

# Building African Scientific Capacity in Food and Agriculture

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## ABSTRACT

After 50 years of independence, Africa is still a profoundly agrarian continent where 2/3 of the people directly or indirectly derive their living from agriculture. The central question facing African governments and donor agencies today is “What can be done to transform agriculture in Africa?” The most difficult challenge facing Africa is how to borrow and generate new technology that is supported by an efficient set of core institutions that can increase agricultural productivity and reduce poverty. Building an interactive system of three core institutions – research, education and extension – has been, and will remain, a multi-generational challenge. This paper focuses on building African research capacity and graduate education in Africa in an era of globalization.

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## KEYWORDS

Africa, institutions, institution building

## I. Introduction

When Ghana won its independence a half century ago, it was the richest nation in West Africa and its political leaders and intellectuals shared dreams of becoming industrial nations by the year 2000. But under the leadership of Kwame Nkrumah, the government abolished its national extension service for smallholder farmers and built state farms modeled after those in the Soviet Union. Today, Ghana has a struggling agricultural sector and a per capita gross national income of \$590 (World Bank 2009). What happened? Why have Ghana and virtually every country in sub-Saharan Africa (hereafter Africa) failed to develop a modern agriculture after a half century of development projects and billions of dollars of foreign aid?<sup>2</sup>

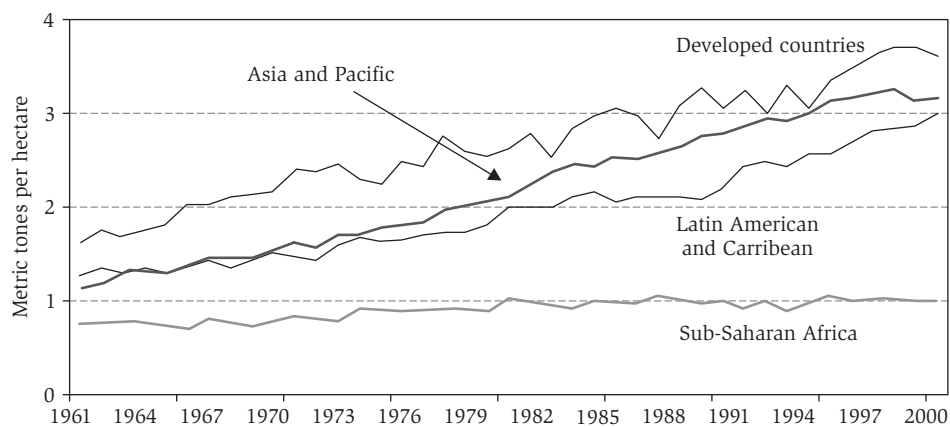
The role of science and technology in promoting African agricultural development has been given boosts of promise and dreams of payoff during its 50 years of inde-

pendence. The first call to action came when Kenya’s Minister of Economic Planning, Thomas Mboya, addressed the 1967 opening meeting of the Economic Commission for Africa and articulated a vision of Africa becoming a major food exporter:

No matter how successful our efforts are to industrialize, Africa will be for many generations, primarily a producer of agricultural and other primary products. We must learn to do it well and on a rapidly growing scale. This will require a massive frontal attack, not only on the research needs to which I have already referred, but also on the practical problems of production, storage, and marketing (Mboya 1967).

Instead of answering Mboya’s 1967 call for African governments to make the hard choices necessary and become food exporters, the following summary dramatizes the current crisis in African agriculture:

- The average yield of cereals has been flat since independence in 1960 (Fig. 1).
- Population growth in sub-Saharan Africa is expected to more than double from 809 million in 2008 to 1,698,000 in 2050 (Thompson, 2009).
- The total donor cost of food aid to Africa swamps donor spending on agricultural development programs such as rural roads, research, and irrigation.
- Farmers in the state of Iowa produced more maize (Africa’s most important food staple) in 2007 than all African countries in 2007 (Baker, 2009)<sup>3</sup>
- From 1987-1997 the World Bank invested \$4.7 billion in agricultural extension and research and \$108 million in agricultural higher education (Willett 1998).
- South Africa, Egypt and Uganda are the only countries in Africa where smallholders are producing GM crops commercially (Table 1)).



Source: World Bank 2005.

Figure 1. Annual cereal yields by region, 1961-2000.

**Table 1.** Seven case studies: Projections of the timeline for the release of GM crops to smallholder farmers in Africa.<sup>a</sup>

| Crop         | Target Country/Region              | Problem Addressed          | Research Started (Year) | Projected Time of Delivering GM Crops to Smallholder Farmers |
|--------------|------------------------------------|----------------------------|-------------------------|--|
| Sweet potato | Kenya                              | Feathery Mottle Virus      | 1991                    | 8 or more years  |
| Potato       | Egypt <sup>b</sup><br>South Africa | Potato Tuber Moth          | 1993                    | 4 or more years  |
| Maize        | Kenya                              | Maize Stem Borers          | 1999                    | 4 or more years  |
| Cotton       | Major cotton growing countries     | Cotton Bollworms           | 2000                    | 5 or more years  |
| Banana       | Uganda                             | Banana Weevil and Diseases | 2000                    | 7 or more years  |
| Cowpea       | West Africa                        | Pod Borer                  | 2001                    | 8 or more years  |
| Cassava      | Kenya, Nigeria, Malawi             | Cassava Mosaic Virus       | 2001                    | 8 or more years  |

a. Excluding South Africa where GM crops are commercially grown by farmers.

b. Michigan State University Bt potato research with Egyptian scientists was discontinued in 2001.

The priorities of Africa's new universities in the sixties were focused on training B.S. students to replace colonial research officers and teachers. African universities were set up primarily for teaching purposes, while the Ministries of Agriculture continue to carry out research and extension programs. But most new governments invested in industrialization as a means of bypassing the agrarian stage of development. However, the industry-first strategy failed throughout Africa. Over the past 50 years, the experience of Asia and Latin America has demonstrated that there are four main drivers of development: human capital, technology, institutions and biological and physical capital. The coordination and sequencing of these interlinked investments is a complicated political exercise at both the micro and macro levels (Bonnen 1998). For example, Uma Lele studied the agricultural development experience of six countries in Africa in the eighties and concluded that "the World Bank has not had a long-term strategy for broadly-based growth in Africa, nor has it fully appreciated the need for a balanced accumulation of human, institutional and technological capacity for an appropriate sequencing and phasing of investments" (Lele 1991).

This chapter discusses how to improve two key scientific institutions serving African agriculture: building agricultural research capacity and expanding graduate education in agriculture in Africa (Eicher 2006). However, both challenges must be addressed in an era of difficult funding constraints that are affecting African government and donors. While total aid to developing countries grew from US\$7 bil-

lion in 1980 to US \$27 billion in 2006, the amounts spent on agriculture plummeted from 20 percent in 1980 to 15 percent in 1990 and only 4 percent in 2006 (Fan et al 2009). In addition, African governments have spent much less on agriculture than their counterparts in Asia. For example, African countries allocated 5 to 7 percent of their total national budget to agriculture as compared 6 to 15 percent in Asia during the Green Revolution era. In 2006, for example, most African countries spent 3 to 6 percent of their aid budget on agriculture. Moreover, a recent study in Zambia found that the largest recipient of government expenditures on agriculture was fertilizer subsidies for large scale farmers.

## II. Agriculture and Poverty Reduction

There are several key questions about the payoff to investments in agricultural research and the role of technology-driven growth in reducing poverty and driving down real food prices (World Bank 2007). Byerlee et al (2006) reported that the literature on the contribution of agriculture to pro-poor growth attributes a central role to rapid increases in agricultural productivity based on the application of modern science, especially in Asia where the success of the Green Revolution is “unambiguous”. But in Africa, only a few countries have experienced rapid and sustained productivity growth in agriculture.

Four examples illustrate the importance of public investments in research and graduate education in agriculture through an accretionary model of capacity building over a period of decades:

- African countries are under stress because of human capital degradation, HIV/AIDS, retirements and the brain drain (World Bank 2007).
- There is a growing gap between a comparatively small group (China, India and Brazil) of scientific haves and a substantial group of have-nots. This is especially distressing for Africa because it has continued to lose market shares of expenditures on agricultural R&D (Pardey et al. 2006).
- Technical assistance is a useful stopgap measure to provide experience, technical information, and global experience to Africa. However, it can be self-perpetuating unless it is coupled with the development of local training and research institutions because “a succession of expatriates learns more and more about developmental decision-making while the Africans below them in the hierarchy become progressively more alienated and discontented. The experience and collective “memory” which is accumulated during the process of development is thus appropriated by foreigners who subsequently leave the country carrying these invaluable assets with them” (Helleiner, 1979).

- The capacity to use foreign technical assistance effectively depends on local capacity to frame the problems appropriately, drawing on local knowledge coupled with scientific capacity to identify what outside expertise is needed.

### III. Building Agricultural Research Capacity

African political leaders and donors have been reluctant to make long term accretionary investments in science and technology to increase agricultural productivity, boost staple food yields and drive down real (inflation adjusted) food prices. This is a proven way to reduce urban poverty and the poverty of rural families who are net food buyers (Tollens 2001).

But Africa has a weak scientific foundation for developing a modern agriculture. Long- term public investments are required to build the scientific and institutional foundation for a modern agriculture. This is a tall order but this is what the United States accomplished from 1860 to 1920 and what Japan did from 1868 to 1914 and what Brazil, Argentina and Chile have achieved over the past 40 years.

Many African countries are losing their research capacity to deal with the bread and butter problems such as the loss of soil fertility, and *Striga*. Most countries are also ill-prepared to address global warming, building supply chains and carrying out GM research. One reason for this dilemma is that one half of the 27 African countries for which data are available spent less on R&D in 2000 than in 1991 (Pardey et al 2006).

#### A. From Colonial to National and Global Research Networks and Partnerships

The colonial period started in 1885 when the great Western powers met in Berlin and decided how to carve up Africa. In the intervening years until 1912, Africa was colonized with the exception of two independent nations, Liberia and Ethiopia. The independence movement started in the 1930s and Sudan won its independence in 1956. Namibia's independence in 1990 brought European colonial rule to an end. Today sub-Saharan Africa consists of 51 independent nations.

The colonial research era was launched in 1900 when fledgling research institutes were established in most colonies to carry out research on export commodities.<sup>4</sup> Following World War II, the colonial research system was greatly expanded. The colonial research experience embraced many failures such as chronic underinvestment in the training of African scientists and the pursuit of inappropriate research strategies in land-abundant countries. Despite these shortcomings, some important colo-

nial institutional innovations in organizing, financing and executing research have relevance for the CGIAR and the NARS of Africa (Eicher, 1989).

Three institutional innovations were introduced during the colonial research era in Africa from 1900 to 1960. Because of the large number of small countries in Africa, regional commodity research institutes were an imaginative institutional innovation in both Anglophone and Francophone Africa. These regional centers had a small number of well paid scientists, continuity of colonial funding, and administrative continuity. But after independence in 1960, political infighting undermined colonial regional research organizations, and most of them were replaced with national research organizations. For example, five years after Nigeria's independence, the West African Institute for Oil Palm Research station in Nigeria was renamed the Nigerian Institute for Oil Palm Research (NIFOR). The lesson is that the regional research model is scientifically attractive, but it is not a politically viable research model at this stage of Africa's political history. As a result, most regional research organizations and networks will require an indefinite infusion of foreign aid (Byerlee and Alex 1998). Table 2 illustrates how difficult it has been to generate donor funding for SARNET, a regional organization for cassava and sweet potato research.

In most cases, three to four scientists, and in a few cases, no more than half a dozen scientists, formed the commodity teams that produced hybrid maize in Zimbabwe and Kenya, rust-resistant wheat in Kenya and high-yielding soybeans in Zimbabwe. The famous INEAC research system in Zaire carried out a balanced research program in the 1930s on basic and applied research and both food and cash (export) commodities. The Cote d'Ivoire, Nigeria, Malaysia and Indonesia borrowed the basic breeding strategy for hybrid varieties from INEAC and developed varieties for their local conditions. These success stories demonstrated that national agricultural research organizations in Africa can be productive and they can generate spillovers of benefits to neighboring countries.

The Empire (British) Cotton Growing Corporation was a brilliant institutional innovation that was launched in Africa in 1921. The Corporation recruited agricultural scientists of high caliber by offering career opportunities that were not dependent on the research programs within a single colony. The Corporation was a precursor of similar networks established by the Belgian government in the Congo, and by French scientific organizations in Francophone countries. In Francophone Africa, several regional research networks are still in operation, such as the IRCT/CFDT (Dagris) cotton research, extension and an international marketing network. The Malian cotton company is called CMDT – Compagnie Malienne de Développement des Textiles. It is jointly owned by Dagris, the Malian Government, and the Malian Cotton Farmers Union. The Malian cotton subsector is currently in disarray, with acreage having fallen by over 50% in the last 3 years, as farmers have abandoned cotton because of low prices and the failure of the CMDT to pay them on time. The impression among many is that current research networks serve in part simply to provide salary supplements to scientists via per diems to attend meetings. Would re-

**Table 2.** The Discontinuities inherent in using Donor Projects to Support Cassava and Sweet Potato Research in Eastern and Southern Africa, 1986 to 2008.

|           |   |
|-----------|---|
| 1986-1993 | IITA (The International Institute of Tropical Agriculture) in Nigeria established an Eastern and Southern Africa Root and Tuber Network (ESARRN) with USAID as the main donor. IDRC financed some bilateral research projects (e.g. Malawi).  |
| 1993      | IDRC bilateral funding to Malawi was terminated. From 1989 to 1994, an FAO breeder with UNDP funding strengthened the Malawi national root crops program.   |
| 1994      | USAID office in Malawi and later its Regional Office – RCSA – helped establish the Southern Africa Root Crops Research Network (SARRNET). SARRNET was managed by IITA and it had one Internationally Recruited Scientist (IRS) for each of the following countries: Malawi, Tanzania, Zambia and Mozambique.  |
| 1996      | USAID/OFDA (Office of Foreign Disaster Assistance) financed an emergency food recovery program for cassava and sweet potato with one IRS based in Zimbabwe.   |
| 1998      | Due to the termination of funding and the end of phase 1 of SARRNET, the IRS positions in Tanzania and Zambia were terminated and the SARRNET office was closed in Zambia.  |
| 2000      | SARRNET launched phase 2 with one IRS for Tanzania and a new SARRNET Coordinator based in Malawi.   |
| 2001      | USAID/OFDA assistance was terminated and the SARRNET office was closed in Zimbabwe.   |
| 2001      | Regional USAID support was terminated in Mozambique and the SARRNET office was converted to a bilateral office with support from USAID Mozambique.  |
| 2003      | SARRNET Phase II was completed in August and the IRS position was terminated in Tanzania.   |
| 2004      | SARRNET Coordinator position and regional activities are supported by regional funds from the U.S. Presidential initiative to end hunger in Africa (IEHA), with emphasis on Zambia, Mozambique and Malawi until August 2004. It is planned to increase the number of countries and SARRNET activities over the 2004 to 2010 period.   |
| 2005      | Funding through IITA was discontinued. SARRNET activities were funded for one year through a consortium led by Oregon State University (OSU) to cover activities only in Chinyanja Triangle (parts of Northern Mozambique, Eastern Zambia and Central/Southern regions of Malawi all speaking the Njanja – Chewa-language). Activities also in Angola and South Africa. Few partners of the consortium dropped and new ones were added. |
| 2006      | Funding through OSU was discontinued. IITA channeled the funds for the Chinyanja Triangle consortium and SARRNET funded for one year.   |
| 2007      | SARRNET funded for one year through the consortium led by IITA covering the same Chinyanja Triangle + Angola and South Africa. During FYY07, USAID/RCSA changed to USAID/SA (Southern Africa) and later on the USAID regional office in Gaborone closed by July 2007. Chinyanja Triangle consortium managed by USAID/Pretoria.  |
| 2008      | SARRNET funded for one year through the consortium led by IITA but USAID/SA funds to IITA to be channeled through the World Bank as per CGIAR agreement while USAID/EGATT supervises the consortium from Washington. Uncertainty of continuity after 2008.  |

**Source:** Nzola-Meso Mahungu 2/9/2008.

search be more productive if the same resources spent on per diems for meetings went to them as salary supplements to simply stay at their home stations and do their research? The lesson is that commodity research networks should flow from a solid research base, not from a decision by a donor agency to set up a network to promote scientific interchange.

The post-independence experience of NARSs in Africa from 1960 to the present day is instructive. In the early 1960s, virtually every regional research institute in Anglophone Africa was either phased out or taken over by the NARS of national governments. But political instability undermined the continuity of scientific investigation and financing of NARS and sparked a constant reorganization of national research systems and a changing parade of donors over the past five decades. Most NARSs have experienced difficulty in building domestic political support for research. Even in Zimbabwe, where there was a strong organization representing commercial farmers (Commercial Farmers Union), the government recurrent budget for agricultural research declined 25 percent from independence in 1980 to 1990. Most donor projects to assist NARS focus on technical and organizational issues at the sub-political level and shy away from pressing for increased indigenous political and financial support for research.

Vernon Ruttan (1983) sums up what happened during Africa's early days of Independence:

External assistance provides an alternative to the development of internal political support. National research directors have frequently found that generating external support requires less political effort than developing domestic support and have chosen the easier path. The system of external support needs to be reformed in a way that will redirect political entrepreneurship toward building domestic support for agricultural research.

Africa's five decades of independence have been marked by a dramatic increase in the number of researchers and a decline in research productivity of many NARSs. The expansion of the size of NARSs has been guided by domestic political interests in expanding the state bureaucracy, replacing expatriates, and initiating research on a large number of commodities. This expansion of the number of commodities covered came in large part from donor pressures, who argued that food crops, women's crops, and orphan crops had been ignored relative to export crops in the colonial era. In addition, the breakdown of regional research meant that such research took place in small NARS, where a critical mass of research capacity was hardly ever achieved in any of these commodities.

Africa's institutional challenge is basically a search for innovations to deal with the small country problem. African nations have come full circle from regional colonial institutions to a rapid build up in NARS in the 1960-80 period and more recently regional and global networks. Although regional and sub-regional research networks are popular among African research managers, Table 2 shows the uneven flow of donor and African funding for SARRNET (South African Root Crop Re-

search Network). SARRNET's experience illustrates the rule rather than the exception concerning funding for regional research.

#### B. The Gates Foundation and the African Farmer

Without question, the decision of the Bill and Melinda Gates Foundation (BMGF) to invest in African agriculture and supporting institutions has encouraged some donors to increase their support for agriculture in Africa. Several reasons explain this decision. First the BMGF's commitment to agriculture is an admission that the Foundation's massive investments in health and education in Africa are unlikely to be financially sustainable unless they are financed by rising rural incomes.

Second the BMGF has developed an alliance with the Rockefeller Foundation and pooled \$100 million from BMGF and \$50 million from the Rockefeller Foundation to generate Green Revolutions in Africa over the coming five years. The Alliance for a Green Revolution in Africa (AGRA) is developing high-yielding food crop varieties, and it draws on experience of the Rockefeller partnership with the Government of Mexico that began in 1943. Under this program, Norman Borlaug won the Nobel Peace Prize for his role in the development of high-yielding Mexican wheat varieties that were transferred to India in the 1960s and served as the foundation of the Asian Green Revolution (Lele and Goldsmith, 1989).

But we must bear in mind that if the Alliance's budget of \$150 million were equally distributed to the 50 countries in sub-Saharan Africa, it would represent only \$3 million per country over the coming five years. The Gates Foundation's decision to invest in agriculture is important because of its focus on crop breeding research on a few food security crops complemented with investments in seed production, credit, graduate training and pilot extension models. The Alliance's budget will have to be supported by complementary investments from other donors and African governments in building rural roads, biotech labs and rebuilding extension services and irrigation systems.

Third, the Alliance has broadened and operationalized the AKIS (African Knowledge Information System) paradigm of interlinked investments in education, research and extension by adding input and product markets to ensure that NGOs, producer groups and private input suppliers are working with public-sector crop breeders (Maertens 2008). To summarize, the Alliance represents a turning point in thinking about what needs to be done to generate African Green Revolutions. Because of the failure of the single input (fertilizer, seed, and grain banks) and single factor (extension, credit) models to develop African Green Revolutions, the Alliance is carrying out studies of seed, fertilizer and credit programs.

India's Green Revolution experience offers some important insights for the implementation of the Alliance's strategy for Africa. In the early sixties, USAID, Rockefeller Foundation and the Ford Foundation assisted India's Ministry of Agri-

culture in building the scientific foundation for training scientists and boosting cereal yields in India. India reached a consensus on how to tackle its agricultural education problems by setting up commissions (e.g., Indo-American Study Teams) that held meetings throughout India, visited a large number of overseas countries and observed different agricultural institutions in practice (Goldsmith 1990). These meetings helped nurture political and scientific agreements on whether to develop and set up a new type of agricultural university – the State Agricultural University. To train Indian scientists at the graduate level, USAID helped pay for 1000 Indian scientists to pursue graduate studies in the United States and mobilized five U.S. universities to help develop nine new State Agricultural Universities (SAUs) and supply 300 professors on two or three year assignments. Today there are 41 SAUs in India, with at least one in every state in India.<sup>5</sup>

### **C. The Challenge of Borrowing and Developing Biotechnology**

In 1982, M.S. Swaminathan published a visionary paper on the need for new sources of agricultural productivity to feed the world. He called attention to the promise of agricultural biotechnology, and a decade later commercial farmers in some industrial countries were growing GM crops. During the early nineties, it was commonly assumed that it would only take an additional 4 to 6 years of field trials and setting up bio-safety and environmental regulations to enable small-scale farms to grow GM crops in developing countries. South Africa, Uganda and Egypt are currently the only countries in Africa where smallholders are growing GM crops on a commercial basis. (Eicher, Maredia and Sithole-Niang 2006). Based on experience in Africa, the time horizon for getting more GM crops grown commercially by smallholders is likely to require another 10 to 15 years for many countries. This forecast is based on the time it will take to overcome scientific, political, legal and economic barriers, as well as long delays in developing biosafety regulations and environmental guidelines.

The four critical GM issues currently being debated are time, cost, risk and human capital requirements. Resolution of these issues is critical in speeding up biotech adoption in a safe and sustainable number. A Michigan State University example illustrates the cost, time and risk involved in GM crop research in Africa. In 1993, MSU researchers launched a GM potato research program with Egyptian scientists, but the government of Egypt discontinued the partnership in 2001 because of a fear that Egypt's future potato export market to Europe might be curtailed by NGOs opposed to GM crops. As a result, Michigan State scientists shifted course and developed a partnership with the Agricultural Research Council in South Africa. However, questions have now been raised about possible cross-border environmental problems. Currently, the transfer of the bt potato to smallholder farmers in Africa is stalled after 16 years of research in Michigan, Egypt and South Africa because the

multi-national biotech firm that holds the patent on some of the bt genes is raising some questions about possible legal problems surrounding the release of the new potato. Few African countries can afford the risk of investing several million dollars in GM research and incurring legal fees over a period of 10 to 20 years.

The time, cost, risk and human capital requirements for research on biotechnology will be insurmountable for many small countries in Africa (Tollens 2002). Since borrowing is going to be the primary source of new biotechnology for most small countries in Africa, it behooves each country to train a few scientists to the Ph.D. level so they can help African political leaders make science-based decisions on whether to borrow, what to borrow and how to carry out field trials and applied research and develop bio-safety regulations. They also need to engage civil society in a broad and empirically informed debate about the pros and cons of GM products. The failure of government and the scientific community to engage civil society in such a debate has ceded the ground to the NGOs that are opposed to GM crops. Although technology-borrowing appears to be a simple task, Evenson (1977) has pointed out that surprisingly it takes roughly the same level of economic and technical skills to become an efficient borrower of technology as it does to develop new technology. Therefore, most countries in Africa should have a few highly trained experts in biotechnology who can make science-based recommendations to African governments on patents, food aid, food safety and environmental issues surrounding the use of GM technology. The bottom line is that 50 to 100 African scientists should be trained in biotechnology at the PhD level. Most of these will have to be trained overseas in the next one to two decades. However, even if some Ph.D.'s help make "science-based" decisions on whether and what to borrow, the record thus far shows that the decisions regarding GM adoption are ultimately political. Thus, countries need to take a much broader approach than simply training a few scientists at the Ph.D. level if they want to consider pursuing GM crops.

#### IV. Building Graduate Education Capacity in Africa

Universities are on the rebound in Africa. The second wave of debates on the role of science and technology in development was stimulated by (Gaillard 2003, and Saint 1992). The Chicago Council on Global Affairs recently completed a major study of global hunger and poverty and made five recommendations. The first recommendation was to "increase support for agricultural education and extension at all levels in sub-Saharan Africa and South Asia" (Chicago Council, 2009, p. 63). Now that aid flows are being restored for African agriculture, it is timely to draw on the global and historical experience and ask what can be learned about building graduate education programs in other parts of the world. When the Rockefeller Foundation decided in the 1950s to shift program support from Europe and the

United States to developing countries, it was faced with a critical problem of choice. It recalled previous periods when “scatterization” prevailed and one case when separate grants were made to 50 separate institutions in a single year in Latin America. But an evaluation team concluded that the impact of the 50 grants was “minimal” (Thompson 1972). As a result, the trustees and the officers of the Foundation decided on the principle of concentration and decided to assist only one university per country “that had the potential of serving national or regional needs” (Thompson 1972).

But today there are more than 100 African universities with a Faculty of Agriculture and new universities are being added each year (e.g. Senegal, Ethiopia and the Cameroon). The scatterization strategy to institution building is very much alive in Africa today and should be examined by African political leaders, educators and members of the donor community.

During the Green Revolution in Asia in the 1960s Thompson (1972) reports that Foundations meetings with prospective universities were invaluable in raising some hard questions such as:

- What is to be the role of your university in a wider geographic region?
- How do you weigh numerical growth against the pursuit of excellence?
- What are some examples of your university serving regional needs?
- Has the university leadership made a fresh and self-critical review of its strengths and weaknesses?
- How far has it gone in establishing priorities for determining points of emphasis next year, and three to five years hence (1972)?

There is growing evidence that graduate-level training in agriculture in Africa should be accelerated because of the rising cost of overseas training, the unacceptably high percentage of students who remain overseas after degree completion and the declining number of relevant courses in tropical agriculture that are now offered in overseas universities. There is an urgent need for innovations to speed the transition from overseas to African-based graduate training. But first we shall examine the strengths and weakness of graduate training outside of Africa (Eicher 2006).

Africa is currently experimenting with regional and Pan African graduate degree programs. For example, the African Economic Research Consortium (AERC) is offering an Africa-wide Ph.D. in Economics. Likewise, 12 countries in Eastern, Central and Southern Africa are offering collaborative M.S. degree in agricultural economics. More recently the University of Kwa Zulu Natal in South Africa is offering a M.S. and Ph.D. degrees in Crop Science. The African agricultural economics, and crop science models of higher education are often called the “silo approach” to developing human capital. The silo approach has many advantages, including the ability to focus on a critical discipline. But I am unaware of any strong Faculties or Universities of Agriculture that have been built by strengthening one or two disciplines. The faculty model was used to train 1000 Indian scientists in many different fields of

agricultural specialization in the United States in the sixties and seventies. The same faculty and university institution building approaches were used in Brazil. The following hard questions should be debated in Africa: What are the essential skills in agriculture that should be taught by African Faculties of Agriculture and overseas? Should private schools be established to train the new skills required in food science, supply chain management, finance and other skills demanded by the private sector? Where should they be trained (South, North, South and North and South/South partnerships)? How will they be trained (e.g., distance education)? Should donors be encouraged to contribute to the development of entire faculties or universities of agriculture or helping fill a few silos, discipline by discipline?

#### A. **Relevance of Overseas Training**

In many industrial countries, the agricultural sector now directly contributes less than 2% to GDP. In response to this decline in agriculture, some Faculties of Agriculture in Europe have changed their titles to a Faculty of Bioscience or Bioscience and Engineering or Life Sciences. For example, Wageningen Agricultural University in the Netherlands changed its name to Wageningen University and Research Centre (WUR). The Agricultural and Veterinary University of Copenhagen has merged with the Danish University of Sciences and the University of Copenhagen. It is now called the Faculty of Life Sciences of the University of Copenhagen, the largest university in Scandinavia. Neither agriculture nor animals nor livestock are mentioned on the KVL website because of student concern in Europe over the environment, health (animal diseases) and animal welfare problems. For example, in the Netherlands today, food and livestock production concerns form only part of the agenda of the Ministry of Agriculture, Nature Management and Fisheries. The same is true in the US, where roughly 50% of the USDA budget deals with food and nutrition assistance programs, not food production.

As a result of the broadening of the agricultural curriculum in European universities, tropical agriculture has been relegated to a minor specialization. Courses in tropical agriculture are usually taught as a part of “rural development in the tropics”. These factors help explain why Wye College in the U.K. recently closed its program after offering courses in tropical agriculture for 125 years. With population doubling in many countries in sub-Saharan Africa in 25 to 30 years, food production needs to be increased to help meet food security goals. African scientists require training in the traditional applied disciplines such as soil fertility management, plant breeding and plant protection, post-harvest management, livestock production and animal feeding. The bottom line is that these applied courses in tropical agriculture should be shifted from overseas to African universities and increased reliance on graduate training in Asia (e.g., India, China, Malaysia) and Latin America (Brazil, Argentina). One of the advantages of overseas training is

that it allows students to see different ways of organizing the economy and research from that practiced in their home countries. This permits more “thinking outside the box” when students return home. Another advantage is that students get plugged into a broader international professional network, e.g., through meeting fellow graduate students from throughout the world who will serve as his/her future professional peer group. The issue of overseas training is particularly relevant given the large number of scholarships for graduate training currently offered by China to Africans.<sup>6</sup>

### **B. The Returnee Problem: New Evidence**

African educators and donor specialists have learned a great deal about the brain drain and how to slow it down. The Agricultural Development Council (ADC) of New York provided fellowships for 532 Asian students for overseas study over the 32-year life of the Council and an impressive 91 percent of the students returned home (Stevenson and Locke 1989). The total expenditure of the ADC over its three-decade existence was \$100 million (expenses adjusted to 1985 dollars). The reasons for the high returnee rate were the institutional innovations, mentoring and incentives that were assembled to help students upon returning home. These incentives included funding to attend professional meetings, small research grants and a supportive environment for young scholars to build productive careers as teachers, researchers and agribusiness managers at home.

A recent study by Jamora (2007) tracked the pathway of 97 M.Sc. and Ph.D. graduates enrolled in the USAID-financed CRSPs (Collaborative Research Support Programs) in 15 countries in Latin America and Africa over the 1980 to 2005 period. Jamora found that 84 percent of the graduates had returned home, 12 percent remained overseas and 4 percent were still in school. The logical question is why were the returnee rates so high in the ADC study in Asia and Jamora’s recent CRSP study in Africa and Latin America? The answer is basically the same: students were carefully observed in their home countries by visiting U.S. researchers before being awarded a scholarship, they were mentored in US classrooms and labs, they maintained their research links and secured modest research grants to do their thesis research at home. The lesson for African governments and donors is that long-term training should be sponsored by NARS and Faculties of Agriculture to enable researchers who have completed their M.S. and Ph.D. degrees to return home and have access to laboratories and economic incentives to perform as researchers, teachers and agribusiness trainers. The bottom line is that long-term training by itself is a narrow and incomplete approach to capacity building for both the public and private sectors.

Plans should be developed to increase M.Sc. training in agriculture within Africa over the coming decade (World Bank 2007). There is also a need to train roughly

1,000 Ph.D.s in the major fields of agriculture at home and abroad over a 15-year period. About half of the 1,000 will probably need to be trained abroad, over a period of a decade until African Ph.D. programs are being established. It would be a mistake, to design a human capital investment strategy based on the training of all Ph.D.s in all fields of agriculture solely within Africa (Eicher 2006).

Regional models of agricultural training and research were productive during the colonial period and the early years of Africa's independence. But development specialists have few answers to the difficult problem of financing regional organizations and regional centers of excellence. The wave of the future should be to encourage regional knowledge networks and regional training programs and increase the use of ICT. Donors should explore investing in "invisible regional centers of excellence" such as the Faculty of Agriculture at Katibougou in Mali, where 25 percent of its students are currently from six surrounding countries. Donor support of a million dollars a year for the coming ten to fifteen years might eventually turn Katibougou into a small but highly productive regional center of excellence in West Africa. Locating the new Nigerian Institute of Science and Technology at Abuja rather than near a university is questionable.

The CGIAR links with African universities are all too tenuous. The training challenge is mentioned in the CGIAR (2006) training study, but CGIAR centers have been unable to mobilize funds for stepping up CGIAR training within Africa. However, the CGIAR still plays a role in helping to supervise research through dissertation research fellowships. Based on the experience of the last two decades, the most productive model is for the CGIAR to partner with Universities, and help supervise dissertation research.

Fienup (1976) studied capacity building in Latin America in the 1960s and 1970s and concluded that the most critical sustainability requirement for a quality M.S. graduate program is some minimum core of competent, full-time national staff with Ph.D. level training and dedication to defined teaching and research objectives. It is difficult to specify the minimum size of this core, but it should probably include no less than four or five Ph.D.'s in a given discipline to provide the necessary vision, leadership, financial management and incentives for carrying out both teaching and research activities.

## V. Internationalization of Higher Education and Research

Since development is basically a process of borrowing ideas, technology and learning-by-doing, it is important to understand what India learned from the Japanese experience in designing its higher education system. Japan's *Meiji* Revolution of 1868 launched a quest for gaining scientific knowledge from abroad. Japan sent a large mission to the United States and Europe that brought home a number of me-

chanical innovations, new crops and agronomic practices. Japan also imported teachers from the United States and Europe and sent over 600 Japanese students overseas to study agriculture (Bassala 1967). India and Brazil followed the Japanese training model and each sent about 1000 students overseas for training in agriculture in the 1960s and 1970s.

India has 100 years of experience in agricultural teaching programs and it is aggressively pursuing the internationalization of higher education. Currently one million Indian students are studying abroad at an annual cost of over \$4 billion. India has been especially adroit in developing regional and global linkages in food and agriculture (Paul 2009). Today India has 41 State Agricultural Universities (SAUs) and many are signing partnerships with overseas universities and research institutes. The SAUs are being charged to play a major role in research on agricultural productivity and training a new category of undergraduates to address new problems such as climate change, globalization and markets. Market-driven curriculum reforms are being pursued at both the undergraduate and graduate degrees. India has the capacity to train a large number of African graduate students every year in fields such as agribusiness, irrigation, marketing, and trade.

EMBRAPA the NARS of Brazil, has a budget of US \$300 million, and over 2000 scientists and it plans to add another 300 in the near future. Currently, Brazil is spending 40 times as much on agricultural research as Nigeria (World Bank, 2009). Brazil has opened an office in Accra with an aim of promoting scientific cooperation between Brazilian and African universities and NARS.

China is a startling example of how a large country can rise from poverty within a generation. In 2004 10% of the people in China were living in poverty as compared with around 40% in Africa (Ravallion 2009). China is aggressively building human capital chains with African teachers and researchers. Some African countries are currently receiving more graduate scholarships from China than from any other country. Recently the Chinese Academy of Sciences announced plans to attract 1500 top researchers from throughout the world to come to China and work along with China's senior scientists and promising foreign researchers more research funding than they were receiving at home. China's aggressive plan to help Africa develop its human capital should be debated with participants from the North and South. Without question, China's bold moves are helping move from donor promises of South-South partnerships to operational partnerships.

## VI. Lessons and Implications

1. Africa's historical experience in building scientific capacity in food and agriculture has shown that an indigenous and cost-effective human-capital renewal system is central to the long-run sustainability of African universities and research

and extension systems. Because of the brain drain and the cutback in foreign aid for overseas training, it follows that African universities are needed to train graduate students and increase Africa's scientific capacity (Eicher 2006).

2. There is empirical support for the proposition that the accretionary and virtually invisible process of borrowing technology requires the same capacity as inventing and developing new technology at home. Some countries such as Nigeria, Kenya, Uganda and Senegal are developing science and technology policies to support the development of new technology within Africa.
3. Because policy reforms have failed to reduce poverty in Africa, there is a growing awareness that institutions matter as much as policies for accelerating development.
4. Many universities in Africa have more agricultural scientists with M.Sc. and Ph.D. degrees than are employed by their NARS. However, most African universities have difficulty in developing research partnerships with NARS and the CGIAR centers.
5. The CGIAR system is facing another "Quiet Crisis". Buoyed by the important role that it played in Asia's Green Revolution, the CGIAR system added five new Centers in the early 1990s without an assurance of political support from donors to finance 30 to 50 percent of the core budgets of the Centers. The CGIAR has responded to its over-expansion error by reducing the number of Centers from 18 to 15. Since the CGIAR system allocates around half of its total budget to Africa, it is important to solve its financial crisis. Fortunately, the Gates Foundation is providing badly needed financial support to the CGIAR system.
6. Africa has 51 countries but many are too small to finance high quality graduate programs and a critical mass of researchers. To address the "small country" problem, most African governments and donors have tried for 50 years to organize and finance regional research programs, research networks and regional graduate programs. But many of the regional models are financially unsustainable. New models of private education are needed to develop the skills demanded by the market. But private investment in African research and training trails the expanding role of the private sector in agriculture in both Asia and Latin America. The bottom line is that foreign aid will be needed for a period of decades to help craft and build global research and educational partnerships to address the small country problem (Tongoona et al. 2007).

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## NOTES

1. Carl K. Eicher, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan 48824-1039 USA, phone: 517/353-9330, fax: 517/432-1800, e-mail: ceicher@msu.edu.
2. Sixteen African colonies won their independence in 1960.
3. Doyle Baker personal communication, March 30, 2009. The Markets and Trade Division of FAO/Rome reports that all countries in Africa produced 49,718 thousand tons of maize in 2007 while farmers in Iowa produced 59,423 thousand tons of maize in 2007.
4. The history of colonial research in Africa is captured in the following studies: Storey 1950, McKelvey 1965; Eicher and Baker 1982, Hodge 2007 and Haggblade et al. (forthcoming).
5. T.W. Schultz (1981) has described the SAU as “a brilliant institutional innovation” because it directed the new universities to focus on a triple mission of teaching, research and extension and it helped decentralize decision- making down to the states in India.
6. Where in Europe or North America would an African agronomist receive training in the agronomy of oil palm, cassava or rubber production?

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