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Innovation for Agricultural Training and Education



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Modernizing the Agricultural Education and Training Curriculum

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This document was written as part of a series of InnovATE thematic studies. These research papers examine a particular agricultural education and training (AET) system, cross-cutting theme, model, or technique and offer an analysis of the subject in question. These studies often highlight AET innovations in good practices. Case studies examine how agricultural education and training intersects with other development issues which are important to AET capacity building.

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Table of Contents

Introduction.....	1
Supply and Demand	2
Agricultural Value Chains	3
Skills for the Agricultural Sector	5
Disconnects in AET	8
<i>Curriculum Quality & Relevance</i>	8
<i>AET Isolation</i>	12
<i>Training - Skills Disconnect</i>	12
<i>AET- Smallholder Farmer Disconnect</i>	14
A Way Forward	16
References	18
Appendix A.....	21
I. <i>Agribusiness programs in Sub-Saharan Africa</i>	21
II. <i>Factors Impacting Higher Agricultural Education Quality and Relevance</i>	22
III. <i>Main elements of investment in direct or indirect curriculum reform</i>	22

Introduction

The Innovation for Agricultural Training and Education (InnovATE) Project promotes sustainable food security, poverty reduction, and natural resource conservation in the developing world by assisting in the development of effective and sustainable agricultural education and training (AET) systems. The purpose of AET is three fold: (1) develop human resource capabilities; (2) produce and apply research to address needs of agricultural production, markets, and end users; and (3) transmit research and technology to smallholders and other marginalized groups to improve food security and livelihoods (Rivera, 2006).

Globally, nearly 800 million people live in a state of hunger and food insecurity (FAO, 2015). The highest prevalence of food insecurity and poverty as an underlying factor are seen in developing agricultural countries of Southeast Asia and sub-Saharan Africa (FAO, 2015). According to findings by the International Fund for Agricultural Development (IFAD) (2013), a per capita increase of 1% in agricultural sector GDP was five times more effective in reducing poverty than growth in other sectors.

Agricultural education and training contributes to poverty reduction for rural populations across the globe (Wallace, 2007). The World Bank (2007) determined four effects of AET on agricultural productivity: (1) enhanced worker productivity; (2) formal education increases farmer's ability to choose prime combinations of inputs and outputs; (3) additional school influences farmer's capacity to innovate and adapt new technologies; and (4) additional education facilitates interaction with commercial markets.

However, the AET system has been characterized by a lack of integration across educational institutions and providers including government ministries, NGOs, and the private sector (Rivera & Alex, 2008). At the vocational level, programs have been critiqued for an overly narrow and production-oriented focus that is misaligned to the range of current agricultural occupations and overlooks agricultural systems as a part of rural development (Vandenbosch, 2006) while appraisals at the undergraduate level demonstrated heavy theoretical and academic emphasis that are discordant with employer needs and those of smallholder and entrepreneur clientele (Rivera, 2006). Additionally, country-level labor market assessments that are necessary to align content and instruction with employment outcomes are missing or inadequate (Wallace, 2007). Curricula and pedagogical updates are necessary for AET systems to produce graduates with the knowledge, skills, and attitudes that enable sustainable food security, improve livelihoods, and facilitate natural resource conservation.

Supply and Demand

Enrollment levels in agricultural education and training programs should correspond to agricultural development and labor market needs (World Bank, 2007). Disparities between supply and demand within any level of the technical education pyramid leads to skill shortages, qualification mismatches, or skill gaps (World Economic Forum, 2014). For example, in Cambodia, agriculture comprises 29% of the country's GDP and employs 59% of the workforce, compared to an under enrollment of 4% in tertiary level agricultural programs (di Gropello, Tandon, & Yusuf, 2011a). Additionally, a large portion of the population in many developing countries is comprised of youth with low levels of education and limited work qualifications - rates have been as high as 56% in Cambodia and 82% in Malawi (World Economic Forum, 2014).

Imbalances between supply and demand can also result in over-qualification and graduate unemployment when tertiary institutions turn out more graduates than the labor market has the capacity to absorb (World Economic Forum, 2014). For example, in North Africa, the graduate unemployment rate has been as high as 20%, compared to 10% unemployment for those with primary education (McKinsey Global Institute, 2012). Similar imbalances have been seen in India and in Nigeria where the higher education system expanded more rapidly than jobs were created (McKinsey Global Institute, 2012; Ogege, 2011). In Ghana, labor market analysis for tertiary graduates demonstrated an over-supply of agricultural graduates seeking positions in central government, the foremost employer of tertiary graduates, while there were critical shortages in management and administration, engineering and technical fields, and in medical and health sciences (Boateng & Ofori-Sarpong, 2002).

Labor market imbalances can also reflect a skills mismatch between workforce qualifications and the expertise needed by employers (World Economic Forum, 2014). In Upper Egypt, results of a skills gap analysis demonstrated that AET graduates did not have the necessary communication, management and technical skills needed by employers in the international dairy, horticulture, and agribusiness sectors (Vreyens & Shaker, 2005). Mabaya, Christy, and Bandama (2014) called for AET systems to expand the scope of curricula to include executive training skills such as supply chain management and finance in addition to the traditional content in order to foster agribusiness entrepreneurship and ensure employability of AET graduates (see Appendix A for agribusiness degree programs in SSA).

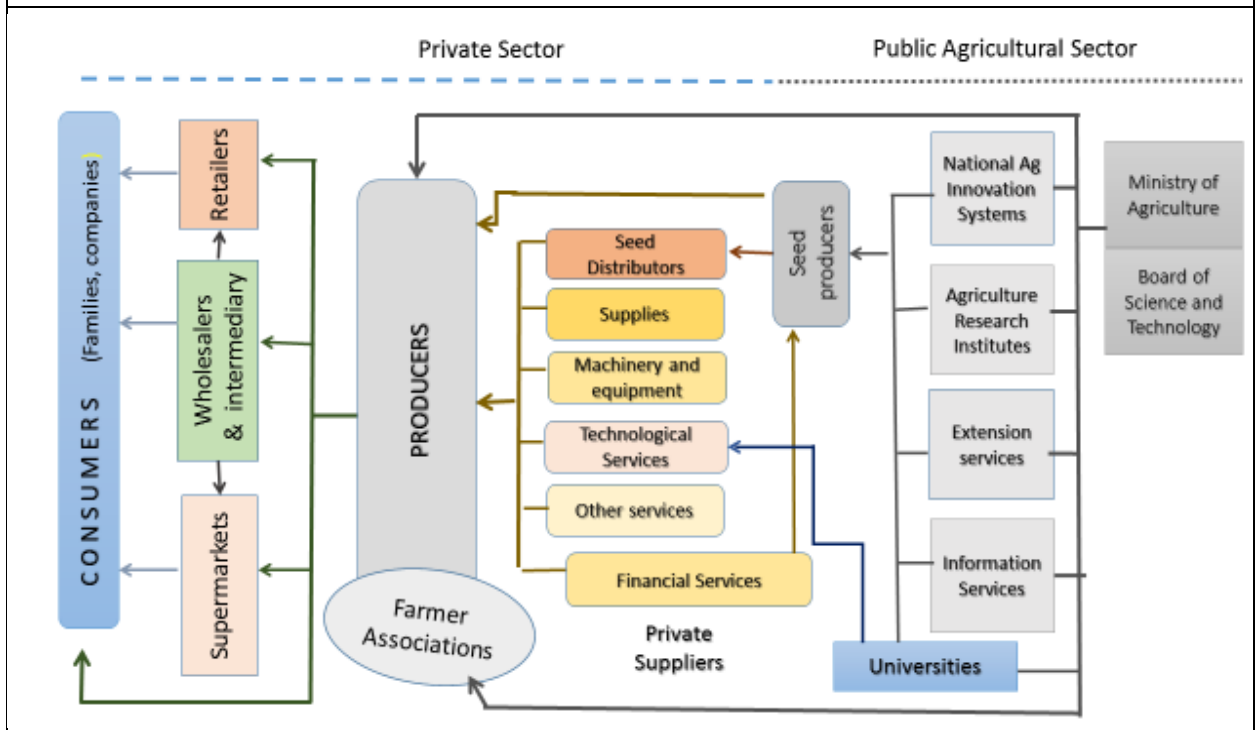
Box 1 Agribusiness Management Program at Makerere University, Uganda	
Faculty of Agriculture at Makerere University in Uganda partnered with the private sector to restructure curriculum used in undergraduate and graduate programs. Master’s program divided into two separate tracks: agricultural economics and agribusiness with an advisory board of private sector representatives.	
Agribusiness Degree Tracks: <ul style="list-style-type: none"> - Full time - Part time - Evening Class Options 	Master’s Degree: Private Sector Partnerships <ul style="list-style-type: none"> - Gives agribusiness degree credibility and visibility - Potential of private sector sponsorship of students - Facilitates linkages between University and employers - Ensures course content is relevant to labor market needs - Increases likelihood of students doing theses on topics relevant to the private sector (possibly for sponsorship).
Source: Mabaya, Christy, & Bandama (2014)	

Agricultural Value Chains

Agricultural development is increasingly dependent upon access to market innovations and value chains to improve rural livelihoods (Swanson & Rajalahti, 2010). USAID defined *value chains* as “the full range of activities required to bring a product or service from its conception to sale in its final markets – whether local, national, regional or global”. The links between stages of production in the agricultural sector are inputs, producers, processors or traders, and retailers. As agricultural production shifts from subsistence level towards a market economy, farmers and other producers become reliant on off-farm sectors for both (a) purchased inputs and (b) procurement or processing beyond the farm gate (Bernsten & Staatz, 1992). Thus, as low and middle-income countries seek to expand their economies, the need for higher education and a skilled workforce increases across all sectors (di Gropello, Tandon, & Yusuf, 2011b).

Figure 1 identifies the agricultural value chain. From the framework, we can see that education and research institutions are positioned at the base of agricultural production. The information and resources provided by this base supports producers (farmers, fisherman, herders, foresters) and workers in cultivating a healthy commodity and the agricultural firms that bring the commodity to market. Occupations that support production include research scientists, lab technicians, extension and advisory agents, financial lenders, seed and fertilizer salespeople (agrodealers), and agricultural technology and equipment suppliers (Jones, n.d.).

Figure 1: Agricultural Value Chain



Source: French (2013). Presentation: *The Inter-American Institute for Cooperation of Agriculture (IICA) Innovation for Productivity and Competitiveness Program*.

Prior research identified a need for workforce skills to be upgraded within each stage of the value-chain (Fernandez-stark, Bamber, & Gereffi, 2012). The workforce employed in the lower level of value chains are mostly manual laborers who have typically had low literacy levels and limited general education. At this level, lower-level supervisors or quality control staff conduct informal training in-house through demonstration and explanation of job functions. Additionally, laborers can be trained in several operations such as washing, grading, and packing, so they are able to move across functions as-needed (Dolan & Sorby, 2003).

Moving up into the mid-level of the value chain, the complexity of operations increases as does the level of training and education needed by the workforce (Fernandez-Stark et al., 2011). In the middle of the value chain, certification-related occupations ensure compliance with strict industry standards necessary to maintain market access. Technical training is vital for machinery operation and maintenance, irrigation system management, and agrochemical handling.

Bottleneck positions are common throughout the value chain stemming from high-demand and limited supply of qualified, trained personnel with the qualifications to fill supervisory, management, and quality control positions. The supply of employees for these bottleneck positions has been low due, in part, to misaligned training at the vocational and tertiary levels. Lastly, the highest level of the value chain employs a small number of skilled professionals in specialized roles that require tertiary degrees.

The greatest opportunity for post-secondary AET to contribute to workforce development lies within these bottleneck positions in the middle and high parts of the value chain where job functions require higher skill competences and workers need specific technical training (Fernandez-stark et al., 2012; World Economic Forum, 2014). Table 1 provides an example of the range of occupations and jobs available in the fruits and vegetable value chain.

Table 1: Job profiles in the fruit and vegetable value chain		
Position	Formal Education Requirement	Skill Level Required
EXPORT PRODUCTION		
Harvest Worker	No formal education required	L
Tractor/truck operator	License / certification	L – M
Pesticide handler	Technical education	M – H
Irrigation technician	Technical education / BSc	M – H
Quality control	Technical education / BSc	M – H
PACKING AND COLD STORAGE		
Packing worker	No formal education required	L
Labelers	Literacy and numeracy skills	L – M
Transport driver	Literacy and numeracy skills	M
Managers (line/shift)	Technical education	M – H
Inspector	Technical education	M – H
Packing manager	BSc	H
Quality assurance manager	BSc / MSc	H
PROCESSING		
Line workers	Literacy and numeracy skills	L – M
Mechanics & Machinery Maintenance	Technical education	M - H
Production Supervisor	BSc	H
KEY:	L Low, no formal education; experience L-M Low-Medium, literacy and numeracy skills; experience M Medium, technical education, certification M-H Medium-High, technical education/undergraduate degree H University degree and higher	
Source: Adapted from Table 10, Duke CGGC, (2011).		

Skills for the Agricultural Sector

Higher education is the supply mechanism for skilled workers, managers, and entrepreneurs who support innovation and facilitate economic growth within a complex and interconnected agricultural chain. Davis et al. (2007) proposed that AET providers serve four main agricultural systems whose needs vary according to scale (Table 2). Important to note is the requisite for qualified extension services for the subsistence and small-scale agricultural systems (Davis et al., 2007).

AET systems are tasked with preparing students with the knowledge, technical skills, and practical abilities to manage and problem-solve in modern agricultural systems. Employers need

Table 2: Agricultural Skills Market	
Agricultural System	Skills Needed
Small-scale, resource-poor subsistence farmers	Extension services Integration of new technology into indigenous systems
Small farms operating in domestic market	Skilled workers Marketing & Distribution Agribusiness management
Farmers with potential to become commercial	Entrepreneurial Marketing & Distribution Agribusiness management Collective bargaining &/or forming associations Technology
Large commercial farm operators, high-value export sector	Skilled workers & Labor supervisors Advanced technologies (irrigation, greenhouse, agrochemicals) Export laws and safety standards Marketing & Distribution
Source: Adapted from Davis et al., 2007	

personnel with expertise in current agriculture-specific techniques such as production, biotechnology, and agroprocessing/post-harvest handling (Oketch, 2007) while entrepreneurial and business management skills complement technical know-how and are foundational to self-employment and local agribusiness creation (Rivera & Alex, 2008). Additionally, graduates need skills to move commodities through commercial supply chains and markets including competence in information communication technologies (ICTs); marketing and certification standards; transport and logistics; and food safety and quality control (Fernandez-stark et al., 2012). Furthermore, “soft skills” such as communication, leadership, and team work are necessary across middle and high-level supervisory positions that require interaction with a range of stakeholders (Fernandez-Stark et al., 2012; World Bank, 2007).

Supervisors and managers in large commercial firms need additional interpersonal communication and gender-sensitivity training, particularly for positions with direct command of female employees. Women employed in high-value agriculture are often in entry-level, temporary, or seasonal positions that do not afford the same legal protections as permanent employment, which increases their vulnerability to sexual harassment and poor work conditions (Dolan & Sorby, 2003; World Bank, 2013). Dolan and Sorby (2003) attributed the prevalence of sexual harassment and discrimination of female workers in cut flower and fresh fruit segments of Africa and Latin America to informal employment arrangements combined with local gender norms and patriarchal systems. However, in Kenya, sexual harassment and management skills training for supervisors was shown to improve the productivity of female workers as a result of the better-quality work environment (Fernandez-Stark et al., 2011; World Bank, 2013).

Table 3: Advisory services needed by three value chains in Upper Egypt.

Value Chain Example	Advisory Services Needed	Employment Opportunities & Level of Education
Tomato	<ol style="list-style-type: none"> 1. Information on new varieties of tomatoes, including fertilizer advice and seed sources 2. Market information – target local or export markets. If the former, identify consumer demands; If the latter, need information on standards 3. How to form a cooperative/producers group to better compete, enhance their capacities to vertically integrate 4. If exporting, need help with certification, grading, access to transportation 5. New varieties of tomatoes that use less water 	<ol style="list-style-type: none"> 1. Expert advisors in horticultural products, BSc. 2. Expert advisors in marketing, including advertising, BSc. 3. Expert advisors in forming producer groups, BSc. 4. Expert advisors in export certification processes, BSc., possibly lawyer 5. Tomato breeders, BSc. or MSc. 6. Government extension worker, BSc 7. Food inspection services, BSc. 8. Agricultural economist, BSc. or MSc. 9. Transportation logistic manager, BSc. 10. Community development advisor, BSc. 11. Storehouse managers, BSc. 12. Packing house supervisor, VoTech
Citrus	<ol style="list-style-type: none"> 1. Information on new citrus varieties, integrated pest management, and fertilizer management 2. Citrus tree pruning training 3. Water saving drip irrigation training including irrigation scheduling and use of treated waste water 4. Pump station operation and maintenance 5. Post-harvest and market information – target local markets; Identify consumer demands and cold storage facilities so citrus crop does not flood the market all at once lowering prices 6. How to form a cooperative/producers group to better compete, enhance their capacities to vertically integrate 7. Target export markets; Grading, transportation 	<ol style="list-style-type: none"> 1. Expert advisors in tree pruning, BSc. 2. Expert advisors in irrigation and irrigation equipment maintenance (including pumps), VoTech to MSc. 3. Expert advisors in integrated pest management and fertilizer use, BSc. 4. Expert advisors in postharvest and marketing, including advertising, BSc. or MSc. 5. Cold storage services, VoTech to BSc. 6. Storehouse managers, VoTech to BSc. 7. Expert advisors in forming producer groups, BSc. 8. Government extension worker, BSc. 9. Transportation logistic manager, BSc. 10. Community development advisor, BSc. 11. Export marketing, BSc. 12. Staff training, BSc.
Rangeland	<ol style="list-style-type: none"> 1. Livestock nutrition including concepts of rotational grazing and reduction in numbers of stock 2. Rangeland rehabilitation 3. Animal care, e.g., para-veterinary services 4. Use of biosolids to restore rangelands, land management overall 5. Alternatives to olive production 6. Non-agricultural income earning alternatives 	<ol style="list-style-type: none"> 1. Expert advisor on animal nutrition, BSc. 2. Para-veterinarian, Vo-Tech 3. Expert advisor on rangeland rehabilitation, MSc. 4. Expert advisor on soil remediation, BSc or MSc. 5. Community development advisor, BSc. 6. Marketing alternative products expert advisor, BSc.

Source: Jordan AET assessment report: Recommendations and strategies to modernize the capacity of agricultural and technical education in Jordan to meet the demands of water saving agriculture. InnovATE (2014).

Additionally, graduates must be prepared with the breadth of knowledge and skills needed to work with rural farmers and adapt information based on literacy level, geography, resources, and farming system (Anderson & Feder, 2004). Fundamentally, government agencies have limited capacity to establish the organizational infrastructures necessary to fund, implement, and monitor advisory services beyond a limited scope (Swanson & Rajalathi, 2010). Nevertheless, employment opportunities exist within private sector firms, NGOs, and INGOs for well-trained AET graduates to provide diversified and specialized services to smallholder and subsistence farmers. Besides those technical, practical and “soft skills” mentioned, graduates entering extension and advisory roles with either public or private agencies need: (a) technical and management skills; (b) agricultural marketing, business, and value-chain development skills; (c) skills to organize producer groups and facilitate market linkages; and (d) communication and training skills for working with adult learners (Swanson & Rajalathi, 2010). Moreover, the rising dependence of agricultural development on market innovations and value chains expands the traditional view of extension agents as a means of technology transfer into a *brokerage* function that connects rural farmers to other actors in the network through collaboration and partnerships that will facilitate the attainment of rural development goals (Swanson & Rajalahti, 2010). Table 3 provides examples of specific extension/advisory services needed within three value chains.

Disconnects in AET

Curriculum Quality & Relevance

In many countries, there are both internal and external constraints on tertiary AET that elicit concern about the educational quality and relevance of programs (Maguire & Atchoarena, 2003) (Appendix A). At the institutional level, AET programs are marked by declining numbers of prepared faculty and/or educators with low levels of experience coupled with student enrollment above program capacity (Rivera, 2006). The World Bank (2007) attributed the decline in qualified faculty to the limited availability of postgraduate programs coupled with low enrollment in available MSc degree programs. Additionally, faculty have limited opportunity to engage in professional development and emerging agricultural technologies, a factor that further confounds curriculum and instruction. Rivera’s (2006) assessment of post-secondary AET providers across sub-Saharan Africa (SSA) uncovered constraints related to: (a) curriculum characteristics, (b) capacity building of faculty and students, (c) institutional linkages, and (d) infrastructure and technology. Moreover, deficits in physical infrastructures, equipment, and ICTs have hindered AET programs in the region. Specifically, programs lacked: (a) library

and reference materials, (b) field equipment and learning farms, (c) laboratory equipment, and (d) computer availability and internet connectivity.

The scope of literature reviewed points to substantial gaps in AET relevance and quality. Low and negative perceptions of agriculture as a viable career option undermine agricultural and workforce development; prospective students, parents, and often faculty are not aware of the full range of agricultural career opportunities (Rivera, 2006; Vandenbosch, 2006). Reports from Jordan revealed tertiary faculty had limited knowledge of employment opportunities, and thus focused on traditional preparation for government jobs (InnovATE, 2014). Moreover, the majority of AET programs do not offer valuable student services such as, career advising, internships, or job placement services that could help attract new students to the field (InnovATE, 2014; InnovATE, 2015; Rivera, 2006). Further contributing to poor relevance is the lack of collaborations with external stakeholders (NGOs, employers, farmer associations) that provide feedback to educational institutions on workforce readiness and curriculum while students gain valuable job experience in the form of internships or practicum (World Economic Forum, 2014).

Broadly, AET curricula and pedagogy are obsolete and out-of-sync with current agricultural and human resource development needs. Courses are delivered through traditional didactic methods centered on scientific processes and theory and overlook the array of disciplines necessary for competence in modern agricultural systems (Davis et al., 2007; USDA, 2011). Anecdotally, students complain about professors teaching from “twenty year old notes”. The focus on theory and academics leaves out practical skills development. Further, concentration on large-scale production and export crops overlooks the needs of smallholder farmers whose growth is more-likely secured through regional markets (Lee, Gereffi, & Beauvais, 2012). Moreover, narrow programmatic focus does not prepare graduates with innovation and entrepreneurial aptitudes necessary to generate self-employment and adapt within dynamic agricultural systems (Seuneke, Lans, & Wiskerke, 2013; Spielman, Ekboir, Davis, & Ochieng, 2008).

Agricultural innovation systems (AIS) are “a network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect their behavior and performance. It extends beyond the creation of knowledge to encompass the factors affecting demand for and use of knowledge in novel and useful ways” (World Bank, 2006). Jordaan and Taylor (2014) encourage academic institutions to apply a *systems approach* at both the organizational and operational levels and provided recommendations for adapting curriculum, instruction, and assessment to foster innovation and entrepreneurship in AET (Figure 2). At the operational level, the authors (2014) suggest adoption of

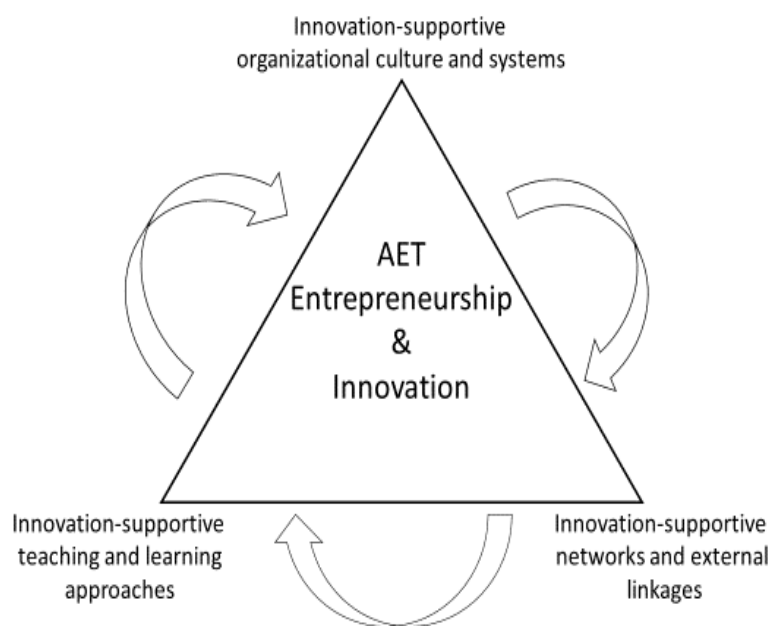


Figure 2: Framework for developing entrepreneurship and innovation in AET
 Source: Jordaan & Taylor (2014).

pedagogies that cultivate an innovative and entrepreneurial mentality in students such as, (a) participatory and experiential learning methods, (b) debate, discussion, and critical thinking, (c) interdisciplinary teamwork and problem solving, and (d) opportunity recognition and treatment of ambiguity and uncertainty.

Box 2. Nelson Mandela Metropolitan University, South Africa	
Partnership between Nelson Mandela Metropolitan University, Government Ministry, and Thembaletu Agricultural Community, a peri-urban community of recent land reform beneficiaries located near the city of George, South Africa.	
Objectives	
<ul style="list-style-type: none"> - Facilitate enterprise development & entrepreneurship education - Adapt conventional business incubation model to local context 	
Stakeholders	Agribusiness & Entrepreneurship Training
<p>University provides:</p> <ul style="list-style-type: none"> - seed money to participants in form of interest free loans <p>Ministry of Agriculture provides:</p> <ul style="list-style-type: none"> - Expertise and support to academics & students for demonstrations and hands-on training <p>Trainee Entrepreneurs:</p> <ul style="list-style-type: none"> - 5 community members (trainee entrepreneurs) buy into business at start of project cycle for R120 (US\$17) and participate in training - Manage project as a team 	<ul style="list-style-type: none"> - Order day-old chicks - Day to day management - Market mature birds - Sell finished broilers - Assess profitability of business - Liquidate venture at end of cycle (repay loan) - Option to retain profits and re-invest in new business cycle - Maximum re-investment option is 5 program cycles before graduation
<p>Innovative behaviors & entrepreneurial attitudes identified :</p> <ul style="list-style-type: none"> - Opportunity recognition - Initiative - Creativity - Ability to adapt & change - Value creation 	<p>Technology transfer and innovation success:</p> <ul style="list-style-type: none"> - Combined traditional rural systems with high-tech genetics and feed technologies - Introduced “new-to-the-context” technology - Participatory methodology combining demonstration, training, and hands-on participation for all stakeholders - University innovation networks strengthened
Source: Jordaan & Taylor (2014).	

The emerging paradigm of AET within the innovation perspective requires AET to produce graduates with the ability to facilitate market-oriented production and technological innovation in addition to traditional services of technology transfer for crop production and animal husbandry. Thus, the challenge to AET systems is to prepare students with the appropriate mix of technical skills and functional competencies to adapt and innovate within their professional track (Jordaan & Taylor, 2014). Indeed, most AET curricula lack breadth of interdisciplinary coursework that provide students with well-rounded and in-demand skills (Vandenbosch, 2006). Throughout the literature, employers call for graduates with competence in “soft skills” like leadership, communication and problem solving, and ICTs (Rivera & Alex, 2008; World Bank, 2007). Respectively, many programs were also deficient in technical depth, especially in areas such as agribusiness and marketing; agroprocessing/post-harvest technologies; natural resource management; and rural finance (World Bank, 2007; Rivera, 2006; USAID, 2011).

Box 3. Earth University, Costa Rica	
EARTH is a private, nonprofit, 4-year university established in response to rural poverty, high population growth, low productivity, urban migration, ecosystem destruction, and political instability and war throughout Central and South America.	
<p style="text-align: center;">Mission</p> <p>Prepare leaders with ethical values to contribute to the sustainable development of the tropics and the construction of a prosperous and just society.</p>	<p style="text-align: center;">Educational Model is based on four pillars</p> <ul style="list-style-type: none"> • Technical and scientific knowledge • Entrepreneurial mentality • Values and ethics • Social and environmental commitment
Five keystone programs based on experiential learning:	
Work experience:	Year 1-3: students work in crop, animal, and forestry production modules on EARTH farm. Year 4: students identify work site on campus or in community that aligns with a career goal, develop, and implement a work plan.
Community Development:	Year 2: students work with small-scale producers and organized groups to resolve local issues in sustainable community development
Academic Program at Earth-La Flor:	Year 3: students spend 7 weeks living with rural host family near EARTH’s education and research center. Students work with companies in the region on topics related to: crop & livestock management, aquaculture, alternative energy, water management.
Entrepreneurial Projects:	Year 1-3: accompanied by a series of classroom modules: business organization, accounting, marketing. Students work in small groups to develop a business venture. If approved by review committee, university loans money to implement the project.
Internships:	Year 3 (third trimester): 15-week internship with host organization (i.e. NGO, farm, or business).
Source: World Bank, (2012).	

AET Isolation

AET institutions operate in isolation rather than as a system of workforce development (di Gropello et al., 2011b; Rivera, 2006). In many countries, AET falls in-between agricultural and education policies and thus functions without clear objectives under divided, and often competing, government ministries. The lack of specific AET policy or mandate underlies poor coordination amongst agricultural education providers. Moreover, curricula across the system is not aligned and students have little mobility between education levels (di Gropello et al., 2011a). Maguire and Atchoarena (2003) articulated this concern, “an extension worker with secondary education and a two year agriculture certificate plus considerable field experience can rarely bridge to a degree programme”. Consequently, lack of continuity across the AET system limits pathways for skills acquisition and career advancement, and thus impedes development of a national AIS (World Bank, 2007; di Gropello et al., 2011a; Rivera & Alex, 2008).

Developing a system-wide framework aids in establishing institutional linkages within an education and training system and assists educational leaders in forming explicit competencies for AET graduate employability. Shifting curriculum focus towards employability (competency)-outcomes provides opportunities to develop multiple system entry and exit modes via certifications, specializations, and comprehensive training and expands opportunities within AET for an array of students while meeting the diverse labor market needs for skilled technicians (di Gropello et al., 2011b).

Training - Skills Disconnect

The disconnect between AET institutions and employers in the agricultural industry has been attributed to weaknesses in information, capacity, and incentives (di Gropello et al., 2011a). In many countries, there is little communication between educational institutions and the private sector. Consequently, AET providers are missing necessary *information* to align education and training to labor market demands including feedback on curriculum relevance; labor market assessments; and graduate tracer studies (di Gropello, Tandon, and Yusuf, 2011a; World Bank, 2007).

Additionally, faculty *capacity* to collaborate on or conduct research pertinent to local industry needs is diminished due to high student-instructor ratios coupled with insufficient resources (di Gropello et al., 2011a). Subsequently, the capacity to properly train the next generation of educators, extension agents, technician, researchers and so on is also diminished (di Gropello et al., 2011a). In Mozambique, investigators found that most M.Sc.-level students were not equipped to conduct even basic research and data analysis, which is an indication of weak capacity within the faculty to engage in research and to train students in those methods (Davis et al., 2007). Moreover, there are scant consequences for public

institutions to demonstrate educational results, leaving faculty with little *incentive* to modify curriculum or gear programs toward local industry needs (di Gropello et al., 2011a).

Repercussions of the training-skills disconnect are evidenced by weakened economic growth and lower productivity. At the national level, long-term skills mismatch leads to structural unemployment and contributes to overall decline in industry productivity (World Economic Forum, 2014). For example, in Cambodia, 15.5% of national agricultural firms described shortages in skilled labor as a “major constraint to growth”. Moreover, 73% of employers reported that university graduates had the wrong skills (InnovATE, 2013).

At the industry level, jobs are commonly filled with ill-prepared workers who require in-house training to supplement deficiencies in formal education (di Gropello et al., 2011a; InnovATE, 2015). In Jordan and other places, employers reported that recruiting workers from other locales with the *right* skills was more cost-effective than investing money to train local hires (InnovATE, 2014; InnovATE, 2015). Similar experiences were described in Ethiopia and Mozambique where horticultural firms had difficulty finding skilled employees in the local environs and sourced workers from neighboring or foreign countries (Davis et al., 2007).

Box 4. Zamorano, Honduras	
Context: Rapid changes in agrarian structures, modernization of agricultural production, and significant urban migration and rural poverty.	
Focus on career-oriented programs :	
<ol style="list-style-type: none"> 1. Agribusiness Management 2. Agronomic Economics 3. Food Agribusiness 4. Environment and Development 	
Outreach Program: continuing education, extension, technical assistance, consultancies, applied research for off-campus clientele.	
Curriculum Updates:	Instruction Updates:
<ul style="list-style-type: none"> - Reduced total number of credits offered by university - Eliminated most courses with theoretical based content - Combined courses deemed as over-specialization at the undergraduate level 	<ul style="list-style-type: none"> - <i>Zamo Enterprise</i>: learning-by-doing activities simulate real-world production. - Group learning, active learning, student-centered learning - Specialized, non-academic staff oversee content activities, professors provide support
Year 1-2:	Student apprentices: productive work & administrative tasks
Year 3:	Students in different career paths return to <i>Zamo Enterprises</i> to carry out independent projects, begin thesis work.
Year 4:	Students who return to <i>Zamo Enterprises</i> act as innovators and assistants to the administrators. Students may also participate in off-campus in-service training.
Source: (Maguire & Atchoarena, 2003).	

AET- Smallholder Farmer Disconnect

Additionally, AET graduates are inadequately prepared to work with smallholder farmers as extension/advisory agents (Davis et al., 2007). Largely, AET graduates have little understanding of adult education strategies and the knowledge and skills already possessed by smallholders (Rivera, 1998). Gender dynamics exacerbate these limitations as globally, and in Africa in particular, at least half of all smallholder farmers are women while a majority of extension agents are men. For example, the Galmiche-Tejjeda and Townsend (2006) study on gender and fish farming in rural Mexico found that agricultural extension agents were ill equipped to address the specific gender roles associated with fish farming. Moreover, the program design lacked analysis of rural household generative norms for both men and women, which limited their involvement in farming activities (Galmiche-Tejjeda & Townsend, 2006). Therefore, AET graduates (extension agents) must be trained to work with rural women and to design agricultural programs within the context of these gender roles in order to effectively provide services for smallholders in developing countries (FAO, 2015).

The rising complexity of agricultural value chains and farming systems has increased the technical and managerial needs of farmers and the corresponding demands of extension advisory services (Rivera & Alex, 2008). In order to offset rising costs of agricultural inputs, extension personnel must expand training repertoire to include post-harvest and value-added activities that facilitate improved food security and livelihoods of rural farmers (Hakutangwi, Makina, & Taruvinga, 2014). However, findings from Ethiopia demonstrated that district-level agents did not receive adequate training to assist smallholders in organizing producer groups or to assist with market linkages (Davis et al., 2007).

Magistro et al. (2007) identified three relative advantages for smallholders to maintain or develop local market access through small-plot production of high-value crops: (a) proximity, (b) price, and (c) quality.

- *Proximity advantage*: Familiarity with local food crop preferences and shorter distance from markets affords fresher produce and reduced transportation costs;
- *Price advantage*: Willingness to reduce labor compensation combined with access and use of family labor permits smallholders to sell commodities at lower price to consumers compared to larger commercial firms;
- *Quality advantage*: Residing near production enables greater oversight and care of high-quality commodities (Magistro et al., 2007).

Smallholder advantage only exists if there is public investment to develop infrastructure, create markets, and provide access to affordable inputs and technology including extension services. Realizing the *quality advantage* is dependent on access to training in market requisites (Magistro et al., 2007).

AET systems must adequately prepare extension agents to engage smallholders in achieving these advantages through expanded curriculum to include topics pertinent to smallholders such as appropriate technology, value-added processing, pricing and marketing, financial management, and entrepreneurship which graduates in turn are equipped to apply in the field (Magistro et al., 2007).

Box 5 Community-Based Research, Chiang Mai University, Thailand	
<p>Background: Students and faculty in the Department of Agriculture Extension in the Faculty of Agriculture at Chiang Mai University were unprepared to work in rural areas. Students and faculty were unfamiliar with rural living conditions, technical agricultural challenges, and social issues. Undergraduate students had limited ability to analyze and synthesize information or conduct community-based research, and had poor facilitation, communication, and writing skills.</p>	
<p>Key question: “How can research findings be used by local people – the users of research results?”</p>	
<p>Community-Based Research Program (CBR)</p>	
Goals:	<ul style="list-style-type: none"> - Integrate teaching and learning, research, and community service - Create a learning community of undergraduate students based on CBR projects.
Approach:	<p>Empowerment, People-centered</p> <ul style="list-style-type: none"> - Identify problems and research questions in participatory manner with local residents - Involve local people as researchers
Extension Communications Students:	<ul style="list-style-type: none"> - Visit active CBR projects, write article on observations and village issues; - Produce script for broadcast over community radio - Submit article to local newspaper
Extension Media Production Students:	<ul style="list-style-type: none"> - Develop media products that reflect needs of community researchers (i.e. newsletters, DVDs, radio programs)
Graduate Students:	<ul style="list-style-type: none"> - Visit and participate in CBR projects, write review of visits - Materials produced combined with experiences in communities form the basis of thesis topics.
<p>Impact</p> <ul style="list-style-type: none"> - Established links and collaboration with rural communities; - Demonstrated isolation of university from life in rural communities; - Curriculum updated to reflect the knowledge and skills needed by graduates who will meet technical and social needs in rural areas. 	
<p>Source: World Bank, (2012).</p>	

Ofir, Swanepoel, and Stroebel (2014) assert that modernized AET systems should have a positive and direct effect on smallholder farmers. Specifically, AET should bolster smallholder capacity by providing

access to information, tools, and resources to problem-solve at the farm level. Moreover, AET must adapt technological innovations to the smallholder context and facilitate upstream and downstream market linkages in order to improve livelihoods in the long term (2014).

A Way Forward

Agricultural education and training systems have come up short in producing workforce-ready graduates. Broadly, AET curricula is mismatched to the needs of both modern industry employers and those of rural farmers. Curricula and pedagogical updates are necessary for AET systems to produce graduates with the knowledge, skills, and attitudes that enable sustainable food security, improve livelihoods, and facilitate natural resource conservation. At the tertiary level, heterogeneity of AET systems suggests that necessary reforms will vary depending on policy structures, labor market assessments and stakeholder needs, and the degree to which AET curricula is mismatched (USAID, 2011).

Subsequently, AET reform may occur through several avenues: (a) system wide restructuring; (b) curriculum and instruction; or (c) targeted programmatic reform (World Bank, 2012). These reforms may be undertaken at the institutional level, either through coordinated involvement of stakeholders, or through faculty-led initiatives linked to rural communities (2012) (Box 5). Previous research established investment priorities for tertiary-level AET reforms that are applicable across the diversity of contexts in which AET operates:

- *Develop or update policies;*
- *Pursue an agenda of agreed, specific reforms within agricultural universities, faculties of agriculture, and agricultural colleges;*
- *Institutionalize reforms;*
- *Attain accreditation;*
- *Base curriculum reform on consultation with stakeholders; and*
- *Link curriculum reform closely to pedagogical reform (World Bank, 2012).*

Curriculum and pedagogical reform in Upper Egypt provides a model for AET updates (Barrick, Samy, Gunderson, & Thoron, 2009). A skills gap analysis revealed academic programs were mismatched to employer needs (Vreyens & Shaker, 2005). Based on these findings, a three-step process for updating AET curriculum was undertaken in five agricultural universities: (1) faculty trained in active teaching and learning methods; (2) updates to content and materials of core courses; and (3) established private sector linkages, extension-outreach centers, and career research centers. Maguire (2012) explained the complexity of curriculum reform and the importance of having stakeholder cooperation, noting, “revised or updated curriculum without improved teaching materials and appropriate pedagogical skills is unlikely to have much impact. The benefits of a revised curriculum will not be sustained unless the

curriculum keeps pace with stakeholder’s evolving needs” (World Bank, 2012). Midterm evaluation of the curriculum reforms demonstrated high acceptance rates of faculty for active teaching methods, content and materials enrichment, and positive reviews of increased cooperation with the private sector (World Bank, 2012).

Therefore, collaboration amongst AET providers, the private sector, and research institutions is key to modernizing higher AET curriculum in order to meet the agricultural development needs of smallholder farmers while endowing students with the business acumen and entrepreneurial skills to operate and innovate in a globalized marketplace. *Centers of excellence* or regional specialty hubs are advocated throughout the literature as a mechanism to improve the quality of AET graduates and future faculty through investment in postgraduate programs that capitalize on existing institutional training or research strengths (di Gropello et al., 2011a; USAID, 2011; World Bank, 2007).

Regional networks of such centers provide a channel for AET systems to address two important issues in agricultural development. First, networks of regional hubs are able to address common problems of food security and rural livelihood needs while providing AET graduates with contextually relevant knowledge and skills to meet the needs of the local communities where graduates will work (World Bank, 2012). Second, specialized training of postgraduate students fulfills the supply side of industry demand for highly qualified personnel necessary to eliminate bottlenecks in the middle and high parts of agricultural value chains (Fernandez-stark et al., 2012). Successful collaborations such as the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) program, and the more recent Universities, Business, and Research in Agricultural Innovation (UNIBRAIN) initiative provide promising models and lessons learned. Replicating or bringing such collaborations to economies of scale creates a pathway to develop effective and sustainable agricultural education and training systems that build human resource capacity, meet agricultural industry needs, and improve the food security and rural livelihoods of marginalized groups.

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Appendix A

I. Agribusiness programs in Sub-Saharan Africa

Program		Institution	Country
BSc	Agricultural Economics and Agribusiness	University of Ghana	Ghana
BSc	Agribusiness Management	Egerton University	Kenya
BSc	Agribusiness Economics and Food Industry Management	Jomo Kenyatta University of Agriculture and Technology	Kenya
BSc	Agribusiness Management and Enterprise Development	Jomo Kenyatta University of Agriculture and Technology	Kenya
BSc	Agribusiness Management	University of Malawi	
BCom	Agribusiness Management	University of Pretoria	South Africa
BSc	Agricultural Economics: Agribusiness Management	University of Pretoria	South Africa
Bachelor	Agribusiness Management (AgricAdmin)	University of Stellenbosch	South Africa
BSc	Agricultural Economics and Agribusiness Management	University of Swaziland	Swaziland
BSc	Agricultural Economics and Agribusiness	Sokoine University of Agriculture	Tanzania
Bachelor	Agribusiness Management	Makerere University	Uganda
BSc	Agriculture and Natural Resources (Agribusiness)	Africa University	Zimbabwe
Diploma	Agribusiness Management	Bukura Agricultural College	Kenya
Postgraduate Diploma	Agribusiness Management	Busoga University	Uganda
	Agribusiness Management	Co-operative College	Zambia
	Cooperative Development and Agribusiness	Co-operative College	Zambia
MSc	Collaborative Master Programme in Agriculture and Applied Economics	Egerton University	Kenya
MSc	Agribusiness Management	University of Malawi	Malawi
Master	Agribusiness Management	Makerere University	Uganda
PhD	Agricultural Economics and Agribusiness	University of Ghana	Ghana
PhD	Agriculture and Applied Economics	University of Malawi	Malawi
Source: Mabaya, Christy, & Bandama (2014).			

II. Factors Impacting Higher Agricultural Education Quality and Relevance

Problem Areas	External Factors	Internal Factors
Weak national support	Decline in political influence of rural area	Failure to make HAE case to and for policy-makers
Decreased investment by government and donors	Absence of national HAE policy and shift in donor focus to other development priorities	Inadequate lobbying by HAE leadership and fragmentation of AET system
Declining standards in teaching, research, infrastructure, and staff incentives	Low level of financial support from government and political pressure to accept increased numbers of students	
Isolation of HAE from other higher education system	Remote location of HAE institution	Failure of HAE administration to adjust to multidisciplinary needs of changing agricultural sector and form linkages outside of HAE
'Inbreeding' in staff appointments	Absence of recruitment standards or failure to enforce standards by ministries and public service commissions	Closed nature of HAE communities
Employer dissatisfaction with degree holder's knowledge and skills / High graduate unemployment	Reduction in public sector hiring	Failure of HAE to undertake market analysis. Inadequate connections with potential employers and education stakeholders
Low level of information technology	Inadequate funding	Lack of IT skills in leadership teams

Source: (D. Atchoarena, Wallace, Green, & Gomes, 2003).

III. Main elements of investment in direct or indirect curriculum reform

Elements of investment in Direct Curriculum Reform	Elements of investment in Indirect Curriculum reform through community outreach
- Facilitate dialog between main stakeholders to reach agreement on the need for and scope of the intended reforms;	- Facilitate dialog between main stakeholders to agree on need for university-community cooperation and the operational approach;
- Assign responsibility for each reform step and activity;	- Establish details of program, goals and responsibilities of both sides;
- Identify gaps between stakeholder expectations and the quality of graduates from academic entity;	- Arrange for university staff and students to visit and reside in communities;
- Conduct skills gap analysis to determine necessary curriculum changes;	- Adjust curricula to incorporate community involvement into academic program;
- Review and update curriculum, using external experts if needed;	- Facilitate staff and student experiences and observations in communities;
- Package revised curricular materials to suit a variety of learning styles;	- Translate above activities into processes for developing technical and social solutions;
- Pedagogical upgrades for teaching/facilitating staff;	- Organize meetings with communities to report results of collaboration;
- Designing a monitoring and evaluation instrument (M&E) and implementing M&E;	- Accommodate feedback from partnership into adjusted curriculum;
- Adjusting or revising curricula, based on M&E results and user feedback.	- Funding logistical arrangements for students and faculty involvement in community links.

Source: World Bank (2012).