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A Growth Strategy for Africa: Industrialize Agriculture

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The Green Revolution in South Asia is frequently referred to as an example for Africa to emulate.[1] That revolution resulted from the development and dissemination in the 1960s of hybrid strains of wheat and rice. In conjunction with increased application of fertilizer, the hybrids dramatically raised yields per hectare in the irrigated farmlands of the Punjab and Northern India and defused a looming food crisis. Now it is Africa's turn to revolutionize farming. As its crop yields are among the world's lowest, the scope for raising productivity is immense. Moreover, Africa's expanding population[2] and the threat posed by climate change heighten the urgency of introducing technological and complementary institutional changes that will make agriculture both more productive and sustainable.[3]

Africa's geographic characteristics are not impediments to a farming revolution. Using data from the FAO's Global Agro-Ecological Zones (GAEZ) project,[4] Adamopoulolos and Restuccia (2018) find that, at the aggregate level, poor land quality or geography does not explain low agricultural yields. "If both rich and poor countries could produce according to their potential yields given their internal distribution of land quality, the rich-poor agricultural yield gap would virtually disappear, from more than 200 percent to less than 5 percent" (Adamopoulolos and Restuccia 2018: 3).

Another reason to focus on agriculture is that Africa is short of sustainable drivers of economic growth and income gains. Natural resource exploitation has led to boom and bust cycles, the "resource curse," and corruption, and manufacturing never took off as it did in East or even South Asia. Agriculture remains a possible source of economic expansion in Africa (Leipziger and Yusuf 2015).

Progress to Date Has Been Slow

Despite technical advances, the adoption of new agricultural technologies has been slow. Hybrid strains of maize and of sorghum have been developed that are adapted to African conditions and the brightly colored seeds are becoming more widely available. Improved dwarf rice strains that have delivered good results in South Asia and Latin America can now be grown under climatic conditions prevailing in much of Africa. But diffusion of improved strains has fallen short of expectations and high-yielding varieties account for only 7 percent of the cultivated acreage in Sub-Saharan Africa.

Most African agriculture is rain-fed[5] and, consequently, it is hostage to the vagaries of

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nature. Absent effective institutions for conserving water and ensuring its efficient use, droughts pose a serious risk. Hence, borrowing to finance the cultivation of hybrids, even when subsidized credit is available, remains unattractive to many. Farmers use remarkably little mechanical equipment that would expedite planting, harvesting, and post-harvest operations (processing, storing, transporting, and marketing surplus output). This is partly because labor is cheap, and partly because capital costs and the expenses incurred on fuel discourage the use of machinery that would ease the workload and circumvent seasonal labor shortages.

Disruptive Technologies Transforming Agriculture

There are three reasons why an agricultural renaissance (Bleicher 2013) deserves to be pursued more determinedly by African nations. First, by industrializing agriculture, countries can increase the efficiency of resource use and of value added downstream as raw materials are transformed into the variegated items that urban consumers want (Economist 2016). By expanding their reach across the value chain, food-producing countries can raise their growth potential.

Second, agricultural productivity is being augmented by many developments in science and technology. Augmented crop production is coming by way of

- biotechnology
- agricultural mechanization
- information technology
- cloud computing and advanced data collection and analytics, the building blocks of smart, precision farming6
- food sciences
- GPS guidance systems and geo-marking/ geo-referencing
- satellite imaging
- weather forecasting
- unmanned aerial vehicles (UAVs) with multi-spectral cameras for crop and weed assessment.

These developments are making agricultural production akin to smart manufacturing.[7]

Modern precision agriculture[8] can increase yields while reducing inputs of water (using sensors to measure soil moisture), nutrients, weedicides and insecticides, and conserving soil quality.[9] In addition, farmers benefit from improved weather forecasting—now feasible with the help of advanced computing technologies and models—as well as the data provided by satellites and ground-based sensors.[10] Following the work of Wolfert et al. (2017), there are grounds for believing that the gradual worldwide decline in the growth of yields that commenced in the 1990s could be halted and possibly reversed.

These initiatives will need to be combined with other measures such as greater mechanization (Marsh 2018) and smarter water management. Irrigation can nearly double crop yields; however, the best and most cost-effective results come from providing plants with the exact amount of water needed at each stage of the growing cycle, taking into account soil and environmental conditions (Fuglie and Rada 2013). Such precision calls for the kind of water distribution and application technologies (e.g. drip irrigation[11]) that deliver a metered amount of water to the root system with the minimum losses from evaporation and overwatering. How much water is needed at any time depends on the information collected by the imaging and sensing techniques.[12]

Water management would go hand-in-hand with the optimal application of fertilizer using the appropriate mix. Too much fertilizer is both wasteful and pollutes watercourses.

One promising approach is the so-called deep placement technique; a briquette of fertilizer is inserted some centimeters under the soil to slow the release of nitrogen, reduce loss through leaching (if excess water is applied), and reduce surface volatilization as nitrous oxide or ammonia gas.[13]

The third reason to support an agricultural revolution in Africa is the scope for a fruitful intersection—cemented by the exchange of data—between a growing, modern services sector that supports global value chains and a dynamic agricultural economy.[14] The growth of agriculture into a leading sector depends on high-quality R&D and other intermediary services to promote the assimilation of technologies[15] that will nudge agriculture closer to the production frontier. Research on the manipulation of plant genes and on the exactly tailored application of water and nutrients, for example, will be key to higher yields, nutrient content of foods, and resource conservation. Other skill-intensive services, such as storage, finance, logistics, and (sensor based) tracking of food products as they move through the supply chain[16] will influence agricultural diversification, post-harvest losses[17] maximum value capture, and export success.[18] The Internet of things (IoT) promises to enhance food chain performance by tracking the freshness of products and minimizing the risk of spoilage (Shacklett 2017). Diffusion of blockchain technology should facilitate transactions and make them more secure.[19]

Is IT-intensive agriculture, high-tech mechanization, and efficient water management too much of a stretch for Africa? It may appear so from the current development perspective, which is focused on growth driven by urban industrialization. However, upgrading agriculture technologically can generate higher returns for many more people and ease the burden of migration on urban centers. The development of urban manufacturing and services is also a necessity to support agriculture, but a strategy that assigns more weight to agriculture in the medium term could be superior. It builds on current comparative advantage, while at the same time generating spillovers that spur activity in other sectors of the economy. In other words, one has to start somewhere, and agriculture may offer the greatest promise in many Sub-Saharan country contexts.

There are promising trends and developments that could facilitate the transition to industrialized agriculture. For example, African farmers have readily adopted mobile telephony and e-banking (e.g., M-Pesa in Kenya). Information and communication technology (ICT) also provides an avenue for extending crop insurance to farmers, thereby mitigating risks. For example, the Syngenta Foundation offers an insurance product for farm inputs (Kilimo Salama, "Safe Agriculture")[20] that uses data from weather stations and mobile technology. This product protects farmers by insuring purchased inputs (certified seed, fertilizer, and crop protection products) against bad weather shocks. "Mobile phones scan the barcode of products purchased by farmers, and M-Pesa is used for payout at the end of the growing season in case of bad weather" (WEF 2015). The insurance is currently available to thousands of farmers in Rwanda and Kenya. These new technologies can significantly raise productivity in the sector, and their application should be supported.

The Way Forward for Africa

If more of Africa's growth is to be derived from agriculture, then increased investment to support this goal deserves priority. Investment should target capacity-building in R&D and engineering, as well as the hard

infrastructures that will provide essential services to farmers—principally transport, energy, water and ITC. Many bilateral assistance efforts have gone into the social sectors of late; however, increasing farmer incomes, dealing with stubborn poverty patterns, and enhancing rural livelihoods is a major priority for many countries on the continent.

Infrastructure constraints to modernization are many and foremost among them are the major bottlenecks in transport and energy.

- At present, rural transport problems hamper the processing and marketing of food grains, dairy products, and cash crops such as coffee and cut flowers. Accessible and maintained all-weather feeder roads would greatly decrease the ton/km cost of transporting agricultural produce and encourage yield-enhancing improvements for the market.
- A crippling shortage of electric power in some countries compounds the problem caused by transport constraints. Looking ahead, an increasingly industrialized agriculture that harnesses digital technologies to raise yields and enlarge rural value-adding activities cannot gain traction without an adequate supply of power.
- Seasonal shortages of water are another handicap for a number of countries, thus highlighting the need for better irrigation systems and water management.
- Finally, a shortage of affordable fertilizer hinders crop yields.[21]

Technical solutions to these constraints exist, however. As the McKinsey Global Institute notes in its "Brighter Africa" report (2015),[22] there is potential for developing renewable sources of power such as solar-powered microgrids. Of course, the larger energy needs for Africa may well rest with large hydro-power projects that have now become easier and safer to build. Some projects that would significantly ameliorate the continent's energy constraints are still on the drawing board due to cross-border regulatory issues, governance concerns, and lack of effective private-public partnerships. Agriculture, similar to energy, requires government to address existing policy constraints that impede the sector. It is up to governments to take the lead and to step up their efforts to mobilize resources and harness the technologies that will make agriculture the engine of growth and employment.[23] Doing so can help can help mitigate urban pressures, while at the same time enhance the incomes of a growing population.

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Endnotes

1. Rosenberg (2014) describes how the Green Revolution succeeded and what Africa can learn from this experience.

2. Food production needs to expand by 60 percent over the next 15 years in order to feed Africa's growing population (Diop 2016).

3. Food security is a concern for North African countries that import one half of the food grains consumed domestically (AfDB 2015).

4. The FAO's Global Agro-Ecological Zones (GAEZ) project has assembled high-resolution, gridded, micro-geographic data covering the entire globe (FAO 2018).

5. Only 6 percent of the land under cultivation is irrigated, much of it in just five countries including South Africa, Egypt, and Madagascar (NEPAD 2013).

6. Smart tractors can now be equipped to gather information on soil and crop conditions and seed performance, which can be analyzed and farming practices adjusted accordingly.

7. Sonka (2016), Sonka and Cheng (2015), and Wolfert et al (2017) assess the contribution that Big Data and other tools can make to the agricultural system.

8. Precision agriculture relies upon data from multiple sources to inform and improve decision-making (Herring 2001).

9. For information on productivity and other data, see Guthiga (2012) and Alene and Coulibaly (2009).

10. Accurate forecasts can help farmers decide when to sow and harvest crops, when to apply fertilizer and of what type, when application of weedicide is desirable and how to prepare for a prolonged dry spell. See American Meteorological Society (2015) and ADAS and Cranfield University (2013).

11. The initial higher material and installation costs are more than offset by the saved water, reduced soil erosion, and reduced expenditure on weedicides (see Seigel 2016).

12. Low earth orbit (240–400 miles high) small satellites with frequent revisit times, high spatial resolution, and multi-spectral sensors can provide daily coverage at an affordable cost and help farmers track pest infestation, nitrogen sufficiency, crop yields, and other indicators of farm conditions (Jacobson 2017). Flocks of such satellites are already in operation (Niles 2017; Luccio 2014).

13. Farmers in Burkina Faso and Niger are using deep placement, for example. It can increase yields of rice by as much as 30 percent.

14. See WEF (2015, chapters 2.1 and 2.2) and Wolfert (2017).

15. For example, the National Agro Foundation in India provides a variety of services to villagers in Tamil Nadu to improve farm productivity, including through the education of farmers (Govindrajan 2014).

16. Tracking can now be done with the help of tablet or laptop-based apps.

17. The FAO (2011) estimates that post-harvest losses in SSA are around 37 percent. However, other studies estimate lower rates of about 20 percent for grains such as maize, with most of the losses occurring in post-harvest handling and storage. Losses of fresh produce, meat, and fish occur during handling, packaging, and distribution. Prevention measures can reduce grain losses to less than 5 percent (Sheahan and Barrett 2016; Affognon et al. 2015).

18. Lee, Juma, and Mathews (2014) emphasize the necessity of innovation to sustain development in Africa. A number of relevant innovations for low-income economies are described by Ramesh (2015).

19. The agricultural commodities trader Louis Dreyfus has already commenced using blockchain.

20. https://kilimosalama.wordpress.com/.

21. According to the AfDB (2013), surface transportation costs in East Africa are the highest in the world and access to electrical power is the lowest. See also Africa Monitor (2012) and Mbabazi et al. (2015).

22. Solar power supported by advances in storage technologies might be the solution for parts of the continent that are sparsely populated and distant from cities (and generating plants). Providing grid connections to these remote locations would be prohibitively expensive to install and to maintain and the likely transmission and distribution losses would be high. Africa's renewable energy potential is enormous and largely untapped.

23. Agriculture is the source of 60 percent of all jobs in Sub-Saharan Africa (Diop 2016).