Building an Alliance for a Green Revolution in Africa

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Most of Africa's people live in rural areas and depend on agriculture for their livelihoods. These predominantly small-scale farmers face many challenges, including food insecurity, rising poverty, and natural resource degradation. To increase the productivity, profitability, and sustainability of their farms, they need greater access to affordable yield-enhancing inputs, including well-adapted seeds and new methods for integrated soil fertility management, as well as to output markets where they can convert surplus production into cash. To address these needs, the Rockefeller Foundation and the Bill and Melinda Gates Foundation established the Alliance for a Green Revolution in Africa (AGRA). AGRA is now African led and is working within the context of the comprehensive agricultural development program established by Africa's leaders. From offices in Nairobi, Kenya, and Accra, Ghana, AGRA will support work across all key aspects of the African agricultural value chain to help millions of small-scale farmers and their families lift themselves out of poverty and hunger.

Key words: **agriculture; economic development; crops; soils; fertilizer; markets**

Importance of Agriculture in Africa

Agriculture is critical for both human welfare and economic growth in Africa. In sub-Saharan Africa, roughly two-thirds of the population live in rural areas and are dependent on agriculture for their livelihoods; nearly half live in extreme poverty, earning less than $1/day; and one-third are undernourished.[1] Most of this poverty and hunger is rural, and the root cause is lack of sufficient food production and income generation from small-scale farming. Low farm productivity in Africa has many causes, including use of traditional crop varieties, increasingly depleted soils, shrinking plots of land, scarce and unreliable water supply, crop losses from pests and diseases, inequitable land-distribution patterns, inefficient and unfair markets, and poor agricultural and transportation infrastructures. Yet poor rural families in Africa have few, if any, good non–agriculture-dependent livelihood options. In the poorest countries, such as Malawi, more than 90% of the population depends on small-scale farming for their survival (TABLE 1).

Agriculture currently contributes 30%–50% of national incomes in sub-Saharan Africa and can generate considerably greater income and stimulate economic growth. In fact, in agrarian societies, such as those that predominate in Africa, agricultural development is an essential prerequisite to overall national economic development. Agriculture significantly affects broader national economies through forward and backward linkages and consumption linkages.[2] Forward linkages exist because agriculture supplies farm outputs and raw materials to the nonagricultural sector, especially for agroprocessing and marketing activities. Backward linkages occur through demand from the agricultural sector for farm inputs, finance, and other services. Consumption linkages occur because higher incomes in the agricultural sector spur demand for consumer goods and services that are produced in the nonagricultural sector. Agriculture serves many purposes, including the provision of food and fiber; import substitution and conservation of foreign exchange through domestic food production; release of labor into the industrial sector; provision of raw materials for industrial growth; lowering of food prices, thereby raising real wages; and generation of employment. Sustained economic growth will not occur in Africa unless farm productivity and food production from agriculture increase significantly. As farm productivity and profitability increase, farm families have greater real incomes that

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TABLE 1. Importance of agriculture (2000)

Region	Population engaged in agriculture (%)	Agricultural labor (% of total labor)
Sub-Saharan Africa (SSA)	61	63
Northern SSA	77	78
Eastern SSA	79	80
Southern SSA	70	72
Central and Western SSA	51	52
South Asia	54	59
East Asia	60	62
Latin America	21	20
Industrial countries	4	3

Source: FAOSTAT.

they can allocate between food and other needs, including health care and education. And when farm families are more productive, wealthier, healthier, and better educated, they have greater opportunities for off-farm employment and entrepreneurship that can spur economic growth in other sectors. Because agriculture has yet to become an engine of economic growth in Africa, urbanization is occurring without a reduction in poverty.

The Challenge

The low performance of agriculture in Africa is at the heart of its food insecurity and slow economic growth. Cereal yields in Africa are a quarter of the global average. Despite periodic local progress, average yields for sub-Saharan Africa have not increased for decades, whereas yields in Asia and Latin America have shown a steady increase. Africa has tried to keep up with its growing population's demand for more food by significantly expanding the area of production, thus contributing to deforestation, and by reducing fallow periods, thus contributing to land degradation. More than three-quarters of the farmland in sub-Saharan Africa has been depleted of basic plant nutrients, and farmers increasingly face severe soil fertility problems. Feeding most of the poor and vulnerable populations in Africa, while preserving the natural resource base and the environment, is one of the most pressing development challenges of the 21st century.

The challenge is serious because Africa's population has already exceeded the productive capacity of the continent's current food production systems, and population growth rates remain high. By 2020, the population of sub-Saharan Africa is expected to grow to nearly 1 billion. Dire consequences for food security are projected. The International Food Policy Research Institute predicts that Africa will probably continue to be the "troubled region" in terms of imbalance between food demand and supply.[3] Their projections suggest that Africa is the only region that will experience major food shortages and where malnutrition is projected to rise over the next 20 years. Because of poor performance in its agricultural sector, Africa's annual food imports are projected to rise from the current $6.5 billion to $11 billion by 2020, with the economic, social, and political costs of relying on imported food being high. Clearly, much more needs to be done by African governments, the international community, and the private sector to reverse these trends by stimulating gains in agricultural productivity as the basis for food security, poverty reduction, and economic growth.[4]

The First Green Revolution Bypassed Africa

The Green Revolution was one of the great technological success stories of the second half of the 20th century. In many developing countries of Asia and Latin America, the genetic improvement of staple food crops, combined with complementary agronomic practices, supportive policies, and strengthened institutions, enabled overall food production to keep pace with population growth while both more than doubled. Modern varieties first introduced into South Asia in the 1960s were planted on about 80% of the cereal area in South and East Asia by 2000. Over the same period, average yields roughly tripled.

When food production rises through such increases in land and labor productivity, the rural poor gain. Thus, the benefits of the Green Revolution reached many of the world's poorest people and the proportion of the population in Asia that is undernourished declined from 41% in 1960 to 16% in 2000.[1] Massive famines that had been predicted for the world's two most populous countries, India and China, were averted. And, following the example set by all the world's developed countries in earlier decades, the increased productivity and profitability of Asia's small-scale farms helped to kick-start the overall economic development that continues in that region today.[5]

In contrast to Asia and Latin America, Africa has not experienced a sustained Green Revolution despite considerable funding and effort aimed at promoting agricultural development on the continent. Increases in crop yields have occurred in Africa but in recent years have tended to be project specific with little farmer adoption of yield-enhancing technologies beyond the

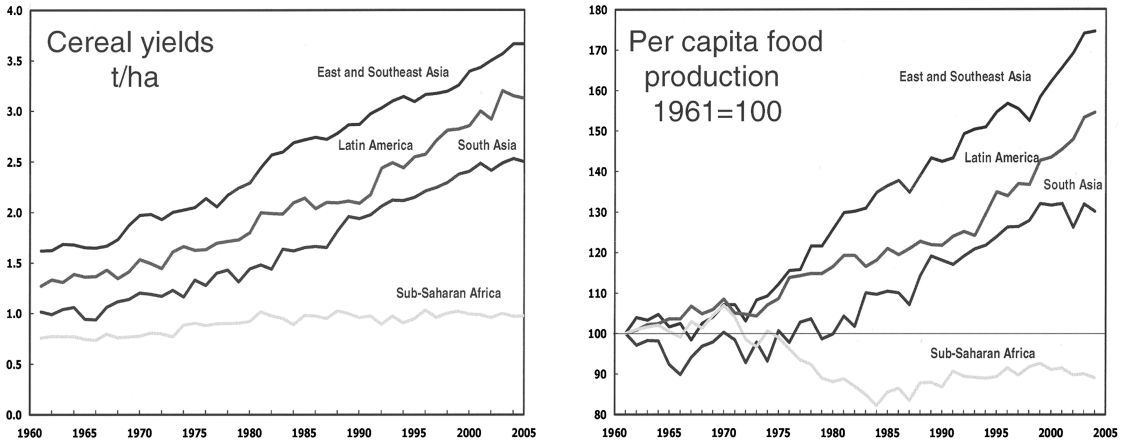

FIGURE 1. For the past four decades, cereal yields in sub-Saharan Africa have been stagnant and per capita food production has declined. The *right panel* shows the % increase or decrease from 1961 which was assigned 100.

project's geographic focus and time frame. The conditions for improving agricultural production in Africa are substantially different from and more challenging than those that existed in Asia in the 1960s. Rainfall is often too little or too much and erratic, there is little irrigated land, the rural population is more dispersed, labor is scarce and labor-saving mechanization is mostly absent, the cost of inputs is high, and there are few roads and railroads providing access to markets. Africa also has a much more diverse set of agroecologies and cropping systems than Asia. Consequently, higher-yielding varieties developed by international centers and others have tended to have a limited range of influence. In fact, the increases in production that have occurred in Africa are largely the result of expanding the area committed to crop production rather than increases in yields (production per unit area). Between 1961 and 2001, for example, cereal production in sub-Saharan Africa did increase from 31 million to 77 million tons, but more than 90% of the increase was due to expansion of the area under cultivation. This increase has led to a rate of deforestation two times the global average. Over the same time frame, the population of sub-Saharan Africa more than tripled to nearly 700 million, one-third of whom are now undernourished. Food production has not kept pace with population growth, and Africa remains the only region where average yields have been stagnant and food production per capita has steadily declined (FIG. 1).

The type of Green Revolution that rapidly spread across Asia, raised agricultural productivity, and laid the foundation for broader economic growth has, to date, bypassed Africa. The "one size fits all" approach that worked so well for the vast irrigated regions of Asia is simply not appropriate for the highly diverse rain-fed farming systems of Africa. What Africa needs has been called a "rainbow" of crop improvement revolutions that combine productivity growth for many different crops and place greater emphasis on farmer participation, local adaptation, strengthening national and local institutions, and the building of agricultural value chains that enables farmers to generate profits from surplus production.[6] With such locally well-adapted interventions, most African farmers have the land assets adequate to provide food security and to rise above subsistence farming. To do so profitably, they need to intensify production by combining genetic and agroecological technologies that require only small amounts of additional labor and capital, and they need greater access to markets.[7]

Building on the Rockefeller Foundation Model in Africa

The Rockefeller Foundation has a long history of helping to build the national and international research resources necessary to generate and disseminate agricultural interventions that can increase the productivity, profitability, and sustainability of small-scale farms in developing countries. For many years, the foundation's agricultural funding has included a component in Africa. The successes and failures of that work have led to a better understanding of the diverse agricultural systems on the continent and of the special needs of African farmers and the agencies and institutions that serve them. Drawing on lessons learned from this experience, the foundation decided in 1999 that the time was right to shift most of its agricultural funding to Africa and to begin implementing an expanded

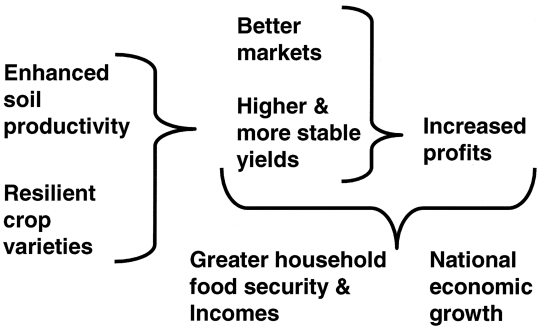

FIGURE 2. Theory of change.

program on the ground from its field office in Nairobi. The program strategy is based on a rather simple theory of change referred to as "market-led technology adoption," as depicted in FIGURE 2. There are three basic components:

1. To help farmers increase the yield potential of their fields by enhancing soil productivity through innovative farming practices that supply adequate plant nutrients, improve the land's water-holding capacity, and are labor saving
2. To help farmers realize a higher proportion of their farms' potential yield by planting more resilient varieties of Africa's staple food crops that significantly reduce losses and increase the stability of yields while meeting human nutritional needs and consumer preferences
3. Helping to build and make more equitable both the input markets that can deliver better seeds, small fertilizer packets, and other inputs to farmers, and the output markets that enable farmers to convert surplus production into profits and to generate greater income from cash crops and livestock

Enhanced soil productivity combined with more resilient crop varieties enables farmers to obtain higher and more stable yields and frees up land and labor for other uses. In the presence of fairer and more efficient markets, this leads to increased farm profits, which encourage even further adoption of yield-enhancing technologies. Higher yields and increased profits provide farm households with greater food security and incomes and stimulate national economic growth. Whereas Asia's Green Revolution had a somewhat similar theory of change, the specific strategies for achieving each of these objectives need to be different in Africa from what had been used in Asia. The differences are as follows.

Resilient Crops

In Asia, the principal genetic factors limiting increases in crop productivity were related to plant type. When provided with additional plant nutrients, Asia's traditional irrigated varieties simply grew taller. With a little wind they tended to lodge, reducing both yields and the farmer's incentive to use fertilizer. Thus, the primary objective of breeding programs was to produce a new plant type (semidwarf, short duration) that responded to fertilizer by growing more grain on shorter plants in less time.[8] Breeding to reduce losses and improve quality were secondary objectives that often came later. For example, IR8, the first of the miracle rices, produced yields several times that of traditional varieties when provided with ample fertilizer and water on experiment stations and yielded two or three times traditional varieties on farmers' fields. Even though it was susceptible to pests and diseases and did not have the desired taste and aroma of traditional varieties, IR8 swept across Asia and Latin America because it made money for farmers and fed the starving.

On the predominantly rain-fed farms of Africa, the key factors limiting crop productivity are the lack of plant nutrients in the soil and the loss of a significant portion of the crop owing to pests, diseases, and abiotic stresses. Thus, the primary objectives of Rockefeller Foundation–supported breeding programs in Africa are as follows: (1) to reduce crop losses by introducing genetic resistance for pest and disease control and for tolerance of drought and other stresses, (2) to enable the crop to use soil nutrients more efficiently, and (3) to do this in varieties that are well adapted to local conditions and meet farmer preferences. This goal requires many breeders working on many crops in many locations, all using the best breeding lines that they can obtain from each other and international centers, the best tools that science has to offer, and in-depth farmer knowledge obtained through new and more effective farmer participatory methods.[9] The result has been the release of hundreds of locally well-adapted new varieties. These include maize varieties combining disease resistance, drought tolerance, and nitrogen use efficiency with traits unique to local growing conditions and consumer preferences; rice varieties that combine the yield potential of Asian rices with the weed competitiveness, disease resistance, and quality characteristics of African rices; cassava and banana varieties resistant to major diseases that had devastated production in some regions and had been spreading across Africa; bean varieties with various combinations of multiple stress resistance targeted to specific locations; four improved sweet potato varieties targeted to

specific locations in Uganda; and maize varieties that use a herbicide seed treatment for resistance to the parasitic weed *Striga*. But just funding breeding programs was not sufficient. The foundation is also investing in (1) African-based training programs designed to produce and put to work in Africa whole new cadres of additional crop breeders; (2) local, African-owned seed companies that can multiply seed and distribute it to the locations where it performs best; and (3) a network of retail shops that sell the locally adapted seeds and fertilizers directly to farmers while training them in the proper use of these inputs.

Soil Productivity

During the Green Revolution in Asia, soil fertility and water were seldom important factors limiting crop production. In 1960, Asia already had 86 million ha of irrigated land and vast areas of fertile alluvial soils, chemical fertilizer was readily available and cheap because of subsidies (often funded by donors), and labor was abundant and used to expand irrigation and to use more intensive crop management practices.

The opposite is true for Africa. Most African farms are rain-fed, often receiving too little or too much water; fertilizer is expensive, if available at all; labor is in short supply; and donors now shun subsidies (through some still shower them on their own farmers and dump their resulting surpluses on Africa). Most of Africa's soils are ancient, derived from granite weathered over millennia. Driven to meet the food demands of a growing population, African farmers have steadily abandoned traditional practices that restore soil nutrients, such as leaving fields fallow for several years between plantings. Without replacing lost nutrients, after 5–10 years of cultivation, nitrogen, phosphorous, potassium, and other trace nutrients are insufficient to support adequate crop growth. More than 95 million ha of sub-Saharan Africa's arable land, or 75% of the total, now has serious soil fertility problems, and farmers are still losing 8 million tons of soil nutrients each year, estimated to be worth $4 billion.[10] With less plant growth, soil organic matter also becomes depleted, reducing the soil's water-holding capacity, which further reduces nutrient use efficiency. Meanwhile, few small-scale farmers in Africa can use fertilizers to restore soil health because either it is simply not available or they cannot afford to purchase inputs. Today, sub-Saharan Africa (excluding South Africa) uses only 1% of the world fertilizer supply and at 1/10 the average rate commonly applied on farms around the globe.[11]

The Rockefeller Foundation learned useful lessons from investments that it has made aimed at trying to improve the soil fertility of African farms under these difficult conditions. Cereal rotations with grain legumes are one of the most promising strategies. To be effective, they often required small amounts of phosphorous fertilizer and legume varieties, such as promiscuous soybeans, that produce larger amounts of organic leaf matter as well as fixed nitrogen. Being able to market the legume grain in addition to the cereal is key to farmer adoption.

It is also possible to improve soil fertility by using combinations of "strictly organic" methods, such as green manures, cover crops, agroforestry, and collecting and composting crop residues and other available organic materials. Often, however, these methods are not broadly adopted by farmers beyond the project sites. Technically they work, but for most farmers these methods do not increase the yields of their staple food crops sufficiently to warrant the extra labor required of the farmer, who is often a woman seeking to maximize returns relative to a limited labor supply. Growing a cover crop can be just as difficult and labor intensive as growing a food or cash crop. Only with special incentives, such as subsidies or guaranteed premium pricing, does organic farming alone generate sufficient returns to achieve broad adoption. Again, however, if just a little carefully formulated inorganic fertilizer is used along with the organics methods, yields increase sufficiently to warrant the extra labor.

The foundation also funds projects aimed at promoting locally adapted fertilizer blending and the marketing of fertilizer in smaller packets that farmers can afford. Even these small amounts of fertilizer can improve crop productivity, but the yield increases achieved are sometimes not sufficient to warrant the high unit cost of fertilizer. Again, adoption is limited without some form of subsidy. Hence, in Malawi and Kenya the foundation is experimenting with "market smart" subsidies that stimulate demand for fertilizer and seed from private markets by providing farmers with targeted vouchers redeemable at local shops to help cover the cost of specific inputs.

The most effective approach to enhancing soil fertility is various forms of integrated soil fertility management (ISFM). The ISFM strategy involves assessing local soil and water resources and considering how organic matter, fertilizers, cropping systems, and farmer knowledge can work in concert to create highly productive and environmentally sustainable approaches to soil revitalization. It combines judicious use of inorganic fertilizer with locally adapted "organic" methods. The two types of inputs, organic and inorganic, are highly synergistic. The fertilizer is formulated to meet local needs and greatly increases production of organic matter. In turn, organic matter in the soil improves its

water-holding capacity and increases the efficiency of fertilizer use by crops. Building on what works best, the foundation now focuses its support on development of locally well-adapted ISFM practices while simultaneously trying to reduce the price of fertilizer and make it more readily accessible to small-scale farmers. This effort included helping to organize and sponsor the African Fertilizer Summit in Abuja, Nigeria, in June 2006, where African leaders pledged to improve fertilizer access for small-scale farmers by establishment of financing mechanisms, providing tax and tariff reductions, building supply chains, and training farmers in ISFM practices.[12]

Markets

The rate of uptake of agricultural technologies by poor farmers is positively correlated with the state of market institutional development. When critical markets are missing or existing markets fail, technology uptake and productivity growth are low. In Asia, one of the reasons that the Green Revolution spread as rapidly as it did in the 1960s and 1970s is that governments and donors manipulated input and output markets to promote adoption of yield-enhancing technologies. In India, the Green Revolution was state led and state supported. Governments built infrastructure, including roads; subsidized inputs, such as seeds and fertilizers; and provided financial services, including price supports that helped ensure that farmers made a profit from surplus production. To reduce risks, they established grain reserves that helped stabilize prices and served as insurance against famine-associated production shortfalls.

Across most of Africa these types of complementary government investments have been limited. Where they did exist, structural adjustment programs imposed by donors have "restructured" them by promoting privatization of government agencies, liberalization of markets, removal of government from agricultural markets, and elimination of subsidies. It was assumed that the private sector would be able to perform marketing functions more efficiently and would subsequently increase investments in critical market infrastructure, especially storage, transport, market information systems, and grades and standards. These market improvements were in turn expected to lead to increased sale prices for poor farmers and stimulate more widespread adoption in improved agricultural technologies.

The reality has not been as predicted. It is now widely accepted that market reforms have had negative effects on poor farmers, especially those in areas far from major markets. Prices for food and agricultural inputs have increased substantially. Although the private sector did move into markets for agricultural inputs and outputs, their investments have been concentrated in areas closer to urban centers with better market infrastructure. In most rural areas, where millions of the poor live and earn their livelihoods, farmers now face significant difficulties in getting access to seeds, fertilizer, and other inputs and often cannot sell their farm produce at profitable prices. When they produce a surplus for the market, they are often forced to sell at low prices. Moreover, these farmers have not effectively organized themselves to achieve economies of scale in bulking, storage, and marketing their produce or in accessing agricultural input and capital markets. Consequently, they have not been able to drive down their market transaction costs.

Although building markets had not been a traditional forte of the Rockefeller Foundation, lack of markets was increasingly recognized as an impediment to African farmers' adopting yield-enhancing technologies generated through foundation support for work on improved seeds and soils. Thus, the foundation began supporting projects that were trying to reduce the search costs and travel times of farmers looking for inputs, improving on-time access to inputs during the crop production season, providing inputs in appropriate quantities, and lowering the farm gate price of inputs through a reduction in market transaction costs. Then, to help farmers sell their surpluses at better prices, the foundation supports work to reduce inefficiencies in output markets by improving market coordination between buyers and sellers, reducing market transaction costs, improving economies of scale through collective action in storage, bulking and marketing, and improving transparency and equity by using market information systems. This endeavor is complemented by interventions directed at improving on-farm product development, product transformation, and value addition for crops, so that poor farmers can increase their share of the income generated from their crops. The foundation also seeks to improve the overall policy environment for agriculture, including the gradual process of moving agriculture away from subsistence systems into more market-oriented systems that can better support the incomes and livelihoods of farmers.

With the difficulty of building markets, there is a strong need for multiple institutions to work together from the public, private, and civil society sectors. For that reason, the foundation is increasingly focusing on joint projects where grantees work together to solve the multiple problems faced by farmers. For example, the Rockefeller Foundation and the Gatsby

Charitable Foundation jointly helped to establish the African Agricultural Capital Fund to address the capital constraints facing local companies serving rural areas, particularly seed companies.[13] However, there was also a lack of small retail shops in rural areas that could sell the seeds and complementary inputs, such as fertilizer, directly to farmers. To build the input supply pipeline, the foundation supported nongovernmental organizations (NGOs) that train local shop owners to become agrodealers. The NGOs train these village retailers to develop their technical, product, and business management skills. Those that meet the requirements are certified as agrodealers. Certified agrodealers are linked to the seed companies and other input supply firms using partial credit guarantees that cover 50% of the default risk. Agrodealers are also organized into purchasing groups to facilitate bulk purchasing and to provide joint collateral to guarantee repayment. Some agrodealers repackage seed and fertilizer into small packets (e.g., 1 kg for seeds, 2 kg for fertilizer) to increase the affordability for poor farmers. And, increasingly agrodealers serve as extension agents conducting demonstrations of new technologies for input suppliers, governments, and donors. Agrodealers have contributed significantly to the increases in crop production that have recently occurred in Malawi.

In Africa, the foundation has had to support the development of the whole agricultural value chain, from building the capacity required to create the inputs farmers need, to delivering these inputs directly to farmers, to helping farmers convert their surpluses into value-added products and other profitable outputs.

Monitoring and Evaluation

If the foundation's theory of change is correct, then African small-scale farmers with access to input and output markets should readily adopt new farming practices and improved crop varieties that can enhance soil fertility and reduce crop losses, thereby increasing farm productivity, food security, and incomes of the rural poor. To determine whether this is indeed occurring and to accelerate learning about the effectiveness of each component of the strategy, the foundation is also funding a monitoring and evaluation component. Foundation officers work with grantees to ensure that cohorts of farmers in test groups are informed of and provided access to improved crop varieties, soil management technologies, and collective marketing opportunities. The progress of farmer adoption of each intervention is now being monitored, farmer interviews are being conducted, and comparisons are being made with locations where similar farmers did not have access to the interventions. All grantees in the target region meet regularly with the monitoring and evaluation team to discuss results. There have been spirited discussions, much has already been learned about why farmers do or do not adopt technologies, and useful modifications have been made in how the foundation seeks to help build agriculture value chains in rural Africa. Much of this learning and many of these Rockefeller Foundation–funded activities are now being transferred to the Alliance for a Green Revolution in Africa (AGRA).

Establishing the Alliance for a Green Revolution in Africa

In 2005, the Bill and Melinda Gates Foundation began an exploration of several new areas for program funding, including agricultural development. This development was welcome news to the agricultural sector because this relatively new foundation was by far the largest in the world and had already revitalized the global health sector with significant funding, innovative programming, and new leadership. Board members and program officers from the Gates Foundation traveled to Africa as part of this exploration and visited several agricultural development projects, including those supported by the Rockefeller Foundation. Intrigued by the promising initiatives they saw, these representatives began discussions concerning a potential partnership. The two foundations had previously worked together effectively in the health sector and saw real opportunities to do the same in agriculture.

Initially the discussions concentrated on seed systems. However, after a meeting of the presidents and key vice presidents of the two foundations, the decision was made to establish a more comprehensive partnership for agricultural development in Africa that would build on current Rockefeller Foundation support for seeds, soils, and markets; expand to include work on extension, water resources, policy, and other interventions as necessary; and attract complementary financial commitments from national and international sources. AGRA was established in 2006 to implement this comprehensive funding program from Africa.[14] During this startup phase, four program officers from the Rockefeller Foundation served as the corporate officers of AGRA while a permanent and predominantly African staff was being recruited. A significant portion of the Rockefeller Foundation office space in Nairobi was provided to AGRA for its headquarters, and many of the foundation's support staff in Nairobi were transferred to AGRA. In September 2006, the Bill and Melinda Gates Foundation provided $100 million

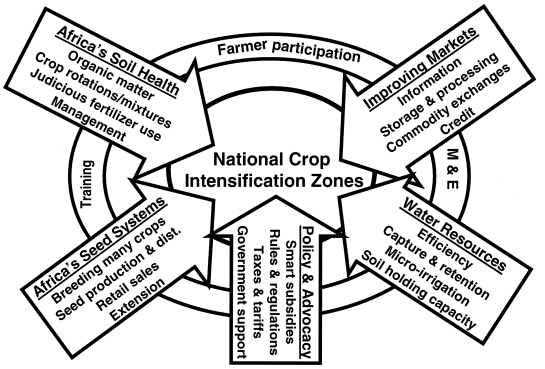

FIGURE 3. Funding programs of the Alliance for a Green Revolution in Africa. M&E, monitoring and evaluation.

and the Rockefeller Foundation provided $50 million to AGRA to initiate its funding program on Africa's seed systems. In late 2007, the two foundations committed $180 million to AGRA for its soil health program. AGRA is currently developing a proposal of roughly similar magnitude on building markets that will soon be submitted to the two foundations and other donors. Additional proposals will be developed by AGRA, and AGRA might host funding programs developed by others as long as they reinforce AGRA's programmatic mission.

AGRA now has an eight-member board of directors, including five distinguished Africans. Former United Nations Secretary-General Kofi A. Annan serves as chairman. Recently, Dr. A. Namanga Ngongi, former executive deputy director of the World Food Program, was elected as AGRA's president. Two Rockefeller Foundation program officers remain seconded to work full-time for AGRA, one as vice president for policy and partnerships and one as director of the Program for Africa's Seed Systems. Several additional program officers have been hired by AGRA, and more professional staff are being recruited. AGRA will have a regional office in Accra to serve West Africa as well as its headquarters in Nairobi.

Although the full extent of AGRA's funding programs are still evolving, they are being developed within the context of the Comprehensive African Agricultural Development Program established by African leaders through the New Partnership for Africa's Development. In this way AGRA can focus its support on national priorities in collaboration with national governments and other donors. As depicted in FIGURE 3, AGRA's programming will probably focus on national crop intensification zones. These are the regions in each country where most poor, small-scale farmers are located and where the types of interventions that AGRA supports have the greatest potential for increasing the productivity, profitability, and sustainability of these farms. It is expected that programs funded by AGRA, the national government, and others will come together and be integrated on the ground in these prime agricultural zones (FIG. 3).

Each of AGRA's programs will work across the full value chain, have training and capacity-building components, include farmer participation as an integral part of the work, and have a built-in system for monitoring and evaluation. AGRA's Program for Africa's Seed Systems was funded first, has carried out the most grant making to date, and serves as a model for how other AGRA programs are likely to be developed. As described later, it is making carefully targeted and interdependent grants by following a business plan that has four components making up the seed "value chain."

Education for African Crop Improvement

Wherever postgraduate training is judged to be of a sufficiently high caliber, Master of Science–level training is supported in-country. This approach reduces costs while building national institutions and allows students to perform their thesis research within their own country on topics that are relevant to local farmers. M.Sc. fellowships are generally funded at a level of $30,000–$40,000, which includes 1 year of coursework and 1.5 years of field study and thesis writeup.

Two centers of excellence for Ph.D.-level training in plant breeding are being developed. One is at the University of Kwa–Zulu Natal (the African Center for Crop Improvement), and the other is at the University of Ghana–Legon (the West African Center for Crop Improvement). Cornell University is providing backup support for both centers. Ph.D. fellowships are funded at an average of $200,000 per student for a 5-year program, which includes 2 years of coursework at the main campus and 3 years of thesis research and writeup at the home institution.

In addition to M.Sc. and Ph.D. fellowships, AGRA will develop and fund inservice training initiatives on critical topics of practical importance for breeding and seed development for both public- and private-sector crop and seed specialists. The training will be at regional centers, such as the International Institute for Tropical Agriculture in Nigeria, and at one or more regional seed companies that have offered to host such training events.

Improvement and Adoption of African Crops

AGRA operates a continuous "searchlight" function that analyzes how African farmers lose crop yields because of poor-performing crop varieties and then

supports breeding programs to address those yield losses. Most of these breeding initiatives are implemented by breeders working within their own country's agricultural research institute, where AGRA funding of operational costs is matched by government funding of fixed costs. However, where a unique opportunity exists to fund breeding within international centers or local seed companies, AGRA will also provide funds for these initiatives. Over time, many of Africa's active plant breeders working for national agricultural research institutes will receive funds to accelerate and improve their breeding programs. AGRA program officers will work closely with prospective principal investigators to design high-impact, farmer-participatory, agroecology-based breeding strategies that attempt to deliver newly released varieties in the minimum time necessary. In addition, as Ph.D. students graduate from the training programs, AGRA will attempt to create alignment between their newly gained knowledge and farmers' needs and fund their breeding programs to develop and make popular improved, adapted crop varieties. The average size of grants for crop breeding is $150,000 over 3 years, renewable for an additional 3 years on the basis of progress made.

Seed Production for Africa

AGRA expects to follow up support for the development of improved crop varieties with funding for the multiplication and dissemination of seed of these varieties to farmers. The primary goal is to establish a continuous supply of quality seed of improved varieties among poor farmers. One way of achieving this goal is by facilitating the establishment of small- and medium-sized private seed enterprises that are locally owned and managed. AGRA program officers will work closely with the executives of Africa's young seed enterprises to develop business plans that deliver better seed to farmers via sustainable channels. AGRA is supporting the emergence of these "grass roots" private seed companies through two channels: (1) modest-sized grants of $100,000–$200,000 for startup seed companies to multiply and distribute seed and educate farmers on the value of seed through demonstration plots, radio messages, and farmer field days and (2) larger ($300,000–$2 million) debt and equity investments to allow Africa's better-established seed companies to grow into larger seed firms covering two or more countries. Grants to start up seed companies should generate 300–600 tons of seed per grant over 2 years and are made directly by AGRA after extensive, onsite interaction between program officers and the management of seed companies. Private equity investments in seed companies are designed to permit companies to expand their production from roughly 600 tons annually to several thousand tons annually and will be made through placement of AGRA funds with intermediary investment funds or banks. For truly noncommercial products, such as planting materials for cassava and sweet potato, AGRA funds foundation stock multiplications by researchers and production of "certified" planting stock through farmer-based multiplication schemes. This endeavor provides for rapid, decentralized dissemination of new varieties of these crops to farmers. Likewise, when the private sector fails to express any interest in investing in the dissemination of a new, seed-based crop variety, AGRA will support public sector and NGO-based seed initiatives to disseminate seed.

Agrodealer Development Program

Few African farmers live close enough to seed companies to buy seed directly from the producers. Therefore, AGRA is funding a major effort aimed at establishing and professionalizing the supply of seed, fertilizer, and other inputs at the village level through agrodealers. AGRA works closely with service providers (usually NGOs) with a proven track record in agroenterprise development to extend the reach of Africa's emerging seed companies into remote rural settings. These service providers increase the quantity of seed that agrodealers can keep in stock by setting up loan guarantee schemes between banks and input suppliers. They also improve business management skills among agrodealers by providing management training through locally sourced, qualified business trainers. When agrodealerships are nonexistent, the NGOs provide small-business loans to local entrepreneurs to start up operations of such businesses. AGRA also helps to create national associations of agrodealers, which serve to provide business owners with information on new products, establish and disseminate best practices, and provide dealers with ways of selling and buying surplus stocks according to their needs. AGRA expects to support the certification of roughly 10,000 agrodealers across Africa over the next 5 years.

In 2006, AGRA's Program for Africa's Seed Systems made 40 grants in 10 African countries, totaling more than $34 million. Moving forward annual funding at roughly this level is expected for each of AGRA's approved programs.

Conclusion

AGRA was established by the Rockefeller Foundation and the Bill and Melinda Gates Foundation as an African-led, broad-based partnership dedicated

to helping millions of Africans lift themselves out of poverty and hunger by dramatically improving the productivity, profitability, and sustainability of small-scale farming across the continent. AGRA's approach is comprehensive, addressing key challenges across the agricultural value chain, ranging from the development of more resilient crop varieties that can cope with pests, diseases, and harsh climates, to new methods of integrated soil fertility management and water management that can supply crops with necessary nutrients while restoring the natural resource base, to strengthening local and regional markets, and to building and strengthening extension and other forms of technology delivery systems for farmers. Building on funding programs initiated in Africa by the Rockefeller Foundation, AGRA is making good progress. Its investments have already strengthened the capacity of several African institutions and are helping to deliver new technologies that are enabling Africa's small-scale farm families to improve their livelihoods. Its funding programs are expected to expand significantly over the next few years.

Conflicts of Interest

The authors declare no conflicts of interest.

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