African Farmers In The Digital Age

FOREIGN AFFAIRS

Overcoming isolation, speeding up change, and taking success to scale

A Special Issue Curated by Kofi Annan, Sir Gordon Conway and Sam Dryden

AFRICAN FARMERS IN THE DIGITAL AGE

How Digital Solutions Can Enable Rural Development

FOREIGN AFFAIRS

FOOD SYSTEM TRANSFORMATION

*** Essays Commissioned by the Digital Thinking Initiative*

Editor's Note

Gideon Rose
Editor, *Foreign Affairs*

Farming is one of mankind's oldest endeavors, and digital technology is one of its newest. The contributors to this fascinating volume bring them together, showing just how much good can come from the collaboration. By thinking in terms not just of crops or yields or prices, but rather of an integrated food system that links all players in the agricultural economy, Kofi Annan, Sam Dryden, and their fellow contributors allow us to see African agricultural issues in a new light. From mobile phones to big data, nutrition to climate change, the collection covers it all, with authors who have something powerful to say and the authority to be heard. They deserve kudos for their efforts in putting it together.

PREFACE: Food and the Transformation of Africa

Getting Smallholders Connected

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African agriculture has long been a symbol of the continent's poverty. Officials considered the hundreds of millions of African smallholder farmers too backward to thrive; the future would arrive not by investing in them but rather by bypassing them. But all that is changing.

In recent years, African agricultural policies have been haphazard and inconsistent. Some countries have neglected smallholders in favor of commercial farmers. Others have given them attention but focused narrowly on increasing their productivity. African farms' harvests are indeed much smaller than harvests elsewhere, so increasing productivity is important. But agriculture is about more than yields. A vast food system spreads beyond farm and table to touch almost every aspect of life in every society. Making that system in Africa as robust as possible will not merely prevent starvation. It will also fight poverty, disease, and malnutrition; create businesses and jobs; and boost the continent's economies and improve its trade balances.

Food systems cannot be created quickly out of whole cloth. They tend to evolve incrementally over time. But in digital technology, today's African leaders have a powerful tool they can deploy to help clear away the primary obstacle to progress: the profound isolation of the vast majority of smallholder farmers. Until now, it has been very hard to get information to or from smallholders, preventing their efficient integration into the broader economy. But mobile communications can shatter this isolation and enable the creation of a new food system suited to contemporary needs. If farsighted leaders seize this opportunity, they can transform African agriculture from a symbol of poverty and backwardness into a powerful engine of economic and social development.

Five Principles

The new African food system should be built around the idea that agriculture is about more than producing calories; it is about changing society. Its five components should be valuing the smallholder farmer, empowering women, focusing on the quality as well as the quantity of food, creating a thriving rural economy, and protecting the environment.

Neither of us is sentimental about small farms, but we recognize the need to be practical. More than 80 percent of African agricultural production comes from smallholders. Any rational food system for Africa must put its smallholders first. Over the years, many African governments have tried to bypass the existing agricultural sector by investing in large-scale commercial farms, on the theory that they would be more efficient. But allocating large blocks of land to foreign investors, reserving water for industrial-sized operations, and concentrating research and development on a few cash crops doesn't help most farmers. It also hasn't generated enough produce to feed the continent's rapidly growing urban areas, which is why food imports are going through the roof—and why city dwellers are spending more than they should on food.

In fact, Africa's smallholders are more than capable of feeding the continent—so long as they boost their yields by using the latest agronomic practices in combination with appropriately adapted seeds and fertilizer. Most have not adopted these improvements, however, because they don't know about them, or can't get to a place where they can buy them, or can't afford them. The infrastructure to link most

smallholders to markets simply doesn't exist, which means that many farmers have little incentive to increase their productivity in order to generate surpluses to sell. Enabling smallholder farmers to grow more food and sell it in formal markets for a fair price would change life for almost every poor person in Africa.

The keys to fixing this problem are supplying smallholders with appropriate seeds and fertilizer, providing education and training, and ensuring easy access to markets and larger economic networks. Mobile technology can help on all these fronts. Cell phones and digital videos, for example, can revolutionize education and training. Digital Green, an organization that broadcasts videos of farmers conducting training sessions in local languages, is the next generation of farmer extension programs. Because farmers tend to trust their peers more than outside experts, Digital Green's model has led farmers to adopt better methods at very high rates. The organization expanded from India into Ethiopia and is exploring pilot programs in Ghana, Mozambique, and Tanzania.

Women, meanwhile, provide the majority of the labor on African farms, but on average, they are less productive than men—13 to 25 percent less productive, according to a report published last year by the World Bank and the one Campaign. The reasons for this are complicated, ranging from sex discrimination in extension programs to cultural norms that can make it difficult for women to hire and manage labor during the harvest. But fixing it is a necessity. Not only do women form a major part of the agricultural work force; they also spend much more of what they earn than men do on goods such as education, nutrition, and health care, which have large positive multiplier effects. So when women have money and the power to decide how to spend it, everybody benefits.

Here again, digital technology can be incredibly useful. Giving women cell phones allows them to transact business directly, without mediators; open bank accounts only they can access; receive information and training that local men might not support; and get market prices in real time in order to negotiate effectively with potential buyers.

As for food quality, only now is the true impact of malnutrition on poor countries beginning to be understood. It is an underlying cause of almost half of all the deaths of children under five around the world and leaves tens of millions more children cognitively or physically impaired for the rest of their lives. Food everywhere is less nutritious than it should be; in the United States, for example, the food system is

designed to supply people with as many calories as possible, that taste as good as possible, for as little money as possible. As a result, American agriculture focuses on corn as a vehicle for sugar, breeds that corn for high yields rather than nutritional value, and processes it to remove whatever nutrients might still remain. This means that Americans get lots of cheap, tasty breakfast cereal that isn't good for them.

The current African food system shares some of these features. The seeds available in Africa are bred for yield almost to the exclusion of other traits; the breeders who develop these seeds focus mostly on corn and wheat, so crops such as cassava and sorghum remain unimproved; and roller mills remove nutritional value in Africa just as they do in North America. But there are some reasons to be optimistic. For example, the fortification of food that has long been standard in developed countries has begun coming to Africa as well. Rice in Ghana, maize in Zambia, and sweet potato in several countries are now being fortified with vitamin A. And biofortification promises even bigger opportunities, as advances in genetics have made it easier to breed seeds with specific nutritional characteristics, such as high-zinc wheat and high-iron pearl millet.

In a robust food system, farms support a range of businesses. Farmers need financial services, seeds, and fertilizer before they begin planting; after they harvest, they need storage, transport, processing, and marketing. Every step in this process can be an opportunity for entrepreneurial activity, so in theory, a healthy food system could nurture an entire rural sector that creates wealth and provides off-farm employment opportunities to spread it around.

So far, such businesses have been few and far between in Africa, but that may be changing. In Nigeria, for example, for 40 years, the government bought seeds and fertilizer and then had them delivered to farmers. Not only did the system not work—little of the seeds and fertilizer ever reached smallholders—but it also crowded out entrepreneurs who could have served rural communities directly. To address these issues, Nigeria recently dismantled the public procurement system and implemented policies to spur new businesses. By giving farmers a 50 percent subsidy (via vouchers sent to their cell phones), the government has helped generate demand for seeds and fertilizer. In the meantime, to make sure there is enough supply to meet that demand, the Ministry of Agriculture and the Central Bank of Nigeria launched a risk-sharing program to encourage local banks to make agricultural loans. And with the partial guarantee, banks have quadrupled their lending to the agriculture sector.

The number of seed companies operating in Nigeria has gone from just 11 to more than 100, and there are now thousands of local mom-and-pop shops selling these companies' seeds directly to farmers.

The green revolution of the 1950s and 1960s, finally, introduced new and highly productive agricultural technologies and methods and fed a billion people in Asia and Latin America. But it also ended up doing significant damage to the environment of those regions, depleting the soil and reducing biodiversity. We now know that ensuring the long-term sustainability of the African agricultural environment is more critical than ever, given the problems already being caused by climate change.

The good news is that with digital education in basic conservation techniques, such as crop rotation with legumes, so-called green manure, and good water management, smallholder farmers can not only increase yields in the short term but also restore soil health over time. This is crucial, since African soils are the most depleted in the world.

The Promise Of Digital

Digital technology can help advance all these principles simultaneously. It makes connections possible, transfers information instantaneously, and can help build virtual communities even among widely separated and remotely located individuals and communities.

Some appropriate digital applications are already in use, and more are in development. In 2014, for example, Ethiopia's Agricultural Transformation Agency launched an agricultural hot line, and it has already logged almost 6.5 million calls. It also sends text messages and automated calls containing up-to-date agronomic information to 500,000 users. The agency is also developing the Ethiopian Soil Information System, or EthioSIS, a digital soil map analyzing the country's soils down to a resolution of ten kilometers by ten kilometers. Eventually, these two systems will merge, transmitting cutting-edge, highly tailored information to millions of farmers.

Digital technology can also revolutionize farmer organizations. Membership in agricultural cooperatives has always lagged in Africa, because smallholders are too spread out. New, digitally powered organizations, however, can succeed in doing what farmer cooperatives are supposed to do: purchase seeds and fertilizer

in bulk and pass on the savings to their members, serve as trusted sources of information on farming practices, and help farmers aggregate and warehouse produce and negotiate fair prices.

The digital infrastructure for interacting with smallholders is already being put in place, so now is the time to make sure it gets done right. This means making sure that all farmers are included from the start, especially the poorest and most remote. Digital agricultural applications need to be run on neutral digital platforms to which any farmer can connect, rather than proprietary platforms for a select few. It doesn't matter who builds the platforms—whether governments, agribusinesses, or telecommunications companies—so long as they are made accessible to all. To get the most out of these platforms, moreover, farmers need to be assigned unique user identifiers, so that they can receive services tailored to their needs. And information needs to be governed in a way that makes most of it open source. Ethiopia's digital soil map, for example, is public, so anybody can use the data.

As the two of us began our careers, one of the big questions in development was whether the world would be able to feed itself in decades to come. Many predicted a coming global famine, so simply avoiding mass starvation has to be considered a significant success. But it is high time to move beyond simple calorie provision and think about agriculture in the developing world in a more holistic way. Smallholder farmers in Africa can finally be seen not just as part of the problem but also as part of the solution. Using digital technology to reach them, listen to them, support them, and help them organize holds out the potential for another agricultural revolution. Making sure the opportunity is seized will require policy changes, investments, and a great deal of effort on the part of everyone from government officials and entrepreneurs to agronomists and coders. But what is needed most is leaders who can envision a continent transformed.

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FOREWORD: Digital Thinking to Transform Africa's Food System

Overcoming Isolation, Speeding Up Change, and Taking Success to Scale

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In the past decade, the global conversation about Africa has shifted from how hopeless to how hopeful its story is. Many observers see a great future for the continent. We do, too, and if that future is to come to fruition, it will be because the continent's leaders helped create a thriving rural economy based on the effort

and ingenuity of smallholder farmers. If Africa's evolving food system leaves those same farmers behind, however, the continent will not reach its immense potential.

Those are the stakes underlying this collection of essays.

For the past several years, the authors of the essays have been participating in an energetic and ongoing discussion with each other and with other leaders about food systems and the transformation of Africa. In this collection, they capture the spirit of that discussion by asking and trying to answer the question, "How can Africa's family farmers drive the development of a thriving rural economy across Africa?"

Over 80 percent of Africa's farmers are smallholder farmers, living in poverty and farming less than two hectares with low levels of production. Many are women who are less able than their male counterparts to access secure rights to land and the inputs for their farms. Nevertheless, we know from experience that they can be highly innovative.

There is much good news coming out of Africa. The incidence of conflicts is declining, stable macroeconomic policies are encouraging investment, and many countries have high growth rates, including in agriculture. A growing urban population is demanding more food, including more varied and nutritious diets.

Some trends are more mixed in their effects. There is growing investment in large commercial farms, foreign and domestically owned, but in some cases, this investment is causing rural people to lose their land rights. The rapidly growing population of young people provides a potential work force, but they are often not attracted to agriculture.

There are also major threats. The land is degrading rapidly. Over 25 percent of Sub-Saharan Africa's land is seriously degraded. A changing climate is already having highly adverse effects. One estimate suggests there may be a 20 percent increase in malnutrition and hunger by 2020.

Yet there are experiences and tools at hand, both in research stations and in farmers' hands, that can help withstand the adverse trends and capitalize on the many opportunities. Foremost among these are digital technologies, both hardware (mobile telephones, satellites, supercomputers) and software (applications to facilitate decision-making, digital soil maps, and faster breeding cycles for traditional African crops). There are myriad uses of digital technologies in Africa, beginning

eight years ago with the pioneering creation of mobile banking in Kenya. A selection is described and discussed in the articles below.

Ultimately, the combination of the technology itself and human creativity in deploying the technology can revolutionize life for family farmers in three ways.

By overcoming isolation. Many African smallholder farmers live far from cities and towns and are often poorly served by roads. Markets that provide inputs or purchase outputs may be many kilometers away and essentially inaccessible. Digital technology has the potential to effectively shorten the distance between previously isolated smallholders and the other components of the food value chain. For example, it can speed up the supply of inputs through e-vouchers and real-time tracking of inventory. The eWallet system in Nigeria was developed as a means for government to identify and provide input subsidies directly to farmers. Smallholder farmers provide their personal and biometric information and, once registered, can use their eWallets (via a mobile phone or a unique identification code) to make purchases from agro-dealers.

By speeding up change. Traditional extension is a ponderous process relying on poorly paid extension workers to travel from farm to farm or village to village. Digital Green uses technology-enabled dissemination based on projectors and web portals in local languages that greatly speeds up the transfer of information while improving its quality and relevance. Local access to credit can also be made more timely and efficient through digital technology, as can access to micro-insurance. The marketing of farmer products can be made more accessible through SMS messages that provide information on prices offered for crops in different market locations. Farmers no longer have to wait for buyers to come to them; they can actively seek out better deals.

By taking success to scale. Throughout Africa there are numerous successful projects and programs delivering greater yields, more nutritious foods, higher incomes, accessible fairer markets, and benefiting more women. Many are intrinsically sustainable. The challenge many organizations have taken on is determining how to scale them up. The Alliance for a Green Revolution is ensuring key inputs such as improved seed, blended fertilizers, credit and micro-insurance are accessible on an extended basis. The World Food Program's Purchase for Progress Program helps create stable and fair markets on which smallholder farmers can depend. A key component of going to scale is the generation, analysis, and accessibility of mega-data. One example, developed by the

Agricultural Transformation Agency of Ethiopia, is EthioSIS, a digital soil map that provides information for more tailored soil management practices.

The breadth and depth of the ideas in these articles point the way toward a dynamic future for African smallholder farmers and Africa in general. We hope that they spark more conversation and, eventually, powerful action to create a future for Africa that matches Africans' aspirations.

Food System Transformation

A Note from the Digital Thinking Initiative: *Thom and Lulama illuminate the trends that African policymakers will need to consider–and respond to–in the near term if they are serious about food self-sufficiency and agriculture-led growth. They illuminate distinctions between the development story in Asian economies and the one being written in Africa, and remind us that current trends are not inevitable. Proactive policymaking can still steer the trajectory of African food systems toward inclusion and sustainability.*

Megatrends Transforming Africa's Food Systems

Getting Ahead of the Puck on Policymaking

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Wayne Gretzky quipped that a good hockey player plays where the puck is, but a great hockey player plays where the puck is going to be. Policymakers can be game changers too by anticipating and proactively skating to where

the economic puck will be. As the global economy becomes more complex and changes rapidly, African governments and development partners are seeking to better anticipate future opportunities and emerging challenges, so that they can respond proactively rather than being whipsawed by them.

This article identifies seven near-term trends likely to fundamentally influence Africa's economies over the next decade. Rather than accept these "megatrends" as *faits accomplis*, we argue that most current trends are not inevitable. Just as the current trends and transformations being observed in African food systems are the outcomes of policies and public investment patterns of prior decades, the future will be shaped by today's policy decisions—either those taken proactively or those taken passively as a result of no action. Enlightened public action can "bend" many of these trends in socially desirable directions if properly anticipated.

Seven Emerging Trends

1. **While the share of Africa's work force in agriculture is declining gradually, the majority of Africa's population will continue to be engaged primarily in agriculture for at least the next decade.** While Africa's recent economic growth and the arrival of Walmart has sometimes led to exaggerated claims of a rapidly urbanizing middle-class society, the agri-food system will remain the primary source of employment for most Africans for at least the next decade or two.[1] The fast growing wage sector is starting from a very low base (typically below 10 percent), so it will take at least two decades before wage earners will constitute even a third of the work force. Because such a large share of Africa's labor force will be engaged in agriculture for years to come, government actions that make farming more profitable will raise incomes for millions of rural families. This will in turn kindle the demand for goods and services that farmers tend to buy—goods such as processed goods, housing materials, agro-inputs, clothing, and education for children—thereby decisively influencing the pace of job growth in the non-farm sectors and the growth of the overall economy.

2. **The youth bulge.** Forty-five percent of sub-Saharan Africa's population is below the age of fifteen. Over the next two decades, 330 million young Africans will be entering the job market looking for work. Even under the most favorable projections, less than a third will be able to find wage jobs. Farming and informal sector jobs in the agri-food system will be a major source of employment and livelihood for these youth. The viability of family farming is therefore likely to determine whether

millions of young Africans are productively engaged in agriculture and the informal sector or whether they join the ranks of the underemployed poor. The latter scenario will bring major political risks. Fortunately, policy and public investments can rapidly improve the profitability and attractiveness of agriculture—a major win-win opportunity for African youth, governments, and society.

3. **Increased competition for Africa's farmland.** The pace of land acquisitions by wealthy Africans is one of the underappreciated "megatrends" affecting African economies. While the international media has spotlighted "land grabs" by foreign investors in Africa, such land acquisitions pale in comparison to the amount of land acquired by local, often urban-based, investors. A recent review of seven African studies indicates that people based in urban areas control 15 to 35 percent of all national agricultural land and an even greater proportion of these countries' big farms.[2] Further, these numbers are rising over time. Land acquisitions by this group are part and parcel of changing perceptions in Africa about how agricultural development should unfold. On the one hand, investor farmers may be a source of dynamism in agriculture, bringing needed capital and new technologies to farming. They may be a source of employment for unskilled and semi-skilled people, although most of those jobs they provide will be barely above the poverty line. On the other hand, the rise of emergent land investors is constraining the scope for young people to access land, accelerating "push" migration from rural areas, and contributing to urbanization, but not necessarily in ways associated with rising living standards.

4. **Macroeconomic management**. Macroeconomic management has improved dramatically in the post-structural-adjustment period. Gone are the days of Idi Amin forcing finance ministers to print money; most Ministries of Finance are run by professionals who are committed to a market economy. There have been few cases since 2000 of African countries falling into massive debt, requiring bailouts from international financiers, experiencing hyperinflation or rapid currency depreciation. The relative stability of African countries' economies over the past fifteen years has attracted much greater foreign investment, is a major cause of improved economic performance in the region, and is likely to improve further over time.

5. **Telecommunications revolution.** Like Kofi Annan and Sam Dryden, we anticipate continued growth in Africans' use of mobile banking, and software-based provision of information and services. Netscape cofounder Marc Andreessen predicted recently that almost every African will own a smart phone by 2025. Software

providers are feverishly working to meet the growing market for digital services. In parallel to the transformational effect of digital technologies on business practices in developed countries, digital technologies will increasingly provide African farmers with access to information that improves their decision making and makes them more competitive. Digital technologies hold great potential to reduce if not overcome the historical link between remoteness and poverty, and even to redefine what remoteness means.

6. **Widespread soil degradation in densely-populated African farming systems.** Growing land scarcity in Africa's densely-populated farming areas is causing a gradual shrinking of farm sizes over time. Smallholder farmers respond by more continuously cropping their fields every year, mainly to their priority staple foods. Fallows have largely disappeared in densely-populated areas.[3] Continuous cultivation of existing plots would not necessarily pose problems for sustainable intensification if farmers were able to maintain or improve soil quality over time through sufficient use of fertilizers, soil amendment practices and other land-augmenting investments. However, there is mounting evidence of serious soil degradation arising from unsustainable cultivation practices in high-density areas of the continent.[4] Losses of soil organic matter and micronutrients pose special problems, both because they cannot be ameliorated by the application of conventional fertilizers and because they tend to depress the efficiency of inorganic fertilizer in contributing to crop output. Smallholder farmers are often unable to benefit from the current yield gains offered by plant genetic improvement due to their farming on depleted soils that are unresponsive to fertilizer application. Rising rural population density and associated land pressures are important underlying drivers of these processes, but they are also clearly within the scope of policy to ameliorate through coordinated investments in crop science and extension programs to help farmers to improve their management practices.

7. **Greater climate variability.** The precise impacts of climate change are still highly uncertain and are likely to vary significantly across the region, but two general predictions are that much of Africa will experience greater variability in agricultural production and possibly a decline in crop productivity.[5] In the developed world, 31 percent of total wheat, rice, and maize production has reached a yield plateau, experienced an abrupt decline in yield growth rates, or both.[6] In contrast, Africa's low levels of yields indicates the potential to experience continued growth in food production before reaching the region's biophysical limits. Africa and Latin America

are experiencing the world's fastest growth in the share of global farmland under cultivation.[7] However, expansion of agricultural land will involve degradation of natural ecosystems. The alternative, ecological intensification of agriculture, would require relieving the constraints that farmers face in adopting suitable production practices and technologies. This can't happen in the highly varied and changing agricultural production environments of Africa without much greater investment in location-specific crop and animal science and extension programs. Moreover, these programs have a long gestation period; major crop science and extension investments will be required today to realize productivity gains in the next decade.

The Way Forward

The agri-food system remains a major vehicle for achieving economic transformation in the vast majority of African countries. Currently, farming itself is the primary source of employment and income for roughly 60 to 65 percent of the region's workforce. However, this share is declining gradually due to both "push" and "pull" factors. Land scarcity and limited profitability of subsistence agriculture pushes many people out of farming, generally into poverty-type employment in the informal sector. By contrast, people are pulled out of agriculture when it is thriving. When millions of farmers are able to raise their productivity and incomes, this stimulates the demand for non-farm goods and services and creates new business or wage-earning opportunities that the more marginal farmers can fill. Rising living standards in the region will depend on more "pull" migration, which in turn can be achieved by public policies and expenditures that encourage employment-promoting private investment in agri-food systems.

The evolution of African economic systems ultimately reflects the investment decisions of millions of private sector actors. Yet the pace and composition of private investment is determined by the enabling environment set by governments (consider the difference between North and South Korea, for example). For these reasons, our focus is on what the public sector can do in the first instance to open the floodgates for private investment that will contribute to broad-based growth. Research evidence from developing countries has coalesced around public actions that typically include the following: investments in infrastructure such as electrification, increased grid capacity, and roads; rehabilitation of decaying rail and port facilities; agricultural R&D appropriate for small farms; effective farmer education and bidirectional extension programs; irrigation; and policies that promote new entry and competition in agricultural value chains.

The specific forms of structural transformation are likely to differ between Africa and Asia and (to a lesser extent) even between African countries. The structure of their economies differs in important respects. For example, agricultural growth in much of Asia promoted a symbiotic growth with manufacturing and industrial development. Agricultural growth in Africa, by contrast, seems to be generating stronger employment linkages with the booming informal sector. It is unlikely that economic transformation in Africa will feature the growth of manufacturing and heavy industry as it did in much of Asia, in part because Asia already has such a major head start. Differences in the penetration of global capital into local economies now compared to fifty years ago and regional differences in skills and know-how imply that structural transformation in the early twenty-first century in much of Africa will not necessarily follow the trajectory of other regions in the mid-twentieth century, although certain specific features are likely to be commonly shared.

A second major difference between Africa and Asia is the degree to which Asia's broad-based agricultural productivity growth was catalyzed by two new technologies—hybrid seeds and fertilizers—because many of the other preconditions such as infrastructure, nearby demand centers, and irrigation were already in place. Asia's green revolution was largely confined to its irrigated area. Fortunately, over 60 percent of south and southeast Asia's cropland is irrigated or benefits from some form of water control. By contrast, 95 percent of sub-Saharan Africa's cropland is dryland, and much of it is in areas vulnerable to unstable weather. This underscores the importance of ramping up public investment in agricultural research and development and innovative farmer assistance programs like those discussed by Annan and Dryden to encourage greater private investment in Africa's agricultural value chains.

In some parts of Africa where the economic transformation process is occurring only very slowly, farming will continue to be the primary source of income and employment for decades to come. Neglect of smallholder agriculture may have been the rule during Africa's first fifty years of independence, but it is becoming increasingly evident that the region's ability to rapidly reduce hunger and poverty will depend in large part on the performance of African farmers and the broader agri-food system on which they depend. Policymakers can play a pivotal role in the process by anticipating and responding to the major challenges and trends looming on the horizon—before the time for responding has passed. Fortunately, there are signs that Africa's leaders are increasingly recognizing the need to skate to where the puck will be.

AUTHORS' PERSONAL STORIES

T.S. Jayne

My interest in Africa started in 1982 as a young kid in a remote village in Ghana with the Peace Corps, but it quickly dawned on me that I needed more than good intentions and the ability to play the guitar to be very useful. I could see how the hard work of rural farmers could be nullified by an administrator's stroke of a pen in the capital city, and quickly became interested in developing the skills to understand the effects of government actions on rural people and to encourage the adoption of policies that would protect their rights and improve their living standards. Thirty years later, I'm of the view that one of the most effective ways to promote development with equity in Africa is to support the advancement of high-quality African-led policy think tanks, an aim that I have actively pursued for the past decade.

Lulama Traub

I was born in 1975 (International Women's Year) in Monrovia, Liberia, the daughter of an exiled black South African freedom-fighter and a Swedish-American civil rights activist. Under these auspicious beginnings, I suppose it was inevitable that a commitment to justice and equity would shape my career. In the 1980's, we moved to a Bantustan in Apartheid South Africa. We spent holidays on the family farm where water came from rain-fed tanks and heat from burning foraged wood. I observed the long hours and little pay involved in subsistence farming. My take-away: avoid farming, the math doesn't add up.

In 1992, I saw a starving African child on the cover of the September 7th issue of Time magazine. I was in high school, planning a career in finance. That magazine reminded me of my childhood—my parents passing envelopes of cash to my grandfather, the community pulling together to ensure everyone ate. These images stayed with me even as I pursued an economics degree. Despite my reservations about agriculture, I found myself increasingly drawn to issues of hunger, poverty alleviation, and the policy reform needed in Africa. Now here I am, researching staple food marketing and trade policies, and teaching agricultural economics to future farmers at the University of Stellenbosch, driven by the idea that everyone should be able to eat.

A Note from the Digital Thinking Initiative: *Sub-Saharan Africa is not the first region of the globe to undergo an agricultural transformation. But its transformation will have three elements that those in other times and places haven't had: sustainable intensification, adaptation to climate change, and a reliance on digital technology. With innovations that allow smallholders to produce more crops on less land without adding significantly to greenhouse gas emissions—innovations that can be spread and made easier via mobile phones—Africa's farmers will set a new standard for future transformations to live up to.*

Recipe for a New Revolution

Africa's Twenty-First Century Agricultural Transformation

Sir Gordon Conway *is a professor of international development at Imperial College London and was the former President of the Rockefeller Foundation*

Poverty is not inevitable or permanent. Many countries that we would not consider poor, such as China, Indonesia, and Brazil, were mired in poverty only a lifetime ago. Today, thirty-four out of the fifty poorest countries in the world are in Africa. Their gross national income per head is under $750, they suffer from poor health, nutrition, and education, and their economies are weak and highly vulnerable.

What does it take to get out of poverty and how quickly can it happen?

Successful developing countries undergo a structural transformation whereby they become urbanized and industrialized and, either simultaneously or beforehand, experience an agricultural transformation. At the core of this transformation is rising productivity in both agricultural and non-agricultural sectors. Crucially, the two are connected.

Agricultural transformation through higher productivity provides food, labor, and even savings that fuel urbanization and industrialization. It pulls up rural wages and gradually eliminates the worst dimensions of absolute poverty. But if the nations of Sub-Saharan Africa are to do this, the agricultural sector requires major investment itself.

Past Transformations

The agricultural transformations that eliminate poverty have come at different times and in different forms. The first began in the United Kingdom, in continental Europe and the United States some two hundred years ago. Japan's transformation was at the end of the nineteenth century. More recently, in Asia and Mexico, the transformation known as the Green Revolution took off in the late 1960s.

The Asian pattern of transformation started with improvement of production for subsistence households through the adoption of new technologies—high-yielding, fertilizer-responsive, cereal grains coupled with irrigation and high fertilizer inputs—that increased surpluses and rural food security. From there it progressed to more diversified farm activities driven by commercial forces and finally to the full integration of agriculture into the overall economy.

In sub-Saharan Africa there has been virtually no growth in agricultural labor productivity since 1961. Indeed, there has been a widening of the gap between labor productivity in the agricultural and non-agricultural sectors. For a variety of reasons, not least the heterogeneity of the African agricultural environment, the Asian model is not immediately relevant to Africa's needs.

What is now needed in Africa is a sped up, relevant version of the Asian model.

The Ingredients of an African Agricultural Transformation

In practice, there are twelve key ingredients for a successful African agricultural transformation:

At the core are small farm households that have

1. secure access to agricultural land and that belong to farmer associations;
2. easy access to seeds, fertilizers, credit, and insurance that are
3. sourced from local seed and fertilizer-blending companies and financial institutions.

With these inputs smallholders will be able

4. to produce a diverse and nutritive harvest of crops and livestock, significantly in excess of their subsistence needs;
5. to delivered to warehouses and food processors along value chains; and
6. to access efficient, fair, and transparent national, regional, and international markets.

The farmers and the entrepreneurs in the value chain will be supported throughout by

7. innovation in technology;
8. financial investments; and
9. appropriate enabling environments and macroeconomic policies created by political leadership.

Finally, the process of implementation will

10. follow the principles of sustainable intensification, with
11. attention to the impacts of climate change; and will be
12. accelerated by digital technology.

The Emerging Narrative

The first nine of these ingredients are relatively conventional, and the international agricultural community recognizes their importance; these ingredients were, after all, critical to previous agricultural transformations. But today's agricultural transformation will occur in a different context. Based on lessons from the green revolution, we have learned the need for sustainable intensification, for adaptation in the face of climate change, and reliance on the technologies offered by the digital revolution. These are the unique challenges and opportunities that shape the emerging narrative of African food systems in the twenty-first century.

Sustainable Intensification

At a superficial level Africa seems well endowed with land and water, but this view is illusory. Most smallholders have little land and much of it is poor quality, in large part due to devastating levels of erosion. Estimates using satellite imagery indicate that about 26 percent of the total land area of sub-Saharan Africa is severely eroded. Water appears abundant in many regions but only 4 percent of the arable land is irrigated and water is misused.

If smallholders are to help both themselves and Africa achieve food and nutrition security they will have to produce more food and other agricultural produce on the same amount of land. Yet such intensification will have to be sustainable. Smallholders will have to produce more with less, while leaving a smaller environmental footprint.

The aim is to achieve not only higher smallholder productivity but to do so while:

- efficiently and prudently using of inputs, such as pesticides, herbicides, and fertilizers;
- increasing natural capital and environmental services such as soil moisture, natural enemies of pests; and
- strengthening resilience and reducing environmental impact.

One approach is through ecological intensification, using ecological principles in farming like conservation farming or agroforestry. Another approach would be using modern genetic intensification, bringing different useful genes together in a single variety, as in the orange-fleshed sweet potatoes or hybrid maize, and socioeconomic

intensification, which builds links among farmers and between farmers and value chains, creating of farmer associations or participatory food processing.

None of this will be easy. But I have seen many good examples of sustainable intensification in experiment stations and on farmers' fields. The challenge is to take them to scale speedily. Here digital technology has key role.

Climate Change

African smallholders are already suffering from the adverse effects of climate change. When I go to villages, farmers are quick to tell me the climate is changing, and in what ways. They also readily explain what they are doing to counteract the effects.

Agricultural production and food security are especially vulnerable to climate change. Crop plants and livestock are inherently affected by too much or too little water, too high or too low temperatures, the length of growing seasons, seasonal variation and other climatic extremes. Smallholders are also especially vulnerable because of their small size, their poverty, and their lack of access to the means of countering the adverse effects.

Lower yields will mean lower incomes for farmers, and hence less available income to spend on nutritious food, education, and agricultural inputs. By the year 2050, hunger and child malnutrition could increase by as much as 20 percent as a result of climate change.

Sustainable intensification is an appropriate response to adaptation: Farmers can try new multiple cropping systems that give a higher probability of producing a good return, or drought-tolerant varieties of maize. As members of a water-users' association, they can build on local experience and initiatives to create a water-harvesting system, or take part in a more extensive irrigation system. They can withstand stresses and shocks by creating more resilient livelihoods, based not only on agriculture, but on other on-farm and off-farm income-earning activities.

Not only are farmers vulnerable to climate change, agriculture is also partly responsible for global greenhouse gas (GHG) emissions, in particular methane, nitrous oxide, and carbon dioxide. It is thus an important contributor to anthropogenic climate change. Of course, individual African smallholders contribute only a small fraction of the GHG emissions

compared to the amounts emitted by people in the developed countries. Nevertheless, the total amount emitted by the African continent is not insignificant. Limiting average global temperature rise to 2 degrees Celsius, let alone 1.5 degrees Celsius, above preindustrial levels will be hard without leveraging the potential of the agriculture sector.

There are many ways to reduce these emissions, but few so far have gone to scale. Agroforestry systems can be helpful. Planting annual crops like maize under trees like the legume tree Faidherbia, not only increases yields without requiring added fertilizer but also results in significant accumulation of carbon in the soil. In this instance the mitigation of GHGs is a beneficial side effect of a more profitable harvest. But more often farmers need to invest time, labor and money in mitigation activities where they receive no direct return. This will only happen if there is appropriate investment from sources such as the Green Climate Fund, and it will require information for farmers and their households on new agricultural practices and products. This can only be achieved through the use of digital technology.

Digital Technology

The final component of the emerging narrative is digital technology. It is crucial not only because it links people with people, institutions, and information, but also because it speeds up these connections in ways that were barely imaginable a few decades ago. Today, mobile-phone connections occur on a global scale and reach the remotest places on earth. Seventy-five percent of Africans own mobile phones; the ubiquity and rate of interconnections are similar to those seen in more developed parts of the world. It is this extent and speed of interconnection that can both speed up agricultural transformation in Africa and at the same time deal the complex challenges of establishing a twenty-first century food and nutrition security system.

There are numerous ways in which digital technology strengthens the ingredients of an African agricultural transformation and speeds up their innovation and application. First, it serves to overcome isolation, in effect shortening the distance between previously isolated smallholders and the other actors involved in producing, processing, transporting, marketing, and regulating food.

Meanwhile, at the local level, smallholder farmers can gain significant support from joining farmer associations that use digital technology to connect their members with each other and with outside information.

Traditional extension is a ponderous process relying on poorly paid extension workers to travel from farm to farm or village to village. Digital Green is a nonprofit organization that partners with local public, private, and civil society organizations to share knowledge on improved agricultural practices, livelihoods, health, and nutrition by using locally produced videos screened by local workers. The information farmers learn is better and more locally relevant than that offered by traditional extension, and they learn it faster. In a controlled evaluation, in fact, Digital Green's approach was found to be ten times more cost-effective and uptake of new practices seven times higher than traditional extension services.

Information isn't the only area in which digital technology can improve farmers' lives; it can also speed up the supply of inputs through e-vouchers and real-time tracking of inventory. The eWallet system in Nigeria, for example, was developed as so the government could offer input subsidies directly to farmers. Smallholders provide their personal and biometric information and, once registered, can use their eWallets (via a mobile phone or a unique identification code) when making purchases from agro-dealers. Such systems make it easier to ensure that inputs are supplied on time and end up in the intended hands.

Local access to credit can also be made more timely and efficient through digital technology, as can access to microinsurance. And marketing of farmer products can be made more accessible through short message service (SMS) messages that provide information on prices offered for crops in different market locations. Farmers no longer have to wait for buyers to come to them; they can actively seek out better deals.

New breeding processes such as tissue culture, marker aided selection, genetic modification and gene editing, which all rely on digital based identification of genomic structures, can greatly shorten the time for new varieties and breeds of seeds to be produced. New digital possibilities can also make the process of innovation more participatory, a change that should dramatically increase adoption of new technologies. Research and development used to happen in remote laboratories where engineers and scientists tried to guess what farmers hundreds or thousands of miles away wanted. With two-way communication, farmers can now simply tell them directly. Smallholder farmers can describe in detail which varieties of seeds tolerate drought, resist local pests, taste better, and take less time to cook. They can explain which traits they want the most, thereby ensuring that the breeding process is relevant and efficient.

As connectivity increases and the flow of information and ideas gets faster, a positive feedback system is created with smallholders at the center. They can get better access to inputs that are provided quickly while they also gain wider access to markets to sell their crops on more favorable terms. Each link in the chain is easier and faster, and so the feedback loop speeds up. It is then easier to get farmers' feedback and also to collect data on their situations, resulting in better tailored recommendations and services than before. Smallholder farmers gain the negotiating power, confidence, and readiness to adopt new technologies and processes and engage with the wider community.

Conclusion

The emerging narrative of sustainable intensification, climate change, and digital technology calls for significantly increasing smallholder productivity in a sustainable and resilient manner, providing the nutritious products that meet growing demands in a way that speeds up the process of African agricultural transformation.

AUTHOR'S PERSONAL STORY

When I was ten years old, Ms. Booth—a grey-haired, rather strict lady—took us out of the classroom onto the grass playing field. She held in her hand an eight inch open wire square. "This is a quadrat," she said, "It helps us see and understand what we normally ignore."

She threw the quadrat over her shoulder onto the grass, and told us to get down on our knees and tell her what we could see within its edges. I was fascinated. From what was previously just a patch of grass over which we kicked our football, I discovered another miniature world.

Thus, I became an agricultural ecologist. My first job was as an entomologist in Borneo where numerous pests were destroying cocoa plantations in the cleared forest. The planters were spraying the trees with all sorts of pesticides. Then I realized that this solution was actually the problem. Once I managed to get all the spraying stopped, the pests came under the control of their natural enemies and the plantations thrived. Throughout my career, I have looked for ways of applying ecological principles and practices to help create productive, sustainable and resilient agroecosystems.

A Note from the Digital Thinking Initiative: *Ethiopia is a great example of a country that is investing in agriculture as a driver of economic transformation. The country has realized substantial gains in productivity since 2006 and has a vision to transition subsistence-based smallholders into market-oriented commercial producers. Ethiopia's Agricultural Transformation Agenda embodies our vision for how a country might approach the development of a dynamic, resilient smallholder-centric food system. It aims to address systemic issues—at scale, and sustainably—and it recognizes the importance of prioritization and coordination, accountability, and continuous learning and iteration.*

Learn As You Go

The Ethiopian Example of Agricultural Transformation in Action

Khalid Bomba *is the Chief Executive Officer of the Ethiopian Agricultural Transformation Agency*

Ethiopia has long recognized the importance of agricultural development to economic growth. This has delivered impressive gains in agricultural productivity and output over the past decade. In order to accelerate and reinforce these gains, the country has established an Agricultural Transformation Agenda. This approach takes a comprehensive view of the sector and aims to prioritize and coordinate the interventions that will make the greatest impact. Our vision is one in which subsistence-based smallholder farmers transition into more market-oriented

commercial producers, with their output absorbed by larger-scale value addition and agro-processing activities. We will have succeeded if we can realize this vision while also achieving environmental and social sustainability.

The Need For Agricultural Transformation In Ethiopia

With over 96 million inhabitants [1], of whom over 80 percent live in rural areas[2], Ethiopia is Africa's second most populous nation and has one of the fastest growing economies in the world. Although the transformation towards a more industrially oriented economy is well underway, the agriculture sector continues to be the dominant aspect of the Ethiopian economy, representing nearly 42 percent[3] of gross domestic product (GDP), 80 percent of employment[4], and 85 percent of foreign export earnings[5]. In addition, the majority of the agriculture sector consists of smallholder farmers who make their living from less than two hectares of land. Based on this, transformation of the agriculture sector is fundamental to Ethiopia's drive to reach middle-income country status by 2025.

Ethiopia has long recognized the importance of agriculture sector transformation for stability and growth, consistently placing agriculture at the heart of its economic development. As far back as 1991, Ethiopia launched its Agriculture Development Led Industrialization (ADLI) strategy, which continues to be the reference document for the country's developmental approach.

Ethiopia's commitment to the agriculture sector has allowed the country to meet both of the African Union's Comprehensive Africa Agricultural Development Program targets of raising public expenditure in agriculture to 10 percent per year by 2008, and increasing agricultural production by an average annual growth rate of at least 6 percent by 2015. More specifically, since 2003, Ethiopia has invested an average of 14 percent of government spending on agriculture[6]. In addition, since 2006, overall agricultural production of cereals has increased by 106 percent and production levels per hectare (yield) have grown by 62 percent[7].

Despite these achievements, there is still more work to be done. On average, national yields of the main crops, such as maize, wheat, barley, and sorghum, are still only 58 percent of the overall world average[8]. Modeling indicates that by 2050 the effects of climate change will reduce average rice, wheat, and maize yields by up to 20 percent in sub-Saharan Africa[9]. Female smallholder farmers produce on average 23

percent less than their male counterparts[10]. Broad-based and sustainable agricultural transformation will depend on our ability to address these issues for all segments of the rural population, including the most vulnerable and heretofore underserved.

Creating A Framework To Accelerate Change: The Agricultural Transformation Agenda

In the past twenty years, Ethiopia has benefited from numerous projects that have helped smallholder farmers to increase productivity and gain better access to markets. However, these various projects are rarely linked effectively with each other, let alone with the major public sector interventions and policymaking process. Furthermore, we haven't employed a systematic approach to distill learning from each project, to solve issues as they arise, or to coordinate interventions within and beyond the agriculture sector. We have also struggled to establish an evidence-based way of prioritizing interventions for effective resource allocation and systematically managing performance.

Over the past four years, Ethiopia has been working with all its key development and implementing partners (in the private sector and civil society) to develop its Agricultural Transformation Agenda—an approach that aims to prioritize and coordinate the interventions that will make the greatest impact in the sector. However, change is rarely linear. Not all of the challenges can be anticipated at the beginning of the process. This requires flexibility among policymakers and development partners to make real-time adjustments as lessons are learned and new facts emerge. Rigidly adhering to the set of activities envisioned at the beginning of the journey often hinders transformation.

As such, the Agricultural Transformation Agenda includes several elements:

- Evidence-based strategies for each subsector that identify the current situation, the primary bottlenecks, and the necessary interventions to reach a long-term vision.
- Prioritization of interventions and assignment of institutional owners who will be accountable for implementation.
- Clear annual and quarterly targets for each intervention against which performance will be measured.

- A problem-solving and implementation-support function that helps ensure that owners deliver against their targets.
- A robust performance-management system with oversight from the minister of agriculture on a monthly basis and from the prime minister and the Agricultural Transformation Council on a quarterly basis.

Learning from the success of other countries, Ethiopia has established a dedicated institution to support this process of change and transformation. In South Korea, this institution was referred to as the Economic Planning Bureau. In Malaysia, it was known as the Performance Management and Delivery Unit. In both cases, these entities provided technical support and developed the evidence necessary to catalyze transformation. In Ethiopia, the government created the Agriculture Transformation Agency (ATA) to serve as this agent of change. The role of the ATA is to coordinate the development and implementation of the Agricultural Transformation Agenda by working closely with the Ministry of Agriculture and other key partners. Similar to examples in other successful countries, this is a time-bound function. The ATA will complete its mandate within fifteen to twenty years, ideally once Ethiopia reaches middle-income country status.

Agricultural Transformation In Practice: Addressing Challenges At The System Level Through Scalable, Sustainable Solutions

Ethiopia's Agricultural Transformation Agenda aims to fundamentally restructure the country's agricultural sector. With this in mind, three major principles have influenced the design and implementation of interventions: taking a systems-based approach, achieving scalability, and ensuring sustainability.

Taking A Systems-Based Approach

Ethiopia's systems-based approach to transforming the agricultural sector focuses on establishing the key building blocks of well-functioning agricultural value chains—including but not limited to research, extension, finance, input distribution, soil management, and markets. In each of these areas, the transformation agenda looks for innovative solutions to remove systemic bottlenecks. In implementation, the agenda integrates its interventions across these areas.

Agricultural research has been the cornerstone of agricultural transformation in many countries, for example in Brazil. However, without a strong link to an extension mechanism that both enables farmers and the market to inform research priorities and provides an avenue to deliver new technologies to farmers, research investments fail to result in overall agricultural transformation. As such, the Agricultural Transformation Agenda's portfolio of research-oriented interventions includes activities specific to both research and extension as well as others meant to improve the links between the two. Some examples of interventions in this regard are

- significantly increasing the salaries of senior researchers and creating a clear career path based on performance to attract and retain high quality researchers;
- establishing an Ethiopian agricultural research council to coordinate national and regional agricultural research priorities and allocate funding efficiently; and
- strengthening the nearly 11,000 farmer training centers (FTCs) around the country and the establishing demonstration plots in each FTC to introduce new technologies to farmers.

Achieving Scalability

Political and strategic leadership from the public sector is vital to designing systems that can reach nearly thirteen million diverse smallholder-farming households. At the same time, the design and execution of initiatives prioritized by government must be market-driven and commercially-oriented to leverage investments by the private sector. The recent Growth and Transformation Plan and the Agricultural Transformation Agenda both include significant areas of collaboration between the public and private sector. This enables the pursuit of the government's societal goals targeting smallholder farmers, while also providing the enabling environment for domestic and international private sector enterprises to realize the economies of scale required for long term economic sustainability.

Another key to achieving scale will be to leverage information and communications and other twenty-first century technologies. One example of such an effort in Ethiopia is the free hotline we've established for farmers to access information on best agronomic practices. In less than one year, over 1 million individuals have registered for this service and over 6.5 million calls have been logged into the sys-

tem. Another example is the national EthioSIS project. This initiative utilizes remote sensing and satellite technology to create a digital map of the country's soil. Based on this data, Ethiopia has revamped its fertilizer recommendations. For the last thirty years, farmers have followed a blanket recommendation of one hundred kilograms of diammonium phosphate and one hundred kilograms of urea. This year, Ethiopian farmers are applying tailored blends that are scientifically proven to provide the greatest yields in their particular geographies with the least environmental impact. By combining powerful, context-specific data with the connectivity of mobile phones, we can envision delivering valuable real time information to farmers to support them throughout the agricultural season.

Ensuring Sustainability

The long-term success of the Agricultural Transformation Agenda and Ethiopia's agriculture sector more broadly depends on the economic, social, and environmental sustainability of the interventions underway.

Economic sustainability in the context of Ethiopia's agriculture sector ultimately rests on the ability of the public sector to effectively engage the private sector. Given the nascent stage of Ethiopia's agriculture sector, the public sector has needed to play a leading role in many areas such as extension. However, as the agriculture sector has begun to expand and commercialize, the private sector has been taking an increasingly larger role. Areas such as mechanization, agro-processing and value addition provide ample opportunities for further engagement. There are also emerging opportunities, such as nucleus farms and out-grower farming schemes, to link larger private sector investments in commercial farming with traditional smallholder farmers seeking to become more market-oriented.

Climate change is a global issue with localized impacts. In a country such as Ethiopia, where over 90 percent of production relies on rain, droughts have sometimes reduced national GDP by as much as 10 percent, with future climate scenarios predicting negative GDP impacts of up to 2.5 percent[11]. Alongside climate issues, the natural resource base upon which the agriculture sector relies is under great stress. Rural population pressures, competition for fuel, open livestock grazing and agricultural expansion have caused deforestation, leading to soil erosion and land degradation in some areas. To tackle these types of issues, interventions in the agricul-

ture sector must be "climate smart," developing a long-term, productive agricultural base that is resilient and adaptive to a changing climate.

Finally, the Agricultural Transformation Agenda also aims to ensure that the development of the agriculture sector in Ethiopia is socially inclusive, with attention paid to the unique needs of diverse farmer groups. As such, we are developing approaches to target the needs of vulnerable groups such as women and youth, and using gender-disaggregated indicators to monitor and evaluate their success.

Looking Ahead: A Bright Future For Ethiopia's Farmers

Rising global demand for food is both a challenge and an opportunity for African agriculture. In Ethiopia, we see it as an opportunity for the country's smallholder farmers. By transforming the country's traditional subsistence farming structure to one that is more market-oriented, smallholder farmers can leverage the comparative advantages that the country's natural resources and economic structures provide to more effectively integrate into the global food system. Through the implementation of its national Growth and Transformation Plan, as well as innovative solutions such as the Agricultural Transformation Agenda, Ethiopia aims to ruthlessly prioritize and effectively coordinate and execute the interventions that will enable it to reach middle-income status by 2025.

AUTHOR'S PERSONAL STORY

Like many Ethiopians, the famine of the 1980s had a profound effect on me. Thankfully, my family and I were unaffected physically by this tragic period. Nonetheless, it was difficult for me to reconcile the rich history and culture of the country that I knew, with the images broadcast across our TV screen every evening. Though I did not come from a farming background, I have always hoped to one day find the opportunity to work on the issues that have seemingly trapped the country of my birth in a vicious cycle of poverty and underdevelopment.

Through a circuitous journey, from investment banking in New York and London to technology and education start-ups in the US and Africa, I now find myself working

in a government organization in Ethiopia's agriculture sector, which employs over 80 percent of the population. What I've discovered through this role is that what holds back progress is often not a lack of knowledge regarding what needs to be done; rather, it is that we fail to make the long-term investments in the systems and institutions necessary to actually get things done.

A Note from the Digital Thinking Initiative: *Twelve years ago, the landscape of African agriculture changed forever when the countries of the African Union agreed to the Comprehensive Africa Agriculture Development Program (CAADP). It included specific targets for national investment in agriculture, but it also conveyed an aspiration—that agricultural transformation and rural development are the key to poverty reduction in Africa. Though AU member nations have made significant strides, they have yet to see the levels of coordination and accountability that were the goals of CAADP in the first place. The AU just recently agreed to the second generation of CAADP. Tumusiime reveals how it can live up to its goals.*

Beyond Malabo

How the CAADP Can Make Good on the Maputo Declaration

Tumusiime Rhoda Peace *is the Commissioner for Rural Economy and Agriculture for the African Union*

In 2003, the African Union's heads of state and government committed to a Comprehensive Africa Agriculture Development Program (CAADP) with the aim of tackling hunger, food insecurity, and poverty in Africa. To this effect, in their 2003 Maputo Summit Declaration on Agriculture and Food Security, they agreed to adopt sound policies and committed to allocating at least 10 percent of national budgetary resources for agricultural and rural development. The message was clear: agriculture and Africa's self-determination are intertwined.

This agreement proceeded from an understanding that the difficulties facing agricultural transformation in Africa came less from lack of resources, better

technologies, or human capacity, but rather more from lack of a commitment to pursue evidence-based policies and to be accountable for their progress.

CAADP has been a qualified success. It was a shot in the arm for a beleaguered agriculture sector, and it has created an important shared understanding of the meaning of agricultural transformation. Now, however, we need to see the follow-through—both from countries and from donors—that was a vital part of the discussion in Maputo in 2003.

A Shared Blueprint for Agricultural Transformation

CAADP helped mobilize all the key stakeholders around a coordinated response to Africa's agricultural development challenges.

To date, over forty African countries have embraced the CAADP framework and signed compacts to operate within it. Most of these countries have developed national agriculture and food security investment plans. Four of the eight regional economic commissions have signed regional CAADP compacts and developed regional agriculture investment plans.

The level of country ownership of these plans has been high, as the process has ensured the strong participation of smallholder farmers, women, youth, civil society, governments, and the private sector. Development partners have also made deliberate efforts to align their country-assistance plans to the national agriculture plans. This move toward alignment replaced a tradition of donor-led interventions that often overlapped and sometimes conflicted, yielding mixed outcomes. The country-led process has established effective coordination and accountability mechanisms that have helped all players take stock of progress, learn lessons from the past, and gather evidence to support better planning in the present and the future.

The result of a decade of efforts shows that CAADP has in many ways been transformational. Expenditures allocated to agriculture have increased by an average of 7.4 percent per year since the adoption of the program, doubling the volume of public funding to agriculture. These investments have spurred agricultural growth from the stagnation and decline of the previous few decades to an average of 4 percent per year since 2003. A few countries have even registered

growth exceeding the CAADP target of 6 percent, thus proving that high levels of agricultural growth are well within the reach of the continent.

Those countries that consistently reached or exceeded the 10 percent public-expenditure allocation target of the Maputo Declaration, such as Ethiopia and Rwanda, have seen a substantial reduction in poverty figures and inequality levels as assessed by the Gini index. These results corroborate the conclusion of a World Bank study that in sub-Saharan Africa agriculture investments are eleven times more efficient in poverty reduction than investments in other sectors.

AU member states have also achieved significant progress in tackling the related challenges of hunger and food insecurity. For instance, the number of African countries that will have achieved the Millennium Development Goal 1 target of halving the proportion of people affected by hunger has increased from twelve between 2006 and 2008 to twenty-two between 2014 and 2016.

The Unfinished CAADP Agenda

Notwithstanding the encouraging achievements over the first decade of CAADP, however, the majority of African governments have yet to deliver on their 2003 Maputo commitment to allocating at least 10 percent of their public expenditures to agriculture. Likewise, most development partners have not yet delivered on their pledge to align their support with the priorities expressed in CAADP-related national and regional investment plans.

Moreover, investment by the private sector (including farmers and agribusiness actors) has been severely constrained by the poor performance of the financial sector vis-à-vis agriculture because of the lending risks associated with the variability of agricultural outputs and incomes, the misperception of agriculture as a "public good," gender bias against women, insecure land tenure issues, and financial institutions' reluctance to lend to unemployed youth.

As a result, the growth in agricultural output observed over the first ten years of CAADP came mainly from expansion of cultivated area, increase in livestock numbers, and increased agricultural labor force, rather than from improvement in productivity. Owing to low investment in agricultural research and a lack of widespread adoption of modern farming techniques and post-harvest technologies, overall productivity in sub-Saharan

agriculture has been growing at half the average pace of all developing regions, and post-harvest losses have risen to 30 percent of the entire agricultural production.

These challenges must be understood in the context of the continent's fast-growing demand for food, which is fueled by population growth (nearly 3 percent per year), strong income growth (at 5 percent or more over the last decade) and rapid urbanization (at the annual rate of 5 percent), as well as slow progress on regional integration and intra-African trade. As a result, Africa's imports of food and agricultural products have increased by 15 percent per year since 2000, and the continent's net food import bill now exceeds $40 billion a year. This diverts considerable resources from domestic investment and job creation opportunities. It also increases the vulnerability of Africa's poor and already food-insecure people to external shock factors such as food price volatility and climate change.

However, this state of affairs also points to some opportunities. With further investment, it is possible to increase productivity significantly to serve this food market, the value of which will only increase. The next decade will be critical in determining whether Africans seize these opportunities. The African Union is again exercising leadership to make sure that they do.

The Next Ten Years

In 2014, the African Union worked with all key stakeholders of Africa's food systems to review progress and to later launch the second phase of the CAADP at the AU summit in Malabo, Equatorial Guinea. This second phase aims to address the remaining challenges to agricultural transformation in Africa.

In the Malabo Declaration on Accelerated Agricultural Growth and Transformation, AU heads of state and government committed to:

- upholding the principles and values of the CAADP process;
- enhancing investment finance in agriculture;
- ending hunger in Africa by 2025;
- having inclusive agricultural growth and transformation contribute half to the poverty reduction targets by 2025;

- boosting intra-African trade in agricultural commodities and services;
- enhancing resilience of livelihoods and production systems to climate variability and other related risks; and
- adhering to mutual accountability for actions and results.

To meet the Malabo goals, countries will also appraise and upgrade their National Investments Plans, with a focus on implementation and accountability mechanisms.

Today, the CAADP is as important as it was in 2003. The evidence so far indicates that success is possible. But inclusive growth as advocated under CAADP is a long-term process. It requires significant budget allocations over time, appropriate policies, and strong political leadership. Those are the pillars of the Malabo Declaration, and the key to the agricultural transformation of Africa.

AUTHOR'S PERSONAL STORY

I was born in Bushenyi district, in Western Uganda. My family had about thirty heads of cattle and a small coffee plantation. As was typical, I helped my mother to fetch water for cooking and my father to graze and water the cattle. Less typical was the fact that my parents encouraged and supported me to start school at an early age despite their meager resources. In my earlier schooling, I learned practical farming skills that I put to use on the family banana plantation. At university, I read agricultural economics, which helped me appreciate the role of agriculture in economic development. The international faculty often made reference to the role of agriculture systems in the development of their own countries. My first post focused on strengthening the capacity of cooperatives to support farmers. Later, as commissioner for planning and development in the Ministry of Agriculture in Uganda, I was responsible for the development and implementation of policies, programs and projects towards modernization of agriculture in the country. And now, as the African Union commissioner for rural economy and agriculture, I am convinced that agriculture matters.

A Note from the Digital Thinking Initiative: *Malnutrition takes a massive toll on the people of Africa; indeed, it's one of the primary obstacles to the continent's growth. However, nutrition has not been part of the conversation about agricultural development until recently. Now, advocates, experts, and leaders are seeing that a fully realized African food system needs to provide not just* enough *food but enough* nutritious *food for a fast-growing population. From "farm to fork," there are interventions that can improve nutrition. Anna shows how the advent of digital technology is increasing the chances that Africans will have access to nutritious food.*

The Promise of a Healthy Future

Re-integrating Nutrition into Agricultural Production and Food Chains

Anna Lartey *is Director of the Nutrition Division of the United Nations Food and Agriculture Organization*

Why Nutrition Matters

The 1960s began a hopeful era for Africa. The decade was filled with enthusiasm to create new nations fully in control of their resources. Kwame Nkrumah, a famous son of the continent, reflected much of this optimism in a speech about Ghana becoming a republic: "We have a glorious opportunity for building a first-class nation comparable to the best in the world."

Many African states entered their new independence with this confidence and hope. Today, although progress has not been as steady as expected, the potential for success still exists. Indeed, it may be closer to realization than it has been in decades, provided we can offload the huge burden of malnutrition still holding back Africa's development.

By doing deep-rooted damage to health, development, and productivity, malnutrition underpins many of the fundamental problems Africa faces. For example, we know that young children who do not eat enough, or who do not eat the right foods, suffer later in life from poor physical growth, increased susceptibility to disease, and compromised cognitive function. The last, while less obvious to the casual observer, is terribly damaging to academic performance and has long-term implications for gainful employment and overall quality of life. These effects trickle up from malnourished individuals to undermine national economic, social, and intellectual development.

These effects are reflected in national and regional statistics. Recent and glaring examples are provided by the Cost of Hunger in Africa (COHA) project, currently underway in twelve African countries. In 2015, COHA studies reported that between 7 and 18 percent of repetitions experienced by African schoolchildren were associated with stunting (in other words, being too short relative to well-nourished children of similar age). COHA studies also show that up to 33 percent of all child deaths in Africa are associated with undernutrition, that undernutrition is reducing African workforces by up to 13.7 percent, and that the estimated annual cost of undernutrition to African countries can be as high as 16.5 percent of gross domestic product.

Additional evidence is provided by the *Lancet* 2013 papers on maternal and child nutrition, which reported that fifty-six million children under five in Africa are stunted. Like the COHA studies, this series of articles links undernutrition in early childhood to short adult height, less schooling, reduced educational attainment, and reduced adult earnings. The studies also highlight how the negative effects of stunted growth can be passed on to the next generation: a child born to a stunted woman is more likely to be stunted than a child born to a woman who has achieved her full growth potential.

The implications of this data are immense. To take just a single example from a single country, a study on preschool nutrition and subsequent schooling attainment in Zimbabwe found that, relative to children in developed countries of the same age, children in the study sample were 3.4 centimeters shorter, enrolled six months

later in school, and completed almost an entire grade less of education. In sum, these children were restricted from the beginning of their academic careers due to undernutrition, a disadvantage likely to follow them into adulthood.

Linking Nutrition, Agriculture, and Food Systems

The backbone of Africa's economy is agriculture. For a continent to produce as much food as Africa and yet carry such a high burden of malnutrition is an unacceptable mismatch.

For many years, nutrition was associated not with agriculture but with public health. Today, however, it is widely recognized that trends in agriculture and food systems—namely, heavy investment in cereals, underinvestment in non-staples, and related shifts in food processing and marketing—have made the cost of a healthy diet very high. Ultra-processed foods, refined carbohydrates, and high-calorie, artificially sweetened beverages are more affordable and ubiquitous, while in many countries fruits, vegetables, and legumes are more expensive than they used to be.

But what is a food system? Composed of a wide variety of moving parts, food systems start "pre–farm gate" with agricultural inputs and production of food crops and livestock, continue through post-harvest supply chains involving processors, retailers, and other middlemen, and end on the plates of consumers.

Faulty food systems have meant that undernutrition persists across the globe while obesity and associated noncommunicable diseases are on the rise. Africa is not immune to this double burden; undernutrition and obesity exist side by side in many of the same communities and even households.

This unsettling scenario is offset by growing awareness, over the last decade, of the need to prioritize nutrition on policy agendas. The Second International Conference on Nutrition (ICN2), hosted by the Food and Agriculture Organization (FAO) of the United Nations and the World Health Organization in November 2014, focused on reforming food systems to better address nutrition. These reforms can be broken down into three broad areas of action, in line with the "farm to fork" food system stages described above.

- *Reforming agricultural production "up to the farm gate."* Making agriculture more "pro-nutrition" requires production diversification into more nutrient-dense

foods. This requires revision of conventional food security paradigms, which to date have focused on maximizing cereal yields and quantity, not quality. It also requires research and investment in technologies that support farmers as they branch out into livestock production and nutrient-dense crops like legumes, fruits, and vegetables. Examples include "biofortification," which uses breeding strategies to improve the nutrient content of crops, and technologies that reduce post-harvest losses, such as solar driers to preserve perishable nutrient-rich foods like mangoes and green leafy vegetables. Extension-based efforts can also provide better information and equipment for intercropping and raising small livestock productively, as well as provide on-farm cold-chain technologies to facilitate the transport and sale of highly perishable produce and animal-source foods. Incentives to diversify out of cereals and into other products for which there is local and regional demand will also bring farmers closer to the goal.

- *Reforming post-harvest supply chains "from farm gate to retailer."* Post-harvest supply chains hold enormous potential for nutrition. In this complicated intermediate stage, raw agricultural crops and products are converted into food destined for retail markets. Research and promotion of innovation in this area are crucial, as are public- and private-sector actions to promote safety and quality. Existing groundnut value chains, for example, are being leveraged for more pro-nutrition purposes, such as production of a peanut-based complementary food for toddlers that can compete with less nutritious cereal-based formulas. These products have been tested in several countries, but their wide-scale production and distribution is hampered by threat of aflatoxin (a toxic mold) and low consumer awareness of the health benefits of a high-protein complementary feeding mix. Navigating these challenges requires both public- and private-sector commitment to regulating post-harvest groundnut storage and marketing the idea of peanut-based complementary food to consumers.

- *Reforming consumer behavior "from market to mouth."* Consumers, including farmers and their households, are the ones who ultimately suffer because of the gap between what the markets are supplying and what is required for good nutrition. In many African countries, traditional foods that once provided diversity in diets are disappearing. Fast foods are invading cities and have become a status symbol for many young people. Changing the food environment (that is, the foods available to people as they move through their daily lives and the affordability, convenience, and desirability of these

foods) through specific taxes and subsidies, nutrition guidelines and labeling, regulation of advertising, and social marketing campaigns can shape consumer behavior and improve nutrition.

In Africa, isolated smallholder farms are the backbone of the agricultural economy and markets are often few and far between. This means that food supply chains are short (that is, characterized by relatively few intermediaries between plant and plate) and directly affected by what farmers grow. The action areas above hold unique potential for Africa, not only in terms of nutrition but also in terms of a pro-smallholder African food system that drives economic growth and development.

- *Agriculture, "up to the farm gate."* This includes targeting smallholder farmers in initiatives promoting healthy food production. Special attention must be given to smallholder women farmers, who produce the majority of the food in Africa. FAO reports that if women farmers in Africa had the same access to land, credit, and services as men, farm productivity would increase by up to 20 percent. Women farmers are more likely to invest in growing healthy foods for their families' consumption or for markets if the nutritional value is made clear to them and incentives and supports are in place.

- *Post-harvest food supply chains, "from farm-gate to retailer."* This includes ensuring that smallholder farmers can meet food-safety and related requirements for high-nutrient crops and products, which are often perishable. In addition to leveraging existing agricultural value chains to increase smallholder participation, there is tremendous potential in supporting the creation of new value chains for high-quality, nationally sourced nutritious food products. Such value chains can also increase rural business opportunities, raising demand for enterprises providing credit, infrastructure, transportation, and all the other services needed to make a strong supply chain.

- *Consumer behavior, "from market to mouth."* This includes targeting poor consumers, including smallholder farmers, with cash transfers and other social protection to increase purchasing power, as well as the previously mentioned nutrition education and social marketing campaigns on the importance of healthy diets. The former makes nutritious foods more affordable while the latter can dispel mistaken notions regarding which foods are healthy. If a critical mass of change can be built up in the way small farmers and others feed their

families, some of the new habits may also be reflected in other areas of the food system, including which crops are being grown and sold in local markets and how much demand there is for specific foods.

Many of these principles are reflected in recent global recommendations that connect the dots between agriculture, nutrition, and food systems, including ICN2's Framework for Action on Nutrition, the Committee on World Food Security's (CFS) Global Strategic Framework on Food Security, and Sustainable Development Goal 2, which aims to "end hunger, achieve food security and improved nutrition, and promote sustainable agriculture."

The Role of Digital Technology

Africa is going digital. Investment in infrastructure—increased access to mobile broadband, fiber-optic cable connections to households, and power-supply expansion—combined with the rapid spread of low-cost smartphones and tablets, has enabled millions of Africans to connect for the first time. In fact, the mobile-subscriber base in Africa is expected to reach over half a billion—49 percent of the continent's population—by 2020.

What does this connectivity imply for agriculture and nutrition? For both sectors, it means a revolution in terms of easy access to information. This includes dissemination of nutrition and health information in local languages, as well as new opportunities for smallholder farmers to obtain timely information on everything from weather predictions, crop selection, and pest control, to management and finance. Even in areas where Internet coverage does not exist, short message service (SMS) messages can remind families of child welfare visits and child health days, deliver simple nutrition information messages about child feeding, provide updates on market prices and fertilizer pick-up locations, and offer a wealth of other health and agriculture messages which previously isolated rural households have historically been unable to access.

SMS messaging in local languages can also provide advice on healthy household meal practices, including suggestions for healthier alternatives. Social marketing can advocate specific crops, for which dissemination strategies are often crucial, thus hopefully increasing market demand and producer incentives.

A current example of this type of circular messaging is *Shamba Shake Up*, an award-winning East African television show which targets smallholder farmers and combines weekly advice on soil health, crop choices and cultivation, livestock care, and nutrition. At the end of each episode, viewers are given the option to write an SMS message to the program producers to follow up on subjects of interest. Another example is the *Foodies,* a televised Ghanaian "food opera" centered on a typical family, combining cartoon and real life characters to present nutrition information in a fun and entertaining way. The *Foodies* also includes SMS options at the end of each episode.

SMS is not the only technology paving the way to a strong food system. Mobile tablets, for example, are transforming nutrition surveys. Information captured directly on electronic-questionnaire platforms is transmitted to a database for quick analysis and decision-making. This obviates the need for manual data entry, which is costly and highly subject to measurement error as well as potential data loss. Digital technology can also be employed in child weighing centers to capture children's nutritional status and to give on-the-spot feedback through embedded child growth standards. If growth is suboptimal, the application then provides recommendations for how the family can address the problem.

Accelerating Investment

Communication and information technology have drastically changed the world and its way of doing things. Today, at the click of a button, information goes around the globe. Yet so many of the problems currently faced by Africans still stem from lack of information, including information on which crops to grow and how, and which foods to eat and why. If we connect Africans with this information, we stand a far higher chance of finally achieving our goals in terms of creating a food system that is a reflection of the farm to fork principles of increasing availability and affordability of healthy foods.

Digital technology has created a huge opportunity to do things differently. It is up to us to take advantage of this to tackle nutrition in a new and effective way. The only limitation is our imagination. Doing less is a disservice to the millions of small-scale farmers and children still waiting to achieve their full development potential.

AUTHOR'S PERSONAL STORY

While in Ghana, I worked for many years in rural communities in the Manya-Krobo district. I had the privilege of meeting some amazing women. Manye Naateki, the queen mother and a woman in her early sixties, really stood out. "Manye" literally means mother of the community. Early one morning, I received a call from Naateki to report to her home. On arrival, she took me to her inner room and showed me a two-day-old baby boy she had just received. The baby, named Emmanuel, lost his father a year ago and his mother had just died in childbirth. I asked her if she would keep this child. Her response was, "Yes, in our culture there is nothing like an orphan. Every child has a home and a mother. If I do not accept this baby he will become malnourished and die." Naateki has divided up her entire community into subcommunities, each headed by a sub–queen mother. Each sub–queen mother is responsible for all the orphan children in the subcommunity. Emmanuel is twelve years old now and calls Naateki "mama." Naateki, who is currently blind, connects regularly with her team of queen mothers through her mobile phone. This article is dedicated to all the Manyes creating homes for orphaned children.

A Note from the Digital Thinking Initiative: *Yaya calls on policymakers at all levels—global, regional, national, and local—to increase collaboration and integration to strengthen agricultural policy. He calls for reduced food imports, asserting that Africa can sustainably exploit its generous endowments—extensive arable land and a growing population—to drive its economic development. He wants to see Africa's millions of smallholder farmers transformed into profitable business actors, whether on their farms or in the surrounding rural economy.*

Africa Can Feed Itself

Rethinking Agricultural Policymaking at Every Level

Yaya Adisa Olaitan Olaniran *is the Permanent Representative of Nigeria to the Food and Agriculture Organization of the United Nations and the Former Chair of the Committee on World Food Security*

It is critical that the world stop thinking of African food producers as it currently does—as poor, wretched individuals with no self-esteem. The future of the African food system will be shaped by the extent to which we can appreciate Africa's ability to feed itself and adjust to a vision of African farmers as profitable business actors. This means putting smallholder producers at the center of how we think about food and agriculture in Africa. At every level—global, regional, national, and local—we can rethink how we approach this important issue.

Revitalizing the Rome-Based Agencies

At the global level, the Rome-based UN Agencies (RBAs) can collaborate more closely with each other and with important African structures such as the New Partnership for Africa's Development (NEPAD) Agency and the Comprehensive African Agricultural Development Program (CAADP). Although the three RBAs—the Food and Agriculture Organization (FAO), the International Fund for Agricultural Development (IFAD), and the World Food Program (WFP)—have different mandates, all assist governments in formulating policies on agriculture and natural resources, food production, rural development, and poverty reduction, with the twin aims of furthering a transformational agenda and reaching the UN's Sustainable Development Goals (SDGs).

The combined strengths of the FAO in technical knowledge and expertise, the IFAD in innovative financing, and the WFP in food aid and development can lend great power to the world's efforts to reach the SDGs in Africa. In order for this to happen, the three agencies need to collaborate—with each other and with African agencies—more often, efficiently, and sustainably than they have in the past.

There are promising indications that such collaboration has already begun: the RBAs are working together (along with many others) to respond to UN Secretary Ban Ki-moon's Zero Hunger Challenge, and to achieve SDG2 (the goal to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture). More recently, the FAO and the World Health Organization collaborated to establish the Rome Declaration on Nutrition in 2014, which recognizes the importance of nutrition-sensitive agriculture.

The RBAs can reinvigorate their relationship with Africa by working hand-in-hand with NEPAD, which leads the African Union's technical efforts related to agriculture and food security. For example, the RBAs can support NEPAD efforts to integrate nutrition outcomes into member states' agriculture and food security investment plans under the CAADP. In support of CAADP, the RBAs could advocate for sustainable agriculture and for agricultural transformation plans that keep the smallholder at the center. The more closely the RBAs work with African structures to realize a self-determined future, the more effective the RBAs will be as partners in the development of a dynamic, resilient African food system.

The World Committee On Food Security: A Model For Integrated Policy Formulation

The 2009 Rome Declaration of the World Committee on Food Security (CFS) reaffirming the fundamental right of all people to be free from hunger is laudable. However, hunger, malnutrition, and poverty will never be eradicated by any single entity or organization. It will take collaboration at all levels to defeat them. The multifaceted, multidisciplinary, multi-stakeholder nature of the CFS poses challenges, of course, but it is nonetheless creating greater willingness among disparate actors to pool thoughts, resources, and action in an integrated, focused way. This represents a new business model for policy formulation.

The next step is to introduce the CFS model at regional, national, and even local government levels. If key government ministries such as the ministries of agriculture, finance, health, education, commerce, and industry can function as a collaborative nucleus with which other nongovernmental actors can work, it is possible to avoid reinforcing the silos that have proven unproductive historically. With the establishment of such a structure to ensure strategic long-term planning, policy formulation, and implementation based on strict budgetary regimes and robust monitoring and accountability practices, it is possible to work together to fight malnutrition, food insecurity, and extreme poverty.

Africa's Agricultural Trade Deficit Hurts Its Development

It is high time we realize Africa's tremendous agricultural potential. Policy inconsistency, poor implementation, and weak leadership have so far failed to lift the continent out of food insecurity, malnutrition, unemployment, and poverty, with the sad result that Africa remains a net importer of agricultural products. Policymakers, businesspeople, and average consumers need to value and invest in the sustainable exploitation of Africa's endowments—both its natural resources and its human energy and ingenuity—over the expediency of imports.

The agricultural exports of most African nations are insufficient to pay food import bills, so governments are forced to appropriate money earmarked for other purposes or, worse still, hope that food donations ensure a stable food supply. In its first ten years, the World Trade Organization turned African countries into food importers,

costing millions of farmers their livelihoods. Many global organizations such as the European Union have taken steps to improve the situation by eliminating harmful subsidies, but African farmers continue to be negatively impacted. African authorities should continue to ensure that their farmers are given the opportunity to compete on a level playing field.

Intra-African trade accounts for a dismal 10 to 12 percent of food trade on the continent. While boosting such trade is not the primary goal, doing so provides an excellent opportunity to protect farmers on a sub-regional level, to create greater economies of scale, and to increase competition in inefficient agricultural industries. These benefits would translate directly to healthier local economies and numerous jobs, with the smallholder farmer at the heart of a booming food economy.

The importance of leadership and strategic policy formulation and implementation cannot be overemphasized in the move to reduce African nations' agricultural import costs. Under the strong leadership and skillful policy implementation of the former Minister of Agriculture Akin Adesina, for example, Nigeria experienced a rice revolution and produced more than 50 percent of its own rice demand. The Nigerian private sector responded accordingly, creating jobs in allied industries while imports fell.

Local Resilience

One of the prime causes of volatility in food prices is an overdependence on a very limited foodstuff base of carbohydrates: rice, wheat, maize, and potatoes. Despite producing over 7,000 different crops, the continent's food base is overly dependent on a limited set of carbohydrate staples—rice, wheat, maize, and potatoes—which experience severe price volatility. To reduce farmers' and consumers' vulnerability to such price fluctuations, we need to diversify what we plant. This will not only help overcome hunger and poverty but will also create a platform for overall economic growth and sustainable development.

To sustain such development, we must grow more food more efficiently, eat, drink, wear, and burn (as fuel) more of what we grow with less waste and more dignity. In times of food-price crisis, Nigeria has always reverted to its yams, sweet potatoes, cocoyam, plantain, cassava, breadfruit, sorghum, and millet. The rising demand for food on our continent provides a unique opportunity to emphasize, with an intense

awareness campaign, both the economic and health benefits of farming a broader range of indigenous plant species.

Food systems are strongly tied to tradition and culture, which vary widely between and within countries. The introduction of exotic varieties, both plant and animal, has not disrupted these traditions, but has nonetheless altered the indigenous germplasm. The amount of money invested in the breeding of foreign varieties has led to the underdevelopment of breeding activity focused on indigenous seeds and animals, which in turn depresses local production of them. What you eat is what you are. The policies shaping the future of the African food system must encourage the breeding, multiplication, and use of local foodstuffs.

The End Goal: African Farmers Organized For Agribusiness

Africa can achieve inclusive, sustainable, grassroots growth by tapping into the continent's huge reserve of natural and human energy. But organizing millions of smallholder farmers with a wide variety of beliefs, cultures, and ideologies into an efficient and effective farm-to-fork production system that values diversity and long-term sustainability is no small task. It will require the economic empowerment of women and youth, the use of local cultivars, including underused plant species and indigenous knowledge, and local innovation in science and technology. Policies will need to be restructured, physical infrastructure improved, and political will gathered until we find our way forward into a better future. Africans—leaders and followers—must rise to the enormous challenges that face them by taking decisive and concrete action to transform the lives of hundreds of millions of rural and urban people. When they do so, they will balance food trade deficits, improve food security and nutrition, raise income, and increase human dignity.

My plea to policymakers is to reject Oscar Wilde's reflection, in *The Importance of Being Earnest*, that we should "leave it to the poor to pretend that poverty is a blessing." They should instead endorse King David's assertion in Psalm 140:12: "I know that the Lord will maintain the cause of the afflicted and the right of the poor."

AUTHOR'S PERSONAL STORY

I am a believer in organic food, home cooking, and farming with integrated pest management. I owe this, and my career in policymaking, to my wise mother.

She gave me a healthy beginning by breastfeeding me for over two years, and after weaning, she fed me with soup made of fresh leafy vegetables, chicken, and local carbohydrates. Breakfast was always beans, or corn, with gaari. My primary school snack was bambara nut with boiled sweet potatoes or cassava, washed down with water—not carbonated soda.

She bought each of her children a cock and hen. The birds were free-range; we joyfully fed them with grains and dutifully swept their droppings into our compost heap. I enjoyed counting my hen's eggs while she sat, and was flabbergasted to see the chicks emerge! When we put stems of mature vegetables on the compost heap, seeds sprouted into green plants and I watched them become the vegetables for our table. Wow! My first vegetable garden was born.

My early fascinations found an outlet in secondary school when I chose to work on the school farm instead of learning carpentry. This led to a long career as a commodity crops researcher. In retirement, my home garden of dry season vegetables plus snail farming fetched me returns four times my annual salary, with only three months' production.

A Note from the Digital Thinking Initiative: *While recognizing that technology isn't a panacea, Ertharin asserts that, if applied correctly, with an awareness of context, it can help overcome many of the barriers that have hindered the sustainability of food systems throughout Africa. Through digitally enabled farmer cooperatives, smallholder farmers can escape the isolation which prevents them from thriving in the current system and which contributes to food and nutrition insecurity. Women in particular can use cell phones to build networks and ultimately empower themselves as farmers, as heads of households and as individuals. Technology access doesn't just happen by itself, however. We need to make sure that every African has access to the right tools.*

The Smart Thing to Do

How Technology Can Help Rebalance Food Systems

Ertharin Cousin *is the Executive Director of the United Nations World Food Program*

Food systems are fundamentally about people—people whose daily routines involve connections with each other as family members and neighbors, and also as suppliers, producers, processors, buyers, and consumers—people who utilize the natural resources and services offered by their ecosystem. In well-functioning food systems, these connections are efficient and predictable enough to provide adequate incentives and returns while delivering safe and nutritious food to consumers. In poorly functioning food systems, however, inefficiency and unpredictability distort incentives and reduce returns, inhibiting food and nutrition

security. Too often smallholder farmers in developing countries bear the brunt of such food system failure.

A number of factors contribute to the burden smallholder farmers must carry. In remote areas, markets are highly segmented. Poor roads and lack of infrastructure impose high transaction costs in such markets. Financial institutions are concentrated in urban areas; even where financial institutions capable of serving smallholder farmers exist, access to the credit and financial services required for long-term investment is limited, and the services farmers can access are not tailored to their needs. This exclusion, coupled with weak purchasing power, hinders investment, productivity, and ultimately prosperity.

In order to improve food systems—that is, sustainable community food systems—we must establish entry points along the entire agricultural value chain. We need integrated efforts from farm to fork. Local communities, and particularly farmer organizations, play a crucial role, but they cannot realize the necessary change alone.

Digital Technology's Role

Technology-driven solutions offer the potential to address myriad issues and rebalance food systems to deliver food security for all. Advances in digital technology, in particular, now provide an unprecedented opportunity to overcome isolation and bridge knowledge gaps, creating new opportunities for smallholder farmers and transforming rural communities. As these tools become increasingly available and affordable, the challenge is to ensure that they are both scalable and sustainable.

The World Food Program has witnessed the power of technology to enable change. Under the Purchase for Progress initiative, over one million farmers became better connected to markets, even in places where mobile connectivity is limited. Working through farmer organizations such as the Melik Siltie Cooperative Union in Worabe, Ethiopia, smallholders use the Internet to access the real-time market price information about seeds and fertilizers and to check weather forecasts for the entire region. The Cooperative Union exchanges information on the price of beans and maize with sister unions and even monitors the price of corn at the Commodities Exchange. Once enough information has been gathered, the union can sell its members' grain profitably on the open market and has the confidence to take capital loans to invest in infrastructure such as storage and processing

facilities for quality grains. As a result of these and other uses of information technology, the Melik Siltie Cooperative Union tripled its food aggregation capacity within a three-year period. The end result for these smallholders was increased productivity, greater return on investment, better preparedness against risks and more nutritious food on the table.

Technology And Women Farmers

However, digital technology's promise is not one-size-fits-all. Designing and implementing sustainable technology solutions requires an understanding of local mores and unique community hurdles, in particular a sensitivity to gender-related issues. Women act in every role across the food system—they are producers, processors, sellers, and, of course, consumers. Yet they often have little say in decision-making and don't always have access to the information and tools that would enable them to maximize their contribution.

Technology solutions must affirmatively close agriculture's wide gender gap. Correctly applied, they can not only provide economic and educational opportunities, they can also assist women in overcoming barriers to empowerment, including freedom of movement and freedom of association. Women can use mobile phones to join virtual communities, for example, that generate social capital for their members and overcome barriers that keep women from working together, particularly in geographically disparate, highly segregated, and gendered food systems.

The evidence shows that when groups of women farmers embrace technology, they gain income and financial independence; they are also more likely to use this income and independence to prioritize investments on children's nutrition, health, and education. Gender equality therefore contributes to overall economic growth by expanding the stock of human capital, raising labor productivity, improving agricultural outputs, and reducing food insecurity.

Unfortunately, despite the massive uptake of mobile phones, in many rural areas simply being female already reduces the chances of owning a cell phone by half. This is why gender-blind technology program implementation and information access is neither desirable nor sufficient. Providing mobile devices and connectivity in a targeted way to women farmers will ensure that these virtual communities are created equitably, enabling women to share information, learning and services—

and ultimately empowering every woman everywhere to harness her capabilities and realize her full potential. Investing in rural women is not just the right thing to do, it is the smart thing to do.

Overcoming Barriers To Technology Access

Africa has witnessed exponential growth in the numbers of users of technology since the year 2000. In South Africa and Nigeria, mobile phone usage now equals that in the United States. This level of access to technology, however, is geographically limited. The International Telecommunications Union reports that, on the continent as a whole, less than 20 percent of people are connected to the Internet. Poor infrastructure, irregular power supply and lack of affordable technologies remain major obstacles to expanding connectivity.

With the right national strategies for public and private investment, however, we can quickly overcome these hurdles, particularly for the poorest populations by, for example, incentivizing infrastructure development in isolated and rural areas and by harvesting the unexploited potential of solar power. With the right enabling environment, the private sector investment will flow.

Digital technology alone is not the panacea for all that ails Africa's food systems. Research examining smallholder market participation demonstrates that farmers make decisions based on a wide variety of factors, including transaction costs, the availability of transport and even family size. Technology simply serves as a vehicle for providing the data, the analysis, the communication, and the access that drives educational, social, political, and economic change, offering farmers an existential helping-hand by opening up previously unimaginable opportunities and choices. These opportunities will support the creation of functioning, sustainable, and durable community food systems—that is, if we are able to provide universal access and scale up technology-based agricultural services across the continent.

AUTHOR'S PERSONAL STORY

My grandfather supported his family as a farm laborer in the Deep South. They lived in a small house on "the plantation." When the land was replanted with trees to replenish what years of cotton farming had taken from the soil, my grandfather began working at the mill. Once, during a drive from Georgia to Chicago, he told me it was good to see the corn fields in Illinois because they reassured him that America could still feed itself.

In 1959, we were one of the first black families to move into Chicago's Westside Lawndale community, then predominantly Caucasian. By 1960, "white flight" was turning the Westside into a black ghetto. In 1966, Martin Luther King brought attention to the poor housing conditions in our community, which was destroyed by riots following King's 1968 assassination. That summer, I was twelve and went door to door with a petition asking my riot-weary neighbors to save the Alaskan baby seals. I wrote a letter to President Nixon telling him, "In America we are a rainbow which should not only bring us together as a people but help us save the baby seals."

With the spirit of my grandfather, I've focused my career on ending hunger and helping ensure that people everywhere can feed themselves.

Smallholders and the Rural Economy

A Note from the Digital Thinking Initiative: *Agnes points out that the traditional image of the smallholder farmer as lazy, irrational, and committed to poverty is not just inaccurate but wildly so. Smallholder farmers spend their time and energy taking very rational steps to keep themselves alive; it's the responsibility of governments and the development community to make sure that they have opportunities to do more than that. Overcoming physical isolation and stimulating youth interest are the two most important steps to take, but African leaders have to begin with the actual smallholder farmer, rather than who they think the smallholder farmer should be.*

Smallholders Front and Center

Farmers and Inclusive Economic Growth

Agnes Kalibata *is the President of the Alliance for a Green Revolution in Africa*

Across sub-Saharan Africa, roughly 70 percent of the population works in agriculture, almost all of it small-scale. It stands to reason, then, that if African smallholder farmers become prosperous, they will change the continent forever.

It is well established that agricultural growth is the best poverty fighter there is. This has been true throughout history, going all the way back to Europe in the eighteenth century and all the way up to China just a generation ago. Globally, economic growth that comes from the agricultural sector is at least twice as effective as other kinds of

economic growth at driving down poverty rates. In sub-Saharan Africa, it is more than eleven times as effective.

But agricultural development is not just about reducing poverty; it's about triggering economic growth too. The landmark 2008 World Development Report makes a powerful case for an agriculture-first development strategy in predominantly rural countries, especially in those in sub-Saharan Africa. Gradually, as countries grow, they diversify, and fewer people are employed in agriculture, but the history of the worlds' strongest economies shows that this process cannot begin without an agricultural transformation.

In short, the future of Africa depends on the future of the largest segment of its society—smallholder farmers.

Unfortunately, the leaders who hope to bring Africa into the future have not as a rule prioritized agriculture. Many see agriculture as a vacuum that sucks up resources and gives little in return and choose to concentrate instead on more glamorous sectors. Others are discouraged by the fact that agricultural progress is generally slow; quick gains are difficult to sustain. Some leaders who do prioritize agriculture don't look through the very specific lens of the African smallholder, focusing instead on commercial farming, which is irrelevant to four out of five farmers on the continent. As a result, smallholder agriculture is a poverty trap.

I believe that it does not have to be. I believe that smallholder agriculture is, instead, the next engine of economic transformation for Africa. Sub-Saharan African job growth between 2010 and 2020 will be predominantly in agriculture and the informal sector. Africa's food market, boosted by a growing population and a growing middle class, is estimated at 1 trillion dollars by 2030. Right now, billions of dollars of that food is imported from other countries. If smallholder farmers can become "agropreneurs," they can take advantage of this market and replace many of those imports with domestically grown produce. In fact, I would say that there is literally no scenario for the broad-based development of sub-Saharan economies that does not focus on smallholder farmers.

But this development needs to gain momentum. In 2003, the member states of the African Union agreed to the Comprehensive Africa Agriculture Development Program (CAADP), which included a pledge to spend 10 percent of their budgets on agriculture. In the decade-plus since then, only 30 of 54 countries have signed

CAADP compacts and only 13 of these have reached the 10 percent threshold. In these countries, however, poverty levels are falling and food security and nutrition rising. The rest of the continent must follow these nations' lead.

The key need in African agricultural development, I believe, is an intellectual paradigm shift: finally focusing on the smallholder farmer. That means believing in agriculture, and smallholder agriculture in particular, as the foundation of inclusive economic growth for the continent. It also means understanding smallholders and forming the development agenda around them, instead of trying to fit them into an idea of the way development is supposed to happen. If smallholder farmers are front and center, we will understand their aspirations, see the obstacles in their way, and make investments and policies that clear those obstacles away.

The beauty of this approach is that if we empower smallholder farmers to achieve their aspirations, they will do much of the heavy lifting of development themselves.

Subsistence Farmers And The Logic Of Security

Many agricultural experts think in terms of "agro-ecologically possible yields"—in other words, how much crop a farmer could theoretically get out of a piece of land if she did everything she could to maximize it. Most smallholders' farms produce a fraction of what's agro-ecologically possible, in large part because they tend not to use improved seeds or fertilizers. In Uganda, for example, 87 percent of smallholders use saved grain as seed. In Asia, where only a generation ago a new understanding of the link between smallholding and economic growth led to changes in land tenure and financial systems, fertilizer use is already more than fifteen times greater than in Africa.

It is easy to assume that farmers who do not adopt technologies to boost their productivity—the Alliance for a Green Revolution in Africa's (AGRA) experience has shown that doing so can quadruple farmers' yields— are simply irrational. This assumption is not only wrong, it is also dangerous, because it prevents both real analysis of what's preventing adoption and rigorous thinking about effective reforms to promote it. In short, it is very difficult to come up with the right solution to the wrong problem.

Over time, smallholders have created their own informal but highly rational system based on a logic of security. Most live on the edge of destitution, and the first filter they apply to every single decision they face is what will prevent them from falling over the edge.

Eighty percent of agricultural land on the continent is cultivated by smallholders who manage parcels of two hectares or less. Most smallholder farmers can't afford to buy food or pay laborers, so they must produce everything they need using their own land and labor and whatever rain happens to fall—which is getting less predictable as climate change sets in.

Smallholder farmers spend virtually all of their time either working or thinking about their land, their only asset, so they are extremely attuned to the environment. They rely on seeds they inherit or get from their neighbors because they know how they will perform. They know which banana variety has the right taste and is therefore fit for a gift for in-laws. They know which seeds tolerate drought. They know that some crops will fail in a rain-fed system, so they mix crops to hedge against a spotty harvest.

If they get a little extra money, they won't buy improved "miracle seeds" or technology unless they can be absolutely sure of the results; the tried-and-true unimproved material simply has too long a long track record. Reported yields under improved conditions in test fields aren't enough. The same goes for chemical fertilizer. In smallholders' security-first system, the proof is in the pudding. (Scientists, by the way, are finding that they like the taste of that pudding; the Consultative Group for International Agricultural Research and other research systems have started incorporating indigenous knowledge in their breeding work.)

Even if farmers were willing to assume the risk of untested seeds and fertilizers, however, they have no incentive to produce more than their families can eat unless they can sell the surplus, and many can't. The most isolated farmers simply don't have access to markets at all. In the Democratic Republic of the Congo, the eleventh largest country in the world by geographical area, there are fewer than 1,500 miles of paved road, about the same as in a middle sized American city.

Even farmers who can get their produce to market are rarely able to do so efficiently. By necessity, many hire a series of middlemen to handle the transport. These middlemen take a big cut—and they may or may not be paying the farmers a fair

price in any case, because smallholder farmers have no reliable way of knowing how much their crops are fetching at market.

Since smallholder farmers don't usually have access to post-harvest storage, and since they almost always need money as soon as harvest comes, they usually sell everything they have immediately. This leads to annual price crashes that cut into their already meager profits.

Before investing in seeds or fertilizer, then, smallholders are likely to use any extra cash to diversify into livestock, starting with chickens and moving up to cows as their means allow. Smallholders buy a cow at the first opportunity for a number of reasons that are completely rational: they can resell the cow if needed, cow manure can be used as fertilizer, and cow's milk is part of a healthier diet, not to mention the fact that it can generate a steady source of income.

Development From The Smallholder's Perspective

It should be clear that smallholder farmers aren't satisfied with poverty as a way of life. Rather, they are responding to the conditions they face, and they take the steps within their power to improve those conditions. Country governments and the development community can help give them better options by moving agricultural products and services closer to communities: training that reaches them with the latest knowledge, improved seeds and fertilizer they can afford to use, and markets that maximize the value of their assets.

There are two ways to do this. The first is to move products and services physically. In Rwanda, for example, there is such a high level of fragmentation that we didn't know if we could reach every farmer with trainings and vouchers for seeds and fertilizer. As a result, we changed our policies so that our extension agents worked with groups rather than individual smallholders. What became the Crop Intensification Program ultimately enabled us to reach farmers with the tiniest parcels of land in the most remote areas.

In parts of Kenya, Tanzania, and Mozambique, AGRA and other organizations have helped nongovernmental organizations and the private sector give smallholders access and knowledge by working with trusted local people who take charge of training and who sell them seeds, fertilizer, and other supplies. These local

extension agents live with the people they're working with, so they find appropriate technologies and demonstrate them *in situ*. Unlike many suppliers, the extension agents tend to sell products in small batches, to take some of the risk out of trying new technologies. This peer-to-peer system costs the government nothing; it is paid for by the private sector and by the farmers themselves. It is working. In the village I visited, adoption rates were as high as 70 percent.

The second way to overcome the geographic challenges smallholders face is to do it digitally. More than 750 million rural Africans already use mobile phones, and rural connectivity averages 70 percent. If these people are given straightforward mobile apps that give them relevant, accurate information—apps developed by technology and agriculture professionals working together—then the isolation of even the most far-flung, sparsely populated communities will be a thing of the past.

Bypassing Africa's Infrastructure Challenges With Digital Technology

The digital connection of smallholders has already begun. Nigeria, with 89 percent cell phone ownership, recently launched its eWallet program, which delivers seed and fertilizer vouchers directly to farmers through their phones. In its first year alone, the program enabled 1.7 million farmers to buy $10 million worth of seeds and $100 million worth of fertilizers and to produce an additional 8.1 million metric tons of food. This is the sort of success that will cut the cost of financial services in rural communities by as much as 50 percent and give farmers both access to credit and the means to mobilize it. Soon more nations will join Kenya, Rwanda, Nigeria, and Ghana in adopting pro-technology strategies and regulatory frameworks to allow technology to spread among smallholders even farther, faster.

The exciting thing about communications technology over the long term is that the democratization of information goes in both directions. Governments and other institutions can provide information in a medium farmers are comfortable with, and they can also pull information from those farmers. Over time, two-way communication can lead to agricultural investments and policies sensitive to farmers' actual needs and preferences. When it comes to crop breeding, participatory varietal selection—letting the farmers who will plant the seeds give input on which ones they like best—has already improved adoption significantly. Cell phones can make every aspect of the agriculture sector participatory.

Not every digitally based reform will be farmer-facing. Take markets. While it will help when farmers are able to store their harvest and wait for an advantageous time to sell, there is no way for smallholder farmers to build functioning market data management systems. Those systems, which will bring transparency to a process that has been shrouded in information asymmetries, are a public good. They will require public investment. Even when investments don't directly involve smallholder farmers, though, they won't pay off unless these farmers' needs are factored in from the beginning. The government may build a system, but they have to build a system that smallholders can use if it's going to have its intended impact.

Conclusion

No child of an African subsistence farmer wants to be a farmer. I know this because I am one. Even though most of us had a decent upbringing and education, and even though we supply most of the food consumed on the continent, the very word "subsistence" implies how little opportunity we saw. Farming kept us alive, but it also kept us poor.

Before I took office as Rwanda's agriculture minister, I told a friend that my dream for the country was to reduce the depth of poverty among rural communities. He said I would die before my dream came true, because Rwandan smallholder farmers were committed to poverty. I responded that I thought the image of lazy, unproductive farmers resistant to change was based not in farmers' character but in our own shortcomings in offering them solutions.

Time is proving me right. Between 2005 and 2014, 2 million Rwandans (20 percent of the country's population) lifted themselves out of poverty. The country's average income went up from less than $250 to almost $650 per year. The World Bank attributed 65 percent of this increase to growth in the agricultural sector.

I don't mean to suggest that agricultural transformation is a simple matter. On the contrary. We didn't get everything right in Rwanda, and in any case our transformation is just beginning; Rwanda is still a poor country. Yet Rwanda's progress shows what's possible.

We know what needs to be done. The technology exists to do it. Countless innovative pilots have proven that smallholder farmers can be highly productive. And while we

cannot cut and paste the experiences of other regions, we have learned valuable lessons from agricultural transformations in Latin America and South Asia.

The reason for Africa's agricultural stagnation is not a lack of potential. It is not a lack of dedication. It is not a lack of demand. It is a lack of attention, a lack of commitment, and a lack of investment. There is an immense opportunity to design and implement policies that help smallholder farmers prosper—and in so doing wipe out poverty and pave the way toward a great African future.

AUTHOR'S PERSONAL STORY

I am a Rwandan born and raised as a refugee in Uganda. My parents were smallholders. Occasionally, my father would sell a cow, and this little income helped put me through school. Though the aspiration was that I would move as far from agriculture as possible, as fortune would have it, I've spent my entire career in it.

From 2004 to 2014, I had the privilege of putting my knowledge to work back in my home country of Rwanda, where I served as permanent secretary, then minister of state, and ultimately minister for agriculture, livestock, and fisheries. During this time, Rwanda prioritized agriculture and smallholder farmers, and the country moved from food insecurity to food security, lifting 20 percent of the population out of poverty.

There is nothing more satisfying than seeing a farmer smile when he or she has a good crop and thinks about what to do with money from selling the extra produce. This little additional income can pay for healthcare or send kids to school. Small changes can make a big difference in the lives of farmers struggling to survive; the rest they can do themselves.

A Note from the Digital Thinking Initiative: *A lot of the essays in this volume talk about how government and the development community can join forces with the private sector to give smallholder farmers a brighter future. But as Akin points out, African smallholders* are *the private sector—the largest segment on the continent. By seeing agriculture as business, smallholder farmers as customers and entrepreneurs, and companies as organizations that want smallholder farmers as customers and suppliers, policymakers and investors can leverage the continent's existing assets to catalyze economic transformation rather than trying to create it from whole cloth.*

Agriculture as a Business

Approaching Agriculture as an Investment Opportunity

Akin Adesina *is President of the African Development Bank and the Former Minister of Agriculture and Rural Development, Nigeria*

I was recently appointed president of the African Development Bank. A development bank is not necessarily an intuitive concept; most banks don't exist to serve explicitly social purposes. But what defines a bank is the way it conducts business, whatever that business may be.

This is why I say I wear my banker hat, and not my development hat, when I speak about agriculture. Agriculture is not a way of life. It is not a social sector or a development activity, despite what people may claim. Agriculture is a business. And

the more we treat it as a business, as a way to create wealth, the more it will promote development and improve people's lives to boot.

One way to treat agriculture like a business is to get the private sector more involved in it. When I was Nigeria's minister of agriculture, the most important thing I had to understand was that government can't create agricultural transformation; it can only enable it by making more room for businesses to intervene. We could do this by putting the right policies and regulations in place, by creating strong institutions, and by building sufficient infrastructure. But there is not much else government can do with a reasonable measure of efficiency. Agricultural transformation has to be led by the private sector.

The problem in Nigeria was that the private sector was largely nonexistent in agriculture. Take fertilizer and seeds. For forty years, the federal government had been procuring these inputs and filtering them down through layers and layers of state and local governments until, in theory, they got to the smallholder farmers who needed them. Except the theory rarely played out in practice. Our data indicated that only 11 percent of the fertilizer procured by the government got to farmers in the end. Since the seeds also rarely got to where they were going, some suppliers started selling the government grain instead as counterfeit seed. In fact, the system existed to serve the rent seekers attached to it, not the smallholders who were supposed to benefit from it.

With corruption and inefficiency like this, it wasn't hard to explain why a country with 84 million hectares imported almost all of its food. We decided to try to replace government-run agriculture with a set of small and medium enterprises that ran the gamut from providing inputs to smallholder farmers to transporting, processing, and selling food. These businesses would bypass government bureaucracies and build supply chains directly into rural communities, generating—we hoped—significant ripple effects.

We dismantled the public procurement system in less than 100 days. Over the next two years, the number of seed companies operating in Nigeria increased from just 11 to more than 100. The new fertilizer market mobilized 5 billion naira from private investors over the same span. Major players like Syngenta, which had stopped doing business in Nigeria because of the corruption, reentered the market. We now have more than 5,000 mom-and-pop shops selling these companies' products—and providing informal agricultural training—directly to farmers.

I don't mean to make it sound so simple. Merely removing the government from the fertilizer and seed business doesn't guarantee that the private sector will step into the breach. We needed to demonstrate that there was a market opportunity—that farmers wanted to buy these products. But without a ready supply, it was challenging for farmers to express their demand. It was a classic bootstrapping problem.

On the demand side, the key was making fertilizer and seeds affordable enough for smallholders to try. So we instituted a 50 percent subsidy, with the idea that farmers would fund more and more of their purchases over time. Subsidies are not new or radical, but we innovated by creating a new and radical delivery mechanism: the eWallet program. We knew that there were 130 or 140 million mobile phones in Nigeria, so phones seemed like the most efficient way to reach millions of farmers. As a side benefit, the eWallet program helped us make contact with farmers, which not only gave us more information about the population we meant to serve but also gave them a means to communicate back to us over time. Yes, eWallet was about delivering fertilizer and seed vouchers, but it was also about building a platform for interacting with millions of once-inaccessible smallholders in the future. Recently, we started using the eWallet platform to deliver other benefits, including vouchers for nutritional supplements.

Some critics said we were crazy for using mobile phones to try to transact business with people who could barely read or write. But we knew that they were already using their phones to arrange for remittances from relatives in the cities, which told us that they trusted mobile communication more than most government institutions. Our priority was to make sure that the mobile phone interface is translated into local languages. Now, eWallet has 15 million subscribers. I am especially proud of the fact that several million of those subscribers are women farmers, who have historically been neglected by agricultural programs.

The eWallet program helped with demand. If farmers were going to start purchasing fertilizer and seed in large numbers, though, we needed to make sure the fertilizer and seed was available, so it was critical to address the supply side, too. The problem was the lack of capital for agricultural start-ups; the solution we hit upon was easier credit. The ministry of agriculture collaborated with the Central Bank of Nigeria to create a new initiative to share risk with banks and encourage them to make more loans to agricultural businesses. With a little more assurance, banks have increased their lending to the agriculture sector from roughly 10 billion naira annually to in excess of 40 billion naira.

I recount this history from Nigeria because it demonstrates four key principles that are guiding me as I take on my new role at the African Development Bank: first, smallholder farmers can be customers; second, companies are interested in serving them if the conditions are right; third, mobile phones can facilitate transactions that used to be prohibitively expensive; and fourth, scale. Africa is the fastest growing continent in the world, with a population that already surpasses 1 billion. The majority of those people earn their living by farming small plots of land. So any institution that is dedicated to inclusive growth for Africa must stand for reaching all African smallholders.

There have been more successful pilots in agriculture than I can count. Sometimes, I joke that we have too many pilots and not enough planes for them to fly. Beyond pilots, we have the accumulated experiences of more than fifty African countries to draw from. Kenya has taught us how to build a thriving horticulture sector. Ethiopia has taught us how to improve extension. Tanzania succeeded in creating growth corridors. Rwanda figured out land registration and titling. Mozambique and Ghana discovered innovative ways to finance agricultural development. We need to take those lessons and apply them on a grand scale.

The African Development Bank is poised to do this because we have resources and relationships with every country on the continent. Currently, about 8 percent of the portfolio is in agriculture (I plan to increase that number), but almost everything we do impacts agriculture in one way or another, because we focus on infrastructure investment. Our work to build roads, to provide energy, and to create telecommunications networks will help farmers as much as anyone else as long as we do it properly. We aim to think comprehensively about our infrastructure investments, so that they form a core of a strategy to link smallholders to the burgeoning formal economy.

The truth, however, is that the African Development Bank is very small relative to the need for investment in African agriculture. Like every business, we need leverage. Building on the lessons I learned in Nigeria, I hope to use our balance sheet to share some of the credit risk of agriculture sector lending across the continent.

Agriculture is seen by banks as a huge risk. It doesn't have to be. If we use our resources to guarantee some loans and help banks get more comfortable with lending in the sector, then we believe we can unlock the many billions of dollars needed to spur new businesses and help the sector function properly. There is no

shortage of entrepreneurs who want to serve farmers' needs. There is only a shortage of capital. If entrepreneurs have the resources they need, then we can get a lot closer to agriculture as it should be—as a business.

It is easy to forget that the largest private sector group in African agriculture is the smallholder farmers themselves. For decades, farming was viewed as a subsistence activity whose loftiest goal was food security for individual households. But life is about more than having enough food to survive. Farmers want to eat nutritious food that helps them thrive. Beyond food, they want education, health, housing, comfort, and a promising future and they will invest on those things if given the opportunity.

When I was a boy in a village school, every classroom was full when the harvest was good. But when the rain failed and the crop was meager, families had to pull their children out of school to work. Many classmates who were just as smart as I was had to drop out so their families wouldn't starve.

Sending children to school when there's enough food to go around is a business decision, and so, unfortunately, is taking children out of school when their labor is needed to keep the household functioning. If the development sector starts treating agriculture as a business, then the hundreds of millions of small business owners operating farms will have better options from which to choose.

My father, who grew up farming, used to tell me that "agriculture doesn't pay." And when farmers have no access to finance, inputs, information, or markets, it doesn't. But there is so much value inherent in agriculture, and we need to unlock it.

Agriculture can pay. Hundreds of millions of small farmers, thousands of local agribusinesses, and hundreds of seed and food companies will make it pay, as long as the development community and governments are willing to try something new.

And when I say pay, I mean it in the broadest sense of that word. Yes, pay in terms of incomes for smallholders, and yes, pay in terms of profit for the businesspeople engaged in the sector. But also pay in terms of a healthier and happier life for hundreds of millions of Africans, and a stronger Africa.

AUTHOR'S PERSONAL STORY

Poverty for me is not theory: I lived in it and came out of it.

My father grew up as a farmer. Father got the opportunity of a lifetime from a benefactor who took him to Lagos and enrolled him in primary school at the age of 14 years.

I attended a village secondary school without electricity or plumbing. When the harvest was good, my classmates, the children of farmers, were in school. They dropped out when the harvest was poor or prices fell.

My father told me, "Son, you never know what God might make you in life. If you ever become an important person, remember the poor. Get poor farmers out of poverty."

While my PhD in agricultural economics at Purdue University gave me the knowledge to work in agriculture, it is my father's words and my growing-up experience that made it my life ambition to use agriculture to lift millions out of poverty.

As Minister of Agriculture in Nigeria, my team and I helped initiate an agricultural transformation that impacted 14.5 million poor farmers. Today, as President of the African Development Bank, my passion remains the same. In treating agriculture as a business lies the future for the economic revival of Africa's rural communities.

A Note from the Digital Thinking Initiative: *Rural transformation isn't just a question of what happens on African farms; in fact, as much as half the income of rural households in the developing world comes from non-farm income. Kanayo explains that what many people think of as the rural-urban divide is actually far better characterized as a continuum or a chain. Africa's way forward requires strengthening* all *the links on that chain and connecting them to one another. The standard of living of millions of people depends on making sure that the on-farm, off-farm, rural, and urban sectors all work together.*

Food Systems Transformation Goes Beyond the Farm

Rethinking the Rural-Urban Dichotomy

Kanayo Nwanze *is the President of the United Nations International Fund for Agricultural Development*

Connecting Rural Livelihoods in Today's Complex World

Human beings love to divide things into matching or contrasting pairs: night and day, sweet and sour, rich and poor. In the field of development, one of the contrasting pairs we see time and again is that apparently neat spatial division, rural and urban.

We have a list of differences that we associate with these two categories. Rural areas are where poor people live; urban areas are wealthier. Rural people are farmers and they produce food; urban people have other kinds of jobs and they buy food.

A more granular picture of people's lives in rural and urban areas, however, immediately reveals a reality that is more complex, more contradictory and more fluid. Take poverty figures, for example: although more than 70 percent of extremely poor people are to be found in rural areas, the absolute number of urban slum dwellers is growing, with an estimated 828 million people currently living in slum conditions, compared to 767 million in the year 2000. And although rural people produce food, many of them are also net buyers of food, just like their urban counterparts.

In today's rapidly urbanizing world, the rural-urban split is more accurately represented as a continuum than a divide. To intervene effectively along this continuum in support of poverty reduction and development, we need to move beyond binary thinking and focus instead on ways to forge and strengthen the links that connect rural and urban realities. In this quickly changing landscape, rural towns are becoming increasingly important, and our thinking about rural-versus-urban will have to evolve into rural-*and*-urban.

The organization that I lead, the International Fund for Agricultural Development (IFAD), has worked in rural areas since it was established in 1977. This is where poverty is concentrated and entrenched, but it is also where food is produced and other key environmental services are provided. We have seen increasingly in recent years that inclusive economic growth in rural areas is powered by resilient two-way connections with urban realities and opportunities.

On The Farm And Beyond

IFAD has a special focus on increasing rural people's access to markets—local, peri-urban, urban, and international. Poor rural producers make connections to markets, after all, within larger agricultural value chains. Every product that is sold—locally, nationally or internationally—is part of a value chain. And every link of the chain has the potential to add value to the product. From a development perspective, value chains are one of the instruments through which market forces can be harnessed to benefit poor rural women and men—not just producers, but wage earners, service providers and others.

Women and men in rural areas rely predominantly on agriculture. Two billion people depend on the world's 500 million smallholder farms for food and income, and these farms provide as much as 80 percent of the food produced in many areas. Smallholders who are connected to markets where they can sell their produce for fair prices and buy necessary farm inputs are able to build their businesses, increase productivity, and take advantage of new openings.

Despite the significance of agriculture, however, statistics show that 35 to 50 percent of rural households' income across the developing world doesn't come from agriculture at all, but from what has come to be known as the non-farm economy. This catchall phrase covers a wide range of activities, including agro-processing, trading, manufacturing, and commercial and service enterprises. IFAD works with partners to build their ability to take part in activities like these, which strengthen rural links to the urban world. A key element of this work involves enabling rural people to establish strong producers' organizations, which both increases their bargaining power and helps them to move up the value chain. Such organizations also give the private sector a way to engage with thousands of small producers effectively. Support for these organizations is an important part of IFAD's work.

Money sent home in the form of remittances by temporary or permanent migrants makes up another big part of non-farm income. The total value of remittances that migrants sent back to their homelands in 2014 was a massive $436 billion, and 40 percent of that total went to rural areas. IFAD aims to strengthen the lifelines that remittances offer, working with partners to reduce costs and facilitate transactions. The organization manages the multi-donor Financing Facility for Remittances (FFR), which pioneers innovative instruments for migrants, their families, and communities to send and receive remittances and to invest them in economic and social development. FFR has also brought many constraints to the attention of governments and development actors, raising awareness and helping drive change.

The Difference That Non-Farm Income Makes

For households with access to land and functioning smallholder farms, additional income earned by family members from other sources makes a huge difference. In fact, rural families with incomes that include non-farm earnings tend to be less poor than those who rely more heavily on agriculture. Non-farm income pays for education

and health services, buys agricultural inputs that increase yields, enables smallholders to diversify risk, allows them to invest in their farming businesses, and buys extra food during the hungry season.

The importance of this economy as a source of income and employment for poor rural people in developing countries is growing everywhere, and increasing the proportion of non-farm income can contribute to families moving out of poverty.

Studies have shown that rural towns are effective generators of non-farm employment as they mediate the flow of inputs, goods, and services between more isolated rural areas and larger urban centers. These small towns can become a focus for the diversification of rural economies. These diversified economies are still based on agricultural production, but they connect farmers to other key actors along value chains, including processors and traders.

There is also evidence that rural non-farm diversification and the growth of small towns can reduce poverty faster than rapid growth in large cities. A fifteen year study by the World Bank in rural Tanzania showed that six out of seven people who escaped poverty were either farmers who supplemented their incomes with non-farm earnings or people who moved out of farming into the non-farm rural sector. Only one in seven people who moved out of poverty did so by migrating to big cities.

Non-farm income can be particularly vital to two vulnerable groups—landless people and women. Rural families with little or no secure access to land earn between 30 and 90 percent of their income from non-farm activities. And women in rural areas often earn small but precious amounts of cash from household-based microenterprises. This is especially important in places where their movements are restricted by traditional norms and their heavy domestic workload leaves them little time or energy to devote to earning extra income outside the home. A heavy workload is a daily fact of life for huge numbers of women. According to a recent report by UN Women, women typically spend two and a half times as long as men on unpaid care work, mostly tending to children and the elderly.

Opening Doors For Young Women And Men

IFAD-supported projects foster rural people's ability to earn off-farm income in a variety of ways. Training in entrepreneurship, particularly for young women and

men, is a significant activity in many countries. Young people who are able to embrace new technologies and take advantage of new openings can play a vital role in driving rural economic growth. In order to do this, however, they need education and training, as well as access to markets, financial services, and information.

In addition to contributing to rural transformation and strengthening food systems, decent work for young people in rural areas can also help stem urban migration and slow the rising number of slum dwellers. In Africa, for example, more than 60 percent of the population is currently below the age of twenty-five. Decent job opportunities in rural and semirural settings are vital, because even under the most optimistic scenarios, urban sectors will not provide enough jobs for all the young women and men who reach working age over the coming decades.

Rural Finance Is A Building Block

Bringing financial services to rural areas is a basic building block for many of the development projects that IFAD supports. Without accessible financial services, such as credit, savings, and insurance, small producers and micro-entrepreneurs struggle to pay for basic inputs or equipment that would enable them to boost productivity, build their businesses and connect to markets. In the worst scenarios, poor rural people fall prey to moneylenders and loan sharks. Rural communities in developing countries are particularly poorly served by financial institutions. Only about 10 percent have access to basic financial services.

IFAD intervenes on many levels to strengthen rural finance provision, building capacity both at the institutional and the client level, supporting credit lines, and working with higher-level government institutions to improve the policy and regulatory environment for rural finance. In Swaziland, for example, a rural finance project played an important part in the development of several policies to modernize the business environment, including the small, micro and medium-sized enterprises policy, the microfinance policy, the consumer credit bill, and a financial inclusion strategy. In Tanzania, a project focusing on market infrastructure and value addition contributed to the development of regulation for the country's microfinance sector.

Farm And Non-Farm Sectors Contribute To Rural Transformation

Because of the strong evidence connecting the non-farm rural economy with poverty reduction, policymakers sometimes regard the sector as an alternative to agriculture to drive economic growth outside urban areas. However, the farm and non-farm economies are both fundamental to the twin development goals of poverty reduction and food security. Under the right conditions, growth in one feeds growth in the other in a virtuous circle.

At the level of rural households where income derives from both sectors, the synergies are clear, particularly where non-farm income is invested in family farming businesses. At the level of the local economy, smallholders who are making bigger profits have more money to spend in local businesses and service providers. A more economically vibrant rural community will generate stronger demand in turn for local agricultural produce, stimulating farmers to increase and diversify production.

Key Conditions For Growth

However, inclusive growth in the farm and non-farm sectors of the rural economy can only take place when basic key conditions are met. Rural infrastructure, particularly roads, transport, and markets, must be adequate and accessible to everyone. Essential services, including health, education and financial services, must be available. Rural areas must be interconnected both physically and digitally with urban areas.

Unfortunately, in many rural areas of developing countries the necessary infrastructure is not yet in place. For example, although there is a strong positive correlation between economic development and the quality of road networks, in Africa, nearly a third of the rural population lives more than five hours away from a market town of five thousand or more people. Lack of infrastructure can isolate rural people or oblige them to engage in urban markets and value chains on very unequal terms.

To tackle the issue of rural poverty at its roots and to strengthen local and national food systems, governments and partners must invest in the economic and social transformation of rural areas. This means developing smallholder agriculture, fostering the non-farm sector, investing in rural infrastructure and services, facilitating private sector investment, and connecting rural people to urban and peri-urban markets and opportunities.

Information and communications technologies generally, and mobile telephones in particular, are playing a rapidly growing role in connecting people of all ages along the rural-urban continuum with information and services. Today, even in remote areas, increasing numbers of women and men own or are able to access a phone. Growth in mobile use is particularly strong in Africa and in Asia and the Pacific, where penetration rates reached 69 and 89 percent in 2014. Mobile money transfer services are now widely available in developing countries, making it faster, cheaper, and safer to move money. There is also a whole range of short message service-based services available to smallholder farmers, offering information on seed pricing, weather forecasts, pest outbreaks, market prices, and more. It's no exaggeration to say that a mobile phone can be a world of opportunities in the palm of your hand.

The success of the global community's renewed efforts to eradicate hunger and poverty—and to strengthen food systems to the benefit of producers and consumers—will depend in no small part on governments, donors, and the private sector working together to build resilient links between remote settlements, villages, small towns, urban centres, and megacities. These links must include hard infrastructure and virtual connectivity. Both are essential to ensure the two-way flow of goods, resources, information, and labor and to make the rural-urban divide truly a thing of the past.

AUTHOR'S PERSONAL STORY

In Nigeria we say that when you go to fetch water, your bucket will only be filled with water that is yours. Life will give you what you deserve, nothing more and nothing less, but first you must walk to the stream and dip your bucket.

Walking to the stream is not always easy. At times, I thought I would never get there. My father was a travelling teacher, and the year I finished elementary school my family moved three times. I had to wait another year to start high school. Then, just when I was back on the path to higher education, war broke out. The Biafran War ravaged my country and three years passed before I finally got to university.

So when I say that we have to give young people opportunities, and to invest in rural areas, I am remembering my own challenges, and how lucky I was. Today, forty years

later, my greatest joy is listening to the stories of people in rural communities. Small changes make a huge difference to their lives. They know where the river is. It is our job to help them get there so they can dip their bucket and collect their water.

A Note from the Digital Thinking Initiative: *Ousmane acknowledges the challenges of aggregating the surplus produce of millions of small-scale, isolated farming families in order to feed a continent. He recognizes the important role of intermediaries in both organizing and establishing the credibility of smallholders as business actors, and argues that smallholder producer organizations are best positioned to play this role in Africa. Information and communications technologies underpin his blueprint for building producer organizations' financial and operational capacity while retaining the social capital that makes them unique.*

The Twenty-First Century Agricultural Cooperative

Increasing the Business Credibility of Smallholders

Ousmane Badiane *is the Africa Director for the International Food Policy Research Institute*

Geographic distance and diseconomies of scale have historically made the cost of doing business with smallholder farmers prohibitively high. Where this problem has been overcome are instances in which public or private sector actors mediate. These firms serve to increase the financial credibility of participating smallholders with input dealers, technology providers, traders, financial services providers, processors, and exporters. I will refer to this role as "business credibility intermediation."

With the dismantling of parastatals and a dearth of private companies operating in rural areas on a large scale, the future of smallholder agriculture will depend on finding workable alternative approaches to business credibility intermediation. The best candidates to fill the gap in the near future are the large number of smallholder producer organizations that have mushroomed across Africa. Most of these organizations, however, lack the organizational, commercial, and technical capacities to operate effectively.

Modern information and communications technologies (ICT) can enable producer organizations to provide business credibility intermediation both at a lower cost and more effectively for their members. ICT can help overcome the physical, infrastructural, and institutional obstacles facing smallholders, not just with the promise of innovation but first and foremost by reducing costs and ensuring scalability.

The Challenge Of Integrating African Smallholders Into Agricultural Value Chains

Increasing globalization presents African smallholders with considerably greater challenges than those faced by Asian producers during the Green Revolution era. African smallholders today need not only to produce more efficiently, but also to contend with far more complex and competitive markets. Growing specialization, rapidly changing consumer preferences, and increasingly intricate technical specifications place significant demands on the average smallholder

With the exception of producers of major traditional and some high-value export commodities, the large majority of African smallholders are isolated from the rest of the agricultural value chain for a variety of reasons, most of which center on their small scale, their geographic isolation, and their lack of capital.

Due to the small scale of production that one household can effectively manage, independent smallholders are unable to realize economies of scale for input procurement and output commercialization . The firms that sell inputs to and buy output from smallholders tend to be significantly larger and better capitalized than the farmer, and do not experience the fragmentation or logistical difficulties associated with agricultural production . When it comes to selling their output, farmers find themselves in a poor negotiating position, and inter-farm competition lowers

prices further, relegating many household farmers to subsistence production or migration out of farming.

Inconsistent quality and reliability of smallholders' output, as well as the costs of assembly, storage, and transport, make financial intermediation complicated and expensive for both farmers and the financial sector. Low productivity and a limited ability to buy and sell reduce the expected rate of return and thus smallholders' inclination to invest. Small transaction sizes and the dispersion of holdings raise the cost of providing financial services, which in turn raises the cost of capital to those who are inclined.

Compound all of this with a lack of information, unenforceable contracts, and poor physical infrastructure and, operating individually, smallholders are unlikely to generate the demand for financial services necessary to stimulate significant investment by the banking sector. In turn, the banking sector offers a limited range of services that do not meet most smallholders' needs.

The Role Of Producer Organizations In Agriculture In Developing Countries

In Africa, as elsewhere, a plethora of institutional arrangements govern agricultural production , but collective action—increasing scale and market power while retaining independent ownership—is increasingly being recognized as a way for rural smallholders to deal with missing markets or to empower themselves against monopolies or monopsonies. Cooperative producer organizations thus appear to be an essential institution for inclusive agricultural development in rural Africa. In fact, cooperative organizations have been showing consistent growth throughout Africa over the past decade. At the same time, numerous studies show that the role played by collective action organizations in emerging markets remains highly contested). For every success story there seem to be many failures.

A major challenge to the effectiveness of such organizations is their general lack of sufficient customer service and business orientation, which hinders their ability to deal with the commercial and technical issues facing their members. The transformation of producer organizations into market-driven actors that can efficiently provide technical and commercial services to their members

and serve as credible business partners will result from the achievement of two objectives: one, organizational maturation and two, market intermediation and technological innovation.

Organizational Evolution And Maturation

Organizational maturation is reflected in the capacity of producer organizations to apply effective governance and management practices that ensure transparency and accountability. Historically, the organizational evolution of cooperative producer organizations has proven problematic. Practically all cooperatives start on a small scale, with a small number of founders—neighbors, colleagues, and relatives—most often all living in the same small geographical area. Establishing a jointly owned organization entails significant risk by creating mutual dependence; if one or a few members decide to free ride, the entire group suffers. Therefore, the establishment of a producer organization requires a high level of *social* capital. To run its operations and make the necessary investments for vertical integration, however, a cooperative must build up *financial* capital. The resource base of cooperatives is the social capital that makes the members willing to supply financial capital.

To stay competitive, cooperatives—like any business—tend to integrate vertically toward the more lucrative and less price-sensitive consumer goods markets, where there are greater possibilities for product differentiation and market segmentation. The strategy of vertical integration is especially resource demanding; the cooperatives need more capital, and the capital must ultimately originate from members. Likewise, cooperatives integrate horizontally, mainly through mergers, to lower costs through economies of scale and scope. However, the shift toward horizontal integration (large-scale operations) tends to create large, heterogeneous memberships. Management becomes increasingly autonomous, with members having less influence on the cooperative's decision making.

The strategies of vertical and horizontal integration are a way to adapt to the developing market situation, but such market orientation is at odds with the member orientation necessary for cooperatives to succeed. Social networks based on reciprocity and trust appear to be the most essential asset of cooperatives, in comparison to investor-owned firms. Failing cooperatives are

often characterized by an imbalanced relationship between financial and social capital. From this perspective, social relations within a firm should not just be assessed as a random configuration of human beings but as a concrete resource, the productivity of which depends on the organizational form.

The challenge for producer organizations going forward is to identify the size and level of heterogeneity at which they can maintain a stable base of social capital while generating sufficient financial capital and establishing credibility with business partners.

Market Intermediation, Financial Services, And Technology Innovation

The transformation process also requires the acquisition of the technical, commercial, and financial resources necessary to meet the needs of the producer organization's membership and develop into business entities that can serve as credible business partners. Historically, smallholder cooperatives have acquired technical and commercial skills through services provided by public or private organizations. However, even in the first couple of decades after independence, when extension services had their widest coverage and strongest capacities, skill development of smallholder cooperatives had very limited reach either in terms of subsectors involved, topics covered, or both. Hence, very few cooperatives have been able to successfully integrate vertically and enable smallholders to participate in emerging value chains.

Cases of successful integration of smallholders into value chains, however, do exist. In West Africa, for example, smallholders have been able to aggregate and sell groundnut and cotton competitively to global export markets. Common to all cases where smallholders have successfully integrated into value chains is the important role played by third party, public or private sector firms in providing services.

The third party helps negotiate business contracts, facilitate payments, and source technology, as well as access training and other advisory services. Through the partnership between the producer organization and this service provider, smallholders are able to access to improved seeds, fertilizers, pesticides, herbicides, machinery, transport, storage facilities, packaging, and other quality

management equipment and infrastructure. In value chains where public or private sector firms have not been operational, such as millet and sorghum or to a lesser extent cassava or maize, yield gaps and dispersion tend to be larger and input use lower, as are the volumes of sales.

It is important to note that the costs for all the services and support provided by public or private third parties are usually paid by the farmers themselves. The role of the public and private entities is largely to signal to other value chain members, through their presence and link to producer organizations, that the associated smallholder farmers are credible partners. Over the last three decades, however, the number of public sector companies providing such services has dwindled to near zero after the dismantling of costly parastatals in the 1980s, and the private sector remains hesitant to expand its presence substantially. The only option to integrate smallholders at scale is to work directly with a critical mass of producer organizations and help them acquire the technical, commercial, and organizational skills and capital they need in order to effectively fulfill the same credibility signaling function, and to enter into their own agreements with technology providers, market operators, processors, and financial services providers. They need to build their own credibility and capacity to serve their membership.

Technical skills will enable producer organizations to

- source and apply technologies by working with technology providers; and
- claim a greater share of the added value through processing by meeting the technical requirements of third party processing firms or mastering the technical operations of their own plants.

Commercial skills will enable producer organizations to

- work with financial services providers to meet the capital and insurance needs of their members;
- strengthen their bargaining positions with traders and exporters; and
- where possible, competitively expand their participation in trading and export activities.

Organizational skill will enable them to

- avoid erosion of social capital;
- achieve the level of governance and coordination required to participate in value chains; and
- improve the effectiveness and efficiency of service delivery to their members.

The Role Of Ict In Increasing Social Capital, Efficiency, And Effectiveness Of Producer Organizations

At the heart of the cost of doing business is the making, monitoring, and enforcing of contracts, processes influenced by the extent of imperfect information involved in any transaction. Central to the economics of a producers' organization is therefore the cost of acquiring information.

The cost and risk associated with doing business includes coordination cost (the cost incurred in coordinating with units actually or potentially producing an input or purchasing the output), operations risk (stemming from conflicting goals among the parties and supported by information asymmetries or difficulties in enforcing agreements due to differences in bargaining power or incomplete or unenforceable contracts), and opportunism risk (the risk that other parties in the transaction willfully misrepresent or withhold information, shirk their agreed-upon responsibilities, or take advantage of a lack of bargaining power or the loss of bargaining power directly resulting from the execution of a relationship, that is, a difference between ex ante and ex post bargaining power).

Strategic deployment of ICT could help producer organizations minimize risks by reducing the cost of communicating and reacting to information and of explicit coordination. Increased information availability and information processing capacity reduces operations risk by making monitoring easier and by enabling more efficient incentive structures. ICT investments could lead to more outsourcing and other strategic business partnerships, thus enabling producer organizations to reap the benefits of greater coordination, specialization, and economies of scale.

In the context of a producer organization, efforts to reduce the cost of acquiring information using ICT sometimes take place through the development of a portal. In such cases, mobile-to-web technology can then be used to collect essential data on the business operations of producer organizations (i.e., virtual bookkeeping). Such a portal can increase the transparency of the operations of producer organizations and, if made accessible to banks, for instance, can increase the transparency and credibility of an organization. In addition to the portal, ICT can be applied in a more targeted fashion such as grading and certifying products, delivering technical content, or improving organizational management skills.

A multitude of applications are currently being deployed in many parts of Africa targeting smallholder farmers. A key weakness is that many are targeting an isolated problem for a single segment of a given value chain, often in a specific geography. They offer solutions that are either not replicable or not scalable. Effectively linking farmers, in numbers large enough to make a difference, into modern value chains will require integrated solutions that deal with all major interfaces between smallholders and other value chain actors.

The twenty-first century producer organization can be more than an advocate or marketing body. With modern information and communication technologies at their fingertips, such organizations can upgrade their skills as well as their operations, to offer a comprehensive set of services to their members. With such an intermediary working in their interest, the potential of African smallholders can be harnessed to feed the continent and fuel economic development.

AUTHOR'S PERSONAL STORY

My father grew up on a farm and worked in the post office in Kaolack, a town in Senegal. Though he never went to school, he taught me many things. He taught me what was right and what was wrong, and he made sure I got the education he never could. I felt like I was going for both of us. Luckily, I loved biology and math. I received a scholarship to study agricultural sciences in France. Then it was taken away and given to someone else whose family had more influence. I appealed and was awarded a different scholarship to study anywhere in Europe. I chose to study in Germany based on my favorite soccer team then, Monchengladbach, the destroyer of all European teams!

I have spent the past thirty years working to promote positive change in Africa through agriculture, including lending support to the African Union and the New Partnership for Africa's Development to advance the Comprehensive African Agriculture Development Plan. I believe agriculture is a pathway to a great African future. I like to say that the gold of tomorrow looks green.

A Note from the Digital Thinking Initiative: *Thom and Lulama zero in on the issue of increasing demand for land in Africa, and consider its causes and its implications for the growing rural population, as well as the environment. They assert that an assumption of land abundance is a fallacy in all but a few countries, and that failure to reform land policies will likely hinder the process of economic transformation. Policies that protect the land rights of rural communities will minimize deforestation, and facilitate the smooth transition of smallholders into rural non-farm employment as productivity rises.*

Where Will They Land?

Keeping Rural Youth in Business

T.S. Jayne *is University Foundation professor in the Department of Agricultural, Food, and Resource Economics at Michigan State University and a distinguished fellow of the African Association of Agricultural Economists*

Lulama Ndibongo Traub *is Senior Lecturer at Stellenbosch University and the Research Director for the Regional Network of Agricultural Policy Research Institutes in East and Southern Africa*

Over 60 percent of Africa's population is under the age of twenty-five. Roughly 350 million young people will be entering the labor force between now and 2035. Even under the most optimistic projections, wage jobs in sub-Saharan Africa will absorb only 25 percent of these 350 million workers. Farming and self-employment will be called upon to provide gainful employment for at least 70 percent of young Africans entering the labor force till at least 2030. However,

agriculture won't be attractive to young people unless it earns good money, and profitable farming, among many other things, requires access to land.

The African leaders attending the 2014 Africa Union Summit in Malabo, Equatorial Guinea, were well aware of these realities. The AU Commission Chairperson Nkosazana Dlamini-Zuma, spelled out the AU's strategic direction for agriculture, underscoring the relationships between access to land, profitable farming, gainful youth employment, and civil stability and peace. Some pundits countered that agriculture is a declining sector, that Africa's youth seek to get out of farming, and hence other sectors should be prioritized. This is faulty and dangerous logic. Over the course of decades, it is true that Africa will most likely follow the economic trajectory of other regions in a gradual shift of the work force from farming to better paying non-farm jobs. However, it is crucial not to forget how fundamental agricultural growth has been in those regions for creating non-farm jobs in the first place. Almost no country in the world has ever successfully transformed its economy from an agrarian to a modern economy with low poverty rates without sustained agricultural productivity growth.

As Africa's leaders understand, promoting agriculture is important for employment creation, food security, and many other goals. Their political and public investment policies will dictate the incentives and scope for investment by the private sector, and will largely determine whether the region's economic transformation is a relatively smooth, robust and peaceful process or a painful and protracted one. The real questions are in the details—how specifically to move forward? And what does land have to do with it?

The Rapid Rise Of African Investor Farmers

The proportion of agricultural land controlled by urban-based individuals in African countries is rising, and land acquisitions by African investors have real implications for the future of the continent's food systems. Recent evidence indicates that, in the seven African countries examined, urban-based people control 15-35% of all national agricultural land, and an even greater proportion of properties over 20 hectares.

The recent rise of the local land investor reflects three underlying trends: the perception that land values will continue to rise rapidly in much of Africa, population growth, and rising wealth at the top. A rising number, but still very

small proportion, of Africans are becoming middle or upper class, and they are seeking good investment opportunities. Land values in rural areas close to towns and cities are skyrocketing, reflecting market opportunities for food production, housing, natural resource extraction, and speculation for those who can acquire the land.

Meanwhile, sub-Saharan Africa is the only region of the world that will continue to experience rural population growth up to 2050. The United Nations projects that there will be 48 percent more rural Africans in 2050 than today. Many young Africans cannot obtain land from their parents, who are living longer and not ready to bequeath their own small landholdings. Policies that expand access to land for young people will be essential, not only for employment goals but in some instances for societal stability as well.

The apparent paradox of rising land scarcity amidst land abundance is largely reconciled after considering that 91 percent of Africa's remaining arable land is concentrated in nine countries—including the Democratic Republic of the Congo, Angola, and Sudan—many of which are politically fragile states. The recent rise in land investment by both local and foreign investors reflects rising land value and land scarcity in Africa's other forty-five countries. Roughly a third of the region's surplus land is currently under forest cover. The conversion of forests to cropland would entail major global environmental costs, but it is likely to happen under the land institutions currently prevailing in much of the region.

Despite evidence of rapid changes in farmland ownership patterns in Africa, the consequences of these changes are poorly understood, since official agricultural statistics are often not well suited to detecting or accurately quantifying changes in farmland ownership or structure over time. As a result, the evidence base for quantifying the impacts of Africa's changing farm structure is weak, yet the following patterns appear to be emerging: a shift in farmland from customary to statutory tenure systems, with an associated shift in local power from chiefs to state authorities; changes in rural-urban multiplier effects resulting from agricultural productivity growth; increased concentration of the marketed surplus for some food crops; changes in service provision and technologies along agricultural value chains, including the increased use of farm mechanization; and rising land scarcity for smallholders.

The Path From Here To There

Most governments' existing strategies are officially oriented to promote agricultural growth and food security for the millions of their rural constituents who are small-scale farmers. However, most of these strategies assume unhindered access to land. In spite of rhetorical support for smallholder farmers, there are increasing concerns that *de facto* agricultural and land policies have encouraged, and are continuing to encourage, the transfer of land to moneyed interests without due recognition of how this is affecting land access and the viability of agriculture for Africa's future generations.

Countries such as Japan and South Korea, which now rely on manufacturing and technology-driven service economies, were predominantly smallholder farming societies sixty years ago. Through good policies and public investments in infrastructure, agricultural research breakthroughs, and extension services to help farmers benefit from new technologies, smallholder farmers in these countries increased their productivity and incomes, thereby supporting the demand for non-farm businesses and the growth of employment opportunities off the farm. Over time, most smallholder farmers eventually moved into these non-farm jobs.

Some commentators have concluded that because economic development is generally associated with the labor force's transition from farm to non-farm, African leaders should expedite the process by giving up on the romanticized vision of smallholder agriculture and instead favor commercialized large-scale agriculture. Yet large-scale agriculture is usually an extremely weak employer of labor— about one worker per every one hundred hectares cultivated of grain production. A sober assessment will acknowledge that even in 2014, most African countries are inhabited mainly by unskilled and semiskilled rural people who are primarily engaged in farming. While they might wish to put down their hoes and walk into office jobs tomorrow, their levels of education and skills will prevent this from happening quickly. If increasingly populous rural communities are unable to access new land because of increased competition for it from local elites and outside interests, then it is likely that urban squalor and unemployment will be further intensified, risking overwhelming governments' capacity to cope.

Africa's transformation from a semi-subsistence, small-scale agrarian economy to a more diversified and productive economy will require unwavering support for smallholder farmers so that they are able to participate in and contribute to the

region's economic transition rather than be marginalized by it. While migration from farm to non-farm sectors and from rural to urban areas will provide the brightest prospects for the transformation and modernization of Africa's economies, it will happen only as fast as educational advances and growth in the non-farm job opportunities will allow. These advances in turn depend on income growth among the millions of families still engaged in smallholder agriculture. Hence, even as Africa slowly urbanizes, smallholder agriculture will remain fundamental to absorbing much of Africa's burgeoning young labor force into gainful employment.

Government policies and public investment can make agriculture much more attractive to young people by making it profitable. Public investments in agricultural research and development, extension programs, and rural infrastructure will surely help. So will government policies to promote incentives and scope for investment by the private sector. And public efforts to protect the land rights of rural communities can be achieved while also encouraging the development of investor farms and large commercial operations in appropriate locations. Judicious land policies can promote synergies and minimize sacrifices.

In these ways, governments hold the key to determining whether the region's economic transformation will be a relatively smooth, robust, and peaceful process or a painful and protracted one.

Digital Technology for Rural Development

A Note from the Digital Thinking Initiative: *Bill has been watching digital technology change the world for three decades and now sees it disrupting the lives of African smallholders, in ways that offer them unprecedented opportunities. Reflecting on the ways that mobile phones have transformed financial services, he articulates how they might also bridge the gap between the formal systems of commercial agriculture and urban food markets, and the informal systems surrounding smallholders and rural trade. As always, he reminds us that technology is just a tool, and that human ingenuity is what converts technology into impact.*

The Secret Decoder Ring

How Cell Phones Let Farmers, Governments, and Markets Talk to Each Other

Bill Gates *is Co-Chair of the Bill & Melinda Gates Foundation*

The Innovation Timeline

One thing I've learned in my work with Microsoft is that the process of innovation tends to take longer than many people expect, but it also tends to be more revolutionary than they imagine. We are seeing this dynamic play out right now in the way digital technology is fundamentally reorganizing life for the poorest people in the world.

Twenty years ago, when the Internet was brand new, a lot of people thought computers would quickly become part of daily life in developing countries. And when I say "a lot of people," I include myself. But those people weren't thinking about all the facts.

In 1997, I traveled to South Africa for the first time. I spent most of my time in big office buildings in downtown Johannesburg. One day, though, I took a side trip to Soweto, where Microsoft was donating computers and software to a community center—the same kind of thing we did in the United States.

It became clear to me very quickly that Soweto was not like the United States. I had seen statistics on poverty, and I had seen a lot of poor communities, but this was the first time I had ever really seen true poverty. I was struck by what I didn't see. No electricity. No running water. No toilets. No roads.

The community center had no consistent source of power, so they had rigged up an extension cord that ran about two hundred feet from the center to a diesel generator outside. Looking at the setup, I knew right away that the minute I left, the generator would get moved to a more urgent task, and the people who used the community center would go back to worrying about challenges that couldn't be solved by a PC.

When I gave my prepared remarks to the press, I said, "Soweto is a milestone. There are major decisions ahead about whether technology will leave the developing world behind. This is to close the gap."

Yet as I was reading those words, I knew there was much more to the story. What I didn't say was, "By the way, we're not focused on the fact that three quarters of the people in this region are eking out a living on tiny farms that don't produce enough food. But we're sure going to bring you computers."

In the past twenty years, however, digital technology has gradually insinuated itself into poor people's lives in ways I never could have predicted. For example, about two-thirds of Africans now have mobile phones, and pretty soon cellular coverage will be more or less universal. The power of a phone in every pocket is turning out to be extremely disruptive in exciting ways and the poor finally have a chance to use technology in ways that solve the real problems they face in their lives.

Cell Phones And The Financial Services Revolution

Mobile phones have recreated the economics of providing financial services to the poor. In an analog era when banking required buildings, piles of paperwork, security guards, and tellers, the cost per transaction was high enough that no company could even conceive of profiting by serving poor people who transacted in tiny amounts. As a result, the poor led their financial lives informally, paying exorbitant amounts in fees and interest to borrow, save, and send money.

Phones get rid of all that expensive infrastructure. Transaction costs are so low that companies can make money by serving the poor. And in the process of competing for poor people's business, these companies will develop new financial products that meet poor people's unique needs. One example is a new company called M-KOPA, which lets 250,000 customers in three African countries pay for solar electricity—instead of kerosene—in small daily installments through their cell phones. In short, digital financial services can create one thriving formal economy that includes everyone.

In fact, since developing countries aren't stuck with a legacy analog banking system, I believe that for the foreseeable future the boldest ideas in financial services will be coming from upstart companies in poor places instead of the big companies we've all heard of.

Digital Agriculture

If there is another example of a market that simply does not work for the poor, it's agriculture, but digital technology can change that, too.

Right now, hundreds of millions of Africans rely on farming for a living, but they don't grow as much, and they don't sell as much of their surplus, as they could. As a result, Africa had to import $40 billion worth of food last year. Something is not functioning properly when half of the continent's labor produces food, and the continent still buys its food from somewhere else!

So what is going wrong? Why aren't African smallholders tapping into that $40 billion market?

The main problem stems from the fact that agricultural markets, like banks, exist on a formal plane, whereas smallholders exist on an informal one. So farmers and

markets cannot communicate effectively. Smallholders don't know what the market will pay. They can't grow crops according to the market's specifications because they don't know the specifications. They have no way to learn the farm-management practices that would let them double or even triple their yields. Instead, they grow mostly what they can eat or trade locally, the way they've always grown it.

As long as this information disconnect exists, there will be a related physical disconnect. The rails and roads that would take crops from the farm gate to the market don't exist, because the market doesn't want the crops the farmers are growing in the ways and volumes they're growing them. So farmers are isolated, stuck with no money and no voice that the marketplace can hear.

But digital technology can act almost like a secret decoder ring that links the formal and informal sectors. Smallholders are already using mobile phones to communicate within their networks, to talk to family and friends. The institutions that make up the formal marketplace communicate in much the same way. So it is now possible to generate a two-way conversation between Africa's producers and Africa's consumers. This is an entirely new conversation. Each party will be able to express its needs to the other for the first time ever.

Imagine a smallholder farmer who can discover, easily, that yams are expected to fetch a high price this year. She can also contact a local cooperative to combine her yams with those of her neighbor, satisfying the buyers' volume requirements. Because she is assured of sale at harvest, she can afford to take out a loan, using her phone, to buy fertilizer or better storage or whatever else she needs to maximize her yield. In the meantime, instead of waiting for a visit from an extension worker who may or may not know about yams and the soil in this particular region, she can get advice tailored by crop and soil type via digital video or text.

When information can flow easily, when data is democratized, the cost of doing business in agriculture goes way down, just as transaction costs go way down when financial transactions are digital. The excessive time and money farmers, agribusinesses, and cooperatives spend managing the risk of doing business with unknown partners is a drag on efficiency. When these partners can know each other easily, can function as nodes in a single marketplace, agriculture will thrive.

It's not as easy as the above paragraphs may make it seem. Building a digital agriculture system that actually accomplishes these goals will take innovation and

investment. But the point is that before it wasn't possible, and now it is. The added variable of digital technology has changed the agricultural development equation.

Other Digital Applications For Agriculture

While mobile phone technology—and the way it can collapse the formal and the informal—is perhaps the most revolutionary of the digital opportunities in agriculture, there are many others.

Take seeds. Advances in genomics are fundamentally changing the way breeders do their work. It took researchers thirteen years to sequence the human genome. Now they can do it in twenty-seven hours. The cost of sequencing a genome has been reduced more than tenfold in the past five years.

The cassava crop is a powerful example of what breeding powered by the revolution in genomics can do. It's hard to breed cassava and every breeding cycle takes five years, which means it usually takes a full decade to release a new variety.

But scientists can now use computer algorithms to link sequence data from the cassava genome to the performance of cassava plants in the field. This technique was first developed to predict levels of milk production in cows.

Breeders in developing countries will be able to predict how a tiny cassava seedling will perform. Consequently, the breeding cycle can be shortened from five years to two years. And it's not just a shorter cycle. It's also higher quality, because breeders can focus on the most desirable traits early in the process. This will also allow for more participatory breeding, a process in which farmers themselves have input into the development of the new varieties they'll be growing.

The digital revolution also provides opportunities to collect better data. In an age when a satellite can determine instantly how much wheat is in a field, it is a shame that we ask countries to use limited resources to send enumerators around with pen, paper, and tape measure. What we get is a lot of wasted time and inaccurate or incomplete data. The digital revolution can improve the quality of critical data while freeing up people to do other high-impact work.

Conclusion

I still can't predict precisely how, or when, these changes will take hold. The beauty of innovation is that once the technology and tools are widely available, people with every possible insight and point of view start working on solutions to problems others can't even see. Ultimately, it's the way human beings, with our vast stores of ingenuity, deploy the power of the technology and tools that makes the biggest difference.

AUTHOR'S PERSONAL STORY

I'm a city boy at heart. I grew up in Seattle, spent most of my free time reading and writing software, and probably didn't set foot on a farm until I was in my forties. But for the past fifteen years I've been spending more and more time with farmers, especially in the world's poorest countries, and learning lots about agriculture. The Gates Foundation is trying to reduce inequity, and there's no better place to see inequity in action than on a farm in, say, Rwanda. The farmers are ingenious and optimistic, but the seeds are poor. The soil is poor. Pests and disease are prevalent. The yields are low. The reasons for this have everything to do with circumstances, or bad luck. Change the circumstances, and farmers can change their lives. I've seen many examples of farmers who've become prosperous because they finally got access to the tools and training they need. I'm still a city boy at heart, but now I also get excited about how things like crop rotation can improve the future for hundreds of millions of people.

A Note from the Digital Thinking Initiative: *Strive believes that the people trying to create a better future for African agriculture can learn a lot from the success of the mobile-phone industry. New interventions won't succeed just because they're new. They must be built on simplicity, an understanding of smallholders' needs, an extensive field presence, trusted intermediaries, and regulatory support. With these principles as a foundation, improved seeds could be as ubiquitous as SIM cards and airtime top-ups.*

Mobile Revolution 2.0

Lessons for a Sustainable Green Revolution in Africa

Strive Masiyiwa *is the Founder and Executive Chairman of Econet Wireless and the Chairman of AGRA*

When I founded Econet in the mid-1990s, nearly three in four Africans had never heard a telephone ring. Today, thanks to the growth in the telecoms industry, more than three in four Africans have a mobile phone. We now have nearly 700 million mobile phone accounts on the continent, more than in Europe and the United States combined. The phones they are linked to not only ring, but also help facilitate communication and commerce via voice, text, and mobile money payments. The mobile phone offers a powerful new channel to deliver affordable services to Africa's smallholder farmers, who have traditionally lacked access to training, finance, and market facilitation.

The revolution in wireless communications that replaced the old fixed-line infrastructure has given way to a second revolution, a revolution in mobile services. Telecom companies have developed new financial services, starting with mobile payments and diversifying into credit, savings, merchant payments, and insurance. There are now five times more mobile money agents in the developing world than commercial banks. The fundamental architecture of financial service delivery has changed, and sub-Saharan Africa has led the way with over two-thirds of the world's 100 million active mobile money users.

The speed and scale with which the telecoms sector disrupted centuries-old practices in financial services has some telling lessons for its potential to transform agriculture. How can we ensure that our farmers find it as easy to get better farm inputs or new farm equipment as they do SIM cards or mobile financial services? How can we catalyze a sustainable and inclusive African green revolution using these digital platforms?

In this essay, I use the examples of two platforms that Econet has pioneered, EcoCash (our mobile wallet) and EcoFarmer (our suite of mobile agricultural services), to explore some of these lessons. Our journey with these products illustrates the broader trends underpinning Africa's mobile revolution 2.0 and that revolution's ability to improve the lives of our smallholder farmers.

A Ubiquitous Technology And The Green Revolution

We launched EcoCash in Zimbabwe at the start of 2011. This was just after the height of the country's period of hyperinflation, which had brought to its knees one of the strongest and most sophisticated African economies. As the private sector shrank and employment dwindled, the informal sector came to dominate economic activity. We saw an opportunity to help service the informal economy, where mobile penetration was high but payments infrastructure was lacking.

Four years after launch, EcoCash has 5 million customers—over 70 percent of the adult population. To put that into context, all of the country's commercial banks, some of which entered the country over a century ago, had just over 900,000 bank account holders before we launched. In the space of three years we had more than tripled the number of current account holders in the country. Last year, EcoCash processed over $6 billion in transactions, representing nearly 40 percent of Zimbabwe's gross domestic product.

However, we realized that there was more we could do with and for Zimbabwe. With nearly two-thirds of Zimbabwe's population living in rural areas and nearly all dependent on farming for their livelihoods, we decided to explore how our growing mobile services platform could help support this sector. Smallholder farmers contribute over a third of crop production in the country, but to do so they must overcome the challenges smallholders face in most sub-Saharan African countries—limited access to agricultural advisory services, market information, training, quality inputs and financing.

When we launched EcoFarmer in 2013, we deliberately avoided the conventional payments-first approach to providing mobile financial services to smallholders, and instead focused on a tailored set of products. We started with two initial offerings: an information service that sends advisory extension services through SMS to farmers, and a weather-indexed insurance product.

Farmers receive daily updates on three topics: farming tips, market prices, and weather data. They have already provided information on their district, ward, and frequently grown crops; this allows us to customize the messages they receive, such as market prices for different crops in their region and daily temperature and expected rainfall forecasts from the closest weather station covering their field. Farmers are then able to use the information to improve their crop planting and farm management practices, such as the best time to plant and the best place to sell their harvest.

As we successfully rolled out the EcoFarmer information service, we also looked at additional services that would improve farmers' livelihoods and productivity. Erratic rainfall is a challenge all farmers face, but smallholders have generally been excluded by traditional insurance agencies; typically these agencies don't have branches in rural areas, and they have been reluctant to extend their services to farmers, whom they perceive as riskier clients with limited collateral. To address this gap, we began piloting a weather insurance product tied to the purchase of quality seeds.

EcoFarmer insures 10 kilogram (22 pound) bags of certified maize seed, produced by Seed Co., a local seed company. A 10 kilogram bag of maize seed would cover a farm roughly the size of a soccer field. Registered EcoFarmers can purchase this insurance using an Econet-enabled mobile phone by dialing an Unstructured Supplementary Service Data (USSD) code, and entering a voucher numbers that comes in a plastic capsule within the seed pack. The farmer then pays a premium of 8 cents a day for the

season of 125 days (roughly $10) using EcoCash. In the event of excess rain or drought, monitored through weather stations covering the location of the farm, farmers receive a payout of 10 times the premium paid ($100) through EcoCash.

Today we have over 550,000 farmers using the agricultural information service. We believe there is still more to be gained from linking our agricultural services with the EcoCash platform, and are in the process of looking at complementary financial services tailored for smallholder farmers, such as specialised savings and loans products.

Lessons For Agriculture From Mobile Finance

Our experience developing and scaling EcoCash and EcoFarmer taught us three main lessons, which I believe are broadly applicable to how digital technologies can improve the livelihoods of smallholder farmers in Africa.

Lesson 1: Designing systems for scale starts with simplicity and understanding the needs of your clients.

Although we had big ambitions for EcoCash and knew there were a lot of other products that we could deliver, at launch we deliberately focused only on person-to-person money transfer. We chose a simple payment mechanism, whereby customers could send and receive money using the most basic phones. We wanted customers to easily understand and use the product first, before we added complexity. We kept our tariff structures simple and were transparent about what we charged people for the service. We also made the tariffs progressive, to increase the volume of low value transactions.

The same lesson held for EcoFarmer. We developed insurance-premium products that could cover the needs of small-holder farmers while still remaining affordable. We designed the input package around a 10 kilogram bag of maize because that was appropriate for the average size of a smallholder field. We also created a lower-tier insurance product so that farmers could opt for a premium of only 2 cents a day (as opposed to 8 cents) for the season ($2.50 in total) for a payout of $25, which would cover the cost of the purchased seed.

As EcoCash grew, we layered more complex products on top of the basic payment platform, such as merchant payments, payroll, and savings. As EcoFarmer has gained traction, our customers have begun asking for two-way exchange advisory services. Farmers want to interact with farm management experts by calling dedicated lines, and are willing to pay for the costs associated with the service.

We also learned that most smallholders, especially women farmers, want savings products that can help them meet the fee payment schedules of their school going children rather than generic savings accounts. Working with IDEO.org (a global innovation and design firm), CGAP and MercyCorps, we are looking at developing such products. We hope to continue to use customer feedback to build more attractive and relevant products for smallholder farmers.

Lesson 2: Adoption at scale, even for digital technologies, requires an extensive field presence and trusted intermediaries.

When we moved into mobile financial services, we recognized that distribution and marketing would make or break EcoCash's success. Mass adoption would come not from new product features, but from whether people saw the need for EcoCash or EcoFarmer in their lives.

We worked hard to educate consumers on the value of EcoCash. We used "above-the-line" advertising—radio, TV, and print—to raise initial awareness. But since this was a novel service that people hadn't experienced before, we also focused on more direct "below-the-line" customer education. We hired hundreds of young people to act as brand ambassadors and assigned them to high-traffic areas, economic hubs, and rural trade centers. These ambassadors recruited more than three-quarters of all our new EcoCash users in the first few months after our launch.

As we scale EcoFarmer further, meanwhile, we are developing a campaign, "I am EcoFarmer," to show farming is a profession that one should be proud of. We are also using respected peers from farming communities across Zimbabwe to champion the EcoFarmer products.

Our mobile money platform works for those who have adopted it because of a vast network of agents who convert mobile money to goods, services, and cash. They are shopkeepers, butchers, pharmacists, and small business owners—trusted

members of their local communities. These agents form the physical backbone of mobile money and the frontline of customer interaction across Africa. Investing in enlarging our distribution network, rather than prioritizing short-term profitability, was critical to the success of EcoCash.

We have leveraged the same network of agents in rural areas to promote the EcoFarmer products. The suite of EcoFarmer services is underpinned by a farmer registration process, which is necessary to collect information on what a farmer is planting, where she's located and what services she needs. Whilst early iterations of EcoFarmer only relied on knowing a farmer's mobile phone number, we quickly realized that without this next level of detail we wouldn't be able to target our services. By investing in farmer registration programs, we can anticipate and enable the next wave of digital solutions targeting smallholders.

Lesson 3: Without regulatory support you cannot achieve transformation at scale.

When we started experimenting with EcoCash, we anticipated that the banking sector would fight our entry into the financial services market and resist any disruption to their industry. In addition, the idea of being able to send and receive money via phone was foreign to many of our regulators.

Well in advance of our launch, therefore, we made sure that policymakers understood the product and how it worked. We invited them to assess the changes happening with mobile financial services around the world and assisted them in connecting with their counterparts in other countries to understand the benefits. We worked to demonstrate the security of the EcoCash platform, and the advantages of moving away from a cash-based economy. These early engagements ensured broad support for EcoCash as a way to improve financial inclusion.

Likewise, we involved a range of government agencies in the development of EcoFarmer, including the Ministry of Agriculture, the National Agricultural Research System (NARS) and the Meteorological Services. We also worked to ensure that our services were in line with government plans and regulations for the agricultural sector. For example, our extension and advisory text message services incorporate best practices identified by the NARS. In addition, we've used the weather station network of the government and supplemented it with our own stations and other means, including satellite imagery, to design better weather-indexed insurance products.

Digital Technologies And A Sustainable Revolution

I believe we can catalyze a sustainable African Green Revolution. There is no reason village shopkeepers should be readily stocked to sell SIM cards, charge mobile phones, and distribute airtime top-up cards, but not in a position to distribute certified seed and disseminate good farming practices at the same scale.

Mobile services provide a low-cost and ubiquitous platform for providing innovative products tailored to the needs of our farmers. In the next generation, I believe we can meet the challenge of making poverty and hunger history in Africa, a challenge Nelson Mandela called us to tackle head-on a decade ago. Digital thinking and technology can help us meet that challenge by accelerating the transformation of smallholder farming across the continent.

AUTHOR'S PERSONAL STORY

I started off my career training as an electrical engineer, built an engineering company, and soon moved to telecommunications just as the mobile wireless revolution was taking off in Africa in the mid-1990s. My journey into agriculture only really began when I joined the board of the Rockefeller Foundation in 2002. Gordon Conway, then president of the foundation, impressed upon me that what we were doing in Africa's telecommunications sector, taking technologies to scale, could also be done in agriculture. I was intrigued that the mobile revolution I was part of might help power a green revolution.

When the Rockefeller Foundation and Gates Foundation partnered to launch the Alliance for a Green Revolution in Africa (AGRA), I joined its inaugural board, with Kofi Annan serving as our founding chair. Four years ago it was a great honour to succeed Annan as AGRA's chair and to continue to work to change the narrative of African agriculture from one of subsistence to one of economic prosperity. The inspiring grantees, partners, and young entrepreneurs I've met during my time at AGRA have reaffirmed my belief that we can leap-frog technologically—just like we did in the telecoms sector—to transform the lives of Africa's smallholder farmers.

A Note from the Digital Thinking Initiative: *If Africa's smallholder farmers are going to lift themselves out of poverty, they need access to formal financial services instead of the unstable, inflexible, informal arrangements that they currently rely on and that keep them poor. Ngozi reviews the ways in which digital technology is changing how financial services are delivered and made affordable. With the right investments and policies, farmers will be able to access credit, savings accounts, insurance, payment platforms, and other financial products that allow them to invest in their livelihoods without being exposed to exploitation or untenable risks.*

Shine a Light on the Gaps

How Access to Digital Financial Services Changes the Future for Smallholder Farmers in Africa

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Financial Inclusion Matters for Africa's Smallholder Farmers

Agriculture forms the backbone of African economies, accounting for 32 percent of gross domestic product (GDP). A majority of the continent's farmers earn their living on small plots of less than two hectares, which represent 80 percent of all farms across sub-Saharan Africa. But these smallholder farmers are largely excluded from financial services and are therefore constrained from improving their wellbeing and transforming their farms into economically viable businesses. Although smallholder farmers face a number of challenges to raising productivity, bridging the financial access gap must be a priority.

There is much literature on expanding financial inclusion among the world's poor. The issue has been a development priority since Group of Twenty (G20) leaders launched the Financial Inclusion Action Plan in 2010. But Africa's smallholder farmers have received little attention, and women farmers—who make up half of the continent's agricultural labor force—have received even less.

Being excluded from financial services has negative consequences for smallholder farmers. Access to credit can help raise farm productivity by expanding access to inputs as well as better storage, marketing, and processing. Access to savings instruments at harvest enables families to put money aside and helps smooth consumption at other times of the year. Access to payment platforms can offer a secure and efficient way to make transactions. And access to insurance products can protect against illness and weather-related shocks. In the absence of these formal mechanisms, smallholder households often rely on informal instruments. Although they are accessible and flexible, informal financial services can also be inefficient and costly in the short term, and they do not always offer the services needed to help transform subsistence farming into a profitable business.

Understanding farmers' needs, and the range of financial services they rely on to meet those needs, must be the first step. But translating this knowledge into tailored products will be even more critical. While evidence is still emerging, digital solutions are at the forefront of these efforts.

Smallholder Farmers Are Excluded From Financial Services

Large gaps remain in meeting the financial needs of smallholder farmers across

sub-Saharan Africa. The Global Financial Index, or Global Findex, underscores the extent of their exclusion from the formal financial sector. Across forty-two African countries in 2014, only 29 percent of adults in rural areas had a mobile money account or an account at a bank or microfinance institution (MFI), compared to 34 percent at the national level. Although access to bank accounts in rural areas remains low, this represents an increase from 24 percent in 2011. Poor households and women are even more excluded than the rural population generally. Poorer households are much less likely than richer households to have a formal account (25 percent compared to 41 percent), and there is also a significant gap between women and men (30 percent compared to 39 percent).

While more than half of all rural households saved and borrowed money over the past year, only a small percentage used the formal sector. Among those who reported saving, 13 percent saved at a bank or an MFI, and 25 percent saved with a community savings group. The majority saved money under the mattress or in tangible assets such as livestock. Rural households are also excluded from formal sources of credit; only 6 percent borrowed from a formal institution. Forty-two percent of those who reported borrowing turned to family and friends, and 5 percent borrowed from an informal lender, such as a trader or processor. Because they are borrowing informally, the interest rates are usually between two and ten times higher than commercial rates. Furthermore, only slightly over 6 percent of farmers reported purchasing crop or livestock insurance. Finally, a majority of farming households received payments from agricultural sales in cash; only 8 percent received payments via mobile phone, and 7 percent received money directly to a bank or MFI account.

Demand And Supply Barriers Limit Access To Formal Financial Services

A number of demand- and supply-side constraints explain why smallholder farmers are excluded from formal financial services. On the demand side, smallholder households cannot always afford fees or minimum balance requirements to keep accounts active. In Uganda, for example, annual account maintenance fees are almost 25 percent of GDP per capita. Rural clients must travel long distances to reach bank branches; to do so, they have to pay for transportation and forego daily wages. In addition, farmers do not always have the formal documentation, such as identification cards and land titles, required to open an account. There is also evidence of a lack of trust in financial institutions and low financial knowledge

among the poor. For smallholder farmers in particular, the repayment cycles for standard bank and MFI loans often do not align with seasonal cash flows. Finally, gender dynamics further constrain women's access: Given multiple household responsibilities, women are often time constrained, which limits their ability to engage with formal financial services. Women also lack formal land titles, even more so than men.

On the supply side, smallholder households are expensive to serve because a majority live in rural areas. And because agriculture is highly susceptible to weather shocks, financial providers perceive farmers as too risky to lend to. In addition, formal financial institutions often lack information about the credit histories of poor rural farmers, as well as the knowledge and capacity to serve agricultural households. Lenders sometimes fail to see farmers as a substantial source of savings and have therefore not traditionally marketed specific products to them.

Digital Innovations Are Helping To Bridge The Gap

Digital technology has the potential to address multiple demand and supply barriers by offering a new delivery platform to reach underserved clients. Mobile connectivity is rapidly expanding across sub-Saharan Africa; a 2014 Pew Research Center survey in seven African countries found that roughly 80 percent of people own mobile phones. Mobile platforms can allow clients to access bank accounts more easily, and also reduce delivery costs for service providers.

To effectively close the gap in the availability of financial services, it is essential that digital products meet the unique financial needs of smallholder farmers. Digital by itself is not enough. Therefore, a complete understanding of these households' financial needs must be a priority. The Consultative Group to Assist the Poor (CGAP), housed at the World Bank, has focused much-needed attention on smallholder farmers. Through its Financial Diaries of Smallholder Households project, CGAP aims to better understand how farmers in Mozambique, Tanzania, and Pakistan use financial services. Initial findings show that while smallholder households rely on multiple sources of income, including wage labor and off-farm businesses, agriculture accounts for 40 percent of earnings.

However, findings also suggest that income from agriculture is seasonal, creating unique cash-flow challenges. Farmers receive a bulk of their income at harvest,

making it difficult to cover expenses for school fees, health care, and religious celebrations throughout the year. Farmers require capital at the start of the planting season to purchase seed and fertilizer. During the growing season, households must stretch available resources until the next harvest. Income from agriculture can also be risky; crops are susceptible to weather fluctuations, pests, and disease. Considering these diverse needs, financial services for smallholder farmers must move beyond credit for agriculture and include insurance, savings, and transfers to smooth consumption. This approach can help ensure financial instruments have a transformative role on the lives of smallholder farmers.

A suite of digital financial innovations for smallholder farmers has cropped up across the continent. These examples are neither exhaustive nor fully proven in their impact. But they nevertheless highlight the tremendous potential to connect Africa's smallholder farmers to financial services by addressing both demand- and supply- side barriers.

In one model that addresses demand-side constraints, financial institutions are rolling out branchless banking to serve rural clients. For example, Opportunity International hires agents who drive to rural areas and use mobile phones to register new clients, deposit savings, and collect loan payments. In addition, mobile bank accounts are expanding across the continent, most rapidly in East Africa. M-Shwari in Kenya and M-Pawa in Tanzania allow M-Pesa clients to take out loans and make interest-earning savings deposits. Using a secure and familiar platform, rural clients do not have to travel to access accounts, pay fees, or meet minimum balance requirements. These are all important factors that can underpin widespread adoption.

But there are still challenges in reaching the rural poor, including limited network coverage and low financial literacy. Furthermore, recent evidence shows that although account ownership has increased, regular use has lagged. Therefore, products should be designed to meet smallholder farmers' needs to help ensure that that they adopt and use them. To address low financial literacy, for example, the nongovernmental organization TechnoServe trains smallholder farmers in Tanzania on how M-Pawa accounts work in order to encourage the farmers to use them.

Other programs are using mobile platforms to deliver credit and savings products specifically designed for smallholder farmers. For example, One Acre Fund has developed an asset-finance model with a flexible repayment schedule that helps over

two hundred thousand farmers in Kenya, Rwanda, Burundi, and Tanzania purchase high-quality inputs at the start of the planting season. Farmers make a prepayment (10 percent of the loan) prior to receiving inputs and have the flexibility to repay the remaining loan amount in any increment on any schedule, as long as they repay fully by harvest time. In countries like Kenya, where the mobile money infrastructure is well developed, farmers make repayments via M-Pesa. This loan product has helped farmers increase their earnings per acre by 50 percent.

In addition, access to savings can play an important role. MyAgro, a mobile platform, offers a commitment savings device to farmers in Mali and Senegal. Rather than paying a lump sum to purchase seeds and fertilizer at the start of the planting season, farmers save small amounts throughout the year. Clients buy MyAgro scratch cards from local stores and make deposits into their savings accounts, just like buying credit for a mobile phone. Clients of MyAgro have increased their harvests, and raised their incomes by more than 70 percent compared to non-client farmers. Both these uniquely tailored products could serve as effective models for financial service providers.

Digital technology can also be leveraged for payment transfers. Nigeria's mobile wallet program, established in 2012 by the Central Bank and Ministry of Agriculture, has digitized voucher distribution for subsidized fertilizer. The platform's fourteen million subscribers can use electronic vouchers to buy subsidized fertilizer from local agro-dealers. This platform is playing a critical role in connecting farmers to the formal banking system, and it has helped reduce corruption in fertilizer distribution by wiping out middlemen. Between 2013 and 2014, Nigeria's Ministry of Finance also provided additional budgetary incentives that enabled the Ministry of Agriculture to scale up the mobile wallet program's reach to an additional 2.5 million women farmers.

According to CGAP, the mobile wallet platform reaches twice as many farmers as the previous distribution system at one-sixth of the cost. The Nigerian government has also established a mechanism to encourage financial institutions to lend to the agriculture sector. The Nigerian Incentive-Based Risk Sharing System for Agricultural Lending (NIRSAL) addresses an important supply-side constraint by providing a credit risk guarantee that covers between 30 and 75 percent of incurred losses on loans. NIRSAL enables the financial sector to expand its client base, and smallholder farmers and small and medium-sized agribusinesses gain access to financial services.

Keeping Up The Momentum

Promising innovations across the continent are leveraging the broad reach of digital technology to connect farmers to the formal financial sector. Ongoing research is providing rigorous evidence to better understand how these services are affecting smallholder households. There is no silver bullet and the gaps are still large, but there is tremendous international momentum around the issue of financial inclusion. Bringing Africa's smallholder farmers into the spotlight and expanding their access to financial services will be critical to achieving universal financial inclusion and accelerating smallholder farmers' contribution to the continent's economic growth.

AUTHOR'S PERSONAL STORY

As a child, I spent Saturdays accompanying my widowed grandmother on the very long trek to her farming plots. We would set out before sunrise, me carrying water and her carrying food and implements, like small hoes and machetes. The main job was weeding between the mounds of yam. If they were in good shape, we would turn to the adjoining maize and vegetable plots. Lunch was roastedyam or plantain with palm oil and red pepper, which is still one of my favorite meals. I'd overhear my grandmother talking with other farmers about something called fertilizer or about new varieties of cassava and maize that could double output. But they had neither the money nor the know-how to make use of these tools.

From the time I left Nigeria to study economics, I was always trying to figure out what could be done to make farmers' lives better.

For my doctoral thesis I chose the topic of "Rural Financial Markets in Nigeria" and spent months living with rural households all over the country to understand their savings, borrowing, and consumption patterns. That was from 1979 to 1981. While numerous experiments in recent years have yielded promising solutions, the work won't be done until we've revolutionized the lives of African smallholders.

A Note from the Digital Thinking Initiative: *The physical isolation of African smallholder farmers fragments economic and political power in a way that farmers' associations have, despite their best efforts, so far been unable to overcome. Ishmael describes a pilot program allowing farmers to create a "virtual cooperative" that uses technology to increase its members' access to information and markets. This cooperative also aggregates data to target services, leverage the private, development, and public sectors, and raise standards of management and customer service.*

Organizing for the Future

Overcoming Fragmentation with Digital Technology

Ishmael Sunga *is the Chief Executive Officer of the Southern African Confederation of Agricultural Unions*

As a group, smallholder farmers (SHFs) represent the largest cluster of social and economic actors in most African countries, but individually they are marginalized, politically weak, and resource constrained. SHFs are also scattered across outlying areas, making it difficult for development support to reach them and for the farmers to access services and connect with each other and with outsiders. Furthermore, because smallholder farmers lack economies of scale and influence, the fragmented nature of their demand (for inputs and services) and their outputs leaves them economically vulnerable.

The physical isolation of smallholders is fixed, but their fragmentation is not. If fragmentation is the problem, then aggregation to achieve scale economies and efficiency is the antidote. This aggregation takes various forms and covers various areas, including farmers' demand for inputs and services, supply of commodities and products, and a more powerful, united political voice. This is the critical role that farmers' organizations (FOs)—also often referred to as farmers' associations—can play.

The performance of FOs in serving the smallholder sector in this regard has generally been less than satisfactory. The large number of farmers located in far-flung areas makes it difficult to physically aggregate fragmented demand and supply, as well as to consolidate fragmented voices and communicate with members. Furthermore, the financial costs associated with such wide geographic coverage are unaffordable. The lack of extensive logistical infrastructure, such as roads, transportation, and storage facilities, does not help the situation.

Since SHFs naturally shun institutions that do not provide effective and efficient services, the majority of them do not belong to FOs. Low membership levels, in turn, further compromise the financial sustainability of FOs and undermine their policy influence. The advent of the digital era presents substantial opportunities for the transformation of the smallholder sector. FOs, once problems of scale economy and efficiency are solved, can be the driving force behind that transformation. This ultimately ensures the financial independence and institutional sustainability of FOs.

The Scope For Digital Solutions In Fos

The future belongs to those who are able to harness the potential of information communication technologies (ICTs). This is particularly true of SHFs, who, thanks to mobile phones, are now more connected than ever. Information is power, and it is increasingly a crucial source of competiveness. It is at the core of investment decisions and planning (e.g., what to produce, in what quantities, for whom, when, how, and at what cost), as well as effective operations management (e.g., when to irrigate and when to apply fertilizers). The strategic importance of information as a decision-support tool continues to increase, partly driven by the stringent standards and other requirements associated with complex and constantly changing global food systems. Information asymmetry has also been reduced, thereby enabling better price discovery by farmers. Mobile phones have become an easy delivery

mechanism for better prices, money transfers, information, skills, and knowledge, and, ultimately, power to the farmers.

The possibilities for the application of ICTs in FOs are equally broad, and the prospects for their effective deployment are promising. FOs can use digital technology to aggregate the demand for inputs and services from SHFs producing a particular commodity at all levels, and to leverage that demand to negotiate better prices with suppliers. The same potential exists on the commodity-supply side, resulting in better prices for farmers' outputs. Currently, an individual farmer presented with a low price for her outputs has few alternatives for other buyers, while an agribusinesses presented with a price higher than they wish to pay can simply move on to the next farmer. In other words, ICTs can enable FOs to correct the power imbalance between SHFs and agribusiness. ICTs can convert SHFs from price takers to price makers.

One of the primary actors in this area is the Southern African Confederation of Agricultural Unions (SACAU), the regional body made up of FOs throughout southern Africa. SACAU has successfully piloted a digital aggregation platform, which it is now preparing to roll out. The results of the pilot are still being evaluated, but the platform can be conceptualized as a virtual cooperative. An important innovation central to this platform is that, unlike platforms created by agribusinesses, governments, and nongovernmental organizations, it is designed by farmers and for farmers. Through their FOs, SHFs are now aggregating themselves first, and then deliberately and proactively approaching suppliers and the market.

Improved market access, however, is not the only benefit of SACAU's program. ICT solutions can also facilitate better member management. Furthermore, data held by FOs, including socioeconomic data on farmers, production statistics, and information on access to factors of production, can be of significant interest to the private, development, and public sectors, as well as to research and knowledge institutions. Regularly updated, this database can be monetized for stakeholders in a position to pay for it, and also leveraged for negotiating, advocacy, monitoring, planning, and other purposes. Because this data can be a source of economic power and value, it is important that the rights to it remain with farmers through their FOs.

A New Generation Of FOs

Digital solutions have opened up opportunities for FOs to improve upon their shortcomings. ICT-enabled FOs will be more able to finance themselves and thus remain independent of external influences. In other words, ICTs have the potential to bring the FOs dignity, credibility, respect, and power.

The FO of the future will be able to offer its members differentiated and targeted services; not all smallholders, after all, are the same. The ability of FOs to generate, access, process, store, and manage the data generated by the system will allow them to segment SHFs on the basis of size, surplus, gender, age, and other factors. Such capabilities will facilitate the design of services appropriate to a diverse membership.

The new generation of FOs will also ensure that SHFs do not continue to be relegated to primary production, a high-risk and low-return portion of the value chain. Pooled strategic investments in the other segments of the value chain will not only increase financial returns, but also improve the governance of the chain and unlock further value in primary production. An FO-owned crop-storage facility, for example, would allow SHFs to sell their outputs at the optimal time. Identifying opportunities for such investments and structuring and implementing financing deals and other mechanisms are therefore critical functions that the FO of the future should be well positioned to discharge.

Of course, this is only part of the path FOs must take. They must also be able to undertake due diligence and provide the strategic advisory and commercial services SHFs need to structure deals and partnerships to their advantage. Few FOs currently offer such expertise. Due to the high costs associated with these services, FOs could offer them as part of the menu of services available to their members. The new generation of FOs will also need to be able to forecast the future and keep abreast of changes in market conditions and operational environments.

For these possibilities to be realized, the new generation of FOs will need to establish the strategic capital—including in information technology, analytics, and commercial and agribusiness–related capabilities—necessary to unlock the service and commercial opportunities that ICTs will create.

Conclusion

"The future belongs to the organized." So goes the slogan for the National Association of Smallholder Farmers of Malawi, one of SACAU's members. FOs that are digitally enabled are more likely to efficiently organize their farmers.

Digital technology is a game changer in the development of smallholder agriculture. It addresses the problems of fragmentation and geographic, social, and economic isolation, which are at the core of the challenges faced by SHFs. ICTs therefore promote a more inclusive agricultural development trajectory. By offering the best chance for SHFs to aggregate, ICTs therefore present vast opportunities for the transformation of FOs.

AUTHOR'S PERSONAL STORY

A good part of my early years was spent in a small district town that was surrounded by large scale commercial farms. I still vividly recall marveling at a small plane doing aerial cotton spraying maneuvers. I did not know then that I was staring at one of the most important innovations in commercial agriculture.

No school holiday was complete without being dispatched by my parents to a place they called our real home, back in the rural areas. My legendary fear of chickens, pigs, goats, and donkeys, let alone wild animals, made me a "city boy" and the subject of ridicule. These were the first, unknowing steps on my lifelong journey with smallholder agriculture. At least I can say I know where milk comes from—something that cannot be taken for granted these days.

I have traversed far and wide in my association with the agricultural sector, and I am now the chief executive officer of SACAU, a regional farmers' organization. I guess I am involved in a special kind of husbandry—that of raising farmers' organizations. I believe that developing innovative ways to organize African smallholder farmers is fundamental to helping them engage in an ever-growing and rapidly changing agricultural sector.

A Note from the Digital Thinking Initiative: *Graziano takes on one of the most difficult challenges in the international agriculture community today: how to move from the data collection and information sharing methods of the 1960s and 1970s to emerging methods that offer real-time visibility into what is happening on the ground in every country, all over the globe? He rightly asserts that even perfect data won't sufficiently empower individual smallholders; organization is critical to giving them a voice.*

Big Data, Small Farms

The Role of Data and Statistics in Unleashing the Potential of Africa's Smallholders and Family Farmers

José Graziano da Silva *is Director General of the United Nations Food and Agriculture Organization*

The international community has unanimously recognized the need to shift the world onto a path towards sustainable development. The 2030 agenda and its seventeen Sustainable Developments Goals (SDGs), adopted in September 2015, provide a global plan of action to achieve a safer, fairer, and more inclusive world, where no one is left behind. It is not by accident that the eradication of poverty and hunger is at the top of this agenda, under SDGs 1 and 2, respectively. There will never be sustainable development while people continue to feel excluded and continue to suffer from extreme poverty and hunger.

Nearly 80 percent of the world's poor and hungry live in rural areas. Most of them are smallholders whose livelihoods depend on making a living from a small plot of land and from raising a few sheep or goats. Their working and living conditions have been deteriorating as a result of climate change, especially in African sub-Saharan countries.

In order to achieve sustainable development, it is essential to improve the resilience of smallholders and family farmers and enable them to produce more in a sustainable way and to become less susceptible to shocks. This will also help them preserve their limited land and water resources, maintain local biodiversity, and foster their cultural and agricultural heritage.

Data, information, and statistics play an increasingly important role in this sense. They already benefit many farmers, especially in developed countries, who have been using data and technologies to improve productivity, lower input costs, and optimize fertilizer use for example.

It is important to bear in mind, however, that technologies are not the solution themselves, but just a means to one. No matter how powerful the new technologies may appear, their benefits for the poor will depend on how useful they are to respond to their needs and whether and how well they will be adopted.

The first challenge is to make useful data, information, and statistics available specifically for smallholders and family farmers in the poorest areas, such as in sub-Saharan region. For this purpose, smallholders and family farmers must be better understood. Where they are, what they do, and what they need are questions that need the correct answers. Improving African countries' capacities for the collection, dissemination, and analysis of basic food and agricultural data is essential, in order to elaborate and implement right and useful policies and actions to assist smallholders.

The second challenge is to make data accessible. Different tools to reach farmers are being used with success. In Uganda, for example, the UN Food and Agriculture Organization (FAO) and the Grameen Foundation are using smartphones to provide more than 275,000 farmers access to agricultural technologies and practices available on its TECA online platform. Recognizing the need for a single knowledge hub on family farming, FAO has launched the Family Farming Knowledge Platform, which gathers data from national laws, public policy, best practices, and other research and publications from around the world.

Yet to improve data collection and flow of information, a political element is also necessary; smallholders and family farmers not only in Africa, but also in other developing regions, should be better organized, because it is almost impossible to reach all of them individually. Their organization should be encouraged and supported at local, national, and regional levels. This would not only help to better obtain information from all of them, but also to enable them to use the technological tools available to improve their sustainable production and resilience.

Better organization would also promote horizontal dialogue and exchange of information and knowledge among different groups, which would help elaborate technological tools based on their interests and needs. Strong, effective, and inclusive organizations and cooperatives can serve as a vehicle for closer cooperation with national research institutes; provide extension and advisory services to their members; act as intermediaries between individual family farms and different information providers; increase bargaining power when selling their products or buying inputs; facilitate access to markets and financial services; and help small farmers gain a voice in policy-making to counter the often prevailing influence of larger, more powerful interests. For farmers, there is strength in numbers.

More Accurate And More Useful Data And Statistics

A major difficulty in assisting smallholders and family farmers in Africa is that we still know too little about them. Information on the state of agriculture is inaccurate and out-of-date, due to weak information systems and constrained technical, human, and financial capacities.

What we do know comes from infrequent and incomplete censuses or occasional farm surveys. These provide only rough and general information. Many surveys and censuses, for instance, do not include farms smaller than one or two hectares, which means that most smallholders are left out. In this scenario, the individual smallholder remains invisible and therefore cannot be reached and supported properly.

A number of developing countries have responded to this challenge by developing national identification systems. In Africa, these identification systems have also become increasingly popular. Nigeria's electronic wallet system is one such example. It enables identification, tracking, and tailors services to individuals. It ultimately triangulates household-level data from disparate sources that can be used in big data analyses.

At FAO, we are assisting countries not only to improve the quantity and quality of rural data, but also to prioritize and organize it, to communicate it, and to make it more useful to farmers and to those who serve them.

With regard to family farmers, for instance, the FAO is guiding global collaborative efforts through the Forum on Communication for Development and Community Media for Family Farming to design inclusive models to promote access to information.

In tandem, the gap on data and information must also be addressed by improving statistical approaches. High quality statistics are essential for designing and targeting policies to enhance productivity, reduce hunger, malnutrition, rural poverty, and to promote the sustainable use of natural resources.

FAO has been implementing the Global Strategy to Improve Agricultural and Rural Statistics, which aims at enabling national statistical systems. Under this strategy, the Agricultural and Rural Integrated Survey initiative responds to the need to bring faster and more cost-effective information to farmers and policymakers. The main objective is to introduce an integrated survey system to help countries regularly produce comprehensive data on agricultural productivity, livelihoods, and the use of natural resources. FAO is pioneering innovative surveys that include the enumeration of all farmers, no matter how small their holdings are. These surveys would cover all aspects of smallholder livelihoods, their livestock, pastures, and cropland, as well as the tools and machines they use to till their land. These surveys also take into account the farmers' natural resource base and provides gender-specific information on revenues, responsibilities, resilience, and risks.

New Technologies And Data Deluge

These initiatives take advantage of the various technologies currently available: the communication and information platforms and social networks of the Internet, mobile phones which penetrate an ever-wider swath of the population, new remote-sensing tools that offer much higher image resolutions at lower costs, and ever more powerful data processing capabilities.

In the field of remote-sensing, FAO and Google have agreed to work together to make geospatial tracking and mapping products more accessible using Google Maps. New geospatial technologies can enable both policymakers and individual farmers

to assess, monitor, and plan the use of their natural resources. This is especially valuable in the face of climate change. For example, a farmer in sub-Saharan Africa could quickly find the distance from his or her property to the nearest body of water, or share a map of their property with community members. This partnership is designed to foster innovation and expertise and sharply broaden access to easy-to-use digital tools. It will boost the visibility and implementation of efforts to encourage sustainable environmental practices around the world.

Concretely, Google Maps will provide 1,200 trusted tester credentials on the Google Earth Engine to FAO staff and partners, while also providing training and receiving feedback on users' needs and experiences. FAO will train its own staff and technical experts in member countries, upon their request, to be able to operate using Google technology.

Combining information from remote sensing, mobile phones and super computers promises new options for farmers, statisticians, and policymakers alike, but we have to bear in mind that these numerous information sources altogether also creates a deluge of data. Soon, the problem may become one of too much, rather than too little, information. For early warning purposes, for example, the information from billions of pixels at high frequency is only useful if it can be analyzed fast and frequently, ideally in real-time.

Making sense of such very large data, and making it useful to farmers, requires access to high computing power, innovative analytical tools, and easy-to-navigate user interfaces. While modern technologies are becoming increasingly available, it is a challenge for many countries to master them, and certainly for those in Africa, whose countries face the critical need to develop new capacities in this field.

We're Here To Help

The digital revolution is happening, and fast. There is evidence to suggest that Africa's farmers and entrepreneurs have begun to embrace the potential of the digital revolution to raise farms' sustainable productivity, and to combat poverty and hunger. The time needed and the extent of their participation in the full potential of this digital revolution will ultimately depend on whether and how fast an enabling environment, infrastructure, and institutions can be built. No matter how powerful the new technologies may appear, their ultimate benefits for the poor will depend

on whether and how well they can be adopted. They are not the solution, but a means towards one.

FAO seeks to tailor technologies to needs. But it takes a much bigger effort to build the enabling environment that can embrace the all of the continent's 50 million family farms, its even greater number of smallholders, and its many landless rural poor. FAO stands ready to support its member countries to take advantage of this digital revolution in their own food and agriculture systems, with the aim of eradicating extreme poverty and hunger and improving food security and nutrition worldwide. The international community must join forces to ensure that this digital revolution can be brought to scale.

AUTHOR'S PERSONAL STORY

I was born in the midwestern United States but grew up in the rural areas of the state of São Paulo, among what were at the time the most important coffee plantations of Brazil. I was always intrigued by how a country so rich and fertile could be plagued by hunger and poverty. This led me to study and then teach agronomy and economy. What I learned at university was important, but not enough. In the 1990s, I travelled over 90,000 kilometers in Brazil with then union leader Luiz Inácio Lula da Silva to take an in-depth look into how the poor rural and urban populations lived. We met thousands of people, listened to their stories, to their needs and to their dreams. Everywhere we looked, there was potential waiting to be tapped. All that was needed was the right kind of support. To successfully overcome the hunger and poverty trap you needed a combination of action, ranging from productive support to social protection, investing in future generations while providing the tools needed for development today. There are no silver bullets against hunger and poverty, but data is part of the package that can help on the way to sustainable and inclusive development.

A Note from the Digital Thinking Initiative: *A farmer named Mama Churi exemplifies the threat that climate change poses to families whose lives depend on the services provided by their surrounding environment—soil, rain, sunshine, shade, pollination, and natural water filtration. Accurate, timely information is now critical to her survival, and numerous actors are involved in managing and monitoring the resources upon which she relies. Sandy, Peter, and Mohamed are exploring how multiple stakeholders can work together to collect, integrate, and analyze data and then make it useful to farmers like Mama Churi.*

Peace of Mind

Digital Information Reduces Uncertainty for Farmers in the Face of Climate Change

Sandy Andelman *is the Chief Scientist and Senior Vice President of Conservation International*

Peter Seligmann *is the Chairman and Chief Executive Officer of Conservation International*

Mohamed Bakarr *is the Lead Environmental Specialist of the Global Environment Facility*

There are more than 500 million smallholder farms worldwide feeding billions of people. One such farm belongs to Mama Churi, who lives in the community of Mangula B, in the Southern Agricultural Growth Corridor

of Tanzania. She has lived there, together with her family, for fifteen years. She says the area is good for her family. Her husband works as a teacher, which is a good job, but he only earns half of what the family needs to subsist each year. The rest of their income comes from Mama Churi's farming: maize and rice production, beekeeping, and a small fish farm.

Mama Churi recognizes her family's dependence on so-called ecosystem services—the benefits they receive from healthy ecosystems in the surrounding landscape. She says, "If the forest didn't exist, the bees would stop coming to my hives and we wouldn't have plentiful, clean water for the fish farm." But she is concerned that she doesn't have access to the right information to ensure that her farm and the surrounding land remain productive in the face of climate change and other uncertainties.

As the climate is becoming increasingly variable in Tanzania, and rainfall is growing less and less predictable, Mama Churi and her family are increasingly dependent on ecosystem resources, specifically her income from beekeeping. In this way, she's using nature as a safety net to cope with climate shocks. Mama Churi likes beekeeping, she says, because it is easy as long as the bees' habitat persists, and the inputs are not expensive. The only cost is the wood for building the hives. She doesn't have to buy any medicine or food for the bees. Beekeeping now provides 33 percent of her farm income.

Mama Churi also has been raising fish for fourteen years. The water for the fish farm comes from underground springs. Without that supply of clean water, though, Mama Churi would lose 25 percent of her income.

Maize and rice farming together account for 42 percent of Mama Churi's farm income, but this year the yield was very low and it is becoming increasingly difficult for her to figure out when to plant. And if the rain comes before she can plow, then she doesn't get any yield at all. "If someone could help us forecast when the rains are coming, we would be very grateful, because then we would know when to plant so the harvest will be good," she says.

"Because of my farming, my children can go to school and will be able to get good jobs in the future. I am happy and as long as my farming assures us a good income, it will give me peace of mind. "

Access to information—the right information, at the right scales—may be the most important ingredient for Mama Churi's success in maintaining her farm's

productivity in the face of increasing climate variability. Fortunately, new digital tools are making it easier to supply Mama Churi and smallholder farmers like her with the information they need.

What if Mama Churi could access both short- and long-term weather forecasts through her cell phone and take some of the guesswork out of deciding when to plant and what to plant? What if her phone could also give her access to information about which crops will thrive in the unique soils in each of her different farm plots and in this season's weather? She also wants to find out not only which crops to plant but also which varieties and which distributers have them available, so she knows where to go and what the seeds will cost.

Mama Churi's phone should connect her to other farmers in Africa—or anywhere in the world for that matter—who are contending with similar soil and climate issues, so she isn't facing challenges in isolation. In this way, she would extend her social network and her community beyond Mangula B to become part of a global knowledge network. As farmers do in the United States, Mama Churi also wants to be able to access information on crop pests and diseases by taking a photo and sending it through her phone to an extension agent who can diagnose the problem and make recommendations. When it is time to harvest her crops, her phone should give her access to information not only about her farm but also about market prices.

Mama Churi should also have access to information about the surrounding landscape, on which she knows her beekeeping and fish farming depend. For example, what is happening to water availability in the springs that make her fish farm productive? Through her cell phone, Mama Churi should be able to access data on what is happening to ground water, to stream flows, and to the quality of water that she needs not only for her fish but also for drinking and cooking. How can a smallholder farmer like Mama Churi get the information she needs to make better decisions?

Right now, in Tanzania, seven different government ministries are responsible for managing the resources and tracking and providing the information relevant to Mama Churi's livelihood and the productivity of her farm. The Ministry of Transport tracks and provides climate information; the Ministry of Agriculture measures soil health, crop yields, and livestock productivity; the National Bureau of Statistics in the Ministry of Finance monitors income and assets; the Ministry of Water measures water availability and quality; the Ministry of Livestock manages, tracks and regulates

livestock and fisheries resources; the Ministry of Natural Resources and Tourism focuses on beekeeping, forestry, and fisheries; and the Department of Environment in the vice president's office is responsible for policies relating to pollution, sustainable consumption, and production, and natural habitats and environmental conservation. The situation is similar in many other countries around the world. Inevitably, some things fall between the cracks. How can Mama Churi and others like her access all of these disparate, incomplete silos of information, and gain from them the holistic understanding needed to be productive in the face of uncertainty?

This is where Vital Signs comes in. Vital Signs is a knowledge partnership led by Conservation International together with other international institutions, local partners, and governments in Tanzania, Ghana, Kenya, Rwanda and Uganda. Vital Signs collects, integrates, and analyzes data and provides tools to enable farmers like Mama Churi, along with government planners, to make better decisions so they can be more productive while protecting the natural world that sustains them. Vital Signs not only collects and integrates data on the connections between farming systems, ecosystems, and human well-being, it also provides insights to help farmers and government planners solve problems, such as how to farm in ways resilient to climate variability and shocks.

In Tanzania, the Vital Signs field team sits within the Tanzania Forest Conservation Group, a nongovernmental organization (NGO), gathering on-the-ground measurements across a range of different variables, and also integrating and analyzing many different existing data sources to create an accurate and comprehensive picture of the relationship among agriculture, nature, and human well-being. The Vital Signs team makes measurements at all of the scales that are relevant for agricultural decision-making, from a household, through surveys on health, nutrition, income and assets; to a farm field, tracking, for example, which seeds and inputs go into the land and what yields they deliver; to a landscape, measuring the relationships between different types of agricultural management and intensification and ecosystem services, together with the well-being of many farming families; to a region, such as the Southern Agricultural Growth Corridor of Tanzania; to a nation, providing data-derived insights at the scale at which governments, donors, and private sector investors make decisions.

Vital Signs also has developed a transparent, open-access system for automated analysis of this data to produce a set of key indicators, including sustainable

agricultural intensification, water security, resilience, poverty, soil health, greenhouse gas emissions, fuelwood sustainability, and rangeland degradation. We have worked with government ministries, civil society organizations, and farmer associations to co-design web-based visualizations of these indicators and decision support tools to help evaluate trade-offs, manage risk, and inform decisions. Doing so influences policymakers to work toward resilient ecosystems and sustainable livelihoods for smallholder farmers. For example, Vital Signs is already providing information to the Tanzania Ministry of Agriculture, Food Security, and Cooperatives to inform evidence-based standards for climate smart agriculture in Tanzania.

Right now, Vital Signs doesn't have the capacity to deliver all of the information farmers need in a way that is accessible to them through their phones. We started out targeting governments, donors, extension agencies, NGOs, and large farmer cooperatives. However, we are exploring partnerships that could help us give back data and insights to individual partners. For example, we're exploring a partnership so that Vital Signs data can feed into a user-friendly app developed by the U.S. Department of Agriculture to enable African farmers to collect data about their soil and land cover and then, using a cloud-based analytical system, receive information on the most productive and sustainable uses of that land. It won't make choices for them, but it will give them a range of options that are sustainable. Mama Churi's farm may be small, but why shouldn't she have access to the same information and technology that can be accessed by farmers in the United States and Europe?

To quote Sam Dryden, "the first Green Revolution was driven largely by cheap oil. The current Green Revolution can and should be driven by cheap information." There are many groups moving in that direction, working toward green productivity and green environmental sustainability. If we all join forces, we could work with Mama Churi and all the farmers like her to design, test, and truly catalyze the next Green Revolution.

AUTHORS' PERSONAL STORY

Sandy Andelman

I was born in Chicago, Illinois, where my father was a doctor in the days when doctors still made house calls. We also had a small farm that my father called his "investment," but it never made any profit. When I was eighteen, I went to Malaysia to work as a research assistant in the Taman Negara, one of the oldest tropical rainforests in the world. I wanted to understand why gibbons, which are small apes, sing like birds. Later, continuing my research career, I lived in a tent in Amboseli National Park in Kenya for five years while studying monkeys and then elephants. I learned a great deal from the Maasai pastoralists around Amboseli, who were generally tolerant of wildlife, except when an elephant killed a cow or raided a farm. Today, I have a vegetable garden behind my house and I battle with the deer over who is going to reap the benefits. My livelihood doesn't depend on my vegetable crop, whereas an African smallholder farmer's does. I am a conservationist and I love elephants, but conservation can't succeed if smallholder farmers and local communities are the ones who bear the costs of wildlife.

Peter Seligmann

I was born in New York City, the third child of German refugees. At the age of two we moved to the New Jersey suburbs. From my earliest years, I loved mud, climbing trees, fishing, and collecting salamanders. In the summer of 1962, when I was twelve years old, my grandmother gathered her dispersed grandchildren together on a ranch in Wyoming. I fell in love with mountains, rivers, forests and wildlife of the Rocky Mountains. In 1969, I studied grizzly bears in Yellowstone National Park and promptly switched my major at from sociology to wildlife ecology. After graduate school, I took a job as the western Regional Land Steward for the Nature Conservancy (TNC). In 1987, a group of us left TNC and founded Conservation International. Our belief is that humanity needs nature to thrive. Our work focuses on the direct relationship between the well-being of communities and the productivity and security of ecological systems. Ecosystem science, economics, and livelihood are the foundation of our mission to insert conservation of nature into the fabric of development.

Mohamed Bakarr

Growing up in my home country, Sierra Leone, I was influenced by farming and fishing. I particularly enjoyed upland the farming practices involved in growing rice, cassava, sweet potato, maize, and groundnut, which occurred during the rainy season when we were on holiday from school. But my fascination with nature and biodiversity emerged from fishing. As I sat down waiting for fish to take the bait, I often wondered about the overall ecosystem, how the components are linked, and the anthropological forces that influenced its functioning. I was fortunate to nurture these childhood fascinations through secondary school and went on to study Biological Sciences at Njala University. After graduation, I was recruited by the university to help establish the foundation for research and training in tropical ecology. I went on to pursue further studies in this area, obtaining MS and PhD degrees at the University of Miami, specializing in mycorrhizas—associations between fungi and plant roots that help improve uptake of nutrients from the soil. This allowed me to enter into a career that values the interactions between nature and people. I pursued this career in various capacities at Conservation International and World Agroforestry Center, and now in the Global Environment Facility.

A Note from the Digital Thinking Initiative: *Humans have a natural tendency to trust people familiar to them, but, for decades, farmers have received education and training from people with whom they have little in common. Cheap digital video can change this situation by engaging farmers in exciting communities of learning. Rikin explains how Digital Green reaches local farmers with training videos, screened by workers from local communities and showing local people introducing farmers to best practices in local languages. The result is not only better yields but also more empowered farmers.*

Building Community at a Global Scale

Using Video to Improve Extension and Create Farmer Networks

Rikin Gandhi *is Cofounder and Chief Executive Officer of Digital Green*

Reality television programs and social media offer a stage for anyone who aspires to become a star. These platforms offer users a window into the lives of others and inspire them to pursue their own dreams as they watch their peers dance, sing, invent, and cook their way to fame.

Rural smallholder farmers in South Asia and sub-Saharan Africa are motivated by their peers in similar ways. Although they may not have access to the Internet or

even electricity, they learn by observing their neighbors' fields and by asking those who till them about the crops they grow. Governments and companies that work with these rural communities can be critical catalysts in this process.

At Digital Green, we train development agencies and people in the communities with which they work to produce and distribute locally relevant knowledge, mainly in the form of videos. These videos, which feature information about farming techniques and nutrition practices, are then screened by frontline workers among farmer groups, using battery-operated mobile projectors.

This type of digital thinking disrupts the top-down, one-way flow of information characterized by the term *extension*. Traditional agricultural extension methods rely on highly trained experts who go out into the field to interact directly with farmers. However, given that 60 percent of India's population and 80 percent of Ethiopia's population depend on agriculture as their primary source of income, the barriers to extension on a large scale are virtually insurmountable: there are not enough agents, farmers grow too great a variety of crops and speak too many languages, and an inadequate transportation infrastructure can make it difficult for them to reach rural communities.

In the place of extension, Digital Green establishes a platform that brings together public and private agencies and farming communities to exchange knowledge. Videos are produced locally and often feature farmers' own innovations. However, it is important not to romanticize the fact that our partner domain experts are integral to introducing practices based on new research, which even frontline workers may be unfamiliar with, and to moderating the content being produced and shared. The combination of extension agents, farmers, and off-the-shelf technologies like video establishes a network that unlocks the potential of the smallholder farming communities. We have found that facilitated video viewing can spur farmers to adopt new agricultural practices for about one-tenth of the cost of traditional extension systems.

Building Trust Through Localization And Inclusion

When farmers assess the relevance and trustworthiness of a Digital Green video, they consider not just the featured farmer's language but also factors like the clothes she is wearing and the type of dwelling she lives in to determine whether she is someone they can identify with. Indeed, viewers' first questions are often about the name of

the individual featured in the video and the village where she lives. Seeing is often believing for rural farmers—often women with a low level of literacy—and visual cues pertaining to a person or a crop can be crucial in their decision to adopt a practice.

Digital Green's network of partners and community members have produced more than four thousand videos in twenty-eight different languages. We have found that producing a video in each district is much cheaper and more effective than attempting to translate or dub an existing video for a new locale. Roughly 80 percent of the videos a farmer views in her village are produced in the same district in which she resides; the other 20 percent might be from a nearby locale with comparable language, ecology, and agriculture. Smallholder farmers form a diverse social spectrum. We have sometimes found that those on the upper end are unwilling to learn from those they consider below them, and vice versa, although we have also seen bridges formed between factions as individuals learned from those whom they would otherwise never have considered worthy of their attention.

Traditional agricultural extension reaches out primarily to male heads of household in farming communities because of the belief that the man is the primary farmer. However, the bulk of agricultural labor on small farms is done by women. One reason for Digital Green's success is that we reach out to women and other marginalized farmers; in fact, women account for 80 percent of our audience. We have found that women tend to be more receptive to videos featuring fellow women, just as men tend to identify with fellow men.

The videos themselves are not the only part of localization. Village-level frontline workers are also a crucial element of the Digital Green approach. Farmers participating in our program report that watching a practice demonstrated on a video while being told about it by a frontline worker boosts their recall. To build even deeper confidence, the frontline workers, who typically live in the same village as the farmers viewing the video, can vouch for the local applicability of the practices taught, ensure that viewers understand them, connect farmers with necessary inputs (such as seeds and fertilizers), and aggregate their produce for sale at market.

"Previously we weren't even able to grow eight hundred kilos of grain," remarks Sugna Bai, a smallholder farmer in Madhya Pradesh, India. But after watching a video on pest management techniques for wheat cultivation, she increased her yields substantially. "Now we harvest 3,000 to 3,500 kilos. When we see videos

and do it, then we can believe in it. Belief comes by doing, not just by seeing. So after seeing the video we have to practice it. Then we can believe."

Adaptation, Partnership, And Scale

So far, Digital Green's approach has reached more than 800,000 smallholder farmers, with more than 60 percent of them subsequently applying at least one new practice. We estimate that the adoption of these practices has increased crop yield by at least 20 percent and reduced input costs by 15 percent.

Though fundamentals of human behavior, such as the tendency to identify with similar individuals, hold true across geographies, we have found, as we scale from our base in India to parts of sub-Saharan Africa, that the application of digital thinking is context-specific. Some communities in Ethiopia, for example, had never seen a film before attending a Digital Green video screening, and we had to embed visual cues, like stock footage of sunrises and sunsets, to explicitly show the passage of time. Because of the limited reach of media in these areas, our approach affords greater novelty and excitement. Villages in India, by comparison, have more prevalent access to mobile phones, movie theatres, and satellite television, and competition for viewers' attention greater.

In India, Digital Green works primarily with the Ministry of Rural Development, which runs a program called the National Rural Livelihood Mission that mobilizes women's self-help groups; we support district teams that both produce videos and enable peer farmers to facilitate screenings for these groups. In contrast, the extension programs run by federal and regional governments in Ethiopia are more coordinated. The country's public extension system employs domain experts to produce videos and professional extension staff to screen them for development groups, which are primarily led by men. The differences between the two countries lead to trade-offs—for instance, between capturing local nuance and controlling production quality—but we have also found that the various approaches tend to converge. Our partners in India, for example, now ask experts to review the technical soundness of new videos, and their counterparts in Ethiopia increasingly leverage farmer feedback and usage data to better target their programs.

When trying to connect with smallholder farmers in a cost-effective manner, the challenges and the successful approaches are strikingly common in both places. For

example, most smallholder farmers in India are already bombarded with agricultural information, sometimes conflicting in nature, through an assortment of radio, television, newspaper, mobile, and face-to-face extension programs. Therefore we start with a development problem and a partner that is already working on solving it before determining whether a particular technology can amplify its effectiveness. We have also avoided being dogmatic about the use of video; for example, in Ethiopia we are combining mobile and radio services with our video-enabled approach to complement and reinforce messaging. The value of combining multiple channels of communication, though, is not necessarily the additive value of each. The key is to enable farmers to translate information into action, and ultimately income, through localization and integration with existing grassroots-level development efforts.

Digital Green's success is at least as attributable to the grassroots-level organizations that use our approach as it is to the videos themselves. Before making a video on poultry production, for example, we consult with a partner who has already made sure that farmers have ready access to chicks and a market to sell eggs. We also work closely with our partners to balance the process of socializing videos locally with ensuring the technical merit and relevance of the practices that they feature. In addition, we train frontline workers, a group marked by frequent attrition because of the difficult job and low pay, to do more than passively screen a video. They are encouraged to pause, rewind, ask questions, and get feedback in order to engage viewers in a dialog both during video screenings and after, when they visit farmers' fields. Our partners collect a variety of data, from farmer attendance to the application of featured practices; however, this rich data set only has influence when incorporated into existing performance management systems and strategy planning processes.

Empowering The Farmer

The biggest challenge for Digital Green is that smallholder farmers in sub-Saharan Africa and South Asia are increasingly losing confidence in themselves and migrating to cities as farming becomes a vocation of last resort. Mainstream media tend to reinforce this view by portraying farmers in destitute conditions, and, in India, by idolizing software engineers and Bollywood film stars.

Although these aspirations can have positive effects (they have spurred a generation of youth to be educated), agriculture can also be a career of choice; it involves a

unique combination of business acumen, scientific rigor, and technological prowess. Urban and rural communities, much like those in the global north, are increasingly divided, and political constituencies are moving closer to cities. But in the emerging economies of South Asia and sub-Saharan Africa, a staggeringly large population of smallholder farmers still remains. In India, we developed a game on Facebook called Wonder Village and coproduced a reality television series called Green Champion in order to connect urban audiences with the people of rural India and inspire empathy through entertainment, while simultaneously enabling smallholder farmers to see themselves in a new light.

Digital Green also uses data and feedback to inform our videos and target distribution more effectively. Our Connect Online, Connect Offline system, which we affectionately call COCO, allows us to track which farmers attend viewings, which videos they've viewed, which videos have stimulated their interest, and which agricultural practices they have subsequently adopted. This enables a process of rural development grounded in farmers' needs and desires. We do this not only because we think it has intrinsic value but also because farmers are more likely to adopt solutions when those solutions address the problems they consider most pressing.

This approach has the potential to improve the efficacy of knowledge exchange services and food systems more broadly. The combination of social organizations and technology creates a network with potential that expands with the scale and variety of applications that it supports. Agricultural buyers can tap into it to share practices related to the commodities that they are interested in purchasing and to leverage data for food traceability. Researchers can share information more efficiently and inform their studies based on farmer-level data. Curricula in agricultural universities, too, can be complemented with practical videos from actual farmers' fields. Digital thinking shifts the fulcrum of development from distant agencies to smallholder farmers.

Ultimately, technology can only magnify human intent and capability. When a video sparks the curiosity of a farmer in a rural community, it can help her take new steps toward improving her life and the lives of those around her.

AUTHOR'S PERSONAL STORY

For as long as I can remember, I wanted to be an astronaut. Their combination of brains and brawn was inspiring to me. I studied computer science and aerospace engineering, and the next step on the path was joining the Air Force. Before I could do that, however, I had to get eye surgery, and while I was recovering, I decided to help some friends who were starting a biodiesel company in India. The company did not last, but the time I spent immersed in rural communities in India changed my life. I met people who had nothing but themselves and their land, but, like astronauts, they were heroes in their own right. I read biographies of people who had been to space, and I learned that many of them come back to Earth with a new perspective on life. They tended to ask the big questions: Why is there war? Why is there poverty? My time in rural India led me to similar questions, and that is where Digital Green came from. I am not an astronaut, but I still love flying; I took my first helicopter ride just a few months ago.

A Note from the Digital Thinking Initiative: *Sam believes in seeing and listening to farmers as individuals. No wonder that, after several years of thinking about digital technology and smallholder farms, he understands how the unique contributions and choices of every farmer will be critical in enabling two-way communication between the numerous actors and interests within the food system. This communication requires serious public investment, not just to set up unique identifiers for each individual in every rural household, but also to establish the data governance and platforms needed to make use of what we learn from these exchanges.*

What's Unique About Unique IDs

Delivering on the Promise of Digital Solutions for Smallholders

Sam Dryden *is a Senior Fellow at Imperial College London and the former Director of Agricultural Development for the Bill & Melinda Gates Foundation*

When I was a young boy in Kentucky, my family finally got electricity thanks to the rural electric cooperative. I remember there were two novelties about having the lights on at night. Obviously, we could see better. Less obviously, our neighbors could also see us; when the lights were on, they knew somebody was home.

Digital technology has the power to achieve an analogous change in the lives of smallholder farmers in Africa. Farmers will be able to get all sorts of information on their cell phones, which will help them "see." But because telephonic communication is a two-way process, smallholder farmers will also be able to use their phones to express their needs and wants to the outside world, which will help them "be seen" by businesses, governments, and international agriculture institutions for the first time.

This is the great promise of digital technology. However, to see this promise fulfilled—to transform food systems in the way the authors in this collection describe—we need to pursue a very specific digital policy agenda. At the top of this agenda is assigning every smallholder farmer a unique identifier, so that whoever is communicating with a farmer knows exactly who she is.

Unique Identifiers Change The Way We All Live

Unique identifiers play a prominent role in the lives of people in rich countries already. When you log on to Amazon.com, for example, the site knows who you are and what you have bought before. That is why it can recommend books to you; its algorithms are using the data you have provided to make Amazon's service more personalized.

Over time, that data can change the way Amazon interfaces with individual customers and revolutionize the entire publishing industry. Amazon now knows not only how many copies of a particular book were sold, but also to whom, where, when, and, in some senses, why. There will always be books that bomb, but publishers know more about the universe of readers and what they like than ever before.

Right now, agricultural data is based on samples and extrapolations. As a result, it is not accurate or complete. To take just one example, we know that women do at least half of the agricultural labor in Africa, and we know that they work differently from men, but we have no aggregate picture of how gender affects food production across the continent. Instead, we have a best guess.

African governments are trying to design policies to feed their people and fuel economic development without a clear understanding of the farmers that produce 80 percent of their food. International crop breeders are trying to develop new varieties with anecdotal evidence about which traits farmers value. In short, the

current system leaves out smallholder farmers because they are never counted; information about smallholder farmers is interpolated based on unrelated data.

Unique identifiers, along with satellite imaging technology, would allow us to collect data about farmers: where they live, how much land they cultivate, what they grow, what inputs they use, how much they yield, what they eat and what they sell, and what price they fetch. This revolution of information could remake the agricultural sector at every level, from individual farmers to global institutions.

Individual farmers could receive personalized advice and training based on their particular situation, just like the book recommendations from Amazon. If you are a cassava farmer in a rainy region of Tanzania where the soil is alkaline, you do not need information about how another farmer with acidic soil in a dry region should grow her chickpeas. Without unique identifiers, farmers receive low-resolution information oriented around the lowest common denominator. With them, they receive high-resolution information oriented around the real facts of their lives.

At the national and global level, the aggregated data can generate insights we simply do not have right now. Government policymakers face trade-offs constantly, and they must make these decisions without adequate information. Should they prioritize investments in postharvest storage or in input subsidies? To make this decision, it would help to know how much the farmers are yielding and how much of the harvest is being lost to spoilage.

That same principle applies to regional and global institutions. For example, using unique identifiers, the Consultative Group in International Agricultural Research will be able to consult not only with its fifteen research centers but also with hundreds of millions of smallholder farmers through the data they generate.

Getting Concrete: Building Systems That Use Unique Identifiers

There are several important practical considerations to be made before data systems based on unique identifiers are up and running.

First, is it really possible to reach every single African farmer when they are spread out across a vast and often remote continent? There may be a precedent in the global polio eradication initiative. There has not been a single case of polio in Africa in

more than a year because vaccinators were able to reach virtually every child on the continent. Nigeria was the last country to stop transmission of the virus, and new technologies, such as high-resolution satellite imagery coupled with global positioning systems, helped them get the job done. Obviously the goal of eradication and the goal of ongoing two-way communication about food systems are different, but the expertise does exist to reach and serve the poorest citizens, if the political will is in place.

Farmers who currently operate in an informal system may be wary of formalizing their existence, which would make it easier for their governments to tax them. This is only a problem if we fail to make the value proposition clear. In Nigeria, which uses unique identifiers in its eWallet program, the government has assigned identifiers to roughly fifteen million farmers by using eWallet to deliver fertilizer subsidies. If we can prove to farmers that these systems give them something they actually want, they will participate.

The second set of practical considerations have to do with how the systems are set up. Privacy is a major concern. We have to build systems that can identify individuals for the purposes of collecting and analyzing data but can also let them remain anonymous.

The details of who gets identified and how also matter. For example, it is not altogether clear whether identifiers should tie to the household or to the individual. Ideally, they would tie to both. Men and women within a household often have distinct plots of land. For the sake of accuracy, the best systems would identify the man and the woman as individuals and would know they make up one household and establish which plots correspond to which ID.

Data interoperability is another priority. We need to make sure that, as our systems mature, we can incorporate data from all sorts of sources to get a more complete picture of the lives of smallholder farmers. Right now, my Amazon data does not link up with my MasterCard data, which does not link up with data from the supermarket where I buy groceries. The amount of information companies collect on me is astounding, but they use it for their own proprietary purposes.

Of course, companies need to be able to compete, but in agriculture there is a vast pre-competitive space where sharing information widens opportunities for everyone. That is why this work cannot be done by private companies alone. They

will necessarily focus on the farmers they believe can improve their bottom line. To achieve the total democratization of data, we must engage governments in the effort.

The third practical consideration is data quality. The mere existence of the identifier does not generate high-quality data. For that, we need adequate investment and political will. Farmers will benefit the most if we can link up as much data as possible using spatial data infrastructure and unique identifiers. This is currently being undertaken in a few states in India, but much remains to be done to realize the full potential in serving citizens at the bottom of the economic pyramid.

Next Steps

One of the benefits of unique identifiers is that they work without requiring too much of anyone participating in the process. Smallholder farmers live in an informal world. Governments, businesses, and international institutions work in a highly formalized world. With digital technology, we can generate a two-way conversation without having to worry about where one world ends and another begins.

Smallholder farmers already increasingly rely on their cell phones. Unique identifiers will simply make it possible to capture more of the details of their lives. The formal sector can keep collecting data and analyzing it in the way it always has, except the data quality will be significantly better.

Over time, these two contexts, formal and informal, may well merge. When smallholder farmers see opportunities to integrate into the more formal system, they may choose to do so. But the process will be a response to actual incentives instead of demands that smallholders change the way they live.

African leaders are thinking in bold ways about the future of their food system. To realize their vision, they will need to build digital infrastructure that can deliver on the promise of the information age. If they are serious about the potential of the fifty million smallholder farms on the continent, the first building block will be unique identifiers for every single farmer.

AUTHOR'S PERSONAL STORY

I was born in tobacco country, in Robertson County, Kentucky. My family lived on Pea Ridge, and our nearest neighbor lived on the next ridge over, in hollering distance, but no closer. Once a week, the huckster came along Bee Lick Road and stopped to barter with my mother and father, though they didn't have much basis for negotiation. He was the only game in town, and they usually took what he offered. During harvest, I'd cut tobacco all day long for a penny a stick, and I still have the scars to prove it. When I was old enough, I hung around the barbershop sitting on top of a Coca-Cola crate talking with volunteers from a government antipoverty program. The ones who listened actually helped us. The ones who wanted to lecture us, we just hoped they'd get out without hurting themselves. Through the same antipoverty program, I went to the local community college, and eventually to a four-year college. My goal was to get as far away from farming as possible. As luck would have it, though, my career gradually led me back to agriculture. As the chief executive officer of an agricultural biotechnology company, and later as a philanthropist in agricultural development, I always paid attention to the lesson I learned as a boy: that listening is the most important part of understanding.

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Sam Dryden