seeds could play a central role in improving the outlook, particularly because so far little has been invested in research on the seeds used in SSA compared to seeds commonly used elsewhere. There is also the question of financing, with development aid institutions being called to jointly look for expanding and improving financing possibilities. In this context, it should be taken into account that many investors will increasingly orient themselves towards sustainability criteria in the future. For example, the EU taxonomy contains criteria for the sustainability of economic activities in relation to the goals of coping with and adapting to climate change, as well as for the goals of sustainable use and protection of water resources, and the protection of ecosystems and biodiversity (Umweltbundesamt 2023).

As soon as the improved seeds are available, they have to be planted by local farmers. Here, information and financing are two key success factors. The time needed for the development of such seeds should be used to improve both aspects. The studies mentioned have shown that the utilisation of improved seeds, even if available, is not a foregone conclusion. Therefore, systematic research should be conducted on how farmers can be supported in using the new seeds. For example, information campaigns on different aspects of these new inputs could prove useful.

As the financial challenges will increase in an environment with more extreme weather events and more expensive production factors, the various options for designing and granting financial support should also be explored. In all events, the existence of a functioning and inclusive financial system is an important prerequisite for providing support. The development of the financial infrastructure could be supported further by development cooperation programmes.

However, as mentioned at the beginning, focusing solely on increasing agricultural productivity will not suffice. Boosting growth and development throughout SSA calls for massive improvements in security, political stability and education, among other factors. Sustainable growth and development can only be achieved through the complex interplay of a wide range of measures. That said, increasing agricultural productivity is quite definitely one of the most essential steps towards enhancing growth while at the same time adapting to climate change.

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