



Building New Agricultural Universities in Africa

Citation

Juma, Calestous. 2012. Building New Agricultural Universities in Africa. HKS Faculty Research Working Paper Series RWP12-026, John F. Kennedy School of Government, Harvard University.

Published Version

<http://web.hks.harvard.edu/publications/citation.aspx?PubId=8428>

Permanent link

<http://nrs.harvard.edu/urn-3:HUL.InstRepos:9359206>

Terms of Use

This article was downloaded from Harvard University's DASH repository, and is made available under the terms and conditions applicable to Other Posted Material, as set forth at <http://nrs.harvard.edu/urn-3:HUL.InstRepos:dash.current.terms-of-use#LAA>

Share Your Story

The Harvard community has made this article openly available.
Please share how this access benefits you. [Submit a story](#).

[Accessibility](#)



Building New Agricultural Universities in Africa

Faculty Research Working Paper Series

Calestous Juma
Harvard Kennedy School

June 2012
RWP12-026

The views expressed in the **HKS Faculty Research Working Paper Series** are those of the author(s) and do not necessarily reflect those of the John F. Kennedy School of Government or of Harvard University. Faculty Research Working Papers have not undergone formal review and approval. Such papers are included in this series to elicit feedback and to encourage debate on important public policy challenges. Copyright belongs to the author(s). Papers may be downloaded for personal use only.

BUILDING NEW AGRICULTURAL UNIVERSITIES IN AFRICA

Calestous Juma
Professor of the Practice of International Development
Belfer Center for Science and International Affairs
Harvard Kennedy School
calestous_juma@harvard.edu
Twitter @Calestous

ABSTRACT

There is an urgent need to create a new generation of innovation-oriented agricultural that efficiently bring together agricultural research, training, commercialization, and extension. This paper calls for upgrading the training, extension, and commercialization functions of existing national agricultural research institutes (NARIs). This would build on a strong research tradition, ongoing training efforts, connections with the private sector and farmers, and extensive international partnerships. Upgrading NARIs in this manner would also lay the foundation for the emergence of the first generation of research universities in Africa with an initial focus on agriculture. The creation of agricultural innovation universities would serve as a starting point for broader efforts in Africa to strengthen the role of science, technology, and innovation in economic transformation. The paper provides a roadmap that can be used to guide the proposed reform efforts.

CONTENTS

Introduction	1
1. Feeding Africa in the new millennium	2
2. Agricultural science, technology, and innovation	3
3. Challenges and opportunities for institutional innovation	5
4. In search of inspirational models	9
5. Implementation roadmap	11
Conclusion	14

INTRODUCTION¹

This paper aims to promote the role of science and technology and innovation in feeding Africa. It argues that feeding this continent will require fundamental reforms in the structure of agricultural research to bring innovation to bear on raising agricultural productivity. This can be achieved through systemic links between research, training, commercialization, and extension. The paper seeks to give effect to the pillar on “agricultural research, technology dissemination and adoption” of the Comprehensive Africa Agriculture Programme (CAADP), which aims to achieve accelerated gains in productivity.

More specifically, CAADP envisaged that achieving such accelerated productivity gains will require:

“(a) an enhanced rate of adoption for the most promising available technologies, to support the immediate expansion of African production through the more efficient linking of research and extension systems to producers; (b) technology delivery systems that rapidly bring innovations to farmers and agribusinesses, thereby making increased adoption possible, notably through the appropriate use of new information and communication technologies; (c) renewing the ability of agricultural research systems to efficiently and effectively generate and adapt new knowledge and technologies, including biotechnology, to Africa, which are needed to increase output and productivity while conserving the environment; and (d) mechanisms that reduce the costs and risks of adopting new technologies.”²

The paper argues that feeding the Africa will require fundamental reforms in the structure of agricultural research to bring science and technology to bear on raising agricultural productivity. This can be achieved by creating a new generation of innovation-oriented agricultural institutions that strengthen linkages between research, training, commercialization, and extension services.

The paper calls for upgrading the training, extension, and commercialization functions of existing national agricultural research institutes (NARIs). The efforts would build on the institutes’ strong research tradition, ongoing training efforts, connections with the private sector and farmers, and extensive international partnerships. Strengthening NARIs in this manner would also lay the foundation for the emergence of the first generation of African research universities with an initial focus on agricultural innovation.

1. This paper was originally prepared as the keynote speech for the First General Assembly of the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA). I am grateful to Dr. Seyfu Ketema and Dr. Charles Mugoya at ASARECA for their comments on an earlier draft of this paper. I am grateful to Katherine Gordon, AIA Project Manager, for her research support. This paper is based on the findings of the Agricultural Innovation in Africa (AIA) Project funded by the Bill and Melinda Gates Foundation as published in C. Juma, *The New Harvest: Agricultural Innovation in Africa* (New York: Oxford University Press, 2011). The full text of this book can be downloaded from <http://www.belfercenter.org/global/>.

2. New Partnership for Africa’s Development (NEPAD), *Comprehensive Africa Agriculture Development Programme (CAADP)* (Midrand, South Africa: NEPAD, 2003), p. 3.

To advance the argument, the paper is divided into four sections. The first section provides background information on the status of agriculture in Africa. The second section stresses the connections between agricultural transformation and overall economic growth with specific reference to the role of science, technology, and innovation. This section draws from the experiences of the Green Revolution to underscore the importance of research in agricultural productivity improvement. The section suggests that African countries will need to adopt different institutional arrangements that reflect today's challenges and opportunities. The third section outlines the challenges of institutional fragmentation and offers options for upgrading NARIs so that they can serve as loci for agricultural innovation. The emphasis of the section is to create a foundation for the emergence of Africa's first generation of innovation universities using agriculture as a starting point. The fourth section provides elements of such innovation universities drawing from other inspirational models. The final section outlines specific options for action needed to achieve the objectives laid out in the paper.

1. FEEDING AFRICA IN THE NEW MILLENNIUM

In sub-Saharan Africa, agriculture directly contributes to 34 percent of gross domestic product (GDP) and 64 percent of employment. Growth in agriculture is at least two to four times more effective in reducing poverty than other sectors. Growth in agriculture also stimulates productivity in other sectors such as food processing. Agricultural products also compose about 20 percent of Africa's exports. Given these figures, it is no surprise that agricultural research and extension services can yield a 35 percent rate of return, and irrigation projects a 15–20 percent return in sub-Saharan Africa.³

Even before the global financial and fuel crises hit, hunger was increasing in Africa. In 1990, over 150 million Africans were hungry; as of 2008, the number had increased to nearly 250 million. Starting in 2004, the proportion of undernourished began increasing, reversing several decades of decline, prompting 100 million people to fall into poverty. One-third of people in sub-Saharan Africa are chronically hungry—many of whom are smallholder farmers. High food prices in local markets price out the poorer consumers—forcing them to purchase less food and less nutritious food, as well as to divert spending from education and health and to sell their assets. This hunger-weak agricultural sector cycle is self-perpetuating.

Gender gaps are a major concern in African countries. Agricultural productivity in Africa could increase by 10 to 20 percent if such gaps were reduced both in school and in the control of agricultural resources. In addition to this critical gender dynamic, the rural-urban divide is also a key component of the agricultural and economic pictures. Over 50 percent of people in Africa living in rural areas are poor, and reductions in rural poverty typically drive reductions in national poverty levels.

Over the last 25 years, growth in agricultural GDP in Africa has averaged approximately 3 percent but has varied significantly among countries. Growth per capita, a proxy for farm income, was basically zero in the 1970s and negative from the 1980s into the 1990s. Six

3. World Bank, *World Development Report, 2008* (Washington, D.C.: World Bank, 2008), pp. 40–41.

countries experienced negative per capita growth. As such, productivity has been basically stagnant over 40 years—despite significant growth in other regions, particularly Asia, thanks to the Green Revolution. Different explanations derive from a lack of political prioritization, underinvestment, and ineffective policies. The financial crisis has exacerbated this underinvestment, as borrowing externally has become more expensive, credit is less accessible, and foreign direct investment has declined.

Only 4 percent of Africa’s crop area is irrigated, compared to 39 percent in South Asia. Much of rural Africa lacks passable roads, translating to high transportation costs and trade barriers. Cropland per agricultural population has been decreasing for decades. Soil infertility is a result of degradation: nearly 75 percent of the farmland is affected by the excessive extraction of soil nutrients.

Fertilizer use in Africa is less than 10 percent of the world average of 100 kg. Just five countries (Ethiopia, Kenya, Nigeria, South Africa, and Zimbabwe) account for about two-thirds of the fertilizer consumed in Africa. On the average, sub-Saharan African farmers use 13 kg of nutrients per hectare of arable and permanent cropland, whereas the rate in the Middle East and North Africa is 71 kg. Part of the reason why fertilizer usage is so low is because of the high costs of imports and transportation: fertilizer in Africa is two to six times the average world price. This results in low usage of improved seed: as of 2000, about 24 percent of the cereal-growing area used improved varieties, compared to 85 percent in East Asia and the Pacific. As of 2005, 70 percent of wheat crop area and 40 percent of maize crop area used improved seeds, a significant improvement.

Africa’s farm demonstrations show significantly higher average yields compared to national yields show great potential for improve in maize. For example, Ethiopia’s maize field demonstrations yield over five tons per hectare compared to the national average of two tons per hectare for a country plagued by chronic food insecurity. This potential will only be realized as Africans access existing technologies and innovate their own. More specifically, African countries will need to rethink how they position their universities and other institutions of higher learning as agents of agricultural innovation.

2. AGRICULTURAL SCIENCE, TECHNOLOGY, AND INNOVATION

2.1 Agriculture and economic growth

Agriculture and economic development are intricately linked. It has been aptly argued that no country has ever sustained rapid economic productivity without first solving the food security challenge.⁴ Evidence from industrialized countries as well as rapidly developing countries indicates that more productive agriculture stimulated growth in the nonagricultural sectors and supported overall economic well-being. Economic growth originating in agriculture can

4. C. Peter Timmer, “Agriculture and Economic Development,” in Bruce L. Gardner and Gordon C. Rausser, eds., *Handbook of Agricultural Economics*, Vol. 2A: *Agriculture and Its External Linkages* (London: Elsevier, 2002), pp. 1487–1546.

significantly contribute to reductions in poverty and hunger. Increasing employment and incomes in agriculture stimulates demand for nonagricultural goods and services, boosting nonfarm rural incomes as well.⁵

Much of our understanding of the linkages between agriculture and economic development has tended to use a linear approach. Under this model, agriculture is seen as a source of input into other sectors of the economy. Resources, skills, and capital are presumed to flow from agriculture to industry. In fact, this model is a central pillar of the “stages of development” that treat agriculture as a transient stage toward industry phases of the economy.

This linear view is being replaced by a more sophisticated outlook that recognizes the role of agriculture in fields such as “income growth, food security and poverty alleviation; gender empowerment; and the supply of environmental services”.⁶ A systems view of economic evolution suggests continuing interactions between agriculture and other sectors of the economy in ways that are mutually reinforcing.⁷ Indeed, the relationship between agriculture and economic development is interactive and associated with uncertainties that defy causal correlation.

2.2 Research and agricultural productivity

The Green Revolution continues to be a subject of considerable debate. Its impact on both agricultural productivity and reductions in consumer prices, however, can hardly be disputed. Much of the debate over the impact of the Green Revolution ignores the issue of what would have happened to agriculture in developing countries without it. On the whole, without international research in developing countries, yields in major crops would have been higher in industrialized countries by up to 4.8 percent. This is mainly because lower production in the developing world would have pushed up prices and given farmers in industrialized countries incentives to boost their production.

It is estimated that crop yields in developing countries would have been up to 23.5 percent lower without the Green Revolution, and equilibrium prices would have been between 35 percent and 66 percent higher in 2000. But in reality prices would have remained constant or risen marginally in the absence of international research, mainly because real grain prices actually dropped by 40 percent from 1965 to 2000.⁸

Higher world prices would have led to the expansion of cultivated areas, with dire environmental impacts. Estimates suggest that crop production would have been up to 6.9 percent higher in

5. Prabhu Pingali, “Agricultural Growth and Economic Development: A View through the Globalization Lens,” *Agricultural Economics*, Vol. 37, No. s1 (December 2007), pp. 1–12.

6. Prabhu Pingali, “Agriculture Renaissance: Making ‘Agriculture for Development’ Work in the 21st Century,” in Robert E. Evenson and Pingali, eds., *Handbook of Agricultural Economics*, Vol. 4 (London: Elsevier, 2010), pp. 3867–3894.

7. Mary Tiffen, “Transition in Sub-Saharan Africa: Agriculture, Urbanization and Income Growth,” *World Development*, Vol. 31, No. 8 (August 2003), pp. 1343–1366.

8. R.E. Evenson and D. Gollin, “Assessing the Impact of the Green Revolution, 1960–2000,” *Science*, May 2, 2003, pp. 758–762.

industrialized countries and up to 18.6 percent lower in developing countries. Over the period, developing countries would have had to increase their food imports by nearly 30 percent to offset the reductions in production. Without international research, calorific intake in developing countries would have dropped by up to 14.4 percent and the proportion of malnourished children would have increased by nearly 8 percent. Put differently, the Green Revolution helped to raise the health status of up to 42 million preschool children in developing countries.⁹

It is not a surprise that African countries and the international community continue to seek to emulate the Green Revolution or recommend its variants as a way to meet current and future challenges. More important, innovation-driven agricultural growth has pervasive, economy-wide benefits as demonstrated through India's Green Revolution. Studies on regional growth linkage have shown strong multiplier effects from agricultural growth to the rural, nonfarm economy.¹⁰

It is for this reason that agricultural stagnation is viewed as a threat to prosperity. Over the last thirty years, agricultural yields and the poverty rate have remained stagnant in African countries. Prioritizing agricultural development could yield significant, interconnected benefits, particularly in: achieving food security and reducing hunger; increasing incomes and reducing poverty; advancing the human development agenda in health and education; and reversing environmental damage.

3. CHALLENGES AND OPPORTUNITIES FOR INSTITUTIONAL INNOVATION

3.1 Institutional fragmentation

The challenges facing African agriculture will require fundamental changes in the way universities train their students. It is notable that most African universities do not specifically train agriculture students to work on farms in the same way medical schools train students to work in hospitals. Part of the problem arises from the traditional separation between research and teaching—the former is carried out in national research institutes and the latter in universities. There is little connection between the two in most African countries.

There are two main reasons for this separation and the associated fragmentation. Africa established colonial research institutes before it created universities. The main function of the research institutes was to serve colonial agricultural objectives and not to build local scientific and technological capabilities or foster local entrepreneurship.

The first generation of African universities were designed to prepare young Africans for public service and as a result focused largely on the social sciences and humanities. By the time universities were being established, the European tradition of separating research from education was already in place. This separation found expression in distinct laws as well as in ministries.

9. Ibid.

10. Peter B.R. Hazell, "An Assessment of the Impact of Agricultural Research in South Asia since the Green Revolution," in Evenson and Pingali, *Handbook of Agricultural Economics*, Vol. 4, pp. 3469–3530.

This approach, also expressed in ministerial separation, is more evident in former British colonies than in Francophone countries.

The second reason for the separation is legislative continuity and emulation. African countries continued the same tradition partly because their economic structures did not create much demand for locally generated knowledge except in fields such as agriculture. African countries continued to reproduce the structure despite the fact that it did not appear to reflect local realities. For example, much of the research cooperation between foreign universities is conducted through national research institutes. This hampers the ability of African countries to foster stronger international university-to-university partnerships.

The fragmentation was worsened by two additional factors. First, agricultural extension services that used to exist in agricultural ministries collapsed in the 1980s largely because of cut-backs in public expenditure. Second, there are no major efforts aimed at commercializing local research results. The absence of extension support and lack of mechanisms that foster commercialization have left NARIs considerably isolated, and undermined their ability to promote innovation.

3.2 Nongovernmental initiatives

There are extensive opportunities for upgrading existing research or operational activities to create a new generation of African universities. This process has already started with nongovernmental organizations (NGOs). An example of such an initiative is the African Rural University (ARU) for women inaugurated in Kibaale district of western Uganda in 2011. ARU was incubated by the Uganda Rural Development and Training Program (URDT), an NGO founded in 1987. It is the first African university dedicated to training women. It is also the first African university to be incubated by a rural NGO and show great promise in the potential for growth among local organizations.

ARU is an innovative model that focuses on building strong female leaders for careers in agriculture and on involving the community in every step of the agricultural value chain. A key feature of the new university is to help young women envision the future they want and design strategies to achieve their goals. Their programming is tailored to meet locally identified needs that value local lifestyles and traditions while allowing the adoption of new technologies and improved production. ARU is building on a long legacy of URDT, which has resulted in better food security, increased educational attainment, raised incomes for families across the district, better nutrition, and strong female leaders who engage in peace-building efforts and community improvements, among others.

A driving factor in the approach is the community-university interaction that focuses on women and agriculture. URDT also has a primary and secondary girls' school that focuses on developing girls' abilities in a variety of areas, including agricultural, business, and leadership skills, and encouraging them to bring their knowledge out to the community.

At URDT Girls' School, students engage in "Back Home" projects, where they spend some time among their families conducting a project that they have designed from the new skills they learned at school. Such projects include creating a community garden, building drying racks to

preserve food in the dry season, or conducting hygiene education. Parents also come to the school periodically to engage in education and to help the girls design the Back Home projects. School becomes both a learning experience and a productive endeavor; therefore, families are more willing to send children, including girls, to school because they see it as relevant to improving their lives.

URDT focuses on agriculture and on having a curriculum that is relevant for the communities' needs. They have an experimental farm where people can learn and help develop new agricultural techniques, as well as a Vocational Skills Institute to work with local artisans, farmers, and businessmen who have not had access to traditional schooling. There is a local radio program designed to share information with the broader community. URDT also runs an Appropriate and Applied Technology program that allows people from the community to interact with international experts and scientists to develop new methods and tools to improve their lives and agricultural productivity.

3.3 Opportunities for national research institutes

The NARIs in Africa operate a large number of research programs that provide a strong basis for building new initiatives aimed at upgrading their innovative capabilities. In effect, what is needed is to strengthen the educational, commercialization, and extension functions of the NARIs.

More specifically, clustering these functions would result in dedicated research universities whose curriculum would be modeled along full value chains of specific commodities. For example, innovation universities located in proximity to coffee production sites should develop expertise in the entire value chain of the industry. This could be applied to other crops as well as to livestock and fisheries. Such dedicated universities would not have a monopoly over specific crops but should serve as opportunities for learning how to connect higher education to the productive sector.

Internally, the new universities should redefine their academic foci to adjust to the changes facing the continent. This can be better done through continuous interaction with farmers, businesses, government, and civil society organizations. Governance systems that allow for such continuous feedback to universities will need to be established.

The reform process must include specific measures. First, the universities for agricultural innovation need a clear vision and strategic plans for training future agricultural leaders with a focus on practical applications. Such plans should include comprehensive roadmaps on moving research from the lab to the marketplace. They also need to define how to best recruit, retain, and prepare future graduates. These plans should be prepared in partnership with key stakeholders.

Second, the new universities need to improve their curricula to make them relevant to the communities in which they are located. More important, they should serve as critical hubs in local innovation systems or clusters. The recent decision by Moi University in western Kenya to acquire an abandoned textile mill and revive it for teaching purposes is an example of such an opportunity. Such connections can be fostered without owning the facilities. For example,

breweries and distilleries can play key roles in offering opportunities for training in fields such as biotechnology and allied fields.

Many of the NARIs are located in the proximity of a wide range of productive facilities with which they can foster long-term working relations. They can also branch into new knowledge-based fields. For example, NARIs located close to breweries can build up expertise in biotechnology using fermentation knowledge as a foundation. Similar arrangements can be created with other agro-based industries such as sugar mills and fish factories.

Third, the universities should give students more opportunities to gain experience outside the classroom. This can be done through traditional internships and research activities. But the teaching method could also be adjusted so that it is experiential and capable of imparting direct skills. More important, such training should also include the acquisition of entrepreneurial skills and other forms of experiential learning.

Fourth, NARIs have extensive programs that involve working directly with farmers. This outreach is a large part of their mandate and efforts to reach farming communities. A “reverse outreach” approach under which farmers and entrepreneurs can selectively participate in “open classroom” programs would help to strengthen extension services. Under the “open classroom” approach farmers and entrepreneurs would join classes of their choice as participants. This would give faculty and students an opportunity to interact with farmers in a classroom setting.

Fifth, in addition to degree courses, universities for agricultural innovation will also need to extend their reach into the sphere of vocational training. This can be done directly through various programs such as “farmer schools” or in conjunction with high schools. The link with high schools and other educational institutions is particularly important considering the Africa’s demographic structure. In most parts of the continent the major of the population is in school, which makes educational institutions an integral part of the community.

Fifth, one way to facilitate the transfer of knowledge from universities to farming communities is through internships and community service. These activities should be structured so that they are part of the academic calendar. They would serve two main purposes. The first would be to transfer knowledge from universities to farmers. Second, returning students would bring back to the university feedback and lessons that could be used to adjust the curriculum, pedagogy, and interactions with farmers.

Sixth, one of the main teaching missions of universities for innovation is to translate ideas into goods and services through enterprise development. Training young people to learn how to create enterprises should therefore be part of the mission of such universities. This can be done in partnership with financial institutions such as banks, cooperatives, and microfinance organizations. Such activities may also lay the foundation for the emergence of rural-based angel funding or venture capital facilities. Similarly, sources of support such as rural development funds could be redirected to help translate ideas from such universities into new enterprises.

Seventh, continuous faculty training and research are critical for maintaining high academic standards. The new universities should invest more in undergraduate agricultural educators to

promote effective research and teaching and to design new courses. Researchers at NARIs would only need minimum training to acquire the necessary pedagogical skills. In fact, many of them are involved in extensive field training activities and so they already teach without having the title. Additional support to the NARIs can be provided by education departments in existing universities. Where needed, teacher training institutes could create special courses aimed at offering training in experiential pedagogy.

Finally, providing tangible rewards and incentives to teachers for exemplary teaching raises the profile of teaching and improves education. Furthermore, establishing closer connections and mutually beneficial links between all stakeholders (academia and industry, including private and public institutions, companies, and sectors) should generate further opportunities for everyone.

4. IN SEARCH OF INSPIRATIONAL MODELS

4.1 Learning from others

There are numerous models that African countries could learn from when exploring how to make universities more relevant to agriculture. The land grant system originally developed in the United States is being reinvented around the world to address analogous challenges. One of the most pioneering examples in curriculum reform is EARTH University in Costa Rica, created through an endowment provided by the US Agency for International Development (USAID) and the WK Kellogg Foundation. Its curriculum is designed to match the realities of agribusiness. The university dedicates itself to producing a new generation of agents of change who focus on creating enterprises rather than on seeking jobs.

EARTH University emerged in a context that mirrors today's Africa: economic stagnation, high unemployment, ecological decay, and armed conflict. Inspired by the need for new attitudes and paradigms, EARTH University was created in 1990 as a nonprofit, private, international university dedicated to sustainable agricultural education in the tropics. It was launched as a joint effort between the private and public sectors in the United States and Costa Rica. The Kellogg Foundation provided the original grant for a feasibility study at the request of a group of Costa Rican visionaries.

Based on the study, USAID provided the initial funding for the institution. The original mission of the university was to train leaders to contribute to the sustainable development of the humid tropics and to build a prosperous and just society. Located in the Atlantic lowlands of Costa Rica, EARTH University admits about 110 students a year and has a total student population of about 400 from 24 countries (mainly in Latin America and the Caribbean) and faculty from 22 countries. Through its endowment, the university provides all students with 50 percent of the cost of tuition, room, and board.

In addition, the university provides scholarships to promising young people of limited resources from remote and marginalized regions. Nearly 80 percent of the students receive full or partial scholarship support. All students live on campus for four intensive years.

EARTH University has developed an innovative, learner-centered, and experiential academic program that includes direct interaction with the farming community.¹¹ Its educational process stresses the development of attitudes necessary for graduates to become effective agents of change. They learn to lead, identify with the community, care for the environment, and be entrepreneurial. They are committed to lifelong learning. Within the curriculum, there are four activities in particular that embody EARTH University's experiential approach to learning.

4.2 Gaining work experience and advancing community service

The first is the Work Experience activity, which is taken by all first-, second-, and third-year students and continues in the fourth year as the Professional Experience course. In the first and second years, students work in crop, animal, and forestry production modules on EARTH University's 3,300 hectare farm. In the first year, the work is largely a routine activity and the experience centers on the acquisition of basic skills, work habits, general knowledge, and familiarity with production.

In the second year, the focus changes to management strategies for these same activities. Work Experience is later replaced with Professional Experience. In this course students identify work sites or activities on campus that correspond with their career goals. Students are responsible for contacting the supervisors of the campus operations, requesting an interview, and soliciting "employment." Upon agreement, supervisors and students develop a joint work plan that the student implements, dedicating a minimum of 10 hours per week to the "job."

The second activity is an extension of the Work Experience course. Here third-year students work on an individual basis with small, local producers on their farms. They also come together in small groups under the community outreach program that is integral to the learning system. Community outreach is used to develop critical professional skills in students, while at the same time helping to improve the quality of life in nearby rural communities.

The third-year internship program emphasizes experiential learning. The 15-week internship is required for all students in the third trimester of their third year of study. It is an opportunity for them to put into practice all they have learned during their first three years of study. For many of them it is also a chance to make connections that may lead to employment after graduation. The international character of the institution grants many students the opportunity to follow their interests, even when they lead to internship destinations other than in their home country.

4.3 Sharpening entrepreneurial skills

The fourth activity is the Entrepreneurial Projects program. EARTH University's program promotes the participation of its graduates in the private sector as a critical means by which the institution can achieve its mission of contributing to the sustainable development of the tropics. The development of small and medium-sized enterprises (SMEs) is a powerful way to create new employment and improve income distribution in rural communities. For this reason, the university stresses the development of an entrepreneurial spirit and skills. Courses in business administration and economics combined with practical experience prepare the students to engage in business ventures upon graduation.

This course provides students the opportunity to develop a business venture from beginning to end during their first three years at EARTH University. Small groups of four to six students from different countries decide on a relevant business activity. They conduct feasibility studies (using financial, social, and environmental criteria), borrow money from the university, and implement the venture. This includes marketing and selling the final product. After repaying their loan, with interest, the group shares the profits.

This entrepreneurial focus has permeated all aspects of the university's operations. It prepares students to become job creators and agents of change rather than job seekers. About 17 percent of the university's 1,100 graduates run their own businesses. The university also manages its own profitable agribusiness, which has strong links with the private sector. When the university acquired its campus, it decided to continue operating the commercial banana farm located on the property. Upon taking over the farm, the university implemented a series of measures designed to promote more environmentally sound and socially responsible production approaches.

4.4 Going global

EARTH University has internationalized its operations. It signed an agreement with U.S.-based Whole Foods Market to be the sole distributor of bananas in their stores. The university also sells other agricultural products to the U.S. market. This helps to generate new income for the university and small farmers while providing an invaluable educational opportunity for the students and faculty. In addition to internships, students have access to venture capital upon graduation. The university uses part of the income to fund sustainable and organic banana and pineapple production research.

Over the years the university has worked closely with African institutions and leaders to share its experiences. Following nearly seven years of study through workshops, discussions, training courses, and site visits, African participants agreed on the importance of reforms in their own university systems, especially through the creation of new agricultural universities along the lines of the EARTH model.

The case of EARTH University is one of many examples around the world involving major collaborative efforts to disseminate and use scientific and technical knowledge to improve welfare through institutional innovations. Such experiences, as well others from Africa and around the world, offer a rich fund of knowledge that should be harnessed for Africa's agricultural development and economic growth.

5. IMPLEMENTATION ROADMAP

Many models show how to focus on agricultural training as a way to improve practical farming activities. Ministries of agriculture and farming enterprises in African countries should create entrepreneurial universities, polytechnics, and vocational schools that address agricultural challenges. Such institutions could link up with counterparts in developed or emerging

economies as well as institutions providing venture capital and start to serve as incubators of rural enterprises. Establishing such institutions will require reforming the curriculum, improving pedagogy, and granting greater management autonomy. They should be guided by the curiosity, creativity, and risk-taking inclination of farmers. The elements outlined below could act as a roadmap for guiding the implementation of the ideas laid out in this paper.

5.1 Identify concept champions

The first step in upgrading agricultural research institutes involves the identification of a “concept champion”. Agriculture-related constituencies of ministers and other leaders already include people who can serve as champions and advocates for upgrading NARIs into new universities for agricultural innovation. The concept champion will be essential in advancing the ideas at the national, regional, and international levels. Champions will take responsibility for exploring the political feasibility of translating the ideas laid out in this paper into practical action. Much of their work will involve seeking broad political support at the national and regional levels.

5.2 Promote policy and legislative reform

The process of creating universities for agricultural innovation will require supportive policies and possible legislative reform. The policy framework for such actions may already exist in national and regional strategies for agricultural transformation. These policies derive their authority from continental guidelines such as CAADP that stress the importance of investing in agricultural research.

New legal instruments may need to be put in place to foster the creation of new research-oriented universities. There are several ways to approach this depending on available opportunities. The first is to introduce amendments in existing laws to provide for universities for agricultural innovation that include research, training, commercialization and extension. The changes can be made to existing laws on higher education, science and technology, research or agriculture. The second approach would be to introduce new laws creating a separate regime which can be managed by ministries responsible for agriculture in cooperation with higher education authorities. In some cases it may be sufficient to introduce regulations that govern the management of universities for innovation under existing laws without legislative reform.

The key element of such laws and regulations would be to grant sufficient autonomy to the new institutions while fostering excellence in research and practice. Policies and laws for such universities should be written in an inclusive way so other institutions—whether private or public—that meet the established criteria can be designated as universities for innovation.

5.3 Build innovation management capacity

The creation and implementation of universities for innovation will require a cadre of people with expertise in innovation management. This can be achieved through executive education offered to high level leaders responsible for policy promotion as well as the ultimate implementation of agricultural innovation system. In the long run, such courses should be part of

the curriculum of the new universities and should be required for those seeking to work as innovation managers.

5.4 Initiate national pilot projects

One of the roles of the concept champions identified above will be to pilot the idea at the national level. The purpose of the pilot initiatives will be creating a basis for learning about how best to advance the idea of universities of agricultural innovation. The pilots will be carefully chosen to maximize the chances of success and not necessarily to determine the viability of the idea. The lessons learned from the execution of the pilots will be regularly shared by African countries.

5.5 Mobilize additional financial resources

Financing is probably one of the most contentious issues in Africa's history of research and higher education. The perceived high cost of running institutions of higher learning has contributed to the dominant focus on primary education. This policy, however, has prevented leaders from exploring avenues for supporting higher technical education. Creating incentives for domestic mobilization of financial resources is essential for leveraging external support.

There is a wealth of knowledge from around the world on how to finance innovation, which can be leveraged to help African countries identify the diversity of available approaches. These include public as well as private funding. A comprehensive review of known options needs to be undertaken as a matter of urgency.

5.6 Strengthen regional and international partnerships

It is important to establish regional and international partnerships among various institutions to support and develop joint programs. These partnerships should pursue horizontal relationships and open networking to generate more synergy and collaboration, encourage sharing of resources, and foster the exchange of students and faculty. This can be accomplished through regional exchanges that involve the sharing of research facilities and other infrastructure.

Such collaboration could be extended to include international partners through mechanisms such as the OpenCourseware Consortium, a free and open digital publication of educational materials organized as courses. The consortium includes open educational content from 200 higher education institutions and associated organizations. Its mission is to advance education and empower people worldwide through open courseware.

The advent of broadband internet through investments in fiber optic cables offers additional opportunities for the new universities to become part of the global knowledge ecology. Many universities around the world are offering online courses and are using internet connectivity to extend their reach to the developing world. Governments and private enterprises can help strengthen these linkages by facilitating access to broadband facilities.

5.7 Recognize innovation and reward excellence

The tasks laid out above will take considerable dedication, courage and commitment. Such efforts need to be recognized and rewarded. One way to do so is the institute an Agricultural Innovation Prizes for outstanding contributions to strengthening agricultural research in African countries. The prizes would recognize achievements in research, teaching, commercialization and extension.

CONCLUSION

The Comprehensive Africa Agriculture Development Programme is nearly a decade old. Since its adoption in 2003, much of the discussion has focused on the proportion of national budgets devoted to agriculture in general and agricultural research in particular. Although financial resources are critical and require special attention, efforts to reform Africa's agricultural innovation system deserve equal attention.

Over the last decade considerable work has been done to redefine the role of government in agricultural research, decentralize research activities, increase stakeholder participation, identify new financial instruments, and strengthen system-wide linkages. These measures have been purposed on an incremental basis. They have indeed yielded commendable results. The next challenge, however, is to build on these achievements and pursue bold steps aimed at upgrading the status and performance of agricultural institutes by creating genuine innovation systems that involve research, training, extension, and commercialization. This process will be nontrivial and will require bold political action involving high-level leaders. The efforts will come with political risks and debate. Maintaining the status quo, however, is riskier than experimenting with new models. Mistakes will be made. But as Albert Einstein said, "Anyone who has never made a mistake has never tried anything new."