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The changing face of agricultural education and extension within a changing policy context in Africa

J. K. LYNAM[1] and E. J. MUKHWANA[2]
[1]Independent Consultant, P.O. Box 72635-00200, Nairobi, Kenya
[2]Kenya National Qualifications Authority, P.O. Box 72635-00200, Nairobi, Kenya
Corresponding Author: Jums75@gmail.com

ABSTRACT
Tertiary Agricultural Education (TAE) institutions[1] perform a range of functions that complement their principal focus on training and human capital development. These include research, a critical component of higher degree training, outreach and community development, policy and advocacy, and increasingly product development and public-private partnerships. However, there are a range of institutions in the agricultural sector that also provide these functions, most of them specializing in a specific function, in what could be termed the organizational ecosystem within the agricultural sector. Faculties of agriculture often face dilemma in the sense that these subsidiary functions are necessary to ground faculty in a rapidly changing sector and to provide post graduate students with the skills they will need when they enter the labor market. At the same time financial resources are limited in universities to support these functions. This dilemma would argue for closer linkages between faculties and other organizations within the agricultural sector, in what is commonly referred to as agricultural innovation systems. However, such linkages require coordination, resources to support what are termed transaction costs, and mutual benefits from the arrangement. Because of these factors, institutional linkages have proven to be more the exception than the rule, even more so within a rapidly changing policy and institutional environment. This paper looks at an historical perspective in the development of the complex of institutions supporting the agricultural sector and attempts to identify the principal drivers of institutional change and change in institutional arrangements. The institutional ecosystem has varied through time, regionally, and in relation to colonial origins. The paper looks at the main trends through time, pointing out regional differences. It describes the post-independence period up to the mid-1980's, and subsequently up to the mid 2000's, which was dominated by structural adjustment and market liberalization programs. Finally it examines changes over the last decade and a half. Each of the periods had implications in the development of TAE and its role in the evolving agricultural innovation system.

Key words: Africa, agricultural research, extension, tertiary agricultural education, university institutions

RÉSUMÉ
Les institutions d'enseignement agricole supérieur (TAE) remplissent une gamme de fonctions qui complètent leur principal objectif de formation et de développement du capital humain. Il s'agit notamment de la recherche, un élément essentiel de la formation de niveau supérieur, de la sensibilisation et du développement communautaire, des politiques et du plaidoyer, et

[1]Institutions as used in this paper refer to organizations, principally formal organizations. The more specific use of the term institutions refers to the norms, laws, and regulations that govern economic activity, as is particularly used in institutional economics.

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de plus en plus de développement de produits et de partenariats public-privé. Cependant, il existe une gamme d'institutions dans le secteur agricole qui assurent également ces fonctions, ;a plupart d'entre elles se spécialisant dans une fonction spécifique, dans ce que l'on pourrait appeler l'écosystème organisationnel au sein du secteur agricole. Les facultés d'agriculture sont souvent confrontées à un dilemme dans le sens où ces fonctions subsidiaires sont nécessaires pour ancrer les professeurs dans un secteur en évolution rapide et pour fournir aux étudiants de troisième cycle les compétences dont ils auront besoin lorsqu'ils entreront sur le marché du travail. Parallèlement, les ressources financières des universités sont limitées pour soutenir ces fonctions. Ce dilemme plaiderait en faveur de liens plus étroits entre les facultés et d'autres organisations du secteur agricole, dans ce que l'on appelle communément les systèmes d'innovation agricole. Cependant, ces liens nécessitent une coordination, des ressources pour soutenir ce que l'on appelle les coûts de transaction et les avantages mutuels de l'accord. En raison de ces facteurs, les liens institutionnels se sont révélés être plus l'exception que la règle, encore plus dans un environnement politique et institutionnel en évolution rapide. Cet article examine une perspective historique dans le développement du complexe d'institutions soutenant le secteur agricole et tente d'identifier les principaux moteurs du changement et des arrangements institutionnels. L'écosystème institutionnel a varié dans le temps, au niveau régional et en fonction des origines coloniales. Cet article examine les principales tendances à travers le temps, soulignant les différences régionales. Il décrit la période post-indépendance jusqu'au milieu des années 80, puis au milieu des années 2000, qui a été dominée par des programmes d'ajustement structurel et de libéralisation des marchés. Enfin, il examine les changements survenus au cours de la dernière décennie et demie. Chacune des périodes a eu des implications dans le développement du TAE et son rôle dans l'évolution du système d'innovation agricole.

Mots-clés: Afrique, recherche agronomique, vulgarisation, enseignement agricole supérieur, institutions universitaires

INTRODUCTION

The institutional framework supporting agriculture in Africa has its origins in an agrarian economy facing multiple market failures and the initial design of the framework traces back to the colonial period. By the 1950's colonial administrations had recognized the critical role played by the African smallholder in the stability of the agricultural economy and the early anthropological work argued that s(he) would respond to price incentives. The difficulty was that there was a domestic demand constraint in that urban markets were very small and local rural markets were easily saturated. On the other hand, an export orientation required an efficient assembly and bulking capacity where transport infrastructure was limited and expensive. This led to the design of institutions supporting the marketing function, with the prospect that this would shift from public control to competitive markets in the private sector. This shift would entail a restructuring of marketing institutions and institutional arrangements.

Another primary function in the development of the institutional framework was the provision of public goods, particularly research and its complement, agricultural extension services. Technologies that support growth in agricultural productivity were viewed as essential, particularly given the challenge in maintaining soil fertility on the mainly weathered soils of the continent (apart from volcanic soils) and the array of pests and diseases attacking both crops and livestock that were indigenous to the continent and on which little research had been done. The design of research and extension organizations has gone through several

structural changes in the post-independence period in significant part because funding for these public goods has primarily relied on international aid funds and many of the design changes have come from outside the continent. The lack of local participation and presence of sometimes lukewarm participation, has meant that implementation of research and extension policies and programs was always less than optimal.

Arguably the principal constraint on the functioning of agricultural institutions was the lack of adequately trained personnel to staff these organizations. University development was in an embryonic state at independence and the cadre of trained personnel was limited in relation to the need. For decades university graduates had guaranteed positions in the public sector and faculties focused on the skill requirements needed to fill these public sector positions. Universities at the same time were limited by the under investment that had been made in primary and secondary education. Both the size and curriculum of faculties of agriculture would depend on investment in the supply of potential university students, the resources then to invest in tertiary education, and the changing job market for graduates.

Eicher (1999) argues for more of a systems approach to what he calls the agricultural research triangle[2], namely agricultural research, extension, and university institutions. By a systems approach he argues that there is an interplay between the services offered by the three, where weakness in one constrains the provision of services by the other two. This would argue for a planned and sequenced investment in what might be thought of as the core set of institutions driving agricultural productivity growth in the sector. This idea of unbalanced development of the agricultural institutional framework, latter to be termed the agricultural innovation system, is key to understanding capacity of these institutions to support agricultural growth and transformation. This balance or lack thereof was partly influenced by government investment priorities and by the structural changes in the agricultural market economy.

The critical changes in the agricultural institutional architecture since independence have been reflected in the role and structure of the Ministries of Agriculture (MOA). The functions carried out by the MOA over this period have changed significantly, which has affected how these functions are coordinated and funded. Much of the funding of agricultural services and functions is dependent on annual budgetary allocations primarily through the MOA. With many of those functions shifting out of the MOA, this has created a tendency to underinvest in the overall agricultural institutional framework, in many cases supplemented by international aid funds, but where priorities in those have also shifted over time. At the same time funding of agricultural faculties comes through ministries of education, which has often served to isolate those faculties from principal policy initiatives in the agricultural sector and to limit the balance in the development of the agricultural knowledge triangle. The phases in the development of agricultural institution in Africa is discussed in the succeeding three sections of this paper.

Independence to the mid 1980's: The dominance of the public sector-The colonial legacy at independence. The principal dimensions of the colonial legacy can be defined in terms of two issues, namely the development of an institutional framework in support of agriculture, which was the largest contributor to colonial economies, and the very much delayed development of universities and training of indigenous agricultural scientists, which created real constraints on institutional

[2]Eicher, Carl. 1999. Institutions and the African Farmer. Issues in Agriculture 14. Washington, DC: CGIAR Secretariat.

effectiveness after independence. Similarly, the approach to the institutional framework varied significantly between the colonies of France and Great Britain. In the post World War II (WWII) period France developed a centralized, federated system across its colonies in West Africa while Britain supported the development of administrative capacities in each of its colonies, although there were regional approaches in agricultural research in British colonies in East and West Africa. The institutional framework in place at independence became the template for administration of the agricultural sector for the new governments, with the principal issue being how to staff these institutions.

In the British colonies up until the post WWII period, each colony was expected to support its own governmental expenditure. Those colonies that could not meet this threshold were defined as "lacking responsible government". "The finances of some of these (colonies) - the 'grant-aided territories' - were under the strict control of Her Majesty Treasury" (Morgan, 1964). Most of the colonies in sub Saharan Africa (except Southern Rhodesia, today Zimbabwe) fell under this rubric which meant that all expenditure by the colonial governments came under the scrutiny of the colonial office. For agriculture the Colonial Agricultural Service staffed the agricultural departments in the colonies with British post graduate officers who spent one year at Cambridge and one year at the Imperial College of Tropical Agriculture in Trinidad. The Departments of Agriculture were headed by a Director of Agriculture, who reported to the Governor, and oversaw staff that fell into two groups, namely research staff and a field staff of agricultural officers. The latter were placed either at provincial or district level, with the district agricultural officer being the frontline officer (Masefield, 1972). Before independence in the 1950s, governance in the colonies shifted to a ministerial system based on local elections—for example, this took place in Kenya in 1954 (Trapman, 1974) which resulted in the creation of ministries of agriculture. The departments of agriculture also supported an agricultural research system in each of the colonies. Extension had also become more formalized in the post-WWII period, particularly with the large settlement and agricultural development projects, including a focus on soil conservation. However, these often involved coercive measures, which created an animosity by farmers to government extension programs, thereby greatly undermining the efficacy of these initiatives.

In many ways the more critical institution was the commodity marketing board. These differed between the settler colonies in East and Southern Africa and the smallholder-based export economies of West Africa. A principal activity of the settler community was cereal production, but in a context of limited urban demand, thin markets, and price volatility, as well as competition from smallholder production. The depression of the 1930's led local governments pass acts to create marketing boards to set prices and regulate supplies. In particular these acts led to (1) the establishment of restrictions on grain movement from African towns, mines and other demand centers where African production could otherwise undercut European grain production; (2) the creation of monopoly state crop buying stations in European farming areas without similar investments in African farming areas; and (3) assured prices for European farmers (typically above export parity) that were financially sustained through "rake-off" taxes on maize sales by Africans to licensed private traders operating as agents of the boards (Jayne and Jones, 1996). West African economies were based on smallholder production and non-tradeable food staples but with a dynamic export production of cocoa and palm oil and kernels. During WWII in 1940

the West African Cocoa Control Board was set up to manage cocoa purchases and exports, which was extended in 1942 to palm products and groundnuts. In 1947 commodity boards were set up in each of the West African colonies to manage export products (Williams, 1985).

The last major institution to be developed in the British colonies was the university colleges. The Asquith Commission of 1945 recommended that institutions for higher education be created in the colonies, in part reflecting the need for an educated elite in getting ready for self-rule. As a result of the commission report, university colleges were founded in Nigeria (University College of Ibadan), the Gold Coast (University College of the Gold Coast) and Uganda (Makerere University College/University of East Africa), Southern Rhodesia/Nyasaland, and Sudan. These university colleges were affiliate colleges of the University of London, which designed the curriculum, set entry requirements and awarded the degrees. This went against a previous 1938 commission report which recommended a curriculum adapted to African conditions. These colleges had relatively small class sizes in relation to the need for trained manpower. In the period 1952 to 1963 university colleges in anglophone Africa produced about 150 graduates in agriculture—compared to only 4 in francophone Africa (Eisemon *et al*., 1985). One critique of the Asquith Commission approach focused on the over specialization and lack of relevance, the lack of linkages to the technical institutes, and too much of a focus on fundamental research (Ashby, 1966).

As noted above, there were only four graduates in agriculture in francophone Africa at the time of independence in 1960. The dominant characteristic of the former francophone colonies was that institutions continued to be populated by French expatriate staff well into the 1980's. There was only a start at developing higher education institutions by independence and there was only one faculty of agriculture in all of francophone Africa. Whereas the British relied on "indirect rule" delegating authority to chiefs and elites, the French relied on expatriate staff managing all institutions. This applied to the difference in the establishment of farmer cooperatives, which were compulsory in francophone colonies and managed by French staff (Develtere, 2008). Similarly, the French had developed a network of agricultural research stations, mostly organized around export commodities. In the post WWII period these were operated at a federal or regional level but managed through research centers based in France. These research centers focused exclusively on export crops—IRAT which focused on food crops was created in 1960 at independence for the French colonies. These research centers each operated a network of research centers distributed through the francophone region in West Africa.

Managing the agricultural economy by the Ministry of Agriculture. In the anglophone countries the Ministries of Agriculture (MOA) were the central institutions that carried out the functions critical to development of the sector. These functions were aggregated into the MOA and as a result the MOA had one of the largest budgets, in general like the budget for education. The marketing boards, however, were maintained as separate entities or parastatals. Each board handled a different commodity and was given the authority to set prices and organize supply. For example, Kenya had 12 separate boards, one of which supported irrigation (Trapman, 1974) while others worked on coffee, tea, sisal, cotton, cereals, and milk, among others. The boards carried out the same functions, but were now orientated to serving smallholder farmers, particularly in the former settler colonies. This was done by expanding state buying stations into smallholder areas and with links to MOA departments, providing subsidized inputs and credit (Jayne and Jones, 1996). The MOA had departments for research and extension, for agricultural credit, for infrastructure development, and all organized at national, provincial and district levels, although

with a tendency to centralize decision making at the national level.

The MOA in francophone countries had less of an implementation role and more of a planning and coordination role. As Moris (1994) notes, the MOA "serves in a technical and advisory capacity, planning the project portfolio for publicly financed activities in the agricultural sector, which, once they have become part of the national plan and subsequently the annual budget, are usually implemented by an array of parastatal institutions dealing with individual export crops (groundnuts, cotton, cereals, and sugarcane)." These projects were usually implemented by regions and there was significant variation in project implementation depending on institutional capacity that up to the 1980's depended significantly on expatriate staff.

Fragmentation in agricultural research. A significant agricultural research capacity had been developed in most countries at independence, but it was significantly under resourced. As Rosebloom *et al*. (1998) noted, "In 1961, public (agricultural research) systems in 33 of 48 African countries employed fewer than 25 full-time equivalent (fte) researchers." This also included a number of regional agricultural research centers. During the colonial period most countries were integrated into these regional structures. In the anglophone countries this included the East African Agricultural and Forestry Organization (EAAFRO) based in Kenya and in West Africa regional institutes for palm oil, cocoa, and rice. This also included the Empire Cotton Growing Corporation's central station at Namulonge in Uganda. In West Africa the regional institutes were effectively nationalized at independence. EAAFRO continued to function until the collapse of the East African Community in 1977, at which point the stations were integrated into the science division of the Kenyan MOA, as was the Namulonge station into the Ugandan system. The collapse of regional structures meant that many countries lost access to research support for important crops in their economies, and a big chunk of the institutional memory that had been built over time and were saddled with a research infrastructure that did not undertake research relevant to local needs.

Different research capacities were somewhat arbitrarily incorporated in different areas of the MOA, resulting in significant fragmentation and lack of coordination of research efforts. Moreover, with the smallholder focus there was a need to shift away from a focus on export crops to food crops. This often led to competition among different research departments for funding in order to build capacities, which were sometimes duplicated. The macroeconomic mismanagement and stagnant growth of the 1980's, with the need for improved efficiencies in the MOA, led to the restructuring of agricultural research into autonomous, parastatals with centralized management and budgeting of all or most of agricultural research in the countries, namely the creation of the national agricultural research institutes (NARIs).

The development of agricultural research institutions in francophone Africa took a very different approach. At independence in 1960 the federal system of agricultural research was jettisoned as each newly independent country assumed responsibility for its own research. However, given the shortage of personnel, these research centers continued to be managed by the eight research institutes in France up through the mid-1970's. The agreements with France at independence included continued control of research centers in the former colonies. A continuation of French ownership or long-term rights of access to the local research infrastructure throughout Africa formed part of the cooperative agreements that France signed with nearly all the French African territories that gained independence during the late 1950s and early 1960s (Roseboom *et*

al., 1998). In 1970 these centers were brought under one administrative structure, GERDAT (Groupe d'Etudes et des Recherches pour le Développement de l'Agronomie Tropical), which evolved into CIRAD and became the principal basis for French aid in agriculture. By the mid 1970's most francophone countries had taken over control of the research centers in their countries. Because of this history, institutional development was a much slower process in French West Africa than in the former British colonies, especially in terms of the process of "Africanization" of these institutions and their ability to focus on resolving local problems.

Integrated Rural Development to T&V Extension. Agricultural extension in the anglophone countries was the preserve of the MOA and the focus was on food crop production by smallholders. There were no strict extension methodology as different approaches were used, including farmer training centers, model farms, demonstration trials, and progressive farmers. Ruthenberg (cited in Lele, 1975) summarized these different approaches in two organizational forms, namely the "take it or leave it" approach and the contract farming method. The first essentially offered advice or techniques to farmers and it was up to them to decide to adopt, thereby circumventing the more coercive methods used during the colonial period. The latter was usually associated with cash crops such as tea or cotton and was based on contractual forms of participation. Extension agents also were the front line in credit and subsidized input programs, also run through the MOA, and these also were associated with more with cash crop production programs (Mukhwana, 2000). The latter type of organization was also found in francophone countries, particularly in cotton and groundnut programs and often organized through farmer cooperatives.

Robert McNamara's 1973 speech in Nairobi shifted the development agenda to poverty, and in Africa that meant rural poverty. This led to the World Bank's support for integrated rural development programs—IRDP's (Lele, 1975; Yudelman, 1976) The projects built on a range of rural development projects initiated during the colonial period (Hodge, 2007), particularly in anglophone countries. These integrated various services in particular regions and relied on the capacities in the MOA, particularly the extension departments. At this stage extension personnel were still relatively few in relation to the smallholder population and not well trained. IRDP increased the intensity of the extension capacity in program areas and increased the training of extension personnel. As the term integrated implies, technical advice was combined with credit and input delivery programs. These programs, however, were found to be too complex for the institutional capacities that were in place in that period (OED, 1992) and investment in IRDP's essentially stopped.

The decline in support to IRDP's coincided with the World Bank's new initiative in Training and Visit (T&V) extension. The Bank had supported this extension model in Asia in the mid 1970's and piloted the approach in Kenya in 1981, leading to a loan supporting a complete reorganization of extension in 1983. The Bank would go on to supporting T&V projects in 30 countries on the continent (Bagchee, 1994). Extension in these countries was organized around a single model which consisted of a hierarchical management structure, a rigid schedule of visits to pre-selected contact farmers, a focus on a few dominant crops, periodic interaction with research staff, and a significant expansion in and training of extension personnel (Anderson *et al*., 2006). A single methodology dominated extension departments within MOA's in Africa through the 1980's and into the early 1990's and as explained in the next section, World Bank support collapsed, and with-it effective implementation of the model. The model had been heavily financed by the World Bank, and its financial sustainability was obviously in question (Mukhwana, 2000).

Expanding national universities and government management. There was at least one great weakness in the colonial approach. This was the failure to develop institutions that could produce the skilled, indigenous manpower to undertake research and to participate in the management and direction of agricultural growth (Yudelman, 1975). At independence there were five higher education facilities that provided a degree in agriculture in the anglophone countries and one in the Congo. This left a real deficit in the ability of newly independent nations to staff and manage the complex of institutions necessary for agricultural growth and development, including faculties of agriculture themselves. At independence the former university colleges affiliated to the University of London were constituted as national universities. In East Africa Makerere University was reconfigured in 1963 as one of three colleges constituting the University of East Africa, joining more recently established colleges in Nairobi and Dar es Salaam, which ended in 1970 and all became national universities. At the same time in 1963 90% of the academic staff in the university were expatriates (Court, 1991).

With the process of decolonization in the 1960's there was a focus of American foundations, particularly Ford, Rockefeller, and Carnegie, on supporting the development of higher education is sub Saharan Africa (Livsey, 2017). This was soon followed by USAID and the World Bank. These programs had two prongs, namely higher degree training of Africans in northern universities and capacity strengthening programs for the new national universities. The result was a significant expansion of universities on the continent in the 1960's and 1970's, and particularly those offering agricultural and veterinary degrees in faculties of agriculture (Figure 1). However, enrollment in agricultural degree programs was not high. In 1979-81 only about 6% of all students at BSc level were enrolled in agricultural degree programs and just 7% at MSc level. For 19 countries outside Nigeria and South Africa, which had by far the largest number of students, this amounted to only

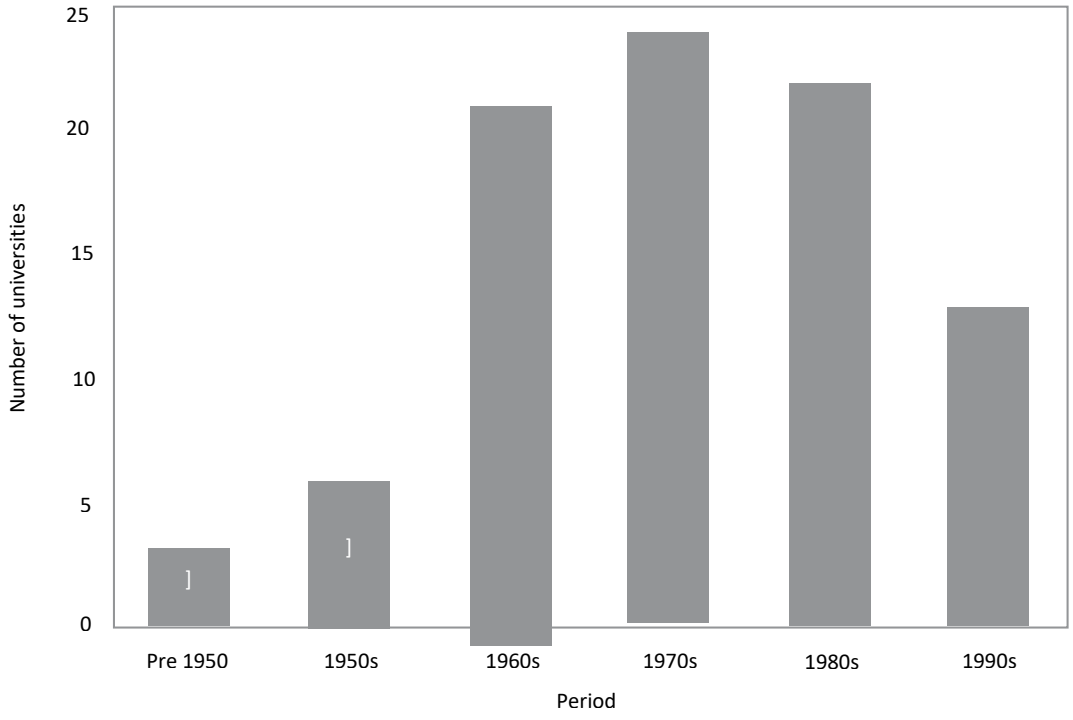

Figure 1. Establishment dates of African universities with a faculty of agriculture or veterinary sciences

4,102 students at BSc level and 493 students at MSc level, compared to 3,931 students at both levels in Nigeria (Bientema *et al*., 1998).

USAID was an early donor to the development of tertiary agricultural education on the continent and particularly focused on adapting the land grant model that had developed in the United States. One of the earliest investments was in 1953 with funding to Oklahoma State University to develop an agricultural university at Alemaya in Ethiopia. This was followed by support to Michigan State University to apply the land grant model in the creation of the University of Nigeria at Nsukka in eastern Nigeria at independence in 1960 (Livsey, 2017). Later this was followed by support to Ahmadu Bello University in the northern region and the University of Ife in western Nigeria. All together there were 11 universities that were supported in Africa, each for a decade, which is a long period by the standards of donor projects (Alemneh, 2014). The land grant model integrated three critical functions, namely education and training, research, and extension and community development, with each reinforcing the other two. Where the model succeeded, particularly at Ahmadu Bello University, there was an integration of the research institute at Zaria with the university and the creation of a research-liaison department, all supported by the Northern Ministry of Agriculture (Eicher and Haggblade, 2013). However, most failed to achieve this integration, mainly because the common ministerial separation between agricultural research (in ministries of agriculture) and agricultural higher education (in ministries of education) hampered the development of agricultural innovation systems in Africa (Eicher and Haggblade, 2013).

Mid 1980's to mid-2000: Structural Adjustment and Market Liberalization. This period market liberalization and demise of marketing boards. The 1980's in SSA was a period of stagnant economic growth, declining per capita food production, and struggling institutions. The expansion in primary education and health services had stretched government budgets and countries tended to run large budget deficits with overvalued exchange rates. Overstaffing had significantly curtailed capital and operating budgets of public institutions, which had constrained their effectiveness. Moreover, whether farm prices were set above or below export parity depended on the country, regulations on produce movement, sales, and trade tended to limit investment incentives in the agricultural sector. This period of "African pessimism" led to the formulation by the World Bank and the IMF in the mid 1980's of policy reforms designed to reverse these trends. These structural adjustment and market liberalization policies were implemented as conditionalities on loans provided to the countries (Woomer and Mukhwana, 2004). Because there was little in terms of private foreign investments, African countries depended on these loans. This period of policy reforms starting in the mid 1980's and extending essentially to the turn of the century were targeted to achieve macroeconomic stability—which translated into control over deficit spending, liberalization of foreign exchange controls and trade regulation, and liberalization of agricultural markets. As a result of this period of structural reform in the economy was a major restructuring of the institutional architecture supporting the agricultural sector.

Kherallah *et al*. (2002) identify three basic policy and institutional features of the market liberalization process in the agricultural sector, namely: (1) liberalizing input and output prices by reducing or eliminating subsidies on agricultural inputs such as fertilizers and credit, realigning domestic crop prices, eliminating pan-seasonal and pan-territorial pricing, and reducing exchange rate overvaluation; (2) removing regulatory controls in input and output markets (for example, allowing the participation of the private sector in agricultural marketing), lifting restrictions on internal movement of food crops, and relaxing quantitative controls such

as delivery quotas and licensing arrangements; and (3) restructuring public enterprises and withdrawing marketing boards from pricing and marketing activities (such as providing market information services and maintaining security stocks). The result of these policy reforms would be to disengage the public sector from participating directly in agricultural markets and thereby encouraging the growth of private sector participation and investment (Woomer and Mukhwana, 2004).

This reordering of functions between the public and private sector in the agricultural economy would provide the rationale for redesigning the public institutions supporting agricultural development. Marketing boards were either dismantled or turned into strategic grain reserves such as ADMARC in Malawi. Significant parts of the MOA lost their role in a liberalized market economy, particularly those departments providing services that the private sector could provide. As might be expected with such a quick shift to reliance on a liberalized market economy, there was a significant lag in the entry of the private sector into the agricultural economy, especially as lack of infrastructure, uncertainty in whether the government would fully extricate itself from market interventions, and the high costs of integrating smallholders into the market economy all resulted in higher returns to investment in the urban sector (Mukhwana *et al*., 2004). Stepping into the breech was a major expansion of the role of civil society, as democratization surged across the continent up to the new century (Bates and Block, 2013). The NGO's, farmer associations and cooperatives, micro credit facilities, and other forms of collective action filled the gap left by the institutional void left by the market liberalization process.

Redefining Extension. The World Bank played a dominant role in African agriculture during the 1990's. At the same time as it was fomenting structural adjustment policies, the Bank was also increasing its loans for T&V extension. In the end, the two were incompatible in the sense that T&V extension required a significant expansion in the number of extension personnel and their mobility leading to significant increases in recurrent budgets. This occurred at the same time as other parts of the Bank were supporting macroeconomic reform particularly in terms of budgetary stringency. A uniform extension model had been rolled out in 30 countries since 1983 and by 1998 all support to T&V extension was terminated. A 1997 report by the Bank's office of evaluation found that "the Bank had errored in the extent to which it has promoted the T&V extension management system in relatively uniform packages of investments and extension practices in large State and national programs", and that "the increased flexibility in African T&V projects was not likely to resolve the problems encountered and therefore the T&V design was unlikely to be the most appropriate approach for improving extension in many African countries (Anderson *et al*., 2006).

In many respects this rather rapid withdrawal left a vacuum in agricultural extension capacity on the continent. This resulted in a period of experimentation with agricultural extension methods, primarily through NGO's but also including the farmer field school (FFS) methodology piloted by the Food and Agricuture Organisation (FAO). This experimentation included assessing new forms of media, including local language radio, video, and FFS curricula. Similarly, farmer participation became a corner stone of most approaches, often involving group methods and farmer associations. This provided the basis for more formal collective action by farmers, which was to be a precondition for cost effective integration of smallholders into expanding agricultural markets. This period of experimentation became the basis for what was termed pluralism in agricultural extension which rejected a uniform methodology delivered by a single agency and argued for multiple methods utilized by a range of providers, including

an expanding private sector. The potential downside of this approach was possible bias in the coverage of the agricultural population, with a tendency for under coverage of more marginal areas or areas with higher rates of rural poverty. This experimentation as well included methods on how to link smallholders to markets, and in that sense civil society responded with integrated approaches given the vacuum in both extension and private sector market development (Woomer and Mukhwana, 2004).

Restructuring of the MOA and its changing role. In many ways the most fundamental change in institutions during this period was in MOAs. Many of the former functions were delegated to other institutions, such as research to the NARIs and market coordination to the private sector. Financing support for extension collapsed with the withdrawal of T&V extension and there were as well initial pilots to devolve extension to the districts as decentralization took hold. The implementation functions of the MOA were progressively devolved, and the role of the ministry was relegated to regulation, facilitation, and the provision of public goods. In the process budgets for agriculture were significantly pared, to the point that public spending on agriculture got to critically low levels, in some cases to 3% of the overall budget[3]. The African Union (AU) Heads of State meeting in Maputo in 2003 issued a declaration stating that government spending on agriculture should reach a target of 10% of overall public expenditure. In many ways this was an opportunity for the MOA to reimagine themselves and redefine their role, but in most cases the MOA retrenched staff and were unable to respond to such diverse constituencies, claims and demands, operating in an increasingly democratic but also decentralized setting. As technical line ministries they were often poorly equipped to do this (Cabral and Scoones, 2006).

At the turn of the century the World Bank and IMF realized that structural adjustment policy reform was having a negative impact on poverty rates, which led in 1999 to the additional conditionality that borrowing countries were required to produce a Poverty Reduction Strategy. Since the great majority of the poor lived in rural areas, targeted investments in rural development were a principal means of poverty reduction. This generated a debate as to whether rural development strategies were an agricultural strategy or extended to critical delivery of health and education services. In many ways it was easier for governments to direct annual budgeting to health and education than to the more complex relations between agricultural investments and poverty. A World Bank (2004) review noted the "disconnect between PRSP priorities and follow-up of the rural themes through Poverty Reduction Strategy Credits (PRSCs), other instruments, and other donors. This disconnect is most pronounced for rural finance, rural private sector development, food security, risk and vulnerability, livestock, decentralization and governance issues. On the other hand, rural education, health and water supply and sanitation, issues related to natural resource management (NRM), the incentive system, as well as agricultural support services, are followed-up in one way or another in all countries where these had been prioritized in the PRSP.

The marginalization of the MOA and the lack of public sector spending in agriculture was eventually viewed to be counter-productive given the importance of the sector in the economy and possibly as important, the weight of rural voters in the increasing democratic process. This led to the development of strategic plans for the sector viewed as critical to justifying the sector's strategic importance in the policy process. Thus, the Plan for the Modernization of Agriculture (PMA) was put in place in Uganda in 2001, with the overall goal of reducing poverty but "through a profitable, competitive, sustainable and dynamic agricultural and agro-industrial sector" (Oxford Policy Management, 2005). Similarly, Kenya developed its Strategy

[3]In a Public Expenditure Review of agricultural spending in Kenya in 2004 involving the Ministry of Agriculture (MoA), the Ministry of Livestock and Fisheries Development (MoLFD) and the Ministry of Cooperative Development and Marketing (MoCDM) the findings included: (1) Sharp decline in overall public expenditure in agriculture as percentage of total government spending: 10 % after Independence, an average of 7.5 % in 1980-89, 3 % in 1990-2000 and 3.1 percent in 2002/03 and (2) Recurrent expenditure dominated by salary payments – 70-90 % of total expenditure in the three ministries." (cited in Cabral and Scoones, 2006, p 21

for the Revitalization of Agriculture in 2004, but interestingly vested implementation in an inter-ministerial Agricultural Sector Coordination Unit (ASCU). Such strategies were designed to support private sector led development of the sector and particularly through integration of smallholders into an expanding market economy. These country level initiatives were reinforced by the AU's launch in 2003 of the Comprehensive Africa Agriculture Development Programme (CAADP), which developed a continental wide process for developing investment plans for the sector.

A return to regional approaches in research. After rapid growth in funding to agricultural research in the 1960's (6.8% per annum), the annual growth rate in spending declined from 2% in the 1970s to 1.3% in the 1980s, and to only 0.8% in the 1990s. Excluding Nigeria and South Africa, total public agricultural R&D spending in Africa actually declined by 0.3% per year in the 1990s (Beintema and Stads, 2004). Although the early reforms in agricultural research were in part supported by donor funding, this dependence increased in the turn of the century. In the early 1980's donors accounted for 34% of expenditure which increased to 43% in 1991 (49% if Nigeria is excluded) (Pardey *et al*., 1995). By 2000 donor funding accounted for 35% of the research funding (Bientema and Stads, 2004). Donor funding was both volatile and accounted for much of the capital and operational budgets of NARIs. Moreover, the termination of large donor programs, such as by the World Bank, had a destabilizing effect on research effectiveness.

With such relatively large investments in agricultural research, donors had a vested interest in increasing the effectiveness of agricultural research. Much of this interest was focused on the organization of agricultural research. Up through the 1990's the trend was a consolidation of research capacities into a unified management structure with its own budget and autonomy of decision making, namely the NARIs. Such reorganization did result in a decline in fragmentation as measured by an index (Pardey *et al*., 1995) and by 1991, 28 of 48 countries had adopted the NARI organizational model (Roseboom *et al*., 1998). With the lack of performance of agricultural research during the 1990's and with the increasing move toward decentralization, another institutional reform process gained consensus at the turn of the century. Chema *et al*. (2004) summarize this reform process as follows: "A major new dimension in the overall focus of the reform agenda… is the shift from centralization to decentralization. Moreover, the new reform agenda forces agricultural research to be more outward looking, client oriented, and impact driven. It is not sufficient to produce good science: research organizations are being urged to ensure that their knowledge and technology are being applied, preferably by resource-poor, subsistence-oriented farmers in hitherto neglected areas." Decentralization was designed to meet local farmer needs and to partner with the complex of actors in the rural areas involved in extension and integration of smallholders into markets. In many cases, the disarray in extension moved NARIs further downstream in piloting innovative farmer participation methodologies.

At the turn of the century, half the countries had less than 100 full time equivalent researchers (Beintema and Stads, 2004). The size distribution of NARIs in SSA was heavily skewed with seven (7) countries having what could be considered a robust size to manage the diversity in crops and ecologies, while the rest had to either set rigid priorities or fail to build critical mass necessary to produce research products. The logic argued for more collaborative structures in research on the continent, building on the commodity research networks managed by the CGIAR centers and the creation in 1984 of SACCAR to coordinate agricultural research in the Southern African Development Community

(SADC) countries of Southern Africa. With donor support ASARECA (Association for Stengthening Agricultural Research in Eastern and Central Africa) was created in 1994 in East Africa and an existing French network, CORAF was extended to anglophone and lusophone countries in West Africa. These sub regional organizations (SROs) were managed by the managing directors of the NARIs in the member countries. They did not have research capacity of their own but rather focused on mobilizing their NARS members to conduct agricultural research that is of regional interest through commissioned or competitive agricultural research grant schemes (Roseboom and Flaherty, 2016).

Fiscal autonomy and change in universities and TAE. Institutional change in TAE in this period was essentially driven by overall changes at the university level. Universities by the mid-1980's were suffering from the same malaise as other institutions. They depended on government education budgets to meet their expenditures, and these competed with the increasing demands from primary and secondary education. Student costs were covered by government grants and graduates were guaranteed a place in the public service. Because government controlled the purse, there was in many cases political interference in the management of universities to contain student political activity. Indeed real spending per student in Africa declined from an average of $6,300 in 1980 to $1,500 in 1988 (Bientema *et al*., 1998). Staffing of faculty with those with post graduate degrees was also a challenge given the limited pool of talent, even as staff salaries fell by 30% during the period 1980-88 (Bientema *et al*., 1998). Limited budgets, low salaries, and increasing demand for university education significantly reduced institutional effectiveness. Structural adjustment programs and a reordering of spending priorities forced a severance of the reliance on government budgets, full support to students, and assured student employment.

The university sector became much more responsive to market forces to meet a pent-up demand for university degrees. Tuition fees became a key source of university finances and at the same time sparked a significant expansion in private universities. The investments that countries had made in secondary education were now reflected in increasing demand for university education and given the participation of youth in the democratic process, there was an expansion in public universities. As an example, Kenya had only two public universities in 1984 and Ethiopia only two up to 1991. By 2007 Ethiopia had 22 and by 2013 Kenya also had 22, adding 15 public universities in that year. In Kenya in 1983 there was a university enrolment of about 6 800 students. This grew to 60 000 by 2002 and to 200 000 by 2012 (Lynam, 2016). Such rapid expansion had a number of effects. Firstly, faculties of agriculture with the expansion in enrollments focused almost exclusively on teaching. Moreover, with the expansion in universities there was an increasing shortage of staff, increasing class sizes and drawing in MSc lecturers. Quality of education became a key issue. Secondly, experienced researchers in the NARIs transferred over to university teaching, creating a drain on research capacity. Finally, the concentration on teaching at the expense of research and the focus on first degree students caused a drain on post graduate teaching capacity (Mukhwana *et al*., 2017).

At the turn of the century faculties of agriculture had gone through first a phase of consolidation and then one of expansion. Another cycle of consolidation was needed and given the number of competing faculties, a period of differentiation was also needed. Some faculties were now located in rural areas, away from the capital city, and could focus on particular ecologies. Some had the potential of developing strong post graduate programs. Others were targeting the needs of the expanding private sector. At

the same time both government priorities and foreign aid was shifting back from the PRSP focus on rural social services to investments in agriculture itself. Between 1991 and 2001, the share of aid to agriculture in Africa fell from 19 to 10 percent, while that of social services (i.e., health and education) increased from 32 to 56 percent. As agriculture lost support from among development organizations, both in absolute and relative terms, poverty in Africa has persisted, and unlike other regions that have made major advances in agricultural productivity to improve the livelihoods of the poorest, Africa has regressed (Kane and Eicher, 2004). Agriculture was poised to move back onto the development agenda but this required strong and interacting institutions.

Positioning TAE in a dynamic institutional context. This brief historical survey decirbed above demonstrates the very dynamic changes in institutional architecture supporting agriculture and how individual institutions have responded to the emergence of different drivers over the last half century, particularly in the last thirty years the interactions of market liberalization, democratization and decentralization. At the same time there has been a significant shift in functions performed by the various institutions. Within this context the key question for this section is how TAE position does itself in this institutional framework going forward. To assess this requires an understanding of how functions are distributed within this architecture, with one institution having capacity, and in some sense responsibility, for that function but with other institutions contributing from the vantage of their specialization. Related to this last point, the other feature of this architecture is how the different institutions interact, particularly around the larger agricultural development agenda. This interaction, while not necessarily coordinated, forms what is now termed an agricultural innovation system (AIS) (World Bank, 2012) and parallels the intent of Integrated Rural Development but based on collective institutional self-interest. The history is suggestive, however, of each institution acting autonomously. TAE has the potential of fostering more interaction between institutions in an AIS (Spielman *et al.,* 2008) given its potential contribution to key functions, namely education, research, extension and policy. This section will assess the role of TAE in these functional domains in relation to the other institutions that operate in those domains.

TAE in Education and Human Capital Development. TAE institutions train the human capital with the skills necessary to drive the agricultural growth process. From a focus on the "Africanization" of management and decision making in public institutions, faculties of agriculture now must meet the need of a highly differentiated labor market, one that is increasingly driven by the requirements of the private sector. There are few other institutions that provide this function, that is apart from universities outside Africa itself. There are some targeted training capacities, such as in business management skills for SMEs, but in general it is the faculties that provide the skilled work force that is the critical determinant of capacity in the other institutions supporting the agricultural sector, including the private sector.

Clearly, the TAE sector is undergoing significant change, driven in large part by market forces, namely a differentiating labor market, a tuition-paying student population that can choose their course and faculty, and an increasing number of competing sources of supply. The rapid expansion in public and private universities has created a real constraint on the supply of post graduate teaching staff, especially of PhD's, which in turn limits innovation in curriculum, pedagogy, and quality assurance. Such shortages limit the development of post graduate degree training itself, creating something of a negative feedback loop. The competitive environment eventually should lead to improved quality and differentiation across faculties of agriculture,

but the staffing and financial constraints in the sector limit that process. This argues even more for differentiation and specialization across faculties. To a certain extent this process is being facilitated by regional network approaches (see earlier section) drawing on academic expertise where it exists in the region. The need currently is for faculty differentiation in those providing high quality post graduate education. In many faculties class sizes are too small across the range of disciplines to justify the investment to develop quality graduate programs. The World Bank's PASIP program supports such a process by supporting centers of excellence. However, such faculties must meet the quality criteria that make them centers of excellence, and that comes from critical changes in internal development of graduate programs and the pursuit of excellence. That excellence comes from staff involvement in other critical functions beyond just teaching, which is where staff time is currently focused, particularly in research, community development, and policy.

Tertiary Agricultural Education positioning in research. Research is essential to keep teaching staff current and critical for any effective graduate program. At the same time, the NARIs have principal responsibility for research and funding for research from ministries of education are scarce. Moreover, many faculties do not have the experimental farms necessary to support ongoing research. Within faculties teaching and in turn research is organized by disciplines, when many of the key problems facing smallholder agriculture are multidisciplinary in nature. Finally, research that produces adoptable technologies is a long-term investment, which is usually not supported by funding realities. Nevertheless, post graduate students are a very effective means of carrying out dedicated research, assuming appropriate supervision and material support, and multiple students could be organized around a multifaceted, research problem. All of this argues for strong research partnerships to maintain the skills of academic staff and develop a strong graduate program.

Research in faculties of agriculture is currently driven by funding, and partnerships are usually organized around grant funding—which is little different from northern universities. Sources of such funding vary by country but include national competitive research funds, usually administered by NARIs, the grant programs of the SROs or RUFORUM (Regional Universities Forum for Capacity Building in Agricultture), a few international research support programs such as provided by foundations, and partnerships with CGIAR centers or northern universities through grants that they have received. For all these sources, faculty staff must compete with NARIs. At the same time, faculties have been hiring staff from NARIs and are increasing their competitiveness. The current situation is that research carried out in faculties of agriculture depend on those academic staff that have the network, skills, and inclination to devote time to grant development and execution and have the time beyond their teaching responsibilities.

In the differentiation process some faculties and universities are moving to branding themselves as research universities, with strong graduate programs. This requires moving from dependence on individual researchers to developing capacities that are recognized in the scientific community. One example of this is the plant breeding and molecular biology capacity at Makerere University. This has involved investment in lab, greenhouse, and experimental farm capacity, identification of skilled staff, partnerships with institutions working in the area, advanced curricula, and selective identification of graduate students. Many faculties are developing research and teaching programs in areas such as dryland agriculture, integrated soil fertility management, and livestock production systems. These centers of excellence focus on departments in developing their competitive niche and the partnerships and funding that follow. Going forward research will become a more significant part of faculties of agriculture

focused on developing strong graduate programs and this will be led at departmental level and these programs will complement rather than displace research as undertaken in the NARIs.

Tertiary Agricultural Education role in extension and community development. In this period of pluralism in the provision of extension and advisory services, there is a circumscribed role for faculties of agriculture in providing such services. As with research, faculty participation in extension should reinforce teaching and student education. It can also be a means of locating student research in ongoing field sites, thereby developing synergies in the work. Extension approaches involve an understanding of smallholder systems, farmer groups and community development, and partnership with other rural institutions. Extension has broadened to encompass the larger processes of rural innovation and there are now departments organized around this area, for example RUFORUM's collaborative PhD in rural innovation between Makerere University, Egerton University, and Sokoine University. Faculties are able to test and evaluate new methodologies, such as innovation platforms (Dror *et al*., 2016). Piloting and evaluation in this area requires field capacity which does require resources. Moreover, choices must be made about whether the faculty identifies a community which it continues to work with or whether it limits its involvement to a particular time frame. Also, the work can be carried out just by the faculty or it can be done in partnership in something like an innovation platform. Properly designed and led, such work in rural innovation can be the point of interaction with other actors in rural development and as a bridge to farming communities.The ongoing efforts by RUFORUM to strengthen university-community engagement through especially Community Action Research and Students extension delivery approaches (Kalule *et al*., 2016; 2019) offer useful insights of how these could be done and scaled up to improve farming household productivities.

Tertiary Agricultural Education role in the policy arena. For much of the post-independence period universities were marginalized from the agricultural policy process. This is partly because diverse faculties could not speak with one voice—as compared to the MOA, most faculties were also outside the capitol city, and departments of agricultural economics, where much of the policy expertise resided, could not respond quickly and in a coordinated way to quickly emerging policy issues. Moreover, MOA's had their own policy research units which supported the policy process in the ministry. This began to change with the market liberalization process in the late 1990's and primarily with the support of the African Capacity Building Foundation which funded the creation of dedicated policy research institutes in several universities on the continent. Examples of this are the Economic Policy Research Centre at Makerere University, which works on agricultural policy, and the Tegemeo Institute of Agricultural Policy and Development at Egerton University. These research institutes could take the longer view on policy issues facing the sector, invest in their own survey and data collection, and provide independent research on policy relevant issues. Moreover, they could draw on graduate students in undertaking the research, thereby reinforcing the link back to degree training. These institutes could set their own research priorities and coordinate and fund the capacity that exist in a university around those priorities. They could also organize seminars for policy makers on their latest research, thus becoming a more pro-active voice in the policy process. These institutes reside in the capital cities, even if the university is located outside. One university tends to take the lead in developing these policy research institutes. A question going forward is whether an inter-university capacity is possible, thereby strengthening agricultural policy research across the faculties, or whether developing such capacity is part of the differentiation process.

CONCLUSIONS

Growth and development of the agricultural sector is supported by a range of institutions that provide several critical functions and deliver a range of services. Most of these are public institutions but in historical terms there are increasing numbers of private institutions as well as an expanding role played by civil society organizations. Clearly TAE institutions are a critical component of this institutional architecture and provide a key function in the training of the human capital that both staffs these institutions and increasingly supports an expanding private sector. To prepare students for these roles TAE institutions must take on some of the functions provided by these other institutions, particularly in the areas of research, extension and policy. These additional functions strengthen teaching and skill development and at the same time provide points of interaction with the other institutions supporting the agricultural sector. In many cases these potential functions and institutional linkages are latent, being overwhelmed by staff time and finances committed to an increasing student body and teaching load. Faculties have the potential of leading the process toward a more functional agricultural innovation system because they provide the knowledge and skills for those staff in other institutions within the AIS. In that regard faculties need to understand this institutional architecture, its needs, and TAE's positioning within what is a very dynamic institutional context.

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STATEMENT OF NO-CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this paper.

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