Capacity Development for Modernizing African Food Systems (MAFS) Working Paper

The Evolution of Agricultural Education and Training: Global Insights of Relevance for Africa

By

Carl Eicher and Steven Haggblade

MAFS Working Paper No. 4
April 2013

The Modernizing African Food Systems (MAFS) Consortium

IFAD International Fund for Agricultural Development · Makerere University · Michigan State University · Universiteit Stellenbosch University · Universiteit van Pretoria / University of Pretoria / Yunibesithi ya Pretoria

Modernizing African Food Systems (MAFS) Consortium

Objective: The MAFS Consortium aims to help African agricultural education and training (AET) institutions develop the technical skills and institutional capacity required to modernize African food systems.

MAFS Consortium Members:

- Makerere University
- Michigan State University
- Stellenbosch University
- University of Pretoria

Activities and Outputs: The MAFS Consortium has assembled a technical team from four major agricultural universities to produce a series of empirical background studies that will provide evidence necessary for informing capacity development efforts in African AET institutions. Substantively, the activities center around the following four thematic areas.

Theme 1. Food System Dynamics in Africa and Consequent Skill Requirements in the Private and Public Sectors

Theme 2. Models of AET Engagement with Private and Public Sector Employers

Theme 3. Existing Capacity of African AET: Case studies of African universities with regional footprints

Theme 4. Impact of past AET institution-building efforts in Africa

Advisory Board:

- Chair, Prof. Richard Mkandawire, Vice President African Fertilizer and Agribusiness Partnership (AFAP)
- Dr. John Purchase, Chief Executive Officer, Agricultural Business Chamber, South Africa
- Dr. Irene Frempong, Director, Capacity Strengthening, Forum for Agricultural Research in Africa
- Prof. Hamidou Boly—Coordinator, TEAM-Africa based at RUFORUM, Makerere University, Kampala
- Dr. Maggie Kigozi—Formerly Executive Director of the Private Sector Foundation in Uganda

Funding:

- The MAFS Consortium gratefully acknowledges financial support from the International Fund for Agricultural Development (IFAD).

CONTENTS

"Since most African's are farmers, raising the productivity of farmers is a *sine qua non* of raising the African standard of living." W. Arthur Lewis, 1955.

"Are we learning from history?" Derek Byerlee 2013.

1. INTRODUCTION

In 1959, on the eve of Africa's independence, Africa exported modest food surpluses while India confronted a food crisis. Facing the threat of a 28 million ton shortfall in food grain supplies, the Government of India requested Ford Foundation funding for an international team of agricultural experts to prepare an emergency report recommending measures to address India's projected food shortfall. The ensuing report, *India's Food Crisis and Steps to Meet It*, became one of the most influential reports in Asian development circles in the 1960s (Ford Foundation 1959). The team called for an increase in the number of trained scientists, stepped-up research on food crop production and the import of new technology as key drivers of agricultural development. With strong political leadership, continuity of government funding and donor guarantees of food aid to feed the cities for a decade, India began a sixteen year march to push up wheat and rice yields until it became self-sufficient in 1981.

To achieve these gains, India invested heavily in human capital, sending nearly 1,000 students to the United States in the 1970s to pursue Ph.D. degrees in various fields of agriculture. India developed a new model of agricultural higher education, the State Agricultural University (SAU), drawing on the U.S. Land Grant model by building at least one SAU in each state during the late 1950's and 1960s. T.W. Schultz referred to the SAU investments as a "brilliant institutional innovation" (Schultz 1964).

After the Green Revolution successes in Asia, the table turned and Africa became home to the world's food crises (Eicher 1982). While cereal yields nearly doubled in Asia between the mid-1960's and the mid-1980's, from 1.4 to 2.5 tons per hectare, African grain yields remained flat-lined at below 1 ton per hectare. During the Ethiopian famine of 1985, one million people died, alerting the world that Africa was facing a long-term food crisis. Ironically, external funding for African agriculture began to decline shortly thereafter. Total donor funding for African agriculture fell roughly in half, from over $2 billion per year to about $1 billion annually between the mid 1980's and the early 2000's as donors reoriented funding toward for social services such as health and education and away from agriculture (GAO 2008). Simultaneously, donor funding for long-term training dried up (Juma 2011). For example, World Bank funding for agricultural higher education attracted only 2% of global bank funding for agriculture between 1987 and 1997 (Willett 1998). Among African governments, funding for agriculture remained mired at roughly one-half to one-third of the levels prevailing in Asia during the early decades of the Green Revolution (Hazell 2012).

Historically, science-driven agricultural research and technology development have provided the "slow magic" that has enabled sustained agricultural productivity gains in the Americas, Europe and Asia (Pardey and Beintema 2001). Yet over the past generation Africa has underinvested in both agriculture and agricultural education. This underinvestment raises a critical question. Where will the next generation of Africa's agricultural researchers, teachers, extension workers and private sector agribusiness leaders be trained?

In a prescient observation, two decades ago, Vernon Ruttan underscored the urgency of agricultural institution-building in Africa: "The thing that bothers me is that the donors have consistently tried to avoid the issue of institution-building in Africa. In South and Southeast Asia in the 1950s, the donors were building the institutional capacity it took to create the growth that began in the 1960s. In the 1970s, we didn't do it in Africa because we were on the basic needs and rural development kick. … I think it's time that the donors begin to take the issue of institution-building seriously, or in 2010 we are going to be having this same conversation" (Ruttan 1991).

As interest by African governments and donors returns to agriculture, this paper aims to draw insights from global experience on the role of agricultural education and training (AET) in increasing agricultural productivity. The paper centers on six case studies, from three developed and three developing countries, that trace the development and impact of AET institutions across a wide range of settings. The paper draws on these diverse experiences to identify critical choices and good practices for strengthening AET institutions in Africa (Table 1).

2. GLOBAL AET EXPERIENCE

2.1. United States

2.1.1. The Land Grant University Experience[1]

Accounts of agricultural higher education in the U.S. generally begin in 1862 when the U.S. Congress passed legislation establishing the Land Grant colleges, the United States Department of Agriculture (USDA), and the Homestead Act. But long before 1862, a global search had already begun to build an agricultural science base for America's ecologically diverse agriculture. In 1819, the Secretary of the Treasury instructed U.S. naval officers and consuls to collect new plants and germplasm from around the world. These germplasm expeditions represented the first institutional step in a large and enduring government commitment to agricultural research and to American farmers. The second step centered around a government decision to link germplasm excursions with the free distribution of seed to farmers, encouraging them to become farmer-breeders in different ecological areas. To supplement this effort, the U.S. Congress allowed its members free use of the U.S. postal system to distribute new seed varieties to farmers. In 1849 alone, the U.S. Postal Service delivered 60,000 packages of free seed to farmers without cost (Kloppenberg 1988). By 1860, American farmers were able to feed a population of 31 million and export 500 thousand tons of wheat – mainly to Europe – in competition with Denmark's grain exports to the United Kingdom. Yet they achieved these production increases through area expansion rather than yield gains (Hayami and Ruttan 1985). Indeed, despite efforts to improve germplasm through farmer breeding and free seed distribution, maize yields remained constant at about 2 tons per hectare.[2]

[1] Bonnen (1998) has produced the definitive account of the evolution of the Land Grant system of higher education as an institution for development..

[2] Early tests of corn yields in Iowa compared "superior" seed corn on Iowa farms for 12 years from 1904 to 1915. The farmer-identified "superior" seeds were planted on 75,000 field plots, producing an average yield of 32.4 bushels an acre (2.03 tons per hectare) from 1896 to 1905 compared with 33 bushels (2.07 tons per hectare) during 1913, 1914 and 1915 (Schultz 1964).

This early U.S. experience demonstrated that farmers, with rare exceptions, were ineffective as plant breeders attempting to develop high-yielding grain varieties. The U.S. experience with corn research reveals that U.S. agricultural universities shifted from the farmer-researcher and free seed model to research on genetics and plant breeding in the 1890s. The first major payoff to this research came with the discovery of hybrid corn in the 1920s, followed by its rapid adoption in the 1930s. The lesson that flows from this example is not to expect farmers, NGOs and extension agents to develop new high yielding crop varieties. Nevertheless, participant research involving farmers and farm organizations has an important role to play in channeling problems to researchers, speeding up diffusion of new technology, and making the case for agriculture in the political process.

Farm lobbies played a key role in mobilizing political support for public funding of agricultural research, education and extension. From the earliest years of the republic, agricultural associations were established by farmers, merchants, politicians and urban leaders who believed that improving agriculture would increase welfare of all members of society, rural and urban. For example, the Philadelphia Society for Promoting Agriculture was established in 1785. The legislative structure embedded in the U.S. constitution – which provides sparsely populated farm states with the same number of senators (two each) as large urban states – has enabled agricultural lobbies to exert political influence disproportionate to their share in the U.S. population. Farm lobbies have actively exercised their influence in promoting the key institutional innovations during the nineteenth century. Farmers began to press Congress for agricultural research funds after the land frontier was closed, in the 1880's. In response, Congress passed the Hatch Act, in 1887, to provide federal funding for research at state agricultural experiment stations.

In 1862, the Land Grant Act provided federal funds to help each state set up a Land Grant College for the teaching of scientific agriculture. The Land Grant Colleges and U.S. farm lobbies subsequently helped persuade the U.S. Congress to enact federal legislation in 1887 to provide permanent federal funding to Land Grant Colleges in order to build a decentralized, applied research capacity – state by state. In 1914, Congress passed the Smith-Lever Act which established a nation-wide extension system by helping finance extension services in Land Grant Colleges and linking them with the USDA in a loose coordination structure (Bonnen 1998). Land Grant Colleges were subsequently expanded to include law, medicine, social science, and renamed Land Grant Universities. Today, 60 Land Grant Colleges and Universities operate in the 50 states. The Land Grant model integrates publically financed agricultural education, research and extension in a single institution. The three individual components of this model were assembled and interlinked through a piecemeal, pragmatic and political process over a sixty year period (1860-1920) (Bonnen 1962).

2.1.1. Implications for Africa

Development of effective agricultural institutions requires multiple decades. It involves long-term, situation-specific institutional experimentation and strong domestic political commitment. In the U.S., farmer and agribusiness lobbies proved highly influential in supporting and sustaining funding for agricultural education. In contrast, Africa's many small farmers face very uneven access to the corridors of political power. A recent review of African maize development poses the key question this way, "Perhaps most important, where will the domestic political pressure for these public investments come from?" (Smale and Jayne 2010, p.112). Looking forward, Africa's farmers and agribusinesses will need to improve the political access of agricultural lobbies in Africa.

Table 1. Case Study Country Agricultural Institutions

	Agricultural Knowledge Triangle		
	Education	Research	Extension
Denmark	• Royal Veterinary and Agricultural University • compulsory national education	Danish Institute of Agricultural Science, Ministry of Food, Agriculture and Forestry	Agricultural Advisory Centre*
India, States	State Agricultural Universities (SAUs)	SAUs	State Ministry of Agriculture
Japan	University of Tokyo, College of Agriculture	National Agricultural Experiment Station	Agricultural Society of Japan*
Malaysia	Universiti Putra Malaysia	10 public commodity institutes	Ministry of Agriculture
Nigeria, Eastern	University of Nigeria	Ministry of Agriculture	Ministry of Agriculture
Nigeria, Northern	Ahmadu Bello University (ABU)	ABU	ABU
USA	Land Grant Universities (LGUs)	LGU	LGU

* indicates farmer-run organizations

2.2. Japan

2.2.1. Japan's Agricultural Transformation: 1868 To 1912

Japan's transformation from a feudal culture to an industrial society in just one generation offers a textbook success story. Soon after Emperor Meiji assumed the reins of power, in 1868, he launched an ambitious program of economic modernization. Under the Meiji Restoration, he committed Japan to rapid modernization based on compulsory universal primary education (1872) and imported agricultural and industrial technology from the United States and Western Europe. The overarching goal of the Meiji government was "to build a wealthy nation and a strong army" (Hayami 1988). The goal of agricultural development was to increase domestic food supplies in order to prevent a rise in the cost of living of urban workers. Agricultural policy focused on rice, the main "wage good" for industrial workers, and later on silk production for export markets.

To achieve rapid modernization through technology borrowing, Emperor Meiji dispatched a high level mission headed by Vice President Tomomi Iwakura to tour the United States and Europe for 22 months between 1871 to 1873. Members of the mission filled hundreds of notebooks with information on every facet of industry and farming in the United States, including a meticulous analysis of large-scale mechanized farms, equipped with horses and reapers. President Grant hosted a glittering reception for the visitors through a special $50,000 fund appropriated by the United States Congress. The mission then visited eight European nations, including Germany. There, Chancellor Bismarck encouraged the Japanese to generate their own investment capital for development purposes and to avoid foreign indebtedness.

When the Iwakura mission returned to Japan, it lauded "the technical superiority of western agriculture and the use of fertilizer and machines" and recommended that Japan borrow western technology, lock, stock and barrel. To implement the Iwakura recommendations, the Japanese set up an agricultural research station to test the foreign farm equipment and new products such as grapes from the United States and sheep from England. They sent students overseas to the so called "advanced countries" for training and hired instructors from the United States and England to teach in the newly-opened Komoba agricultural school, later redesignated in 1892 as the University of Tokyo, College of Agriculture.

In 1893, Japanese government established a national agricultural experiment station with six branch agricultural colleges (Ogura 1970). The curriculum was based on science and technology that had been developed for American farming conditions where the average size of a family farm was many times larger than the average Japanese farm. But after less than a decade of experimenting with imported technology in industry and agriculture, the Meiji government came to the conclusion in the early 1880s that foreign technology was a stunning success in industry, but a failure in agriculture – except in northern Japan where large blocks of land on the island of Hokkaido were suitable for large farms and American horse-drawn farm equipment. The Japanese discovered that the grapes, sheep and large-scale machinery, which were both technically sound and profitable on large farms in land-abundant America, turned out to be "poisoned gifts" to Japanese farmers whose overarching concern was increasing rice yields on small plots of land and soaking up surplus rural labor in farming and related activities.

The economic failure of the American model of large-scale farming prompted the Meiji government to set up a Ministry of Agriculture in 1881 and charge it with developing a new agricultural strategy consistent with Japan's climate and agrarian structure of tiny family farms. The new strategy concentrated on increasing yields on small farms through the application of chemical fertilizer and improved seeds. To develop yield-increasing crop technology, the Japanese government hired German scientists, on long-term contracts, to pursue research on soil science, agricultural chemistry, and chemical fertilizer along the lines pioneered by the famous German scientist, Von Liebig.

The government hired successful Japanese farmers as extension agents, paying them to travel throughout the country to diffuse seed varieties and agricultural practices used by the better farmers. In 1881, the veteran farmers met in Tokyo and established a new organization, the Agricultural Society of Japan, modeled after the Royal Agricultural Society of England, and charged it with extending technical information to farmers. Three years later, they established the National Agricultural Association to exercise political influence on behalf of farmers. All farmers in Japan were required by law to join the Association and pay membership fees.

Japan's economic transformation from a feudal to an industrial power in one generation (1868 – 1912) was based on a development strategy that fostered the concurrent growth of agriculture and industry. Japan's yield-increasing agricultural strategy proved highly successful in boosting rice production on small-scale farms and generating a surplus to feed the cities. The introduction of a land tax in the 1870s provided revenues that helped to support central government agricultural institutions and promote industrialization.

2.2.2. Implications for Africa

Japan's ability to learn from international science and its own experience is highly relevant for Africa. After only eight years of experimentation, 1873 – 81, the government concluded that the American model of large-scale farming with horses was inappropriate for Japan's land-scarce economy and tiny farms. Japan shifted course and invested heavily in developing an indigenous research capacity in order to increase rice yields on small-scale farms and to promote the growth of rural small-scale industries. The results were impressive. Japan's smallholder agricultural strategy generated the same annual compound rate of agricultural growth (1.6%) as the U.S. farmers using horses and tractors over the 100 year period between 1880 and 1980 (Hayami and Ruttan 1985).

Japan's smallholder development strategy, likewise, holds contemporary relevance for land-short countries in Africa (e.g., Malawi and Rwanda). Japan was a pioneer in demonstrating that tiny farms of one to two hectares could serve as a motor of development provided they had access to profitable new technology, access to markets and operated under an acceptable level of risk.

Japan's experience offers equally important political lessons. The seeds of Japanese agrarian power were grounded in compulsory farm association membership and collective action aimed at acquiring political influence for farm people. African farmers will, likewise, need to develop effective lobbying and organizational capacity.

2.3. India

2.3.1. The Sixteen Year March

Currently, India's economy is growing at a phenomenal rate of 9%, and it has grain in storage. However, these impressive achievements can best be appreciated in historical perspective. In 1968, Nobel Laureate Gunnar Myrdal concluded that India and other Asian nations were "soft states", incapable of rapid growth because of cultural and religious beliefs. How do we reconcile Myrdal's pessimistic views with India's growth rate? What can Africa learn from India's development experience?

Soon after India won its independence in 1947, it gave priority to the Soviet heavy industry model of development, setting up a Ministry of Planning and preparing its first Five Year Plan (Mellor 1976). India's agricultural strategy was based on Gandhi's Community Development model wherein a multi-purpose, village-level extension worker encouraged farmers to build schools, roads and plant subsistence crops. In the early 1950s, the Government requested Ford Foundation assistance in upgrading these community development extension programs (Moseman 1970). They invited the Rockefeller Foundation to help strengthen agricultural research capacities and USAID to help introduce and institutionalize a new type of university called the State Agricultural University (SAU) based on the U.S. Land Grant University model. Together, these investments in agricultural research, education and extension formed key pillars of India's science-based Green Revolution.

It is commonly believed that India's food crisis was solved in 1966 with the importation of 18,000 tons of high yielding wheat seed from Mexico that Norman Borlaug and Mexican scientists had developed over two decades of research. But the reality is that Borlaug carried some of the new high-yielding wheat seed to India in 1962. Indian scientists then tested the seed in five years of local trials, training local farmers and participating in debates among Indian scientists and members of the Parliament over the danger of importing foreign wheat and rice – the two main food staples of India. The cabinet approved the importation of wheat seed in 1966 and it contributed to the bumper harvests of 1966-68, launching what became known as the Green Revolution. With the personal attention of Prime Minister Nehru and outstanding political leadership, India slowly increased food output and achieved food self-sufficiency in 1981, after a 16 year march.

The origins of India's important institutional innovation, the State Agricultural University (SAU), began in 1876 when the first agricultural college was set up at the Saidapet Experimental Farm in Madras (Goldsmith 1990). In 1889, the Home Department of the British Colonial Service charged both the Agriculture and Education Departments of the government of India to accept an "obligation to take positive measures for the education of the rural classes in the direction of agriculture" (Wadia 1997). During the 1890s, agricultural colleges were established in three locations and the University of Bombay offered a diploma course in agricultural science.

Postgraduate agricultural education began in India in the 1920s when authorities authorized the Indian Agricultural Research Institute (IARI) to offer postgraduate courses in agriculture (Goldsmith 1990). Thus began a long, intimate link between India's agricultural research and education institutions. In 1958, IARI was granted university status and it became the National

Postgraduate School of Agriculture, thus allowing it to offer both M.Sc. and Ph.D. degrees in virtually all fields of agriculture. IARI provided structured courses to graduate students in contrast to the traditional Indian system in which Ph.Ds were awarded on the basis of only a dissertation and an oral exam. The most important contribution of the IARI was the training of a large number of Ph.D.'s to staff the SAUs that were being set up in the late 1950s and 1960s, and doing so on the basis of graduate degrees that required both course work and field research (Pal 1974).

In 1949, the University Grants Commission recommended that a system of rural universities be created (Tamboli and Nene 2011). An Indo-American team was formed and later an Indian delegation visited the U.S. and was impressed with the contribution of the Land Grant Universities to the U.S. development experience. Upon its return to India, the team recommended the establishment of at least one State Agricultural University (SAU) per state. A second Indo-American team was established in 1959 and it urged the government to develop a few pilot SAU models that could be studied and replicated. In 1960, India took the bold decision to create a new rural institution – the SAU – that was directly responsible to the states and beyond the control of the Federal Ministry of Education. Later, USAID provided funding for five American universities to enter into partnerships with nine of the newly established SAUs. The five American universities supplied 300 professors on assignments of two or more years to these nine Indian universities.

The Governor of each state serves as the nominal head of the university and he/she appoints a Vice Chancellor for the University. Each SAU has a dual research and teaching mandate. Funds for research come from state governments, the Federal government through the Indian Council for Agricultural Research (ICAR), and other sources such as foundations and the private sector. Unlike their Land Grant counterparts in the U.S., SAU faculty do not conduct frontline extension work. Instead, SAU faculty train extension officers for the State Ministries of Agriculture, which in turn manage India's extension system. Today, India's 42 state agricultural universities (some states have more than one) are interlinked to form a national system. Most of the SAUs have respectable M.Sc. programs and an increasing number have solid Ph.D. programs.

A massive buildup of human capital was a central feature of India's drive to cobble together a productive agricultural research, extension and education system. To achieve this critical mass of scientific capacity, India sent over 1000 Indians for advanced training in agriculture and natural resources to the United States during the 1960s and 1970s (Lele and Goldsmith 1989).

Several groups have examined the evolution of the SAUs from 1960 onwards in an effort to help them adapt to changing opportunities and needs (Busch 1988). At the celebration of India's 50th anniversary in 1997, R.S. Paroda argued that "There should be a shift from an information-based curriculum to a skill-based, problem-solving curriculum in the newer sciences, such as biotechnology, information technology and geographic information systems" (Mehta and Mathur 1999). A committee chaired by M.S. Swaminathan was empowered to examine the linkages between the SAUs and the research institutes in the Indian Council of Research. The Swaminathan Committee Report also made the case for multiple sources of financial support for agricultural education and research. First, since agricultural education is a state subject, it is the responsibility of State Governments to provide a major share (about 80 to 85%) of financial support for agricultural education. Through this State financing, pressure can be exerted on the SAU's to conduct research and extension on state problems. The second source of financial support for the SAUs is the

Indian Council of Agricultural Research. The Council acts like the University Grants Commission and it has responsibility for providing supplementary grants to improve the educational standards in SAUs. The Swaminathan Committee recommended that one percent of GDP at the Central and State levels should be earmarked for agricultural research and education, of which at least 20%, both at the central and state levels, should go for agricultural education. The third source of financial support for the SAUs is the private sector.

India has built diverse and complex agricultural research and agricultural education systems. The research institutions come under the national apex body, the Indian Council of Agricultural Research (ICAR) and the State Agricultural Universities (SAU) report to the states. At independence, agricultural education at the university level was offered by only 17 Agricultural colleges. When India celebrated its 50th anniversary in 1997, it had 34 SAUs with an annual student intake of 13,500 at the undergraduate level, 6,000 at the Master's level and 1,550 at the Ph.D. level. Today, India's 42 State Agricultural Universities operate with variable track records in terms of quality and ability to mobilize financial support. Many of the SAUs are in need of reform and the ICAR is pressing the SAUs to develop partnerships with regional and global universities and the private sector in order to facilitate this process. Thus, institutional reform remains an active, ongoing process. Without question, much of India's success in the past 50 years stems from its political stability, its openness to institutional innovation, its sense of urgency and its willingness to innovate to find ways of increasing agricultural productivity, improving household food security and reducing poverty.

2.3.2. Implications for Africa

India offers a textbook example of how a poor country can build an interactive and productive agricultural knowledge system over a period of 40 to 50 years. During the 1960s and 1970s, the Ford Foundation financed a large-scale extension build-up, the Rockefeller Foundation helped strengthen agricultural research, and USAID helped conceptualize and finance a new institutional innovation in agricultural education – State Agricultural Universities. Although donor funding helped to underwrite early investments in pilot efforts, the Indian state and federal governments have committed the bulk of the financing required to operate and manage India's agricultural research, extension and education institutions. African governments will require commensurate financial commitment if they aim to achieve comparable success in promoting science-based agricultural productivity growth.

2.4. Denmark

2.4.1. Denmark: Growth of an Agribusiness Nation

During the 1870s, Denmark was a nation of large-scale farms producing butter and grain, primarily for the British market. But this model came under assault when the United States opened its transcontinental railway and began exporting wheat to Great Britain and Europe. As a result of this competition, Danish wheat prices to fall by 40% and butter prices by 15%, undercutting the economic base of Danish agriculture (Friedman 1974).

In response, after several years of turmoil, a number of technological advances spurred the transformation of Danish agriculture. In 1878, a Danish inventor developed a cream separator and a few years later small-scale farmers organized two new institutions – the cooperative creamery and marketing cooperatives. Together, four factors – investment in education, the cream separator, cooperatives, and a shift from producing grain to dairy, bacon and pork exports – transformed Danish agriculture.

Early investments in rural and agricultural education laid the foundation Denmark's transformation from a grain-dependent to a diversified agribusiness exporter (Ruttan 1982). The introduction of compulsory education in 1814 led to the development of a rural school system and widespread literacy even among the peasantry (Ness 1961). In 1850, the Folk High Schools were introduced as free adult boarding schools. Today, there are around 90 Folk High Schools in Denmark with courses lasting from one week to ten months. Many observers of Danish agriculture have argued that this foundation of mass literacy enabled farmers come together to develop the cooperatives and agribusiness enterprises that began to emerge in the 1880's. Significant public investment in higher agricultural education played a similarly important role. The Royal Agricultural and Veterinary College, established in Copenhagen in 1783, was reorganized to include agriculture and chemistry in 1858. Although Denmark was a small nation of 2.5 million, the Agriculture and Veterinary College was well known in Europe. The Danish College and the German graduate educational model were both forerunners of regional models of education. In 1917, the Royal College had 400 male and female students enrolled from Denmark and several foreign countries, including Bulgaria, Romania and Finland (Haggard 1917).

Technologically, the cream separator lay at the center of Denmark's agricultural transformation. Cows on small-scale farms produced milk and the cooperative creamery picked up the milk by horse-drawn wagons every day and took it to cooperative creameries. The cream separator divided the milk into cream for making butter and skim milk was fed to pigs and converted into bacon. Prior to the invention of the cream separator, the production of butter was dominated by large-scale farms (manors) that could afford to build a "skimming hall", a ventilated room where milk was kept fresh for a day or longer to allow the cream to rise and be skimmed off to make butter. The invention of the cream separator removed the need for building a skimming hall, thus reducing capital requirements as well as the volume of milk that had to be produced daily in order for butter production to be economically viable.

A complementary institutional innovation, the producer and marketing cooperatives, emerged spontaneously between 1880 and 1890 to accelerate this transformation. Danish farmers formed the first cooperative creamery in 1882. Eight years late, 679 were in operation. With the advent of the cooperative creamery, processors could collect a sufficient quantity of milk daily from the small-scale farms that formed the cooperative membership so the creamery could make butter every day (Ruttan 1982). The inflow of cheap grain from the United States and Russia in the 1870s and 1880s, together with growing markets for livestock products in Europe, spurred Danish farmers to shift from growing grain and making butter on large-scale farms to small-scale farms producing dairy products and bacon for European markets. An early study of this transformation reported, "Whatever else may be doubtful or open to argument in connection with Danish agriculture, one thing remains clear, namely, that it owes the greater part of such prosperity to the co-operative movement" (Haggard 1917).
By 1930, agricultural exports accounted for 80% of all Danish exports, thus making Denmark the agribusiness nation of the world.

During this period, the government supported public investment in research and education, helped pay the salaries of livestock advisors (a forerunner to the extension service) employed by farm organizations, awarded prizes at livestock shows, published herd books and supported animal breeding centers. Today, the Royal Veterinary and Agricultural University (KVL) in Copenhagen is the only Danish University specializing in agriculture and veterinary science. Responsible to the Danish Ministry of Food, Agriculture, and Fisheries, it currently serves 3,500 students, including 400 Ph.D. students. The Danish Agricultural Advisory Center currently serves as the national center providing extension services to Danish farmers. Denmark's two main farm organizations, The Danish Farmers' Union and the Family Farmers' Association, jointly own and run the Center. They provide direct advice to farmers through 85 local advisory centers owned and run by local farmers and the family farmers' organization.

2.4.2. Implications for Africa

Looking back, two of the most crucial decisions taken by the Danish government involved the introduction of rural education and the rejection of a proposal by the Parliament to impose tariffs on grain imports. The rejection has forced Danish farmers to innovate and remain competitive in global markets.

Africa's small farmers can likewise aspire to compete in world markets, provided African governments make necessary public investments in the scientific institutions that underlie technical innovation in agriculture. Denmark's small farmers offer a potentially useful model built on longterm investments in rural literacy, agricultural education, and strong farmer organizations committed to delivering research, advisory and marketing services to their members.

2.5. Malaysia

2.5.1. Drive to Reach Developed Country Status by 2020

Malaysia and Ghana both won their independence in 1957. But Malaysia is now a prosperous, middle-income country while Ghana has roughly the same per capita income as it did some 50 years ago. Malaysia's population of 25 million is almost equally divided between the ethnic Malay and the ethnic Chinese who control large segments of the economy, including banking, manufacturing and plantations. Malaysia is a textbook case of a country that has invested heavily in agricultural research so as to generate rapid growth of exports, and also in education to achieve the important social goal of helping the poor Malay farmers while building an industrial labor force. The government of Malaysia, in a series of national development plans since 1991, has maintained its goal of achieving "developed country status" by 2020. The biggest share of government investment – one fifth – is earmarked for education and training in order to maintain Malaysia's competitiveness with China and India in electronic exports.

Following independence in 1957, Malaysia's political leadership committed itself to an agriculture-led development strategy and created a haven for foreign private investment with guaranteed repatriation of profits. While Ghana's Nkrumah was criticizing multi-national firms in the late 1950s and '60s, Malaysia encouraged foreign private investments, even though foreigners owned three-quarters of the large rubber estates, all of the tin dredges, and controlled much of Malaysian foreign trade. A year after independence, Malaysia signed bilateral investment pacts with West Germany, Japan and the United States. In 1966, Deputy Prime Minister Tun Abdul Razak toured the U.S. and wooed American capital, but he did not beg for foreign aid. Instead, Razak took the long view when he met with potential American investors: "We are not looking for direct handouts. If you want to expand and invest and you look around the world for a suitable place to do this, then I suggest you look to Malaysia where you will find the basic requirements you seek – political stability within a democratic framework and potential progress to mutual advantage of both our countries." (Razak cited in Saravanamittu 1983, p.30)

Malaysia's open door for foreign private investment underlies its strategy of financing development via foreign investment rather than foreign aid. This strategy has paid off handsomely. For example, Taiwan's direct investment in Malaysia in 1991 was larger than the total USAID budget of one billion dollars for all of Sub-Saharan Africa.

During the past 50 years, the Malaysian government has maintained its deep commitment to agricultural development. From 1960 to 1983, it invested an average 20% of the government budget in agriculture (Jenkins and Lai 1992). In contrast, African nations invested an average of 4.1% in 2001 (Fan and Rao 2003). Malaysia has also pursued its comparative advantage in natural resource-based export growth (rubber, oil palm and cocoa) long after many development experts had advised African nations to shift from export crops to industrialization. Malaysia's reliance on export crops in the 1960-85 period was crucial for its development. Many development experts have praised Malaysia's success in replacing Nigeria as the leading oil palm exporter in the world (Hashim 1992).

For the first decade after independence, Malaysia continued to give priority to natural rubber. But with declining world rubber prices in the 1960s and increasing competition from synthetic rubber, Malaysia shifted its priorities to oil palm production. The rapid growth of the oil palm industry was fueled by massive public investments in clearing new land, building houses for new settlers, investing in R&D, and private investment in large-scale plantations and processing plants. In 1979, the government set up the Palm Oil Research Institute of Malaysia (PORIM) to increase oil palm yields and find new uses for oil palm in international markets. Starting with only four scientists in 1979, PORIM currently has a scientific staff of 188 (full-time equivalent) scientists working on an array of research projects, including oil palm plant breeding, biotechnology and new industrial products (Stads, Tawang, and Beintema 2005).

Malaysia has pursued a number of different educational strategies over the past sixty years. In the 1960s and 1970s, Malaysia invested heavily in primary and secondary schooling in rural areas in order to achieve the political goal of appeasing its political base—the impoverished rural Malay. In the 1970s, it developed a massive program to send Malays overseas for higher education. The goal was to create a Malay middle class within half a generation. Today, education and training represent the most important government investment in Malaysia's new Five Year Plan. Malaysia's major agricultural university, Universiti Putra Malaysia, founded in 1931, added faculties of engineering in 1975 and biotechnology in 2004.

In addition to investing heavily in education at all levels, Malaysia's human capital improvement strategy has focused considerable attention on incentives. It is refreshing to note that the government is focused on designing an incentive structure to mentor and retain scientists rather than trying to attract members of the diaspora to return home. Today, new research officers in MARDI become eligible for postgraduate training after one to three years of service. Notably, university enrollment in agriculture has shifted significantly toward women students, and 34% of the agricultural researchers in the country are now female (Stads et al. 2005).

Malaysia's drive to achieve "developed country status" by year 2020 has intensified the government's support for biotechnology research on oil palm because it is now the second most important vegetable oil in the world behind soybeans. Malaysia's USD 6.4 billion of oil palm exports in 2004 was second only to its export of electronic goods (Abdullah 2005). From a global perspective, agricultural scientists in Malaysia are using biotechnology to increase oil palm yields so that Malaysia can compete with the three leading global soybean producers— Argentina, Brazil and the United States. Looking ahead, the Director of the Oil Palm Biotechnology Group, University of Kebangsaan, Malaysia reports that crops such as oil palm will not be looked upon as a commodity crop in the future. Instead, the role of the oil palm will change to that of a "biofactory," engineered to produce an array of specialty products such as
bio-diesel, bio-plastics and pharmacology products.

Malaysia has developed a number of national, regional and global partnerships to maintain its competitive advantage, mainly in bio-fuel, especially since the rising price of energy. On the national level, Malaysia's large government R&D activities are closely linked with universities and private companies. MARDI maintains collaborative links with 40 national and international research agencies. Currently, ten different agencies are conducting agricultural research in Malaysia, with 1,200 (FTE) scientists engaged in agricultural research. This is about double the number of scientists in Kenya, a nation slightly larger than Malaysia.

2.5.2. Implications for Africa

Although Malaysia has actively promoted private sector development, the government is financing 95% of the total agricultural research budget. By contrast, many African countries are relying on foreign aid to finance 30 to 40% of their agricultural research budgets. One of the most important lessons of the Malaysian success story is that the government can play a critical role in investing public funds to support research, higher education and the promotion of export crops, and can creatively use trade to build up the economy. Evenson sums up the case for public investments by noting that every country has to use public funds "to buy its way into the growth process" and after that has been accomplished, private investment will follow (Evenson 2004).

2.6. Nigeria

2.6.1. Variable Performance of the Land Grant Model in Nigeria

At independence in 1960, Nigeria inherited only one faculty of agriculture, at Ibadan, which served basically as a teaching institution. Shortly thereafter, in the early 1960s, USAID awarded contracts to four U.S. Universities – Michigan State, Colorado State, the University of Wisconsin and Kansas State University – to assist Nigeria in building new Land Grant Universities in four different regions and help them to expand undergraduate enrollments and strengthen the agriculture extension and research services. The resulting, highly variable outcomes demonstrate the nuances as well as the many factors affecting the development of effective AET institutions in Africa.

In the Eastern Region, the University of Nigeria opened at independence in 1960 with the support of a Michigan State University (MSU) team sponsored by USAID. The MSU team was charged with helping to develop an American Land Grant type of university in the eastern region of Nigeria (Johnson and Okigbo 1989). The MSU faculty posted at the University of Nigeria had a paucity of knowledge about colonial institutions – especially agricultural research, extension and the commodity boards that financed research on export crops. Although naïve, the team was enthusiastic about developing linkages between the new university and the government's agricultural research and extension services.

But the operational challenge of building a national system of interactive agricultural support institutions turned into a nightmare. Two of the universities reported to the Ministry of Education. The University of Nigeria, however, reported to the Director of Extension in the Eastern Region. Despite the institutional advantage of a common parent ministry of agriculture, the University of Nigeria's remote location made communication difficult and continuously hampered efforts to establish effective partnerships between the university and the Ministry of Agriculture's regional research station some 100 miles away. Although the MSU team failed to help the University of Nigeria develop its own research and extension programs, it did assist in teaching and building academic staff capacity through in situ and overseas training programs. Today, the University of Nigeria enrolls 30,000 students and has made important contributions to Nigerian development over the past five decades. In this instance, the balance sheet reveals that the Land Grant model was successful in building teaching capacity, but unsuccessful in establishing research and extension at the University of Nigeria.

In contrast, the more successful Land Grant adaptation in the Northern Region of Nigeria during the 1960s and 1970s offers an instructive contrast (Goldsmith 1990). In 1962, the Legislature of Northern Nigeria created Ahmadu Bello University (ABU) at Zaria. In 1963, USAID awarded a contract to Kansas State University to help develop the new university and teach undergraduates while newly-recruited Nigerian staff were sent for graduate training overseas. The faculty of agriculture began in 1962-63 with six students and a teaching staff of two. Visionary Nigerian political leaders transferred the entire staff of the Research Institute of the Northern Ministry of Agriculture to Ahmadu Bello University.[3] The Ministry of Agriculture also transferred five senior researchers to the newly-established Research-Liaison Section of Ahmadu Bello University in order to promote a two-way flow of information from farmers to researchers and a flow of technology from researchers to extension agents and farmers. They transferred the Institute of Public Administration to ABU and arranged a formal affiliation with the Institute of Islamaic studies in Kano. These politically astute transfers pieced together a Nigerian adaptation of the Land Grant University model that was crafted by edict and concession to serve the 25 million people (mostly farmers) in Northern Nigeria.

2.6.2. Implications for Africa

The ABU experience reveals how African political leaders, together with Nigerian and American scientists, pragmatically created a functioning agricultural knowledge triangle that effectively linked scientists working together in agricultural education, research and extension (Kansas State University 1974). But the success of the Land Grant model at ABU

[3] The Institute for Agricultural Research was established in 1925 by the British Colonial Service and it had a reputation as being the finest agricultural research institute in Anglophone West Africa. In 1962, it had an establishment of 65 senior staff and three research substations (Olson 1965).

depended crucially on the Nigerian political decision to unify research and education in the same institution – ABU – and to transfer its entire agricultural research staff to Ahmadu Bello University. Elsewhere in Africa, the common ministerial separation between agricultural research (in ministries of agriculture) and agricultural higher education (in ministries of education) has hampered the development of agricultural innovation systems in Africa (Rukuni 1996).

3. LESSONS FOR AFRICA FROM THE GLOBAL AET EXPERIENCE

3.1. Mobilizing Political and Financial Support for AET

The *first* lesson from the global AET experience is that mobilizing and sustaining political and financial support for AET investments is the most important and most difficult issue to address in designing and financing a system of agricultural development institutions. The country studies have revealed that many different ways can be used to mobilize political support for AET, and different ideologies and development pathways can be followed. In 1884, the National Agricultural Association of Japan was established to exercise political influence on behalf of farmers. In the United States, the decentralization of agricultural research, education and extension to 50 states and 350 branch research stations established local and state links to the political system, because most of the funding for research and extension comes from state and local sources – not the federal government. But in Africa, most of the funding for research and extension comes from national budgets and donor aid with modest input from farmers and farmer associations.

3.2. Public Investment in Agriculture and AET

The six country studies point out the critical role of public investment in helping a poor country "buy into the growth process" Evenson (2004). Africa's commitment of an average of 2.4% of its government's budget to agriculture is distressing in a continent where more than 60% of the people depend on the rural sector for their jobs, food and income (Fan and Rao 2003). Africa's current expenditure on agriculture is dismal when compared with Asia's public expenditure in the 1970s and 1980s. India spent 10 to 20% of its government budget on agriculture in the 1970s, while Malaysia spent an average of 20% of government investment on agriculture from 1960 to 1983 (Jenkins and Lai 1992; Hazell 2012; Lipton 2012).

The generally low level of African government funding for agriculture raises some tough political questions about priorities and the likely financial sustainability of future AET investments in Africa. To address these questions, a recent World Bank evaluation capacity-building in Africa reports that a paradigm shift is necessary to embrace a broader perspective that includes not only institutional rules of the game, but also "political dynamics that drive institutional change" (World Bank 2005).

3.3. Bridging the Gap between Ministries of Agriculture and Education

Many African countries manage agricultural research and extension under their ministries of agriculture, while agricultural higher education remains under the control of ministries of education. Because this ministerial separation impedes the tight scientific collaboration required among agricultural research, education and extension, it has had a crippling effect on the development of agricultural innovation systems in Africa (Rukuni 1996). This ministerial separation explains, in large part, the generally feeble contributions of Africa's AET researchers to national agricultural research.

Despite their importance for Africa's advancement in agricultural science, AET institutions have been largely sidelined by the CAADP process (Kampala 2010). Low funding for agricultural ministries translates into still-lower funding for AET institutions, which enjoy few natural political constituencies outside of agriculture.

3.4. Increasing Research Contributions of African Universities

The country studies likewise provide insights on how to extract more research output from African universities. Since academics in African universities typically spend about 25% of their time on research, how can their research be focused on high priority national problems rather than turning out what Vice-Chancellor Francis Idachaba of Kogi State University in Nigeria has called a "thick slug of consultancy reports for donors" (Idachaba 1995). The starting point is that one should expect only a trickle of research output from African universities that only offer B.Sc. programs. The key to greater research output is to invest public resources in strengthening graduate programs and research facilities in order to increase the number of graduate students who can work in research partnerships with their academic advisors. Brazil's Federal University of Ceará, for example, produced 335 M.Sc. theses between 1973 to 1989. The graduate student academic research team is a low cost and proven way to carry out agricultural research in India, Brazil, Denmark, the USA and many other countries.

3.5. Multi-generational Time Frame

The lessons of the past century underscore the critical role of time, learning from international experience and local experimentation in nurturing the co-evolution of technology and institutions in any particular setting. The six country studies revealed that building a *system* of agricultural institutions is a multi-generational process. The average time required for the U.S., Japan, Denmark, Malaysia, Nigeria and India to develop a productive and financially sustainable *system* was 40 to 60 years. To be sure, it is possible to develop one or two components of the agricultural knowledge triangle in a time frame of 10 to 20 years. In decades past, when donors financed large-scale human capital development through fellowships for long-term overseas training, developing country governments could focus on strengthening the research and extension arms of the knowledge triangle. But now that donors have slashed overseas training programs, the two-legged research-extension model of agricultural development represents an incomplete and unsustainable model of technology-generation when no consideration is given to human capital replenishment from local and regional universities. Moreover, the multi-generational time frame required to build a system of core AET institutions extends beyond most donor-financed projects.

3.6. Many Pathways to Progress

The final lesson emerging from these country studies is the futility of promoting one model of agricultural higher education (such as the Land Grant model) or one model of extension (such as the Farmer Field School model) (Gallagher, Braun, and Duveskog 2006). The Land Grant University model is a unique American institution where the College of Agriculture internally manages the three arms of the agricultural knowledge triangle – research, education, and extension. In many countries, it has been impossible to replicate the three components of the Land Grant model because of institutional path dependence and preexisting entrenched research and extension departments. Nevertheless, the model has proven successful in some settings, including northern Nigeria and, with some adaptations, in the Indian SAUs.

Africa, unlike India, faces a small country problem, with 54 countries and half of them smaller than an average state in India. Coupled with the minimum scale required for certain modern biotechnology and research facilities, this suggests that ongoing regional initiatives such as those pioneered by the Regional Universities Forum (RUFORUM) and the Collaborative Masters in Agricultural Economics (CMAE) will play a key role in Africa's unfolding AET development.

Because of the accretionary nature of human capital improvement over many decades, priorities for agricultural research, training and extension must flow from the vision of the political leadership of each country about the role of science and technology in the nation's development. The scientific leadership of a country has the responsibility to start with the overall vision and develop a science and technology policy statement and strategies to interlink universities, public research institutes, extension and the private sector (Idachaba 1997).

Although donors with long time horizons can help to underwrite capital investments for a new generation of AET institution building, history suggests that African political leaders and private sector will need to underwrite the bulk of long-term funding. Indeed, these investments will be necessary if Africa is to follow the pathway to a science-based, competitive, high-productivity agriculture for the future.

REFERENCES

Abdullah, Rusian. 2005. A Decade of Oil Palm Gene Manipulation: Where are we now? Paper presented at the 9th International Conference on Agricultural Biotechnology Research, Ravello, Italy. July 6-10.

Blackie, Malcolm, Blackie, Reuben, Lele, Uma and Beintema, Neinke. 2010. Capacity Development and Investment in Agricultural R&D in Africa. Lead Background Paper. Ministerial Conference on Higher Education in Agriculture in Africa. Speke Resort Hotel, Munyonyo, Kampala, Uganda, 15-19 November.

Bonnen, J.T. 1998. "Agricultural Development: Transforming Human Capital, Technology, and Institutions." In International Agricultural Development, Third Edition, C.K. Eicher and J.M. Staatz eds. Baltimore: Johns Hopkins University Press: 271-286.

Bonnen, James T. 1962. Some observations on the organizational nature of a great technological pay off. Journal of Farm Economics: 44(5):1279-1294.

Busch, Lawrence. 1988. Universities for development: report of the joint Indo-U.S. impact evaluation of the Indian agricultural universities. AID Project Impact Evaluation No. 68. Washington, D.C.: U.S. Agency for International Development.

Byerlee, Derek. 2012. "Are We Learning from History?" In The Global Farms Race, Agricultural Investment, and Scramble for Food Security, ed.M. Kugelman and S.L. Levenstein. Washington, D.C.: Island Press.

Eicher, Carl K. 1982. Facing up to Africa's Food Crisis. Foreign Affairs 61(1):151-74.

Eicher, Carl K. 2006. The Evolution of Agricultural Education and Training:Global Insights of Relevance for Africa. Staff Paper 2006-26. East Lansing, Michigan.:Michigan State University, Department of Agricultural Economics.

Evenson, Robert. 2004. Private and Public Values of Higher Education in Developing Countries: Guidelines for Investment. Journal of Higher Education in Africa 2(1):151-176.

Fan, S., and N. Rao. 2003. Public Spending in developing Countries: Trends, Determination, and Impact. Environment, Production and Technology Division Discussion Paper 99. International Food Policy Research Institute, Washington, D.C.

Ford Foundation. 1959. India’s Food Crisis and Steps to Meet it. New Delhi: Ford Foundation.

Friedmann, Karen J. 1974. Danish Agricultural Policy, 1870-1970: The Flowering and Decline of A Liberal Policy. Food Research Institute Studies. 13(3): 224-238.

Gallagher, Kevin. D., Arnoud R. Braun, and Deborah Duveskog. 2006. Demystifying Farmer Field School Concepts. ECAPAPA Newsletter. 9(6): 2006.

Government Accountability Office (GAO). 2008. ‘International food security: insufficient efforts by host governments and donors threaten progress to halve hunger in Sub-Saharan Africa by 2015’. Washington, DC: Government Accountability Office.

Goldsmith, Arthur. 1990. Building Agricultural Research Institutions: Transferring The Land Grant Model to India and Nigeria. Boulder, CO.: Westview Press.

Haggard, H. Rider.1917. Rural Denmark and its Lessons. London: Longmans, Green and Company.

Haggblade, Steven and Peter R. Hazell. 2010. Successes in African Agriculture: Lessons for the Future. Baltimore: Johns Hopkins University Press.

Hashim, Mohd Yusuf. 1992. The National Research System in Malaysia. ISNAR Working Paper No. 41. The Hague: International Service for National Agricultural Research.

Hayami, Yujiro. 1988. Japanese Agriculture Under Siege: The Political Economy of Agricultural Policies, New York: St. Martin's Press

Hayami, Yujiro and Vernon Ruttan. 1985. Agricultural Development: An International Perspective, Revised Edition, Baltimore: Johns Hopkins University Press.

Hazell, Peter B.R. 2012. Options for African Agriculture in an Era of High Food and Energy Prices. Elmhirst Lecture presented to the 27th International Conference of Agricultural Economists, Foz do Iguaçu, Brazil, August 2012.

Idachaba, F.S. 1997. Instability of National Agricultural Research Systems in Sub-Saharan Africa: Lessons from Nigeria. The Hague: ISNAR.

Jenkins, Glenn P. and Andrew Kwok-Kong Lai. 1992. Malaysia. In The Political Economy of Agricultural Pricing Policy. Vol.2. Asia. Anne O. Krueger, Maurice Schiff and Alberto Valdes. Eds. Baltimore: Johns Hopkins University Press: 67-106.

Johnson, G. L., and B.N. Okigbo. 1989. "Institution-Building Lessons from USAID's Agricultural Faculty Development Projects in Nigeria." American Journal of Agricultural Economics 71(5): 1211-1218.

Juma, Calestous. 2011. The New Harvest: Agricultural Innovation in Africa. New York: Oxford University Press.

Kansas State University. 1974. A Terminal Report on Contract AID/afr 830 at Ahmadu Bello University, Zaria, Nigeria 1963-1974. Manhattan, Kansas: International Agricultural Programs, Kansas State University.

Kloppenburg, Jack.1988. First the Seed: the Political Economy of Plant Biotechnology, New York: Cambridge University Press: 141-148

Lele, Uma and Arthur A. Goldsmith. 1989. Development of National Agricultural Research Capability: India's Experience with the Rockefeller Foundation and its Significance for Africa. Economic Development and Cultural Change 37: 305-44.

W. Arthur Lewis, " The Economic Development of Africa" in Africa in the Modern World, ed. Calvin Whitney Stillman Chicago: University of Chicago Press, 1955): 97-114.

Lipton, Michael. 2012. Learning From Others: Increasing Agricultural Productivity for Human Development in Sub-Saharan Africa. WP 2012-007. New York: United Nations Devleopment Programme (UNDP), Regional Bureau for Africa.

Mehta, S.L. and B.N. Mathur. 1999. 50 Years of Agricultural Education in India. New Delhi: Education Division, India Council of Agricultural Research.

Mellor, John W. 1976. The New Economics of Growth: A Strategy for India and the Developing World. Ithaca: Cornell University Press.

Michelsen, H., L.W. Zuidema, C.H. Hoste and D. Shapiro. 2003. Improving Agricultural Research at Universities in Sub-Saharan Africa: A Study Guide. The Hague: ISNAR.

Moseman, Albert. 1970. Building Agricultural Research Systems in the Developing Nations.New York: The Agricultural Development Council, Inc.

Mutsaers, J.W. and W.M. Kleene. 2012. What Is the Matter with African Agriculture?: Veterans' Visions between Past and Future. Amsterdam: KIT Publishers.

Ness, Gayl D. 1961. Cooperative development and industrial capitalism In England and Denmark. Berkeley Journal of Sociology. Spring: 1-15. Ogura, Takekazu. 1970 Agricultural Development in Modern Japan. Tokyo. Fuji Publishing.

Olson, R.V. 1965. University teaching and research in agriculture and in veterinary medicine: requirements analysis, Zaria: Ahmadu Bello University, Nigeria

Pal, B.P. 1974. The India Agricultural Research Institute –The All India Agricultural Research Programs. In Strategies for Agricultural Development in Developing Countries. New York: The Rockefeller Foundation. Pp 90-123.

Pardey, P.G. and N.M. Beintema. 2001. Slow Magic: Agricultural R&D a Century after Mendel. IFPRI Series No. 36. Washington, D.C.: International Food Policy Research Institute.

Razak, Tun. Cited in J. Saravanamuttu. 1983. The Dilemma of Independence: Two Decades of Malaysias Foreign Policy, 1957-1977. Penang: Penerbit Universiti Sains Malaysia.

Roseboom, Johannes. 2004. Case Study of the Financing of Agricultural Research in Chile. Washington, D.C.: World Bank, July.

Ruttan, Vernon. 1982. Agricultural Research Policy. Minneapolis: University of Minnesota Press.

Ruttan, Vernon. 1991. Statement at a "Seminar on Strategies for the Future of Africa. African development: lessons from Asia: Proceedings of a Seminar on Strategies for the Future of Africa" sponsored by the Africa Bureau, U.S. Agency for International Development and Winrock International at the Radisson Hotel, Baltimore, Maryland, June , 1991. Arlington, VA: Winrock. p. 195.

Schultz, Theodore W. 1964. Transforming Traditional Agriculture. New Haven: Yale University Press.

Schultz, Theodore W. 1984. The Economics of Agricultural Research. In Agricultural Development in the Third World. Edited by Carl K. Eicher and John M. Staatz. Johns Hopkins University Press. Baltimore. Pp.335-347.

Stads, Gert-Jan, Arffin Tawang, and Nienke Beitema. 2005. Malaysia. ASTI Country Brief no. 30. Washington, D.C.: IFPRI. November.

Swaminathan, M.S. 2004. Building Impact-Oriented R&D Institutions: Lessons from the National Research System in India, Rome: GFAR Newsletter. Issue 9.

Tamboli, P.M. and Y.L. Nene. 2011. Revitalizing Higher Agricultural Education in India: Journey towards Excellence. Secunderabad, India : Asian Agri-History Foundation.

Wadia, F.K. 1997. Progress of Agricultural Education In India. Journal of the Indian School of Political Economy. 9(2): 286-308.

Willett, A. 1998. Agricultural Education Review: Support for Agricultural Education in the World Bank and by Other Donors. Washington D.C.: World Bank.

World Bank. 2005. An Independent Review of World Bank Support to Capacity building in Africa: The Case of Ethiopia: Washington, D.C.: World Bank Operations Evaluation Department, April.