Strengthening Agricultural Education and Training in sub-Saharan Africa from an Innovation Systems Perspective: A Case Study of Mozambique

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Strengthening Agricultural Education and Training in sub-Saharan Africa from an Innovation Systems Perspective: A Case Study of Mozambique

KRISTIN E. DAVIS, JAVIER EKBOIR and DAVID J. SPIELMAN
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ABSTRACT This paper examines how post-secondary agricultural education and training (AET) in sub-Saharan Africa can contribute to agricultural development by strengthening the capacity to innovate—to introduce new products and processes that are socially or economically relevant to smallholder farmers and other agents. Using the AET system in Mozambique as a case study, this paper examines the role of AET within the context of an agricultural innovation system. This innovation systems perspective offers an analytical framework to examine technological change in agriculture as a complex process of interactions among diverse actors who generate, exchange, and use knowledge, conditioned by complex social and economic institutions. The paper argues that while AET is conventionally viewed as key to the development of human capital, it also has a vital role to play in building the capacity of organizations and individuals to transmit and adapt information, products and processes, and new organizational cultures and behaviors. The paper emphasizes the importance of improving AET systems by strengthening the capabilities of organizations and professionals; changing organizational cultures, behaviors, and incentives; and building innovation networks and linkages. The paper offers several recommendations to enhance the effectiveness of AET for agricultural innovation and development. Key reforms include aligning the mandates of AET organizations with national development aspirations; inducing change in the cultures of AET organizations through the introduction of educational programs and linkages beyond the AET system; and enhancing innovative individual and organizational capacity by improving incentives to forge stronger links between AET and other stakeholders.

KEY WORDS: Agricultural education and training, Mozambique, Innovation systems, Individual and collective capabilities, Organizational incentives, Networks, Linkages

Introduction: AET in Sub-Saharan Africa

Formal postsecondary agricultural education and training (AET) in many sub-Saharan African countries can be traced to colonial systems that emphasized formal education through a few universities and colleges. These institutions were primarily
designed to increase the stock of professionals and civil servants needed for colonial administrative systems and, later to build independent nations (Clark, 2006).

Different colonial regimes left behind different educational approaches. In much of francophone Africa, teaching approaches changed little after independence, emphasizing teaching through elite ‘Grandes Écoles’ (Michelson and Hartwich, 2004). However, postcolonial anglophone Africa has witnessed several significant changes, including a more extensive research mandate into tertiary education (Michelson and Hartwich, 2004), and linking of university-based research with separate agricultural research and extension organizations.

Yet while many postcolonial African countries borrowed AET models from western systems, few managed to build innovative and responsive systems. By and large, many African AET systems have changed little since their inception, and have not been able to adequately replicate the performance of similar AET systems in other countries: a) to produce technically and professionally qualified human resources, b) to conduct research and produce applied knowledge and technologies, and c) to conduct outreach and dissemination of research results (Clark, 2006; InterAcademy Council, 2004; Kroma, 2003).

The ability of AET in sub-Saharan Africa (SSA) to meet these objectives is constrained by factors such as inadequate physical infrastructure, equipment, and communications facilities; limited teaching and research capabilities; poor incentives for personnel; and limited funding from a small pool of resources (Clark, 2006; InterAcademy Council, 2004; Kroma, 2003).

These basic problems are exacerbated by several key issues. First, teaching and research approaches remain organized along a linear vision of science. Second, many African AET organizations and individuals operate in isolation, with little mobility across organizations and insufficient linkages to other organizations with similar or complementary mandates, including local and foreign educational institutions, government agencies, or national and international research organizations. Third, government ministries and donor agencies strongly influence the determination of visions, mandates, priorities, curricula, research agendas and operations in many AET organizations (Clark, 2006; Eicher, 2006; Kroma, 2003; Michelsen and Hartwich, 2004; Vandenbosch, 2006).

It is thus not surprising that there is an ever-increasing call for sustainable reforms in AET in SSA that respond to changing sociopolitical, economic, and ecological conditions. Most of the reform agenda revolves around university visions and mandates; relevance to national development priorities; changes in curricula; improvements in incentive systems for students, administrators, and teachers; alternative financing strategies and organizational structures; and realization of new opportunities in science and technology (InterAcademy, 2004; Juma, 2005).

Vandenbosch (2006) calls for more relevant and effective AET models that are responsive to changing demands in labor markets; and for diversification of funding to increase long-term sustainability, more investment in training and resources for educators, and more effective monitoring and evaluation systems. Eicher (2006) adds to this menu of reforms the need to avoid a ‘one-size-fits-all’ approach to system design and structure, and to maintain a long-term horizon for AET system building. Rivera (2006) emphasizes improving incentives for human capital development and
intensifying linkage-building efforts, including integrating AET into a ‘workforce education system’ that includes public and private players in a knowledge support system catalyzed by government incentives to promote greater innovation in agriculture.

These recommendations suggest the need for far-reaching reforms throughout the AET system in SSA. It is one thing to commit resources, however, and another to build and sustain such systems. Recent reform initiatives demonstrate that a more nuanced understanding is needed of AET’s role in promoting innovation, development, and growth in agriculture.

This is where an innovation systems perspective might be helpful in understanding how to reform AET in Africa more effectively. The innovation system perspective contends that there are multiple sources and users of innovation, AET being one of many. An AET system thus need not take upon itself the monopoly role of being the ‘national innovator’. Rather, it can assume a role as one among many in enhancing innovative capabilities by working more collaboratively and strategically with other actors involved in the wider innovation system.

**Understanding Innovation: A Conceptual Framework**

Several definitions of the term ‘innovation’ have been proposed in the literature (Fagerberg, 2005; OECD, 1999; Schumpeter, [1934]Schumpeter, [1961]). Here we define it as *anything new successfully introduced into an economic or social process*. This definition stresses that an innovation is not just trying something new, but successfully integrating a new idea into a product or process that includes technical, economic, and social components.

This definition suggests the need for a more nuanced understanding of innovation processes. Hence, we define an *innovation system* as the agents involved in the innovation process, their actions and interactions, and the formal and informal rules that regulate their practices and behaviors (Dosi et al., 1988; Freeman, 1987). As shown in Figure 1, an innovation system embeds technological change within a larger, more complex system of actions and interactions among diverse actors, social and economic institutions, and organizational cultures and practices. It goes beyond the traditional linear thinking centered on research systems; research may increase the stock of embedded and disembodied information, but it does not increases the capacity to innovate (World Bank, 2007).

The innovation systems approach offers the following useful insights into the conception of AET for agricultural sector development:

- 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; see also Hall et al., 2003).
- Learning depends on the ability of agents to *interact and exchange* information and knowledge (Fagerberg, 2005; Nelson and Rosenberg, 1993; World Bank, 2007).
- The economic or social performance of a country depends on the *participation* of many innovative agents that foster the emergence of an innovation system, particularly the interaction between a country’s scientific base and its business
These insights mean that a successful innovation system depends on several key elements: the capacity of individuals and organizations to learn and innovate, organizational cultures, behaviors, and incentives; and networks, partnerships, and linkages.

Individual and collective capacities to innovate are the ability to identify and use existing information to create something new. Individual capabilities depend on how an individual sees, understands, and interprets the environment in which he/she is immersed. Innovative individuals possess above-average (but not necessarily exceptional) learning abilities, show strong task commitment, and are creative (Renzulli, 2003; Shavinina and Seeratan, 2003). Innovative capabilities are not necessarily linked to formal education or good grades, but to learning processes. There is evidence to suggest that the distribution of innovative capabilities among individuals...
is highly skewed (Renzulli, 2003), making it difficult to design education systems that are sufficiently responsive to individuals possessing different levels of capabilities (Reis and Renzulli, 2003).

Collective capabilities reside in individuals; in the information and technology used by an organization; and in an organization’s structure, routines, and coordination methods (Argote and Darr, 2000). Collective capabilities result from the interaction among resources, processes, and values. Organizational capabilities are specific to each organization and are contextual.

An organizational culture can be defined as a 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). This stresses that a) an organizational culture is a set of beliefs, not values or behaviors; b) it is invented by a group in the early days of the organization and is passed on to newcomers; c) building the culture takes time because it requires the repeated use of specific approaches to successfully tackle similar problems; and d) organizational cultures usually change very slowly because the assumptions are only changed after they repeatedly fail to deal with new situations and are accepted by the organization as a whole (Christensen and Raynor, 2003).

To address the scarcity of resources with which to innovate, agents often integrate into innovation networks to achieve economies of scale and scope, reallocate labor and human capital more efficiently, reduce transactions costs, exploit complementarities, and realize synergies in the innovation process. Rather than a linear sequence, an innovation process might then resemble a spider web of related individuals and organizations, all of whom contribute something to the application of new or existing information and knowledge. Innovation networks can include universities, colleges, technical/vocational centers, farmer organizations, research centers, private firms, non-governmental organizations (NGOs), farmers, and other actors who create, exchange, or use knowledge and technology.

Recent research has shown that AET plays a different role in innovation systems than that assigned by the linear vision of science (Christensen et al., 2004; Mowery and Sampat, 2005). Instead of being the main source of knowledge and technologies, AET’s main roles are to a) prepare highly trained professionals that can master complicated technologies; b) provide working professionals the specialized knowledge they need to operate in an increasingly complex environment; and c) grant graduates access to a vast network that shares scientific and technical information.

Methods

To analyze AET in Mozambique from an innovation systems perspective, a case study approach that combined several methods was used, including secondary data analysis, semi-structured interviews with key informants, and relational analysis of key AET individuals and organizations and ways in which knowledge flows between them. Key informants included AET professionals (e.g. lecturers, deans; \( n = 7 \)), learners (students in AET institutions; \( n = 18 \)), and key actors (e.g. the private sector and NGOs; \( n = 11 \)).
AET in Mozambique

Mozambique is a largely agricultural economy with high rates of poverty and food insecurity (Table 1). It hosts a largely subsistence agriculture sector characterized by small farms, low modern input use, and limited commercialization. It is a ‘post-conflict’ country, having come out of protracted civil strife in the early 1990s. But since the end of conflict, it has experienced rapid—though often volatile—economic growth and development.

Mozambique has invested in building the fundamental structures of an AET system—universities, technical/vocational schools, and in-service training programs—and has complemented them with agricultural research and extension systems. It has also put its AET system to use in recent years to support agricultural development policies and strategies that focus on boosting agricultural yields and output in order to improve food security and reduce poverty.

However, Mozambique is also host to a fairly weak knowledge economy (see Table 1). According to the Knowledge Economy Index (KEI), Mozambique has weak national-level abilities to generate, adopt, and disseminate knowledge, at least

**Table 1. Key economic indicators, Mozambique, c. 2002–2004**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Mozambique</th>
<th>Sub-Saharan Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP growth rate (%)a</td>
<td>7.7</td>
<td>3.6</td>
</tr>
<tr>
<td>Agricultural GDP (% of GDP)a</td>
<td>24</td>
<td>18</td>
</tr>
<tr>
<td>Rural population (% of total population)a</td>
<td>67</td>
<td>66</td>
</tr>
<tr>
<td>Agricultural population density (persons/ha)b</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Cereal yield (kg/ha)a</td>
<td>876</td>
<td>1,086</td>
</tr>
<tr>
<td>Foreign direct investment (% of GDP)a</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Cereal exports (in millions of US$)c</td>
<td>0.03</td>
<td>–</td>
</tr>
<tr>
<td>Av. export unit value of cereals (US$/ton)c</td>
<td>1,000</td>
<td>–</td>
</tr>
<tr>
<td>Cereal surplus (export–imports) (in 1,000 tons)c</td>
<td>–4</td>
<td>–</td>
</tr>
<tr>
<td>Proportion of undernourished in total populationd</td>
<td>44</td>
<td>33</td>
</tr>
<tr>
<td>Poverty (% of population below national poverty line)e</td>
<td>69</td>
<td>–</td>
</tr>
<tr>
<td>Literacy (% of population age 15+)f</td>
<td>46</td>
<td>65</td>
</tr>
<tr>
<td>Gross primary enrollment (% of school-age pop., male/female)f</td>
<td>114/93</td>
<td>102/88</td>
</tr>
<tr>
<td>Knowledge Economy Index scoresg Mozambique</td>
<td>2.52</td>
<td>2.57</td>
</tr>
<tr>
<td>Economic incentive regime</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovation</td>
<td>0.42</td>
<td>3.03</td>
</tr>
<tr>
<td>Education</td>
<td>0.28</td>
<td>1.39</td>
</tr>
<tr>
<td>Information and communication technology</td>
<td>0.93</td>
<td>2.51</td>
</tr>
</tbody>
</table>

g2004. KEI scores are scaled from 1 (lowest) to 10 (highest). Source: KAM (2006).
according to indicators for the four pillars of the knowledge economy: economic incentive and institutional regime, education and human resources, the innovation system, and information and communications technology.

Eduardo Mondlane University (UEM) serves as the central provider of higher education in the agricultural sciences through its Faculty of Agronomy and Forestry Engineering, and the Faculty of Veterinary Medicine. In addition to UEM, there are three agrarian institutes that provide technical and vocational training in agriculture, as well as a teaching university established to train instructors for these and other institutes. More recent AET additions include two agricultural polytechnics (established in 2005) designed to convey practical skills; and two private universities (the Catholic University of Mozambique [UCM] and Mussa bin Bique University), both established in the last decade.

The formal AET system operates alongside Mozambique’s public agricultural research and extension system. The Mozambique Institute of Agricultural Research (known by its acronym, IIAM) is the national mandated institution for agricultural research. Agricultural extension services are provided by the Ministry of Agriculture (MINAG) and the large NGO sector.

**Strengthening Individual and Collective Capabilities**

Public policy changes and changing market realities in Mozambique suggest the beginning of an agricultural transformation from smallholder agricultural systems into more productive, diversified and commercialized agricultural sectors. This transformation can generate significant demand for AET professionals and graduates with new qualifications to facilitate commercialization of farm production, as managers and technicians in agro-industrial companies, or as entrepreneurs in dynamic sub-sectors of the agricultural economy. Although it may be difficult to identify medium- and long-term market demand for AET professionals, we identified several emerging trends.

The demand for AET graduates has grown with agricultural sector recovery and expansion since the end of the civil war (Figure 2). The Government of Mozambique (GoM) has been the main employer of AET graduates, hiring to fill the ranks of extension agents, teachers at the agrarian institutes and polytechnics, technicians in research stations, and civil service positions in MINAG. However, perceptions among respondents were that the NGO sector is hiring an increasing number of graduates (Figure 3). Mozambique is host to some 400 NGOs that hire AET graduates with skills in the agricultural sciences, community mobilization, and rural extension. Employment opportunities are also growing with the entry of large agroprocessing companies that operate in traditional cash-crop sectors such as cashew, cotton, tobacco and fisheries.

The potential and real demand for AET professionals and graduates is just one part of the story in Mozambique. The other part, from an innovation systems perspective, is whether the AET system is developing individuals and organizations with the innovative capabilities needed to stimulate the growth of a more dynamic agricultural sector. In addition to traditional backgrounds and skills, such as agricultural science and lab skills, employers are looking for proficiency in
While findings indicate that Mozambique’s AET system is generally not building capabilities that can contribute to a more innovative agricultural sector, one initiative in Mozambique is worth noting: the creation of two new agricultural polytechnics. These institutions are a significant break from the traditional AET system, since their goals include a) teaching students ‘how to do it’ and linking teaching/research to practical and relevant competency development; and b) combining agricultural and livestock sciences—a mix that does not exist at the university level. Their mandated focus on practical, hands-on education as a means of developing skilled technicians.

**Figure 2.** Key informant perspective: Number of months perceived by AET learners and professionals for AET graduates to obtain employment after graduation.  
*Source: Authors*

community mobilization, computers, English, project management, and a business/enterprise orientation.

**Figure 3.** Key informant perspectives: Expectations of top three employment opportunities after graduation, by sector.  
*Source: Authors*
and self-employable entrepreneurs is likely to introduce a new set of competencies into Mozambique’s agricultural sector, albeit on a small scale.

Developing the correct skills needed leads to a quantity-quality tradeoff in AET. The GoM has sought to increase access to AET by expanding enrollment and establishing new institutes closer to rural areas; by changing the entry and exit points so that students can cycle through the system at new and different education levels; and by changing the duration of programs to cycle students through the system faster.

Unfortunately, few of these initiatives have been matched by improvements in either the quality or quantity of staffing or infrastructure. Greater student enrollment has made practicum-based coursework increasingly difficult; large class sizes have stretched already short supplies of infrastructure and equipment beyond capacity.

The preceding discussion suggests that developing new and different capabilities requires diverse educational approaches, including informal and experimental approaches adapted from local and foreign experiences as well as the formal ones that characterize traditional AET systems. Such strategies aim to develop learning organizations and professionals in AET that effectively combine technical skills with more practical abilities in problem solving, decision-making, integrating concepts, and acting independently and creatively.

However, although informants listed any type of teaching method (Figure 4) or teaching aid (Figure 5) they had encountered, probing indicated that educational approaches and learning philosophies in Mozambique concentrate on traditional modalities of instruction, do not universally rely on the use of modern educational infrastructure or equipment, and provide professionals and graduates with only a limited set of technical skills and abilities. This study found an AET system that is characterized by inflexible educational approaches and an emphasis on theoretical and conceptual (rather than practical) competency. The country’s colonial heritage has left behind a strong culture of elitism through which social status is attained and

![Figure 4. Key informant perspectives: AET teaching methods in Mozambique. Source: Authors](image)
held by progressing through higher education and eschewing practical employment and association with agricultural livelihoods.

There are several reform efforts underway that may effect change in AET approaches in Mozambique, including the introduction of a competence-oriented (practical) curriculum in the two agricultural polytechnics; and the introduction of several new educational approaches, including new subjects that provide more general, less-specialized education skills; overview courses in multiple subjects for incoming students; shorter, specialized courses; optional courses that allow students to explore their interests; and non-science courses that include management, project cycles, marketing, economics of production, rural extension, and computer skills.

Another encouraging initiative is the GoM’s commitment to upgrade AET personnel. MINAG targets include the immediate upgrading of AET professionals at all levels through both domestic and foreign training. Other proactive experiments are likely to emanate from the private universities, such as UCM’s decision to adopt a more Anglophonic educational approach rather than the traditional Lusophonic one. However, the underlying issue will remain: current educational approaches in Mozambique do not adequately develop individual or organizational capabilities to innovate.

Changing Organizational Cultures, Behaviors and Incentives

From an innovation systems perspective, efforts to develop individual and collective innovative capabilities are contingent upon changes in the cultures, behaviors, and incentives that characterize AET organizations and systems.

Organizational cultures reflect shared beliefs. Study findings suggest that Mozambican AET organizations and professionals hold several shared beliefs about agricultural development, food security, poverty reduction, and the roles and functions of AET. First, they believe that food security and food self-sufficiency are largely synonymous. Second, they believe that the development and dissemination of
new technologies to smallholders will generate the yield increases needed to achieve food security and reduce poverty. Third, there is a shared understanding that the formal AET system’s role is to create the researchers and extension agents who develop and disseminate these technologies.

As a result, policies in both agriculture and education focus almost exclusively on science-based strategies to boost yields through adoption by smallholders of technology packages. Yet in a vibrant innovation system, agricultural development results from a combination of efforts to develop clusters, value chains, contracts and other arrangements that combine technological improvements in production, processing, and distribution with organizational improvements in how information and knowledge are exchanged between various actors in these systems, and with policy changes that create favorable incentives and institutions to promote change.

Organizational cultures in AET organizations in Mozambique are also largely determined by administrative practices, public service regulations, and organizational incentive structures that determine how public administrators view their role in the agricultural development process. The shared belief is one of top-down management practices based on strict adherence to rules and control of staff. As a result, few AET organizations are host to cultures that allow experimentation and risk-taking by field professionals.

Incentive mechanisms in the AET system are largely driven by public-sector regulations. AET educators are poorly paid and receive relatively few benefits, a reality compensated by the long-term benefits of secure employment, public pension schemes, and low expectations in terms of output. Similarly, AET graduates are typically consigned to relatively low-paying positions in public extension services, research organizations, or teaching organizations, often in remote areas disconnected from urban centers. These incentives tend to contribute weakly to organizational cultures that are supportive of innovation.

Thus, NGOs are a particularly popular destination for mid-level AET graduates (diploma-holders from the agrarian institutes) who have more practical skills than their university-educated counterparts. While the average monthly salary for BA-holders in public service is about US$600, some NGOs offer as much as US$1,400 for workers with the same qualifications.

There are some signs that incentive structures are changing in Mozambique, specifically through efforts to upgrade AET instructors’ qualifications, introduce more practical education through curricula reform, invest more in AET infrastructure and equipment, and reach out to stakeholders in industry and the NGO sector. Higher-paying job opportunities and short-term contracts in both the private and NGO sectors may be motivating a new generation of AET graduates to excel not only as technical experts, but as independent entrepreneurs and innovators as well. However, there is limited empirical evidence to suggest that new incentive structures (or market realities) are yet generating the desired changes in organizational cultures and behaviors in the AET system.

Building Innovation Networks and Linkages

The development of individual and organizational capabilities to innovate requires not only supportive organizational cultures, behaviors, and incentives, but also
effective innovation networks. These types of linkages are essential to achieve economies of scale and scope, reduce transactions costs, exploit complementarities among organizations and individuals, and realize synergies.

The dynamism of an AET system relies partly on its ability to interact with agents in the wider innovation system through what we have described earlier as innovation networks (Figure 6). Here, we highlight one particularly important aspect of networking, the notion that innovation occurs in the non-traditional—rather than traditional—links of a network.

AET institutions in Mozambique operate in networks dominated by the traditional links of academics with similar individuals and organizations. Non-traditional links—where new knowledge and information can be exchanged, and where innovation is most likely to occur—are uncommon. Few incentives exist to promote network formation, although several exceptions suggest possibilities for change.

There are similarly few effective linkages between or among agricultural research, extension, input supply services, and agricultural education in the public sector. There are even fewer linkages between AET with private firms in agro-industry or the NGO sector. A contributing factor to these weak interactions is the inward-looking nature of many government organizations, exacerbated by internal preoccupations created by continuous reform, restructuring, and reshuffling.

There have been several attempts to link research and extension in Mozambique, but they have been plagued with difficulties—not surprising given the many changes within the research system and the relative newness of the extension system. The main linkage mechanisms used include periodic revisions of technologies, multi-disciplinary missions, thematic working groups, joint annual meetings, and on-farm trials (Gêmo, 2006). However, some activities have been discontinued or staff has

Figure 6. Hypothetical innovation networks in an AET system.

Source: Authors
been reshuffled, making working together difficult. Weak interactions are related to structural/organizational problem (lack of technical people), motivation/incentive problems (professional merit focusing on publications rather than technology transfer), lack of resources (time constraints), and communication problems (lack of equipment).

Several ongoing experiments seek to induce the emergence of new mechanisms and cultures aimed at facilitating greater network formation in AET. For example, the Ministry of Education and Culture intends to create an academic credit system that will encourage students to transfer between universities and colleges, thereby bringing curricula toward a common level and possibly allowing students to link learning and research activities between faculties at more than one AET organization. Students are also finding new opportunities for practical apprenticeships in the private and NGO sectors. Similarly, faculty are being encouraged to explore joint appointments, secondments, and deputizations between AET organizations. And in the agricultural research community, competitive grant schemes are emerging with the potential to increase links with the private sector and NGOs. However, most of these networking modalities revolve around linkages among similar organizations and individuals, and do little to exploit the synergies created within non-traditional linkages.

Although some efforts to link formal AET with innovative farming operations are emerging—the polytechnics are looking to establish linkages with Mozambique Leaf Tobacco and its contract farming operations among smallholder tobacco growers, for example—few other linkages between the traditional concessionary monopolies and AET exist.

**Recommendations for Strengthening AET in Mozambique**

As the findings of this study suggest, there are signs that the AET system in Mozambique is undergoing some degree of reform in response to changing scenarios in agricultural policies and markets. However, very few of these reforms seem to capture the key elements of the innovation systems perspective. Few reforms focus on strengthening individual and collective capabilities to innovate; changing organizational cultures, behaviors, and incentives; or building innovation networks and linkages. Few seem to prioritize the creation of a more dynamic and responsive AET system through the introduction of new and different educational approaches, learning philosophies, and shared beliefs and practices—and through opportunities to build networks that link a wider range of stakeholders in the agricultural innovation system.

Recommendations for improving AET from an innovation systems perspective are offered here for consideration by AET policy-makers, managers, professionals, and clients. These recommendations should be viewed only as possible options and alternatives based on the findings of this study and on wider global practice in AET. Furthermore, these recommendations should only be considered in the context of country-specific priorities and capabilities.

1. **Realign Visions and Mandates.** This immediate step can be accomplished by promoting new types of educational programs that are less encyclopedic and are
instead more strategically attuned to the different needs of innovative actors. The goal here is to move the AET system into closer, more productive relationships with other actors within the innovation system.

2. **Develop the Human Capital Base by Enhancing Innovative Capabilities.** In the medium term, efforts to further develop the region’s human capital base would focus on the provision of learning opportunities geared to the specific needs of actors in the innovation system. This would entail linking AET training and research agendas more closely to the needs of different user communities, fostering stronger linkages between formal AET organizations and national extension systems, exploring new ways of leveraging expertise and resources from international research organizations and foreign universities, and working to meet the needs of private industry. Specific policies and programs would focus on expanding technical and vocational training institutes, in-service and on-the-job programs, distance education, and other modalities specifically adapted to the needs of diverse actors in the innovation system. Policies and programs would also focus on private sector sources of AET as a necessary complement to the formal, public-sector AET system.

3. **Facilitate the Flow of Information and Technology through Networks and Linkages.** Emphasis in the medium term might also be placed on fostering the development of the innovation networks needed to put this information and technology into socially or economically relevant use. Innovation networks should be flexible and nimble to facilitate the flow of technical and other types of information (e.g. commercial or organizational) among different actors. This should be complemented by renewed efforts to engage international agricultural research centers, foreign universities, and foreign entrepreneurs more aggressively in these networks.

4. **Induce Change in Organizational Cultures, Behaviors and Practices.** In the long term, efforts to induce change require recognition by policy-makers, public administrators, AET professionals and other actors that formal AET organizations are not the only ones conducting research and training, and that linkages with a wide array of other stakeholders can effectively serve AET organizations and the country’s innovation system. Policies and programs should encourage greater openness in AET organizations to collaboration and should focus on strengthening individual and organizational incentives to develop and retain capacity on a national scale, and on introducing organizational and managerial innovations into the AET system itself.

5. **Create an Appropriate Policy Environment.** The long-term transformation of AET systems in SSA also requires an appropriate policy environment and policy-makers with the knowledge and will to facilitate the transition process. Creating the right policy environment would require, among other things, developing courses on research and technology management and facilitating policy dialogue among different actors in the innovation system that put policy-makers into direct contact with researchers, research managers, private firms, and civil society. AET organizations can constructively contribute to the process by serving as a convening force, providing information and analysis of policy options, and participating actively in repeated discourse.
6. **Monitor and Evaluate the AET System.** Continuous evaluation of AET organizations and the AET system as whole is also necessary. Teams of domestic and international experts in AET can play a critical role in assessing progress and designing roadmaps for change. These evaluations can help organizations redefine their mandates and goals relative to changes in the country’s AET system, wider agricultural innovation system, and the availability of resources. Ideally, such evaluations would assist in the efficient reallocation of AET resources across teaching, research, extension, and private enterprise, based on the assumption that a strong AET system should be diversified across all four areas.

8. **Adopt a Long-term Outlook.** Changes in the practices and cultures of both formal and non-formal AET do not happen overnight; the internalization of new skills in applied problem solving, critical thinking, and entrepreneurism can take more than a generation to become common practice in AET. Thus, shifts in policy and strategy do not effect change within five-year time spans. Individual and organizational responses to changes in structures, incentives, and financing require more time to become accepted into procedure and performance.

9. **Support Autonomous Changes in Formal and Non-formal AET.** The menu of educational options in many developed and developing counties is expanding in response to emerging social and productive needs (Christensen et al., 2004). As Mozambique integrates further into the global economy, it is highly likely that new local and foreign educational options will also emerge, as is demonstrated by the creation of new private universities and the training provided by NGOs. Rather than concentrating all resources on formal, traditional AET institutions, policy-makers can allocate moneys to explore these emerging options and foster the expansion of the more successful ones.

**Conclusion**

In analyzing the AET system in Mozambique, this paper relied on an innovation systems perspective to make its case. Thus it has examined the post-secondary AET system of Mozambique with regard to its individual and collective innovative capabilities; organizational cultures, behaviors and incentives; and innovation networks and linkages.

The study found that current educational approaches in Mozambique do not adequately develop individual or organizational capabilities to innovate. There is limited empirical evidence to suggest that new incentive structures (or market realities) are generating the desired changes in organizational culture and behavior in the AET systems of Mozambique. And finally, although some efforts to link formal AET with other players are emerging, few other linkages at present exist.

**References**


