An innovation systems perspective on strengthening agricultural education and training in sub-Saharan Africa

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Abstract

This paper examines the role of postsecondary agricultural education and training (AET) in sub-Saharan Africa in the context of the region's agricultural innovation systems. Specifically, the paper looks at how AET in sub-Saharan Africa can contribute to agricultural development by strengthening innovative capacity, or the ability of individuals and organisations to introduce new products and processes that are socially or economically relevant, particularly with respect to smallholder farmers who represent the largest group of agricultural producers in the region. The paper argues that while AET is conventionally viewed in terms of its role in building human and scientific capital, its also has a vital role to play in building the capacity of organisations and individuals to transmit and adapt new applications of existing information, new products and processes, and new organisational cultures and behaviours. The paper emphasizes the importance of improving AET systems by strengthening the innovative capabilities of AET organisations and professionals; changing organisational cultures, behaviours, and incentives; and building innovation networks and linkages. Specific recommendations in support of this include aligning the mandates of AET organisations with national development aspirations by promoting new educational programs that are more strategically attuned to the different needs of society; inducing change in the cultures of AET organisations through the introduction of educational programs and linkages beyond the formal AET system; and strengthening individual and organisational capacity by improving the incentives to forge stronger linkages between AET and diverse user communities, knowledge sources, and private industry.

Keywords:
Agricultural education
Agricultural development
Innovation systems
Sub-Saharan Africa

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1. Introduction

Innovation is about doing something “new” by using existing or novel information in new ways. This paper looks at how postsecondary agricultural education and training (AET) in sub-Saharan Africa can contribute to agricultural development by strengthening the capacity to innovate—the ability to introduce new products and processes that are socially or economically relevant to smallholder farmers and other actors in the agricultural sector.

To do so, this paper examines the role of AET within the wider context of an agricultural innovation system. An innovation systems perspective provides a broad analytical framework with which to examine technological change in agriculture as a complex process of actions and interactions among diverse actors engaged in generating, exchanging, and using knowledge, and the social and economic institutions that condition their actions and interactions.

The paper argues that while AET is conventionally viewed as key to the development of human and scientific capital in the region, its also has a vital role to play in building the capacity of organisations and individuals to transmit and adapt new applications of existing information, new products and processes, and new organisational cultures and behaviours. The paper emphasizes the importance of improving AET systems by strengthening the innovative capabilities of AET organisations and professionals; changing organisational cultures, behaviours, and incentives; and building innovation networks and linkages.

With this in mind, the paper offers several recommendations that aim at enhancing the effectiveness of AET for pro-poor agricultural innovation and development. Key reforms that might be undertaken—as a complement to, but not substitute for, other reforms that target improvements in AET infrastructure, administration and financing—include: (a) aligning the mandates of AET organisations with national development aspirations by facilitating priority-setting process that are more strategically attuned to the different needs and interests of society; (b) inducing change in the cultures and practices of AET organisations through the introduction of educational programs that are more responsive to demands outside traditional AET clientele; and (c) improving incentives to strengthen linkages between AET professionals and organisations, on the one hand, and diverse user communities, knowledge sources, and private industry, on the other.

This paper is organized as follows. Section 2 provides a background on AET in sub-Saharan Africa, and is followed by a conceptual framework that describes the role of AET within a system of innovation in Section 3. Section 4 sets forth recommendations for strengthening AET in the context of a developing agricultural innovation system, followed by concluding remarks in Section 5.

2. AET in sub-Saharan Africa

2.1. A brief history of AET in sub-Saharan Africa

AET systems in sub-Saharan Africa are commonly structured around at least four different components at the post-secondary level: universities, colleges, technical/vocational schools, and nonformal educational organisations and activities. Each of these components plays a role in fostering agricultural innovation, a role that depends on the strengths of the specific countries and elements of the agricultural economy that it serves. AET in many sub-Saharan African countries can be traced back to formal colonial systems that provided education through a small number of elite universities and colleges such as Fourah Bay College in Sierra Leone, Ibadan University in Nigeria, and Makerere University in Uganda. These institutions were primarily designed to increase the stock of professionals and civil servants needed for colonial administrative systems and, later to build the administrative cadres of independent nations (Clark, 2006).

Different colonial regimes left behind different educational approaches, especially with respect to agricultural education and research. In much of Francophone sub-Saharan Africa, colonial approaches did not change significantly with the coming of independence; education in Francophone sub-Saharan Africa continued to focus on teaching through elite “Grandes Ecoles”. However, postcolonial Anglophone sub-Saharan Africa witnessed several significant changes. First, many of the Anglophone countries introduced a more extensive research mandate into tertiary education (Michelsen and Hartwich, 2004). Second, many countries linked their university research programs in agriculture to agricultural research and extension organisations, a structure reflecting the influence of the United States’ model of land-grant universities and colleges (Lele and Coffman, 1995). Third, many countries invested extensively in expanding their tertiary education systems—including AET—in the 1980s, although economic malaise, structural adjustment programs, and governance issues limited the success of these initiatives (see, e.g., Asenso-Okyere and von Braun, 2007; Manuh et al., 2007; Mkude et al., 2003).

Yet in reality, few AET organisations in sub-Saharan Africa have changed significantly since their inception: Most remain averse to change and are mired in deep crisis. AET systems in the region continue to struggle with inadequate resources in terms of physical infrastructure, equipment, and communications facilities; limited human resources for teaching and research, both in terms of quantity and quality; poor incentives for teaching and research staff in terms of salaries, benefits, and research support services; limited or volatile funding from a small pool of resources; and other resource constraints that impede teaching and research (Clark, 2006; InterAcademy Council, 2004; Kroma, 2003; Alex and Byerlee, 1999).

Reforms to address these constraints have been largely structural in nature—e.g., investments in new infrastructure, administrative decentralization, or the introduction of cost-recovery mechanisms—and undertaken either in response to government demands for larger numbers of trained professionals, or driven by the availability of short-term and often volatile donor funding. But there is limited empirical evidence to suggest that such reforms have been successfully adapted to the specific context of sub-Saharan Africa, implemented in ways that produce long-lasting organisational change, or generated positive impacts on agricultural development, poverty reduction, and economic growth.

These reforms have also contributed little to creating responsive and innovative AET systems that are more attuned to the changing socio-political, economic, scientific, and agro-ecological conditions in sub-Saharan Africa—changes brought about, for example, by economic liberalisation and the globalisation of trade,
demographic pressures such as population growth and HIV/AIDS, ecological changes related to climate change and urbanisation, and new technological opportunities in information, communications and biotechnology.

AET systems in the region remain tied to teaching and research approaches that are organised along a linear vision of science—a vision that subdivides faculties into strict disciplinary departments, provides minimal incentives for understanding the wider demand for scientific applications, gives the greatest importance to theoretical research, and discourages interactions with innovative actors outside academia (Clark, 2006; Vandenbosch, 2006; Kroma, 2003). AET systems continue to operate as loose sets of isolated organisations, each dedicated to a distinct discipline or field with little mobility across organisations, insufficient formal or informal linkages to other organisations with complementary mandates, and limited interactions with external sources of knowledge and information (InterAcademy Council, 2004; Michelsen and Hartwick, 2004; Michelsen et al., 2003). AET systems are also forced to contend with interference in the determination of their visions, mandates, priorities, curricula, research agendas and operations due to the strong influence of several dominant suppliers of funding such as government ministries and donor agencies (Clark, 2006; Idabacha, 2003).

2.2. Calls for reform and new responses

It is thus not surprising that there is a constant call for AET reforms in sub-Saharan Africa—reforms that are meant to improve AET’s contribution to the creation of more innovative, competitive and dynamic agricultural economies across the region. In response to such calls, several notable examples of reform have emerged in recent years.

Mozambique, for example, has established two agricultural polytechnics in 2005 to specifically convey practical technical skills for those to be employed by government, non-governmental organisations, and private firms in the agricultural sector. The introduction of a competence-orientated curriculum in these polytechnics is a bold attempt to not only produce graduates who are endowed with practical skills and are ready for employment or ready to work as self-employable agribusiness entrepreneurs, but also to develop a model for replication by other countries (Davis et al., 2007; Gêmo, 2006).

Ethiopia, in a drive to massively expand its agricultural extension system, has introduced several reforms to the agricultural technical and vocational education and training (TVET) curriculum. Today, TVET students are provided not only with training in basic agricultural sciences and modern agricultural input use, but also in skills such as community mobilisation to support local development efforts, accounting to support managers of smallholder cooperatives, and insights into how to link farmers to markets in an otherwise subsistence-orientated agricultural sector (Davis et al., 2007).

In Ghana, tertiary education reforms—including reforms to AET—have been even more far-reaching. Reforms have attempted to address structural issues (e.g., education policy changes instigated by the World Bank in the 1980s), technological opportunities (e.g., the introduction of information and communications technology in the 1990s), financial crises (e.g., efforts to counterbalance acute resource constraints with cost-recovery measures), and governance concerns (e.g., the democratisation of university-level decision-making and the contribution of universities to national-level democratisation). Though outcomes have varied over time, the efforts to create a more competitive and responsive tertiary education system—including the AET system—persist in Ghana (Manuh et al., 2007).

Country-level reforms have also been complemented by several notable regional initiatives. For example, the Forum for Agricultural Research in Africa (FARA) initiated the Building African Scientific and Institutional Capacity (BASIC) network to improve teaching methods and content in the region’s AET systems by building closer linkages with industrialised countries’ universities and with the international agricultural research centres (FARA, 2007; Jones, 2005; Von Kaufmann and Temu, 2003). The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM)—a consortium of 12 universities in east and southern Africa—is working to strengthen human resource capacities in the region for inter-disciplinary problem solving through a range of training, research, and collaborative programs (RUFORUM, 2006). Similarly, the Partnership for Higher Education in Africa combines resources from several major philanthropies to accelerate the process of modernisation and institutional revitalisation of universities in selected African countries, covering issues such as curriculum reform, human resource development, internal governance, access, quality and sustainability (Matos, 2006).

Other regional initiatives have included efforts to build “centres of excellence” that meet both national and regional AET needs. Examples include the University of Nairobi’s M.Sc. program in agricultural economics, which was established in 1974 but discontinued in 1999 due to a lack of local political and financial support (InterAcademy Council, 2004; Oniang’o and Eicher, 1998); and the University of KwaZulu-Natal’s flagship Ph.D. program in plant breeding. Other initiatives include the Collaborative Master of Science Program in Agriculture and Applied Economics in Eastern and Southern Africa (CMAAE), the African Network for Agriculture, Agroforestry and Natural Resource Education (ANAFE), and the Sustainable Food Security in Central West Africa (SADAOC), among others (Asenso-Okyere and von Braun, 2007).

The 2003 Jinja Consensus offers an even grander vision of reform with calls for a new African agricultural university to build a new cadre of agricultural graduates who will go on to become entrepreneurs and wealth-creators rather than cogs in the wheels of existing agricultural education, research, and extension organisations. Ideally, the university would rely on student-centred learning styles in which instructors would facilitate rather than direct the learning process. These graduates would be armed not only with market-orientated skills, but also with a new standard of morals, ethics, and awareness (Idabacha, 2003; Wingert, 2002). A parallel US$3 billion initiative to build excellence in African institutes of science and technology over the next 10 years has received support from the African Union; while Nigeria announced a supporting effort worth US$25 to establish Africa’s premier Institute of Science and Technology in 2007 (Malakata, 2007; Africa Union, 2007; Dickson, 2006).

These initiatives, among many others, suggest strong interest in reforming AET in sub-Saharan Africa. Indeed, many of these reform initiatives are consistent with proven successes in AET system development in Asia, for example in South Korea during the early decades of its industrialisation program (Amsden, 1989; Chang, 1994). Many are also consistent with parallel reform initiatives in Latin America, such as the Escuela de Agricultura de la Región Tropical Húmeda, or EARTH University in Costa Rica, an institution designed to provide students with a combination of classroom instruction and learning-by-doing activities conducted in collaboration with local farmers and other agricultural sector actors (see Clark, 2006). Others are also reflections on new thinking among educators such as moves toward experiential learning.

However, the majority of these reforms are still structural in nature, giving primary attention to infrastructure, administration and financing (Africa Union, 2007; Juma, 2005; InterAcademy Council, 2004; Idabacha, 2003). While structural reforms are indeed necessary, they may not go far enough to create more
innovative, competitive and responsive AET systems in sub-Saharan Africa. Insufficient attention is given to whether such reforms actually contribute to the realignment of visions and mandates in AET systems, changes in the cultures of AET organisations, and improvements in innovative capabilities among AET professionals and practitioners.

Thus, several scholars offer alternative perspectives on what types of reforms are needed to improve AET in the region in addition to these structural reforms. For example, Eicher (2006) recommends an effort to avoid a “one-size-fits-all” approach to system design and structure, and to maintain a long-term, multigenerational time horizon for AET system building. More practically, he identifies a need to mobilise and sustain greater political support for continuous investment in AET, design incentives that attract and retain trained professionals, explore alternative cost-effective training modalities (such as sandwich programs with foreign universities), and invest in graduate (particularly at the M.Sc. level) programs to strengthen AET research.

Rivera (2006) recommends similar reforms with an emphasis on improving incentives for human capital development and intensifying linkage-building efforts. Specific proposals include extending the region’s AET emphasis on formal degree courses to also include greater informal education (in-service, nonformal, and continuing education) for the agricultural workforce at all levels, and integrating AET into a “workforce education system” that brings together both public and private players in a knowledge support system catalysed by government incentives to promote greater innovation in agriculture. Vandenbosch (2006) also ties AET reforms to changing demands in the region’s labour markets (e.g., combining school-based learning with apprenticeship training) and the need for closer school–community linkages (e.g., transforming educational institutions into multifunctional community learning centres).

Clark (2006) recommends that AET systems consider introducing multidisciplinary learning and research centres; production enterprises such as science parks and start-up ventures; diversification and decentralisation of funding mechanisms; and new relationships with universities in industrialised countries that leverage expertise and resources more effectively. His analysis, based on an innovation systems approach to AET, provides a useful starting point for our analysis.

2.3. New ideas about learning, innovation, and agriculture

These perspectives on AET reforms suggest the need for a more nuanced understanding of how alternative strategies and selective approaches might shift AET into closer, more productive relationships with other actors in the agricultural sector and wider economy, thus building on the comparative advantages of different actors and institutions to reduce transaction costs, achieve economies of scale and scope, exploit complementarities, and realise synergies in innovation.

This is where an innovation systems perspective might be helpful in understanding just how to reform AET in sub-Saharan Africa more effectively. The innovation system perspective contends that there are multiple sources and users of innovation, AET being just one of them. An AET system thus need not take upon itself the monopoly role of being the “national innovator”. Rather, it can assume the role of being one among many in promoting innovation by working more collaboratively and strategically with other actors involved in the wider innovation system. The following section builds on this idea, describing how an innovation systems approach might be used to facilitate the reform of AET systems in sub-Saharan Africa.

3. Redefining agricultural innovation

3.1. Key terms and concepts

In this paper we define an innovation as anything new that is successfully introduced into an economic or social process. This definition slightly changes the conventional concept of innovation that has been traditionally based on what was referred to earlier as a linear vision of science (Table 1). In the linear vision, innovation

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<tr>
<th>Linear science perspectives</th>
<th>Innovation system perspectives</th>
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<tr>
<td><strong>Objectives</strong></td>
<td><strong>Emphasis on</strong></td>
</tr>
<tr>
<td>- advanced technology and radical innovations</td>
<td>- learning within firms and organisations to innovate</td>
</tr>
<tr>
<td>- technological “shocks” that change production modalities</td>
<td>- strengthening individual and collective capabilities to innovate</td>
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<tr>
<td>- focus on conventional research continuum: basic, strategic, applied, adaptive research</td>
<td>- long-term efforts to build holistic innovation systems</td>
</tr>
<tr>
<td>- focus on conventional research continuum: from education to research to extension to user</td>
<td>- Demand and supply-driven science and technology</td>
</tr>
<tr>
<td>- typically embedded knowledge dissemination: in capital goods, production inputs, and technology packages</td>
<td>- focus on the roles and interactions of diverse agents in society and economy</td>
</tr>
<tr>
<td>- R&amp;D undertaken by large firms in industrialized countries and public institutes in developing countries</td>
<td>- focus on complex and dynamic interactions among innovative agents</td>
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<td>- typically centralized management of innovation processes</td>
<td>- network-based knowledge dissemination</td>
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<tr>
<td>- typically decentralized management of innovation processes</td>
<td>- both embedded and dis-embedded knowledge dissemination: in both tacit and codified forms</td>
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<td>- typically decentralized management of innovation processes</td>
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<th><strong>Instruments</strong></th>
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<tr>
<td>- direct public financing</td>
<td>- scientific exchanges</td>
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<td>- indirect public financing: subsidy programs, incentive schemes</td>
<td>- advisory and consultancy services</td>
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<td>- private investment</td>
<td>- stakeholder forums</td>
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<td>- participatory research projects</td>
<td>- public-private-civil society partnerships</td>
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<td>- competitive grant programs</td>
<td>- advanced market commitments</td>
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<td>- advanced market commitments</td>
<td>- changes to individual and organisational practices, behaviours, and cultures to promote labour mobility of educators, researchers, and technicians; and integrate educators, researchers, and technicians into networks with other innovation agents</td>
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Source: Hall (2006); Vázquez-Barquero (2002); Authors.
results from the creation of knowledge through basic scientific research, followed by strategic, applied, and adaptive research, and ultimately to technology development, dissemination and adoption. In sub-Saharan Africa, this process has primarily revolved around formal tertiary educational systems, national agricultural research organisations, and public agricultural extension services.

Yet this framework tends to oversimplify the innovation process (Mowery and Sampat, 2005). Often, technological development precedes scientific understanding of the underlying phenomena (for example, the steam engine and thermodynamics), occurs through the reorganisation of known processes without accompanying research, or results from interactions among heterogeneous economic agents (Freeman and Soete, 1997; Nelson and Rosenberg, 1993). Thus, it might be more accurate to describe technological change as being embedded within a larger, more complex system of diverse actors, their actions and interactions, and the formal and informal rules, organisational cultures and practices, and social and economic institutions that influence their practices and behaviours (Lundvall, 1985, 1988; Freeman, 1987, 1988; Nelson, 1988; Dosi et al., 1988; and Edquist, 1997). It is a system that depends on learning processes, feedback loops, and iterative interactions that are decidedly non-linear.

Importantly, the innovation systems approach offers some useful insights that are relevant to later discussion of AET reforms in sub-Saharan Africa, including the following. First, new inputs or technologies should not be viewed as innovations themselves, but as embedded information that agents can use in different ways, including ways that are different from what they were created for (Metcalfe, 2000).

Second, innovations depend on the ability of agents to learn—on their ability to gather information and use it creatively in response to market opportunities or other social needs (Lundvall, 1999; OECD, 1999).

Third, innovation depends on the organisational cultures within which innovation occurs, or the set of basic assumptions that are invented, discovered, or developed by a group in the process of learning how to deal with external adaptation and internal integration (Schein, 1984).

Fourth, innovation depends on the ability of agents to interact and exchange information and knowledge. Interactions can occur at any stage in the processes of producing, exchanging, or applying knowledge, through various types of networks, linkages and interventions (Fagerberg, 2005; Nelson and Rosenberg, 1993).

Fifth, the economic or social performance of a country depends on the participation of many diverse agents in an innovation system. Particularly important to this notion is the emergence of effective interactions between a country’s scientific base and its business community (Powell and Grodal, 2005; OECD, 1999; Rycroft and Kash, 1999; Nelson and Rosenberg, 1993).

Finally, the economic or social performance of a country also depends on the set of enabling conditions—market infrastructure, appropriate property rights, and effective governance in both input and output markets—that foster the participation of innovation agents in a system (Powell and Grodal, 2005; Nelson and Rosenberg, 1993; OECD, 1999; Rycroft and Kash, 1999).

These insights draw attention to three key elements of an innovation system, namely the importance of strengthening individual and collective capabilities to innovate; improving organisational cultures and behaviours in support of such capabilities; and fostering networks and linkages with other innovation agents (Cohen and Levinthal, 1990). This paper focuses on these elements to demonstrate how an innovation systems perspective can be helpful in designing AET system reforms—reforms that help an AET system undertake a range of functions, involve a wide range of partners, and change in response to new users and new opportunities, ultimately contributing to growth and development.

3.2. Empirical evidence from the innovation system approach

While there is limited evidence to immediately suggest that the application of these elements will have a positive impact on AET reforms in sub-Saharan Africa, evidence from their application to agricultural research system reforms suggests some significant outcomes. Consider, for example, the institutional and organisational reforms undertaken by public research organisations examined by Hall et al. (2002) and Hall et al. (1998) in India, and Smith (2005) in Kenya. These reforms brought extremely isolated researchers into close partnerships with private industry to develop and deploy technologies that were immediately relevant and accessible to small-scale farmers. More importantly, these reforms demonstrated how organisational learning processes allowed a set of rather complacent international agricultural research centres to redefine their roles in the wider innovation system, forge linkages with other innovation actors, and contribute more effectively to pro-poor agricultural development.

Studies by Allegri (2002) in Uruguay and Kangasiemi (2002) in Tanzania demonstrated how similar learning processes helped rural producers’ associations play a more central role in agricultural research priority-setting, financing and execution—roles otherwise reserved by public research organisations. Ekboir and Parellada (2002) extend this approach to highlight the importance of innovation networks among diverse public, private and civil society interests in the dissemination of resource-conserving technologies in Argentina; while Clark et al. (2003) does the same for adoption of post-harvest technologies in India. See a study by the World Bank (2006) for other applications of the innovation systems approach to agricultural research.

These studies distinguish themselves from other works on agricultural research because they embed analyses of technological change within wider processes of organisational and institutional change. Furthermore, they offer some answers to research questions that the conventional research literature is often unable to address such as how organisational cultures change, how knowledge networks form, and how these processes combine to enable rapid organisational and technological innovation. The common thread across these studies is the emphasis placed on the role of diverse actors and interactions within complex systems of innovation, and the institutional context within which these processes occurred.

While this may suggest that an innovation systems approach could similarly contribute to AET reform efforts in sub-Saharan Africa, several caveats should be considered. First, the innovation systems approach is only the latest in a series of models considered for use in AET reforms. Often, the speed at which new models are introduced does not allow for organisations and individuals to adequately internalise, adapt and apply their principles before the next model comes along. Second, the application of the innovation systems perspective to developing-country agriculture are fairly nascent, suggesting that many of its conceptual insights have yet to be put to the empirical test (see Spielman, 2006). Third, the application of an innovation systems perspective should be viewed as a complement to previous models and approaches used to motivate AET reform processes, rather than a refutation of what small positive changes have been achieved in the recent past.

3.3. Implications for AET reform

In the context of AET reforms in sub-Saharan Africa, the above discussion provides several points for consideration. First, educational approaches and learning philosophies need to accommodate different types of individuals. Second, alternative menus of learning opportunities in an AET system must be created or expanded to accommodate diverse capabilities.
Third, since AET systems are, by definition, comprised of organisations with their own innovative capabilities that have developed over time and from context-specific factors, reform processes need to be developed with sufficient reference to the needs of actors both within and outside the organisation. Hence, a strategy to strengthen AET would not only include a discussion of its role in innovation processes, but also of the strategies required to develop organisational capabilities to understand and pursue this role effectively.

Fourth, understanding the nature and dynamics of organisational cultures is important to the design and implementation of successful AET reforms. For example, if the culture of a university researcher’s academic department is one in which colleagues are—or are expected to be—highly productive, then individual researchers tend to conform to the accepted norm. If output is regarded as less important, then their productivity necessarily conforms to a different norm. Similarly, if the department’s culture is one in which colleagues are—or are expected to be—highly interactive with other researchers outside the department, then their networking behaviours will similarly conform.

Fifth, significant change is needed in the cultures and behaviours that characterise AET organisations. This includes a need to transform the cultures and behaviours of AET systems from those driven by traditional sets of beliefs about what AET can and should do (for example, educating for scientific excellence) into cultures and behaviours that allow for greater innovation (for example, educating to create new applications of existing knowledge and information, products and processes, and organisational structures and management). Sixth, networks, partnerships, and other interactions that link a wide range of stakeholders in an agricultural innovation system and that change over time in response to changing users and opportunities, are essential.

Finally, efforts to address the fundamental economic constraint underlying innovation—the scarcity of resources with which to innovate—are essential to reforming AET. One way of doing so is for agents to integrate into innovation networks to achieve economies of scale and scope, reallocate labour and human capital more efficiently, reduce transactions costs, exploit complementarities, and realise synergies in the innovation process. These networks can vary from informal interactions between extension agents and farmers to promote a new plant variety, to very complex contracts between public researchers and private firms to conduct research in advanced biotechnology.

4. Recommendations for strengthening AET in sub-Saharan Africa

As this paper suggests, there are signs that AET systems in sub-Saharan Africa are undergoing some degree of reform in response to changing socio-political, economic, scientific, and agro-ecological conditions in the region. However, few of these reforms seem to capture the key principles of the innovation systems perspective discussed above. Few reforms focus on strengthening individual and collective capabilities to innovate; changing organisational cultures and behaviours; or building innovation networks and linkages. Few seem to prioritise the creation of more dynamic, responsive and competitive AET systems by introducing new and different educational approaches and learning philosophies; by supporting new organisational cultures and practices; or by building networks that link a wider range of stakeholders in the agricultural innovation system.

Furthermore, few reforms are sufficiently geared to complement parallel reforms occurring in sub-Saharan Africa’s research and extension systems, where efforts are being made to foster organisational and technological innovations in support of small-holder commercialisation and private investment in processing, packaging, exporting and other value-adding activities. Few AET reforms are being conducted through consultative processes that result in some degree of coordination and creative engagement with actors in agricultural research organisations, extension service, and the private sector.

Thus, it remains unclear whether these initiatives are the beginning of a substantial transformation of AET systems, or are just isolated experiments. The final outcome will depend on whether private sector investment in agriculture expands, whether budgetary and donor resources are available for improving AET, and whether new reforms focus on strengthening AET as part of a wider system of innovation in the agricultural sector. Ultimately, sustainable changes will be driven by new demands emanating from the smallholder sector, high-value crop production systems, domestic agro-industries, and other parts of the agricultural sector, and by new cultures, practices, and incentives introduced and accepted within AET organisations and among AET professionals.

Recommendations in support of these system-level changes are offered below. These recommendations should be viewed only as possible options and alternatives, and not as a prescriptive package. Furthermore, these recommendations should only be considered in the context of country-specific priorities and capabilities, and as complements to ongoing structural reforms.

4.1. Realign visions and mandates

An immediate step towards improving AET systems in sub-Saharan Africa would be to realign the visions and mandates of AET organisations with national development aspirations. Rather than replicate the mandates of western-style universities and education systems established under colonial regimes, AET organisations may want to rethink their visions and mandates more strategically and in relation to their country’s development objectives and the changing realities of their economies and societies.

The goal here is to move the AET system into closer, more productive relationships with other actors within a country’s innovation system, rather than into alignment with what other countries have done previously or with international best practice. Thus, the process of realigning visions and mandates should be driven not by predictable, top-down priority-setting exercises, but by consultative processes that rely on inputs from user communities—from private agribusinesses, rural producer associations, research organisations, extension services, non-governmental organisations and other sources of demand for AET graduates, professionals and services. Such consultative processes should be backed by labour market and graduate tracer studies to gauge demand for particular skills; and be led by interdisciplinary teams drawn from different interest groups within an organisation (rather than from only administrative bodies for which priority-setting exercises are routine obligations), and supported by facilitators with professional experience in leading such processes.

4.2. Develop the human capital base by enhancing innovative capabilities

In the medium-term, efforts to improve AET in sub-Saharan Africa should emphasise new interventions designed to further develop the innovative capabilities of the region’s human capital base. Such efforts would focus on the provision of learning opportunities geared to the specific needs of different actors in the innovation system, rather than on traditional benchmarks set by standards of public service or academia.

For example, tertiary education systems might consider diversifying away from well-structured degree programs centred solely
on traditional disciplines, and moving into a wider variety of programs, ranging from short, applied courses to short-term professional training to long-term multidisciplinary degrees programs. This would entail the design of educational programs that are less encyclopaedic and more strategically attuned to the different needs of social and productive actors, e.g., user communities such as smallholder farmers, rural traders, agribusinesses, and consumers. Topics and courses would include areas such as agribusiness, entrepreneurship and marketing; agro-processing, value addition, and post-harvest technologies; agricultural operations and project management; accounting and auditing; community development and social organisation; leadership, conflict management, and human resource management; and information and communications technologies.

Specific reforms would focus not only on improving formal AET organisations and their curricula, but also on expanding informal AET programs. This includes technical and vocational training institutes, in-service and on-the-job programs, distance education, apprenticeships, sandwich programs and other modalities specifically adapted to the needs of diverse actors in the innovation system. Reforms would also focus on private sector sources of AET as a necessary complement, or even competitor to, the public sector AET system. Although it may be a challenge in many countries to identify medium- and long-term market demand for AET professionals, experiences from Latin America and Asia could help inform the choice of policies and programs.

A strategy for building a diverse menu of education opportunities in AET also requires flexible policies and practices, such as employment regimes where underperforming professionals can be fired and good professionals promoted; reliance on foreign expertise only to the extent that they transfer expertise to local instructors; and organisational cultures and environments that foster innovation.

4.3. Facilitate the flow of information and technology

Emphasis in the medium-term should also be placed on the development of individual and collective capabilities to access, imitate, and adapt existing information, knowledge, and technology by setting up and supporting more active innovation networks. Such networks would be designed not only to provide technical information, but to also facilitate the flow of other types of information (such as commercial or managerial) among different actors, including AET educators, researchers, extension agents, entrepreneurs, agribusinesses, non-governmental organisations, farmers and the like.

Though innovation networks in AET typically take the conventional form of professional associations, there are many possible alternatives to this traditional approach. For instance, networks among AET professionals could be designed to include opportunities such as apprenticeships, internships, exchange programs, sandwich programs, and sabbaticals which, when supported with adequate funding and sufficient incentives for participation, can go a long way in stimulating individual innovative capabilities.

Other networks might be research-driven collaborations that include university science programs, agricultural research organisations, input suppliers, extension agents, and farmers; and may rely on participatory research programs or other network modalities that encourage innovation through the movement of knowledge and information between and among individuals and organisations.

Still other networks might be formed to engage international agricultural research centres and foreign universities more aggressively and on more equal footing with African counterparts. While initiatives such as the Consultative Group on International Agricultural Research (CGIAR) and the United States’ Collaborative Re-search Support Programs (CRSPs) have contributed much to building AET systems in sub-Saharan Africa, an entirely new generation of north-south linkages is needed to leverage expertise and resources from international research organisations and foreign universities.

Innovation networks can also take the form of programs that link farmers with students and educators, allowing for synergistic interactions that promote multidirectional flows of knowledge, both modern and traditional. This includes fostering stronger linkages between formal AET organisations and national extension systems (in all their plurality—public, private, and NGO) to bring students and educators into closer contact with farmers. There is much to be learned from parallel efforts in other developing countries and regions such as the Escuela de Agricultura de la Región Tropical Húmeda, or EARTH University in Costa Rica, mentioned earlier.

Other such networks might leverage the potential of public-private partnerships in which public and private sector entities jointly plan and execute activities to accomplish agreed-upon goals, commit resources to these goals, and share the costs, risk, and benefits incurred in the process. These collaborations offer much promise for AET institutions seeking to access information and technology from private industry to meet their own goals and objectives, especially in cutting-edge areas of advanced science such as biotechnology.

While regional networks such as BASIC and RUFORUM are encouraging steps along these lines, the size and need of AET systems in sub-Saharan Africa requires many more such networks at both the national and regional levels. And more than just networks, AET systems in sub-Saharan Africa need to put the right types of incentives in place to make these networks work. Thus, reform efforts may also include the provision of financial incentives to those that establish, facilitate and participate in such networks, and may tie such incentives to evaluations of the impact that these networks have on individual and organisational performance.

4.4. Induce change in organisational cultures, behaviours, and practices

Efforts to induce change in organisational cultures, behaviours, and practices are a longer-term undertaking. Such efforts require recognition by policymakers, public administrators, AET professionals and many other actors that formal AET organisations are not the only ones conducting research and training within an agricultural innovation system, and that linkages with a wide array of other stakeholders can effectively serve both AET organisations and the country’s innovation system. Policies and programs would encourage greater openness in AET organisations to collaborating with informal AET service providers, private sector firms, civil society organisations, and traditional/indigenous knowledge institutions also conduct problem-solving, demand-driven research and training.

Policies and programs would also focus on strengthening the individual and organisational incentives needed to develop and retain capacity on a national scale, reverse the region’s rapid brain drain, professionalise education and research management, and introduce organisational and managerial innovations into the AET system itself. Specific reforms—many of which constitute the fundamentals of ongoing reform processes in the region’s AET system—include improvements in salaries and benefits; incentives that reward leadership, creativity, network-building, and fundraising; management training for education and research administrators; and evaluation systems that recognise different types of individual contributions.
4.5. Create an appropriate policy environment

The long-term transformation of AET systems in sub-Saharan Africa also requires an appropriate policy environment and policymakers with the knowledge and will to facilitate the transition process. Creating the right policy environment would require, among other things, creating national and local forums that put policymakers into direct contact with researchers, research managers, private firms, civil society and other innovation system actors to discuss AET reforms and the role of AET in the wider context of national development. AET organisations can constructively contribute to the process by serving as a convening force, providing information and analysis of policy options, and participating actively in these discourses.

A more controversial alternative for the long-term is to eschew efforts to reform entire organisations, and concentrate instead on those professionals with the demonstrated potential to change and effect change. Even in the most path-dependent and conservative AET organisations it is possible to identify high-quality instructors, researchers, and research teams. Although these individuals and teams rarely have the influence or power to change organisational cultures and culture and incentive structures, they can be nurtured to eventually develop a critical mass that can then force a larger process of change from within. One way to do this would be to introduce more flexible employment conditions (e.g., higher-paid, shorter-term contracts, flexibility in hiring and firing, research grants for promising individuals), thereby allowing AET organisations to select those individuals with greater promise and potential, and allowing AET professionals to select organisations that allow them to realise their own potential, inducing greater mobility between and among organisations. Given the uneven distribution of innovative capabilities among individuals and organisations alike, this mobility would allow for more efficient allocation of AET resources according to comparative advantage (such as research, teaching, extension, or private enterprise).

4.6. Monitor and evaluate the AET system

Continuous evaluation of AET organisations and the AET system as a whole is also a necessary component of any reform agenda. Evaluations that draw on expertise of both domestic and international AET experts can play a critical role in assessing progress and designing roadmaps for change. Evaluations can also play a vital role in helping organisations redefine their mandates and goals relative to changes in the country’s wider agricultural innovation system, its wider economy and society, and the availability of resources. Ideally, such evaluations would assist in the efficient reallocation of AET resources across teaching, research, extension, and enterprise, based on the assumption that a strong AET system should be diversified across all four areas.

4.7. Adopt a long-term outlook

Changes in the practices and cultures of both formal and non-formal AET do not happen overnight: the internalisation of new skills in applied problem solving, critical thinking, and entrepreneurialism can take more than a generation to become common practice in AET. Thus, shifts in policy and strategy do not effect change within 5-year time spans. Individual and organisational responses to changes in structures, incentives, and financing require more time to become accepted into procedure and performance, while the formation of innovation networks require long-term investments of time and effort by both individuals and organisations. The recommendations given here require a long-term outlook on AET reforms that allows for learning and adaptation to the specific context of sub-Saharan Africa and to each country and AET organisation in the region.

5. Conclusion

In examining the role of AET systems in sub-Saharan Africa, this paper relies significantly on an innovation systems perspective to make its case. Yet the innovation systems perspective is a relatively new application to the study of developing-country agriculture and thus, the body of methodological and empirical work that precedes this paper is still quite small. Moreover, efforts to link empirical analyses of innovation systems in developing-country agriculture and targeted recommendations that can inform public policymakers are still under development.

This paper attempts to address these issues. However, continued analysis of AET from an innovation systems perspective is needed. Specifically, more discussion is needed of how to produce extension agents, researchers, educators, and skilled labourers in sufficient quantity to boost agricultural productivity and output, and in sufficient quality to play an active role in a changing agricultural scenario. This implies the need for closer consideration of the more nuanced challenges of strengthening innovative capabilities among both individual and organisations; creating organisational cultures in AET that are sufficiently open and dynamic to facilitate change; and building innovation networks, partnerships, and linkages to foster greater adaptation, imitation, and use of available information and knowledge. And ultimately, recognition is needed of the fact that interventions designed to strengthen AET systems are a long-term undertaking—only through a long-term outlook on change can AET systems contribute to the development of more dynamic and competitive agricultural economies that engage farmers, entrepreneurs, extension agents, researchers, and many other actors in a wider system of innovation.

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