THE WORLD BANK

Cultivating Knowledge and Skills to Grow African Agriculture

A Synthesis of an Institutional, Regional, and International Review







REPORT NO. 40997-AFR

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THE WORLD BANK
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Cover design by Bill Pragluski of Critical Stages

Copyediting and Typesetting by ICC Macmillan Inc.

Cover photos clockwise from top left: Curt Carnemark, Kenya; Jonathan Agwe, Faculty of Agriculture and Soil Sciences, Dschang University, Cameroon; Men in field, Curt Carnemark, Kenya; Woman in lab with flowers, University of Swaziland Publications Office (appeared on UNISWA's 2007 calendar); Cattle in a corral, Francois Le Gall, Central African Republic; Two women in a science laboratory of the Faculty of Agriculture, University of Swaziland Publications Office; Eric Miller, Machava ADPP Teachers Training College, Mozambique.

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Acronyms

ACCI	African Center for Crop Improvement (University of KwaZulu-Natal)
ACTAEPA	African Consortium for Training in Applied Economics and Policy Analysis
AERC	African Economic Research Consortium
AET	Agricultural education and training
AGORA	Access to Global On-line Research for Agriculture
AIS	Agricultural Innovation System
AKIS	Agricultural knowledge and information system
ANAFE	African Network for Agricultural and Forestry Education
ATVET	Agricultural, Technical Vocational Education and Training (Ethiopia)
BASIC	Building Africa's Scientific and Institutional Capacity in Agriculture
CAADP	Comprehensive African Agriculture Development Plan
CGIAR	Consultative Group on International Agricultural Research
CMAAE	Collaborative MSc Program in Agricultural and Applied Economics
DFID	Department for International Development (United Kingdom)
EASTA	École d'Application des Sciences et Techniques Agricoles, Madagascar
ECOWAS	Economic Community of West African States
EMBRAPA	Brazilian Agricultural Research Organization
FAAP	Framework for African Agricultural Productivity
FAO	Food and Agriculture Organization
FARA	Forum for Agricultural Research in Africa
FASA	Faculty of Agronomy and Agricultural Sciences, Cameroon
GDP	Gross domestic product
GO-FAU	Global Open Agricultural and Food University (CGIAR)
IAC	InterAcademy Council
ICIPE	International Center of Insect Physiology and Ecology
ICRAF	International Center for Research in Agroforestry
ICT	Information and communications technology
IDA	International Development Association
IFPRI	International Food Policy Research Institute
ILO	International Labor Organization
IRR	Internal rate of return

MAPP	Multi-Country Agricultural Productivity Program (NEPAD)
MSc	Master of Science
NARS	National agricultural research systems
NEPAD	New Partnership for Africa's Development
NGO	Non-government organization
ODA	Overseas development assistance
OECD	Organization for Economic Cooperation and Development
PhD	Doctor of Philosophy
PSRP	Poverty Reduction Strategy Program
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture
SACCAR	Southern African Center for Cooperation in Agricultural and Natural Resources Research and Training
SAFE	Sasakawa Africa Fund for Extension Education
SAU	State Agricultural University (India)
SEMCIT	Sustainability, Education and the Management of Change in the Tropics
SSA	Sub-Saharan Africa
TEEAL	The Essential Electronic Agricultural Library
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
USHEPiA	University Science, Humanities and Engineering Partnerships in Africa

Foreword

For more than a decade, formal agricultural education and training (AET) has been largely abandoned by governments and donors in Africa. This might seem surprising in view of the agricultural sector's sizable contributions to GDP, employment, and exports in Sub-Saharan Africa. Multiple factors have combined to bring AET into its present orphaned state. Among them are: a belief that the battle for food supply had been won with the Green Revolution of the 1980s; doubts regarding the efficacy of publicly provided technical and vocational education and training (of which AET is a part) contained in the World Bank's 1991 policy paper on this topic; the growing concentration of donor and government effort on the universal provision of basic education; and the high priority placed on poverty reduction contained in the Millennium Development Goals.

But the "lean years" for agriculture in Africa may now be a thing of the past. Several recent international initiatives have brought both agriculture and technically focused education back into the work plans and budgets of African governments and development assistance agencies alike. First, the African Union and the New Partnership for African Development issued on behalf of African governments its *Comprehensive Africa Agriculture Development Program* in 2002 that proposed strategies to boost agricultural output on the continent by 6 percent a year over the next 20 years. Second, the international Commission for Africa, chaired by then British Prime Minister Tony Blair, argued in March 2005 for greater attention to boosting economic growth in Africa and recommended higher investments in human resource capacities linked to agriculture, science and technology, and tertiary education. Shortly thereafter, participants at the G-8 meeting convened in Gleneagles, Scotland affirmed this report and committed their governments to provide significant additional funding in support of its objectives. Third, the World Bank reinforced these two initiatives in its multisectoral *Africa Action Plan* of August 2005, which sees agriculture as the driver of regional economic growth and pursues this end through selected outcome-based actions. Then, in June 2006, the African Union delivered a *Framework for African Agricultural Productivity* that outlined a common implementation plan for governments and donors alike.

The Bank's Africa Action Plan quickly generated results, as World Bank investments in Africa's agricultural sector doubled in 2006 and remained strong in 2007. Other donors have responded similarly. Notably, African governments have committed themselves to investing 10 percent of GDP into their agricultural sectors by 2010. Human resource development features prominently in all of these initiatives, with agricultural education and training a potential beneficiary from this. Yet following so many years of neglect, priorities for interventions in the AET subsector are not at all clear. Thus, the Bank's Human Development Department for Africa initiated a major research undertaking in 2005 designed to address the question of what should be done for agricultural education and how to do it. The findings of this effort are contained in this report.

Agricultural education is a multisectoral issue that does not fall neatly into either the education or the agricultural sector. As a result, it may often "fall through the cracks" between the mainline sector programs. Multisector teams and cross-sector collaboration are therefore necessary to ensure balanced attention to both the human development and agricultural knowledge aspects of AET. This is the approach that characterized this study, and we would like to recognize the collegial interaction and the institutional cooperation that have produced this joint publication.

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Acknowledgments

This report is the product of collaboration across continents, institutions, and disciplines. Much of its substance and detail were contributed by the wonderful group of African and international researchers who are recognized in the Principal Research Works listed at the end of this book. Their commitment and professionalism generated the empirical foundation upon which this analysis is erected.

The synthesized report presented here was written jointly by Richard K. Johanson, an international specialist on education and training, and by William Saint, a former Lead Education Specialist (Higher Education) in the Africa Region of the World Bank.

The research project that produced this report is the fruit of uncommon collaboration among three World Bank units: the Human Development Department of the Africa Region, the Agriculture and Rural Development Department, and the Environmentally and Socially Sustainable Development Department of the Africa Region. Each department contributed technical expertise and financial resources to this investigation. Individual staff, especially Eija Pehu, Riikka Rajalahti, and Jonathan Agwe of ARD, as well as David Nielson of ESSD, functioned as a de facto advisory team to AFTHD throughout the two-year undertaking.

Helpful guidance was contributed at the study conceptualization stage by external advisers Carl Eicher, John Lynam, and Arvil Van Adams, and by World Bank reviewers Derek Byerlee and Jean Delion. Additional advice was gratefully received from members of the Working Group for International Coordination in Skills Development during their annual meeting at the Food and Agriculture Organization (FAO) in November 2005.

Valuable critiques of early drafts of the report were provided by Malcolm Blackie and John Lynam, who served as external reviewers, and by Bank colleagues Jonathan Agwe, Stephen Mink, David Nielson, Eija Pehu, and Riikka Rajalahti. Professional associates Nienke Beintema and David Spielman of the International Food Policy Research Institute and Tom Vandenbosch of the World Agroforestry Centre generously reviewed and commented upon a previous draft.

Heartfelt gratitude is expressed to Carl Eicher for unflagging interest, support, and counsel, which far surpassed his formal contractual obligations to this project.

A special note of thanks is extended to Monty Jones and Ralph von Kaufmann of the Forum for Agricultural Research in Africa (FARA), and to Adipala Ekwamu of the Regional Universities Forum for Capacity Building in Agriculture (RUForum), for their advice and feedback throughout the research process, and for their kind invitations to the Bank research team to present and discuss its initial findings at the respective FARA and RUForum regional conferences in 2007.

The visionary role of Arvil Van Adams, who initiated this study, and the managerial expertise of Peter Materu, who oversaw the report's completion during the final months of preparation, are acknowledged with appreciation.

The entire research team recognizes Lisa Li Xi Lau for her careful management of the logistics and production of the report.

Without financial support from the Norwegian Education Trust Fund, which underwrote many of the research expenses, this study could not have been carried out. A financial contribution from the Department for International Development in the United Kingdom enabled an analysis of secondary level agricultural education and training to be included in this research.

Executive Summary

THE CONTEXT FOR AGRICULTURAL EDUCATION AND TRAINING IN AFRICA

Until it learns to grow its agriculture, Africa is unlikely to register significant developmental advances. Recognizing this reality, African governments adopted in 2002 a *Comprehensive Africa Agriculture Development Program* under the auspices of their New Partnership for African Development (NEPAD). This Program states that larger investments in agricultural research, extension, and education systems are required to achieve the targeted increase in agricultural output of 6 percent a year over the next 20 years. In 2006 NEPAD issued a *Framework for African Agricultural Productivity* (FAAP) as a guideline to member states for attaining this production goal. These and other recent continental initiatives frequently recognize the general importance of agricultural education and training (AET), but they offer little specificity on what should be done or how to do it. The analysis contained in this report aims to fill this void.

To this end, the World Bank initiated a series of studies on AET in 2005. These comprised six thematic studies that in turn drew on analyses of 15 country cases, a survey of donor financing trends, an operational review of Bank investments, a survey of the literature, an annotated bibliography, and consultations with stakeholders and donors. The purpose of this report is to synthesize the findings of this research and propose a set of strategic measures for strengthening the contribution of AET to agricultural productivity in Sub-Saharan Africa. The target audiences are African practitioners and policymakers concerned with boosting food supply and agricultural output, donor representatives, and World Bank staff. This report presents a case for increased investment in AET, analyzes issues in the subsector, and outlines possible options for policies and interventions to build skills and capacities appropriate for the changing circumstances of African agriculture in the 21st century.

Lessons emerging from recent agricultural reform experiences demonstrate that a more nuanced understanding is needed of AET's role in promoting innovation, productivity gains, and growth in agriculture. Insight is specifically needed about how to bring AET into closer, more productive relationships with other actors in the agricultural sector and wider economy, thereby sharing in the comparative advantages of different actors and institutions to reduce transaction costs, achieve economies of scale, exploit complementarities, and

realize synergies in innovation. An analytical approach guided by an agricultural innovation systems (AIS) framework has therefore been adopted here in the belief that it contributes fresh perspectives to addressing this need.

In essence, an agricultural innovation system is a blending of institutional capacities, coordination mechanisms, communication networks, and policy incentives that fosters innovation-led gains in agricultural productivity. It emphasizes the need to understand key actors and their roles, their behaviors and practices, and the institutional context within which they interact, all of which are key conceptual elements in innovation systems analysis (World Bank 2006a).[1] This in turn points to issues of institutional structures of governance and management (for greater flexibility and responsiveness), criteria and incentives for professional performance (for improved productivity), access to information and inter-institutional communication networks (for enhanced competitiveness). All of these issues are relevant to African education and training institutions.

AGRICULTURAL EDUCATION IS VITAL FOR AFRICAN DEVELOPMENT

Agriculture continues to be Sub-Saharan Africa's dominant economic activity, accounting for 40 percent of GDP, 15 percent of exports, and 60 to 80 percent of employment. Higher agricultural productivity is a precondition for growth and development in most African countries, and increasing yields is the key to raising incomes in rural areas. Farmers and commercial producers may benefit especially if they can diversify their production into higher-value, but knowledge-demanding, specialized crops. Strong agricultural education and training systems are necessary to underpin such productivity gains. AET directly raises agricultural productivity by developing producer capacities and indirectly increases agricultural productivity by generating human capital for support services. Investments in AET clearly enable research, extension, and commercial agriculture to generate higher payoffs. As stated by NEPAD, "The quality of tertiary agricultural education is critical because it determines the expertise and competencies of scientists, professionals, technicians, teachers, and civil service and business leaders in all aspects of agriculture and related industries." Higher agricultural education also contributes directly to research and advisory services. Finally, the case for improving AET systems is compelling in view of their seminal role in agricultural development elsewhere in the world. AET development was an integral part of strategies of countries that grew agriculture successfully such as Brazil, India, and Malaysia.

AFRICAN AGRICULTURAL EDUCATION AND TRAINING IN PERSPECTIVE

Post-secondary AET was established in Africa as far back as 1924. An essentially bifurcated system of agricultural education emerged from the colonial period, in which post-primary vocational education was targeted at the sons of traditional farmers, and post-secondary agricultural education was designed to lead the sons of the middle class into public employment. This dual legacy, and the separate expectations associated with each branch of it, has hindered the development of agricultural education in Africa up to the present.

Extensive institutional infrastructure for agricultural education and training has been put in place since the 1960s. Africa now has roughly 200 public universities (compared with 20 in 1960) and about a hundred of them teach agriculture and natural resources management. In addition, private universities are beginning to complement these capacities with their own offerings.

The initial institution-building achievements of the 1970s and 1980s have given way to neglect since the 1990s. Donor assistance to African agriculture has declined sharply and, within that total, support for agricultural education and training in Africa has largely disappeared. Assistance for *formal* AET declined to just 0.7 percent of agricultural sector aid between 2000 and 2004. Government funding has tended to follow donor priorities. The ultimate cost of the government and donor pullback from AET has been to distance African professionals from knowledge networks, global information resources, and the cutting edge of technology transfer. This has left a severely depleted human resource pool in African agriculture.

However, underfinancing of Africa's agriculture sector appears poised to change. Recent signs may signal an encouraging turnaround in donor

assistance to agriculture and to agriculture training, including the Commission for Africa Report, *Our Common Interest*, several donor initiatives focusing on skills development for agriculture, the 2003 Maputo Declaration by NEPAD, and the Framework for African Agricultural Productivity issued by NEPAD and the African Union in 2006. If additional investment in agriculture education and training materializes, the key question is *How should these additional funds be used?*

CONSTRAINTS ON BUILDING AET CAPACITY

AET supply is often out of synch with labor market demands in terms of knowledge and practical competencies, especially agribusiness, basic management, and problem solving. AET is not realizing its potential contribution to agricultural development because of poor linkages with research and isolation from knowledge sources. External problems, such as fragmented organizational responsibilities for AET, and internal problems in terms of underfunding, unattractive working conditions, and consequent staff depletion contribute to AET underachievement.

More specifically, (1) *AET enrollment profiles are distorted and declining.* Africa's technical education enrollment pyramid falls short at the upper levels, especially postgraduate enrollments. Enrollment patterns are distorted by gender, with females receiving far fewer opportunities than indicated by their important role in agricultural production. Student interest in AET is waning, in large measure because it was directed almost exclusively to government employment that is now dwindling. Agriculture enrollments show declining shares at all post-secondary levels. (2) *AET institutions tend to be isolated and fragmented.* AET systems lack strategic alignment to national development priorities. AET systems suffer from weak linkages with stakeholders, employers, and the productive sector and therefore make less than their expected contribution to national agricultural innovation systems. They are also poorly connected to international sources of knowledge. Their isolation often results from overcentralized or divided administration. (3) *AET curricula tend to be obsolete and disassociated from the economy.* Curricula are often outdated and focus narrowly on farm production rather than encompassing markets, agribusiness, and processing. (4) *Numerous countries face crises in AET staffing.* Staff shortages are common due to brain drain, a rising tide of retirements, and the attrition of HIV/AIDS. High levels of staff turnover due to unattractive working conditions can be a serious issue. Rapid enrollment expansion and the consequent need to hire many junior staff have left staff qualifications weak at many AET institutions. (5) *Teaching methods and facilities are often inadequate.* Teaching methods are overwhelmingly traditional in their heavy use of classroom lectures. Practical instruction receives insufficient emphasis, and students have little opportunity to develop technical competencies, problem-solving experience, or communication and organizational skills. Learning infrastructure is widely deficient due to insufficient budgets and overdependence on public financing.

African universities ultimately will be responsible for replenishing the stock of human capital in their research and extension services, and for providing them with the broader set of skills necessary to grow agriculture in the 21st century. However, they are ill-prepared at present to train the continent's next generation of agricultural scientists, professionals, and technicians. As stated by NEPAD in the *Framework for African Agricultural Productivity*: "... Urgent action must be taken to restore the quality of graduate and postgraduate agricultural education in Africa."

WHAT GUIDANCE CAN GLOBAL EXPERIENCE PROVIDE?

Global experience shows it is possible to build productive and financially sustainable AET and research systems. Developing countries such as India, Malaysia, Brazil, Chile, and the Philippines have achieved notable successes in establishing productive AET systems. A review of these and other experiences points to the importance of six factors: (1) Mobilizing and sustaining political support for AET investments is simultaneously the most important and most difficult issue to address in designing and financing a system of agricultural development institutions. (2) Public investment in capacity building has been essential for creating the scientific leadership necessary to implement each country's strategy for agricultural development. (3) Building a system of core AET institutions is a process of capacity accumulation that takes sustained commitment over multiple generations

to produce returns. (4) The administrative separation of research and higher education in many African countries cripples the development of national agricultural innovation systems. (5) Massive campaigns to develop human capital have worked in other countries. (6) Finally, incentives are necessary to retain staff once they are developed.

PRIORITIES FOR MODERNIZING AGRICULTURAL EDUCATION

Seven priorities are proposed for those who seek to modernize agricultural education in Africa. *First*, political will must be generated in support of agricultural development by educating the public about its role in economic growth and poverty reduction, creating capacities for lobbying, joining forces with other stakeholders, and sustaining these efforts over two or three decades. *Second*, AET institutions should be integrated into the national agricultural innovation system by establishing better institutional and market linkages. Associated AET reforms ought to be grounded in an analysis of agricultural priorities and market requirements, and to recognize that changes in organization and management can provide opportunities and incentives for productive external linkages. Access to international knowledge sources is becoming increasingly easy, but it often requires external assistance. *Third*, it is desirable to assess and rebalance AET enrollment profiles away from secondary level vocational training and towards diploma, degree, and postgraduate levels. *Fourth*, curricula and pedagogy should be modernized by emphasizing analytical skills, problem solving, agribusiness processes, post-harvest technologies, and "soft" but essential skills such as communication and teamwork. Student interest in agriculture could be sparked by recasting programs in more modern and appealing terms, such as applied sciences and technology, and by educating the public on the full range of agricultural career possibilities. *Fifth*, it is essential to replenish human capital by strengthening and expanding national MSc programs, laying the foundation for PhD programs, and tackling the conundrum of incentives for staff retention. *Sixth*, finances must be managed proactively by making more efficient use of existing resources, mobilizing nonpublic resources, and persuading donors to finance operating costs. *Seventh*, much better gender balance must be achieved among AET graduates.

APPROACHES VARY BY AET LEVEL

What can be done at the various levels to build momentum in the face of existing constraints? Different strategies will need to be pursued at each level of agricultural education and training.

In *secondary-level AET,* efforts might best focus on preventing premature specialization, especially in lower secondary education, where a solid basic education remains the most important goal. Upper secondary technical programs are most effective when they emphasize the acquisition of specific competencies for properly selected trainees, and least effective when they serve as an alternative pathway to university admission. Greater flexibility in the length of courses would also enable secondary-level AET to meet the training needs of a wider range of potential students.

In *tertiary-level AET,* reforms in curricula and teaching methods are likely to be the most immediately useful undertakings. In the medium term, modification of institutional governance structures so as to introduce greater institutional flexibility and increased responsiveness to stakeholders would be a valuable complement. At the system level, a review—and if necessary, a rebalancing—of agriculture enrollments among degree, diploma, and certificate levels could ensure that adequate numbers of competent higher-level technicians are available to meet the increasingly complex demands of the labor market. Clearly, conscious efforts to recruit more women students are needed in order to maintain quality within the technical and professional skills pool while ensuring that it possesses the capacity necessary to work with the large numbers of female farmers and traders found in the agricultural sector. Finally, harnessing the potential for agricultural distance education and online provision of technical training will enable lifelong learning to emerge as a way of maintaining workforce competitiveness.

At the *postgraduate level,* circumstances call for MSc degree programs within Africa to be strengthened in quality and expanded in numbers, enrollments, and gender balance. This is becoming urgent in order to address local staffing shortages and give impetus to local research. Collaborative regional MSc programs offer cost-effective ways to build professional capacities in a range of important specialized areas but are only likely to develop through sustained financial commitments by donor consortia. Looking ahead, aggressive efforts

in staff development at the PhD level will be necessary to lay the foundation for an expanded number of local PhD programs. In doing so, it should be recognized that training outside the region will continue to be needed because of limited regional capacities in doctoral-level training, especially in new scientific areas. Different modes, such as sandwich training or use of third-country universities, could help to keep costs in check and minimize brain drain.

THE TIME TO ACT IS NOW

Agricultural education and training (AET) is a vital, but much-neglected, component of agricultural development in Africa. Continuing neglect of AET risks limiting agricultural recovery and restricting the possibilities for economic growth and poverty reduction. Consequently, countries in Sub-Saharan Africa are encouraged to address the shortcomings of current approaches to human capital formation in agriculture by training a new generation of agricultural professionals with different skill sets. This goal is not amenable to a quick fix. Long-term, patient support over 20 years or more will be needed from government, AET institutions, and development partners in order to attain this objective.

In the short term, representative actors of the national agricultural innovation system (i.e., government officials from agricultural research and extension, science and technology, and export promotion; private sector entrepreneurs; NGO rural advisory staff; AET institutional leaders; farmers' organizations) might usefully be convened for a collective exercise in national priority setting. As a basis for discussion, the following six short-term measures are proposed for consideration: (1) Create networks and associations that can champion the cause of agriculture, and learn lobbying techniques to generate supportive political will; (2) Modernize curricula and teaching methods at the tertiary level, along with the necessary teaching inputs; (3) Improve institutional linkages (e.g., strategic partnerships, professional networks, collaboration incentives) and knowledge access (e.g., TEEAL, AGORA, computers); (4) Persuade development partners to fund essential operational and equipment maintenance costs; (5) Conduct labor market studies and establish a labor market monitoring capacity; and (6) Work to make the agricultural professions attractive employment and career options, while recruiting many more women into this field.

In the long term, beneficial actions would include: (1) Rebalancing AET enrollments away from secondary AET programs in favor of tertiary-level diploma, degree, and postgraduate programs; (2) Strengthening and expanding a selected number of MSc programs in areas of strategic importance to the nation, including associated staff development, so that all major MSc programs for agriculture are available in Sub-Saharan Africa within 10 years; (3) Broadening the foundation for regional PhD programs by launching a major program of postgraduate fellowships to train 1,000 PhDs, initially abroad and eventually at home, over the next 15 years.

National political leaders could usefully consider the following actions to strengthen capacities for skills development in support of agricultural growth: (1) A renewed and sustained political commitment by African governments to building human capital in agriculture; (2) Devolving greater authority to AET institutions while strengthening the relevance of their programs by increasing stakeholder participation in institutional governance; (3) Avoiding proliferation, or atomization, of AET institutions and programs, which dilutes resources and drives down quality. To that end, AET institutions might be integrated beneficially under a single governmental authority, which could allocate public financing to institutions on the basis of their strategic goals and performance in achieving them rather than by following historical precedent or principles of equitable sharing; (4) Increased female enrollment in AET institutions could be attained through enrollment quotas, earmarked scholarships, professional mentoring, and appropriate facilities to accommodate women; (5) The attractiveness of agricultural careers could be boosted by advocating their importance for national development to the general public, by creating new career paths that open up a wider range of employment opportunities, and by stimulating student and parental interest in agriculture as a profession; (6) Governmental incentives and rewards for AET staff, together with diverse staff retention measures such as merit pay, transparent promotion procedures, and administrative streamlining, could be employed to attract better-quality students and facilitate their recruitment as future staff; (7) A portion of public agricultural research might productively be outsourced to tertiary AET

institutions, preferably through the mechanism of competitive research grants.

AET system and institutional managers could productively give thought to: (1) Creating fora among stakeholders for building institutional linkages, fostering information networks, and setting priorities in AET vis-à-vis agriculture development plans; (2) Improving student selection procedures so that only those with a personal interest in agriculture are admitted to tertiary-level studies; (3) Consulting stakeholders, particularly private sector employers, on program definition and conducting periodic employer surveys and tracer studies to assess the effectiveness of AET programs; (4) Linking curricula to the market for graduates, in part by focusing on growth areas and niches in commercial agriculture; (5) Introducing, where possible, interdisciplinary programs at the undergraduate level, e.g., natural resource management. Training must be practical, require contact between students and a range of producers, and focus on solving actual production problems; (6) Budgeting for and providing periodic professional updating of staff; (7) Creating a conducive professional environment for retaining staff, including the definition of clear career ladders and streamlining administrative procedures to reduce inefficient use of staff time; (8) Mobilizing additional resources and using them for upgrading staff conditions and teaching and research.

Development partners could help to build on the numerous positive experiences that have been generated in AET by assisting in their replication across the continent. The resources of African countries alone are unlikely to be adequate for this task. Thus, development partners are encouraged to make long-term financing commitments to help interested governments replenish their human capital and strengthen the performance of their agriculture innovation systems. Development partner actions are recommended in seven priority areas: (1) The most immediate task is to rebuild the human capital base in agriculture—to increase the quality and number of high-level agricultural professionals by means of postgraduate fellowships in order to attain the goal of 1,000 new PhDs in agriculture within the next 15 years. This must be preceded by assessment of current supply capacity and the preparation of a feasibility study and detailed plan with interested governments and donors; (2) Support donor consortia for, say, a dozen specialized collaborative regional PhD programs; (3) Fund the operating and equipment maintenance costs that are essential for retaining skilled academic staff and enabling them to teach and conduct research productively; (4) Ensure gender rebalancing within the above staff development programs, and establish female scholarship programs at the secondary and undergraduate levels to attract more women into agricultural sciences; (5) Expand access to international sources of information by funding electronic innovations (e.g., TEEAL, AGORA, etc.) at key AET institutions, and by financing the facilities and equipment necessary for increased bandwidth and improved computer facilities and networks; (6) Finance competitive grant funds for tertiary institutions to undertake peer-reviewed research. A competitive fund for institutional development could also stimulate initiatives based on strategic plans generated by AET institutions and faculties; (7) Finance experimentation and capacity building in new modes of delivering agricultural education and training that make use of information and communication technologies, including online degrees and various types of distance learning.

1 The Context for Agricultural Education and Training in Africa

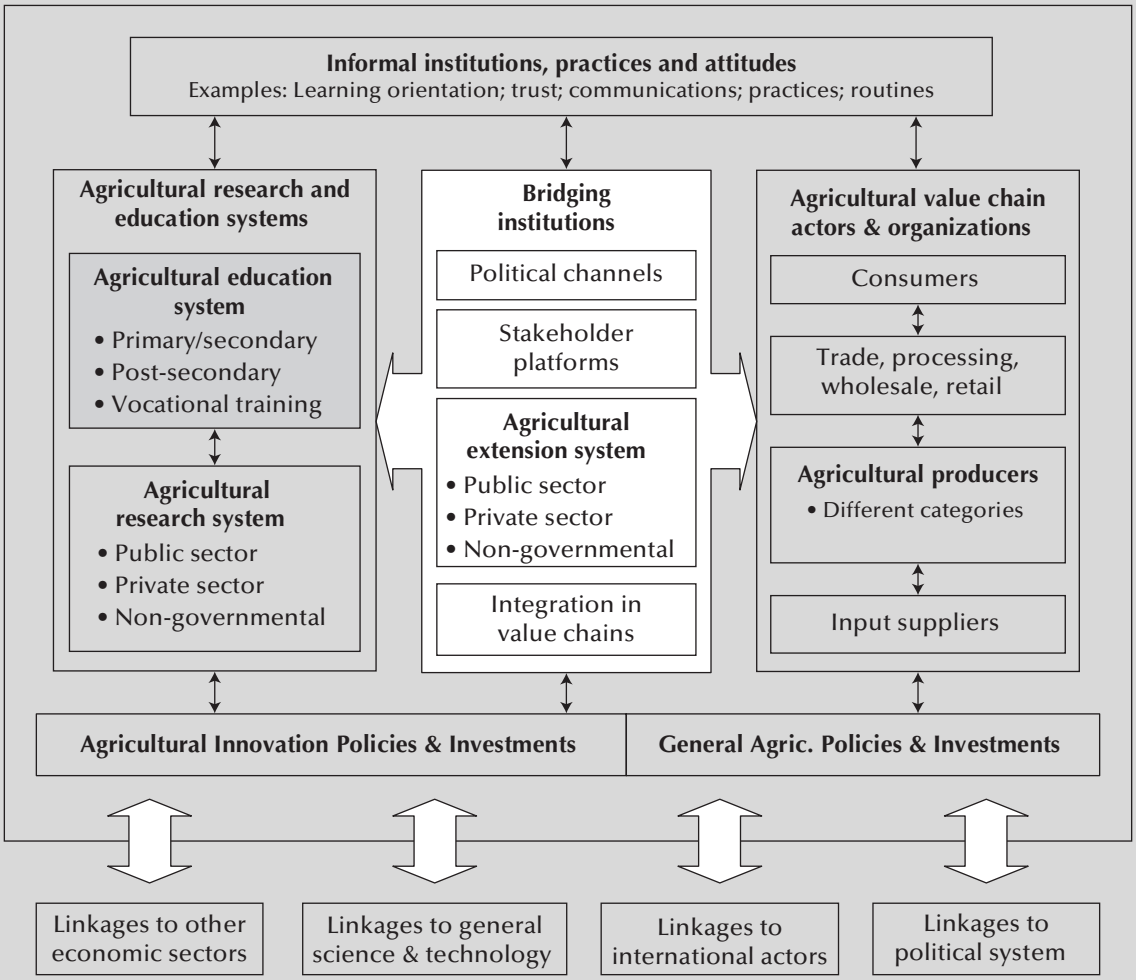
INTRODUCTION

To enable their agriculture to grow, developing nations now face the need to produce the additional knowledge and new skills. Human capital development through agricultural education and training (AET) is an essential component of all agricultural development strategies. When substantial changes take place in the context for agricultural development—such as are now occurring in Sub-Saharan Africa (SSA)—the agricultural education and training system must be adjusted accordingly. In a number of African countries, such adjustments are already underway.

What changes are prompting these adjustments? First, markets, rather than production, increasingly drive development. Second, knowledge, information, and technology are generated, disseminated, and applied more and more through the private sector; consequently, public research and extension programs no longer hold a monopoly on this process. Third, growth in information and communication technologies has greatly eased the process of accessing and applying agricultural knowledge developed in other continents, and in some cases transformed the structure of research and the interactions of research institutions. Fourth, competition and global markets often determine success or failure in local production as globalization makes economies more interdependent. As a result, the environment for the production, marketing, and consumption of agricultural products is growing more dynamic and unpredictable. Agricultural development in the 21st century, market-led and knowledge-intensive, thus places new demands on human capabilities in the agricultural sector. It requires agricultural technicians and professionals with different types of knowledge, skills, and mindsets—and educational institutions capable of producing them (World Bank 2006: xiii, 6).

Two important regional trends shape the larger context for such an undertaking and reinforce efforts to modernize agricultural education in Africa, particularly at the postsecondary level. The *first* is the growing attention to, and conceptualization of, "agricultural innovation systems." This is an increasingly popular concept in the study of how societies generate, exchange, and use knowledge and information (Lundvall 1985, 1988; Freeman 1987, 1988; Nelson 1988; Dosi et al. 1988; Edquist 1997). It is believed to add value to previous conceptualizations of agricultural knowledge and innovation systems (AKIS) by (1) drawing attention to the totality of actors needed

Figure 1.1 Conceptualization of a National Agricultural Innovation System



Source: Birner and Spielman 2007.

for innovation and growth; (2) consolidating the role of the private sector and the importance of interactions within a sector; and (3) emphasizing the outcomes of technology generation and adoption rather than the strengthening of research systems and their outputs (World Bank 2006:iv). An agricultural innovation system (AIS) can be defined as comprising the organizations, enterprises, and individuals that interact to demand and supply agricultural knowledge and technology, as well as the institutions and policy incentives that influence their performance (World Bank 2006:5). The purpose of AIS is to accelerate the movement of ideas, create marketable products, and promote economic competitiveness. Figure 1.1 presents a graphic representation of an agricultural innovation system.

As shown above, an agricultural innovation system framework embeds AET within a larger, more complex system of diverse agents whose interactions are conditioned by formal and informal socioeconomic institutions. The framework captures not only the influences of market forces, but also the impacts of organizational learning and behavioral change, nonmarket institutions, and public policy processes (e.g., labor, regulatory, science and technology, environmental, energy, industrial, trade, intellectual property). An instructive comparison of the agricultural innovation system framework with those of the traditional national agricultural research system (NARS) and the more recent agricultural knowledge and information system (AKIS) is provided in Annex 1.

An important contribution of the innovation systems framework is that it shifts the analysis from a conventional model of one-way information transfers to a more complex, process-based systems

approach. This shift is appropriate for the study of AET given that agricultural development in SSA is more and more influenced by complex interactions among public, private, and civil society actors, and increasingly conditioned by a variety of rapidly changing institutions (Davis et al. 2007). Specifically, the AIS approach focuses analytical and policy attention on the capacity of individuals and organizations to learn and innovate, on organizational cultures and behaviors that facilitate (or impede) this process, and on networks and dealings among innovation agents. These topics will be revisited in the course of this report.

The *second* trend is a groundswell of attention to the relevance and organization of tertiary education systems on the continent. This is driven by rising awareness of the role of human capital formation in enabling national productivity and growth to improve within an increasingly integrated and competitive global economy. This awareness is generating a more systematic and market-oriented approach to education sector development, which recognizes the backward linkages of tertiary education to secondary (and primary) education, as well as its forward linkages to employment, employers, and the general labor market.

The reform agenda associated with this enhanced understanding of tertiary education revolves around the visions and mandates for various types of tertiary institutions, their relevance to national development priorities, greater stakeholder representation in their institutional governance, increased autonomy (with accountability) in institutional management, changes in curricula and teaching practices, improvements in incentive systems for academic staff, alternative financing strategies, public-private partnerships, and the realization of new opportunities arising in science and technology (New Partnership for African Development 2006; Juma 2005; InterAcademy 2004; Idabacha 2003). These themes are interwoven within the following discussion.

One example of how these two trends may converge is the 2003 Jinja Consensus, which calls for the creation of a new African agricultural university to produce a distinct generation of agricultural graduates who will become entrepreneurs and wealth creators rather than cogs in the wheels of existing public agricultural education, research, and extension organizations. It calls for tertiary education to be grounded in student-centered learning in which instructors facilitate rather than direct the learning process and infuse graduates not only with market-oriented skills, but also with a new standard of morals, awareness, and ethical behavior (Idabacha 2003; Wingert 2002).

The two trends outlined above are combining to create a more receptive environment for modernization within the sphere of African agricultural education and training than has existed since 1990. But why is it necessary to modernize agricultural instruction at this time?

WHY IS AGRICULTURAL EDUCATION IMPORTANT FOR AFRICA?[2]

The idea that agriculture is an engine for economic growth within agrarian economies is well established, relatively unchallenged in the literature, and once again an important focus of development activity in Africa (Mellor 1995; Schuh 1997). This "engine of growth" idea, however, is based on achieving increased efficiencies in the use of the primary resources for agriculture (land, labor, and capital), thereby releasing some of these resources for use in other sectors (e.g., services, light manufacturing, etc.) as well as for increased social investments (e.g., health and education). These increased efficiencies depend not only on agricultural public policy and private sector initiatives, but also on the intellectual capital (the accelerator of growth and development) within the agricultural sector that is needed to realize these efficiencies at all levels (farmers, educators, private entrepreneurs, public servants, etc.). Since 60 to 80 percent of the African population resides in rural areas, a revitalized agricultural sector would generate rural employment opportunities and reduce rural poverty. *Based on this framework, we can see the relationship between economic growth, poverty reduction, agricultural development, and agricultural education.*

Agriculture continues to provide the legs on which the economies of most African countries stand. In 2004, the agriculture sector in Sub-Saharan Africa (excluding South Africa) accounted for 40 percent of GDP, 15 percent of exports, and 65 percent of all employment (Beintema and Stads 2004; FARA/NEPAD 2006). Average annual growth in agricultural GDP within Africa rose from 3.3 percent in 1990–2000 to 3.6 percent in 2000–2004, somewhat higher than the averages for all low-income countries over those same periods.

In 2000–2004, GDP growth rates for agriculture in Africa were much higher than those for manufacturing and only slightly lower than those from industry and services. Since economic progress depends on shifting resources from agriculture to other productive sectors, the necessity of increasing productivity in the agricultural sector comes sharply into focus. Given the relative importance of the agricultural sector in the economies of most African countries, addressing economic growth and development at the national level continues to require significant attention to rural areas and to agricultural productivity in order to enable rural farmers to produce sufficient surplus to grow their local economies.

At the same time, considerable scope for improvement exists in the agricultural sector. Agricultural labor productivity has increased only marginally (from a low base) over the past 15 years (FARA 2006). Per-capita food production in Africa has declined by 40 percent since 1970—the only region in the world where this trend has been negative (Chilonda and Minde 2007; Von Braun 2005:1). Roughly one-third of the African population—now more than 200 million persons—has remained malnourished for nearly four decades (Rosegrant et al., 2001). Clearly, getting agriculture moving will generate enormous economic and social dividends for Africa.

It is intuitive to say that "education is a necessary, but not sufficient condition for economic development." This implies that while education is essential, additional factors are also necessary (employment opportunities, favorable business climate, etc.). Other causes may intervene to negate the benefits of education (conflict, corruption, etc.). This makes it difficult to provide clear empirical evidence of the relation between increased education and economic performance or to make comparisons between countries. However, recent research provides stronger justification for this relationship than had been found previously (OECD 2006b; Bloom et al. 2006; Carnoy 2006).

A research report from the UNESCO/OECD World Education Indicators entitled "Financing Education: Investments and Returns" (2002) compares data for OECD developed countries against those for a group of 18 lesser developed countries, using a range of statistical methods to relate years of schooling to GDP per capita. The report summarizes the results as follows: "There is now robust evidence that human capital is a key determinant of economic growth and emerging evidence indicates that it is also associated with a wide range of non-economic benefits such as health and well-being" (p. 7). Further, "human capital plays a stronger role in the [economic] growth process once the level of human capital reaches a critical threshold," such as the attainment of universal primary education (2002:8). Other factors such as civil conflict or political instability may reduce the effectiveness of education; e.g., as occurred in the Philippines and Zimbabwe. This report also cites an OECD study from 2000, which ". . . concludes that the estimated long-term effect on GDP of one additional year of education in the population aged 15–64 is around 6 percent on average."

Analysis in a recently published World Bank book entitled *How Universities Promote Economic Growth* (Yusuf and Nabeshima 2007) looks at more developed economies, but it makes a key point that may have a future bearing on Africa. In looking at natural science and engineering degrees in "latecomer" countries of East Asia, the authors' analysis shows that increases in the output of these degrees have a strong relationship to GDP per capita. Because agricultural education is strongly rooted in the natural sciences and at least a portion of it concerns engineering, this would suggest that a similar positive economic response to increased tertiary education in these areas could occur in Africa.

Other relevant research also merits recognition. Robert Evenson (2004:152), who has conducted various studies on rates of return to agricultural research, argues that "the conversion of knowledge to economic growth production is quite location specific" since it is "affected by natural (soil, climate) and economic (prices, wages) conditions." His studies indicate that higher education programs in agriculture that create skills relating to science and technology "have a public externality value much higher than the private value of these skills in labor markets." On this basis, he believes a strong justification exists for public investment in the creation of graduate programs in innovation-related fields of study in Africa.

Another study with findings relevant for agricultural education in Africa is Bloom, Canning and Chan (2006). The researchers review existing research that analyzes the effects of higher education on GDP and conclude that "tertiary education plays a recognizable role in promoting economic growth." They go on to write that "investing in tertiary education in Africa may accelerate technological

diffusion, which would decrease knowledge gaps and help reduce poverty."

The above evidence demonstrates a strong connection between higher levels of education and economic development. Considering Africa against the backdrop of these findings, it is clear that significant benefits can be derived from improving the overall quality of education in Africa, increasing enrollments in secondary and tertiary educational institutions, and strengthening the areas of science and technology education. Since most African countries remain agrarian societies where agriculture contributes significantly to both economic and social development, the need for renewed support to agricultural education and training is both obvious and necessary. Likewise, it is evident that improved agricultural performance will underpin progress towards many of the Millennium Development Goals.

REGIONAL AND BANK STRATEGIES

African governments have adopted a Comprehensive Africa Agriculture Development Program (CAADP) under the auspices of their New Partnership for African Development (NEPAD). Launched in November 2002, CAADP states clearly (under its "pillar 4") that achievement of the targeted increase in agricultural output by 6 percent a year over the next 20 years will require larger investments in agricultural research, extension, and education systems.[3] To this end, CAADP emphasizes the need to revitalize degree programs in order to capitalize on the rich academic resources in African universities (NEPAD 2002:67, 87). To pursue its CAADP objectives, NEPAD has designed a Framework for African Agricultural Productivity (FAAP) (NEPAD, 2006) and asked the Forum for Agricultural Research in Africa (FARA) to assume the leadership in its implementation. The FAAP document emphasizes that "the broad increase in agricultural productivity that is central to food security, competitiveness, rural growth and poverty alleviation requires increased investments in agricultural research, extension and education, accompanied by institutional reforms to improve efficiency throughout the technology generation, dissemination and adoption chain." A main component of the FAAP is Building Africa's Scientific and Institutional Capacity (BASIC) in agriculture and natural resources at the post-secondary level. Indeed, the strengthening of African capabilities for natural resource management is acquiring greater urgency in light of growing environmental deterioration in some countries, and the increased resource management challenges associated with global warming.

The need to invest more in building capacities for agricultural education and training has been acknowledged in a series of World Bank strategy documents. The Bank-wide policy on agriculture, *Directions in Development: Agricultural Growth and the Poor: The World Bank's Agenda,* notes that numerous studies have shown high economic returns to improving farmers' information and skills to enable more efficient use of technologies. Rapidly changing market conditions require a major shift in the content of agricultural education from a production to a market orientation. This is especially critical given the current need to "substitute growth through increased input use" with "growth driven by a more knowledge-intensive agriculture" (World Bank 2004b:13–14). The document highlights several impediments to increased investment in human capital, including the absence of AET goals in country agriculture sector development strategies. It recommends that the Bank should "re-engage in agricultural education and capacity building" (World Bank 2004b:14).

Within the Africa Region, the Bank's 2000 strategy, *Can Africa Claim the 21st Century?*, calls for major investments to accelerate agricultural growth and rural development, including an expansion of skills and human capital (World Bank 2000:195–196). The strengthening of agricultural services, research, and education features prominently in the subsequent 2002 document, *From Action to Impact: The Africa Region's Rural Strategy*, which proposes a 50 percent net increase in the number of agricultural scientists (World Bank 2002:38). It also argues for greater attention to women farmers and advocates new approaches to extension in order to achieve greater pluralism in the provision of demand-driven and relevant advisory services to diverse client groups. To this end, it may be necessary to decentralize resources and responsibilities to local governments and communities, outsource extension services to NGOs and private groups, and improve linkages among farmers, educators, researchers, and extension agents (World Bank 2002:22). Likewise, the Bank's 2003 policy statement, *Reaching the Rural Poor*, underscores the importance of agricultural education and

training for rural economic growth (World Bank 2003:153). Although not always explicit, all of the above recommendations point to a central role for post-secondary agricultural education and training.

To provide initial support for the implementation of NEPAD's Framework for African Agricultural Productivity, on March 29, 2007 the Bank approved a USD 45 million investment in agricultural research under a West Africa Agricultural Productivity Program (WAAPP) for Ghana, Mali, and Senegal. The WAAPP objective is to generate and disseminate improved technologies focusing on roots and tubers in Ghana, rice in Mali, and cereals in Senegal. Similar operations for Eastern Africa and for Southern Africa are scheduled to follow. All these projects anticipate significant future investments in post-secondary agricultural education.

The above regional capacity-building initiatives recognize the general importance of agricultural education and training, but they offer little specificity on what should be done or how to do it. The analysis presented in the following pages aims to fill this void.

AGRICULTURAL INNOVATION SYSTEMS AND AET[4]

Lessons emerging from recent agricultural revitalization efforts demonstrate that a more nuanced understanding is needed of AET's role in promoting innovation, development, and growth in agriculture. Greater insight is specifically needed of how alternative strategies might bring AET into closer, more productive relationships with other actors in the agricultural sector and wider economy, thereby building on the comparative advantages of different actors and institutions to reduce transaction costs, achieve economies of scale and scope, exploit complementarities, and realize synergies in innovation. An agricultural innovation systems (AIS) approach seems to meet this need.

In essence, an agricultural innovation system is a blending of institutional capacities, coordination mechanisms, communication networks, and policy incentives that fosters innovationled gains in agricultural productivity. It emphasizes the need to understand key actors and their roles, their behaviors and practices, and the institutional context within which they interact, all of which are key conceptual elements in innovation systems analysis (World Bank 2006a).[5] This in turn leads to issues of institutional structures of governance and management (for greater flexibility and responsiveness), criteria and incentives for professional performance (for improved productivity), access to information and inter-institutional communication networks (for enhanced competitiveness). All these issues are relevant to African education and training institutions.

An innovation systems perspective can help in understanding how best to reform AET in Africa. It changes the traditional conception of scientific research, education, and extension in developing-country agriculture. The traditional conception is based on what might be called a *linear vision of science.* In this framework, knowledge flows forth from the classroom to inform basic scientific research and continues outward to strategic, applied, and adaptive research, followed by technology development, dissemination, and, eventually, adoption. This linear framework has oriented the traditional agricultural extension paradigm in which the extension agent receives knowledge from the classroom or research station and imparts it to the farmer, whose role is that of passive recipient. This tends to oversimplify the innovation process and ignore its interactive nature. Often, technological developments precede scientific understanding of the underlying phenomena (for example, the steam engine and thermodynamics) or occur through the reorganization of known processes in the absence of accompanying research (Freeman and Soete 1997; Nelson and Rosenberg 1993).

An important implication of the innovation systems approach is that innovations emerge spontaneously from the interactions of different agents. Their emergence does not necessarily depend on any government action, although these actions can have great influence on their evolution. Consequently, an innovation system is larger than the national research system (NRS), and larger than the set of public sector organizations charged with the creation and dissemination of new technologies.[6] In short, innovation can spring from multiple sources—including agricultural education and training institutions.

The innovation systems approach offers useful insights into the role of AET in agricultural sector development, such as the following:

- Innovations depend on the ability of agents (e.g., farmers, extensionists, input suppliers) 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).

- Learning depends on the ability of these agents to *interact and exchange* information and knowledge. Thus, social networks and institutional linkages can increase the chances of innovation. These interactions can occur at any stage in the processes of producing, exchanging, or applying knowledge (Fagerberg 2005; Nelson and Rosenberg 1993).
- Innovation is constrained by *complexity.* Complexity in process, product, equipment, and instrumentation means that individual agents may not have all the resources they need to innovate fast enough to remain effective or competitive (Powell and Grodal 2005; Rycroft and Kash 1999).
- Successful innovation systems *balance* the search for existing information with the creation of original information, a balance that will change according to the strength of the networks within which agents interact, and their individual and collective capabilities (Renzulli 2003; Rycroft and Kash 1999).
- The economic or social performance of a country depends on the *participation* of diverse innovative agents that interact to form an innovation system. Particularly important to this notion is effective interaction between a country's scientific base and its business community (Powell and Grodal 2005; OECD 1999; Rycroft and Kash 1999; Nelson and Rosenberg 1993).
- The economic or social performance of a country also depends on the set of *enabling* conditions—market infrastructure, appropriate property rights, and effective governance in both input and output markets—that foster the emergence of innovative agents (Powell and Grodal 2005; Nelson and Rosenberg 1993; OECD 1999; Rycroft and Kash 1999).

These insights mean that a successful innovation system depends on several key elements: the characteristics of the information, the capacity of individuals and organizations to learn and innovate, the nature and character of interactions among innovation agents, the incentives that encourage such interactions, and the formal and informal institutions that mediate or regulate these interactions.

To the extent possible, the following analysis is placed within an agricultural innovation systems (AIS) framework. In doing so, it is hoped not only that a contribution may be made to a better understanding of the AIS dynamic, but that clearer insights into the role of agricultural education institutions within this framework might be achieved.

At the same time, action on AET cannot be considered in isolation from the national education system as a whole. It would be imprudent to analyze AET issues apart from the larger systems in which they exist—the education sector more broadly and the technical-vocational education and training subsector more specifically. For example, the quality of AET institutions is often conditioned by the academic preparation of incoming students from the systems of basic and general secondary education. Similarly, many problems in the provision of education and training for the agricultural sector derive from those affecting technical education and vocational training in general (Atchoarena and Gasperini 2003:240). Additionally, opportunities for reform within faculties of agriculture may depend in part on the extent of university management's openness to stock-taking and strategic planning. Likewise, the restructuring of staff incentives in faculties of agriculture is usually dependent upon reforms in broader university and civil service regulations. In short, agricultural education reform is more effective when it is accompanied by tertiary institution reform.

RESEARCH OBJECTIVES, SCOPE, AND AUDIENCE[7]

Concerned with the neglect of agricultural education and training in Africa and its potentially damaging consequences for long-term human capital formation in the agricultural sector, the World Bank initiated a series of studies on agricultural education and training (AET) in 2004.[8] The research comprised six thematic studies, which in turn drew on analyses of 15 country cases, a survey of donor financing trends, an operational survey of Bank investments, a review of the literature, and an annotated bibliography. In addition, the Bank has carried out consultations with stakeholders and several donors. A summary description of the AET institutions included in the country studies is provided in Annex 2.

The purpose of this report is to synthesize the findings of this research and suggest strategic measures for strengthening the contribution of AET to agricultural productivity and natural resource management in Sub-Saharan Africa. The target audiences are African practitioners and policymakers

concerned with boosting food supply and agricultural productivity, donor agency representatives, and World Bank staff. Specifically, this report presents a case for increased investment in AET, analyzes issues in the subsector, and identifies appropriate policies and interventions for African ministries of agriculture and education, the World Bank, and other donor agencies.

The scope of the research is limited to the training of agricultural researchers, educators, and advisory services personnel in Sub-Saharan Africa through educational activities conducted *only at the secondary, tertiary, and postgraduate levels of education*. It intentionally excludes other forms of rural education and training, such as basic education, informal farmer training, and farmer-oriented vocational education. This decision was based on the comparatively greater attention that has been given in recent research to analysis of the educational and informational needs of producers and how best to meet them (CORAF 1999; Gallagher 2000; Alex et al. 2002; Atchoarea and Gaspirini 2003; Fauliau 2004).[9]

Subsequent discussion begins with an inquiry into the relationship between agricultural education and agricultural development. It then recounts briefly the history of agricultural education and training in Sub-Saharan Africa and summarizes its present situation. The principal constraints to the development of AET capacities are identified and discussed in Chapter 4. Next, global experience is reviewed for guidance in addressing these identified constraints. Chapter 6 highlights action priorities that will modernize the practice and delivery of agricultural education and training. Guidelines for intervention at each level of agricultural education (secondary, tertiary, postgraduate) form the basis of Chapter 7. A concluding chapter offers elements for a possible reform program and suggests associated responsibilities for national politicians, institutional leaders, and development partners.

2 Agricultural Education Is Vital for African Development

AGRICULTURE DEVELOPMENT IS NECESSARY FOR OVERALL GROWTH

Agriculture prevails as Africa's dominant economic activity. It accounts for about 30–40 percent of GDP in Sub-Saharan Africa, 20–30 percent of exports, and approximately 60–80 percent of employment (see Annex 3). In most African countries, two-thirds of manufacturing value added stems from agricultural raw materials. In some smaller countries, agriculture plays and even more imposing role, representing 80 percent or more of export earnings.[10] These impressive statistics aside, Sub-Saharan Africa, with 27 percent of its people malnourished (FAO 2004) and 16 of the 18 most undernourished countries in the world, remains the only region where per-capita food production continues to worsen year by year (Rockefeller Foundation 2006:2).[11] In spite of the presence of this "elephant in the living room," agriculture has been largely overlooked by African governments and donors alike in recent years.

World Bank research affirms the premise that enhancing agricultural productivity is the critical entry point in designing effective poverty reduction strategies in low-income countries, including Sub-Saharan Africa (Christiansen et al. 2006:35). Agriculture reduces poverty through its generation of both agricultural and non-agricultural employment. Agricultural growth directly generates demand for rural labor and creates employment opportunities for the poorest. Growth in agricultural production also benefits consumers by driving down food prices, particularly helping the poor. According to the World Bank, a 10 percent increase in crop yields leads to a 9 percent decrease in the percentage of people living on less than USD 1 per day.

The Commission for Africa report argues that the continent's main productivity increases must come from higher yields, not by expanding arable land. Higher agricultural productivity is a precondition for growth and development in most African countries, and increasing yields is the key to raising incomes in rural areas (McCalla 1998:51). Technology and knowledge both make important contributions to this process (World Bank 2002:9). Farmers and commercial producers may benefit if they can diversify their production into higher value, but knowledge-demanding specialized crops (World Bank/IFPRI "Agriculture and Achieving the Millennium Development Goals," as cited in IFPRI 2007). This is what some call "niche agriculture" and others are beginning to call the "new agriculture" in Africa.

STRONG AGRICULTURAL EDUCATION AND TRAINING SYSTEMS UNDERPIN PRODUCTIVITY INCREASES

The crucial role of agricultural education and training (AET) in determining the success of efforts to boost agricultural productivity is widely recognized. "Agricultural training and education have a direct impact on agricultural productivity and on the performance of ancillary businesses and trade. They also stimulate implementation of knowledge-driven economic growth strategies and poverty reduction" (FARA/NEPAD 2006:12). AET contributions take the following four main forms.

1. AET directly raises agricultural productivity by developing farmer capacities.

The lack of "know-how" in the Mozambican farmer, as elsewhere in the continent, limits her ability to grow and improve. A portrait of the smallholder highlights a shortage of expertise in production methods, crop rotation, use of nutrients, post-harvest processing, marketing, dietary needs and machinery maintenance (USAID 2003b:5–6). According to human capital theory, education—and by implication AET—influences agricultural productivity in the following ways:

- The "worker effect" by which more farm output is realized from a given bundle of inputs through enhanced worker productivity;
- The "allocation effect" by which additional years of formal education enhance farmers' ability to choose optimum combinations of farm inputs and farm outputs;
- The "innovative effect" by which additional schooling enhances a farmer's ability to acquire and adapt new technologies, thereby reducing innovation time lags; and
- The "market efficiency effect" by which additional years of schooling foster the capacity to exploit new market opportunities. (Idachaba 1997:543; Atchoarena and Gasperini 2003:56).

FAO states that the skills of farmers in management and production, and of those who provide services to farmers, can be improved through investment in schooling programs and agricultural extension programs. Investments to boost human capital in the farming sector can thus produce growth in per capita food production (FAO, SOFA 2000: 3–4).

2. AET indirectly increases agricultural productivity by generating human capital for support services.

NEPAD's Forum for Agricultural Research in Africa states: "The quality of tertiary agricultural education is critical because it determines the expertise and competencies of scientists, professionals, technicians, teachers and civil service and business leaders in all aspects of agriculture and related industries" (FARA/NEPAD 2006:26). "One of the clearest lessons of experience is that agricultural and rural development require well-trained individuals and strong local organizations to carry out research, provide services to farmers and traders, and represent their interests" (Staatz and Eicher 1998:32).

Expenditures for research are regarded as investments in knowledge capital. Likewise, spending on AET is an investment in the human capital that facilitates and enables research (knowledge production) to take place (Langrock 2006:2, Beintema et al. 1998:4) An earlier review of national agricultural research systems stated that ". . . the quality of agricultural research is only as good as the quality of the scientific human resource base" (Byerlee and Alex 1998). Investments in agricultural research have been shown to have high favorable median internal rates of return (IRRs) of between 34 and 37 percent. IRRs for agricultural advisory services are also high, with a median of 27 percent (World Bank 2004a: 58; World Bank 2002: 21; FAO 2000). Strengthening universities in both research capacity and human resource development is integral to strengthening national agricultural research systems (Byerlee and Alex, op. cit.).

Support for AET is further justified by a projected increase in the demand for agricultural researchers. NEPAD's target is to increase funding for agricultural research from an estimated USD 1 billion to USD 2 billion annually over 10 years. Correspondingly, the number of agricultural scientists would need to increase by a net of 50 percent (World Bank 2002:8). Based on the IFPRI/ASTI survey of 2001–2003, which calculated the existence of 8,609 full-time equivalent agricultural researchers in 26 Anglophone and Francophone countries, at least 4,300 new agricultural professionals will be needed. If attrition due to brain drain, AIDS, and

retirement is taken into account, this estimate could swell to 8,000. In short, AET is the foundation upon which the future of good agricultural research and advisory service programs in Africa must be erected and staffed.

Apart from formal training, AET institutions can support the development of career ladders for public and private sector agriculturalists by providing inservice study options to obtain the knowledge and qualifications necessary for professional advancement. This can be done through sequenced short courses on university campuses, distance education, or online learning. Considerable experimentation and program development have taken place in these areas in recent years (e.g., Sasakawa Africa Fund for Agricultural Extension; Haromaya [ex-Alemaya] University in Ethiopia, Methodist University in Kenya, Africa University in Zimbabwe, and the University of Development Studies in Ghana among others). In many cases, these new approaches may require only a full impact assessment in order to justify the funding increases necessary for scaling up and replication.

Commercial agriculture is a small but vibrant and expanding sector across the African continent. Helped by a reduction in government regulation and an improved functioning of markets, examples of successful "niche agriculture," often for export, are blossoming. As local production systems begin the transition from traditional food supply to competitive exportation, the demand increases for agriculturalists who are capable in the fields of agribusiness, agricultural economics, farm management, marketing, rural finance, and others. These dynamics are creating opportunities for "graduate farmers" that have not previously existed. The recent surge of undergraduate and graduate course offerings in these disciplines attests to this shift in employment demand.

Each aspect of the agricultural innovation system is interrelated and complementary, making it impossible to single out completely the contribution of each.[12] But investments in AET clearly enable research, extension, and commercial agriculture to generate higher payoffs.

3. Higher agricultural education can contribute to research and advisory services.

Agricultural education and training institutions contribute to productive agricultural innovation systems in several ways. First, universities can stimulate innovation. Through academic networks, institutional linkages, and the provision of Internet access, universities serve as information bridges between their societies and repositories of global knowledge, thereby accelerating the flow of new ideas to agricultural organizations. In this way, they play an important role within the information-sharing networks that join the institutional players of a country's agricultural innovation system (Davis et al. 2007).

Second, tertiary institutions (including polytechnics) can help to adapt innovations produced elsewhere in the world to local circumstances. Agriculture is highly location-specific. Thus, available technologies applicable to Africa are likely to require substantial local adaptation and development in order to become cost-effective (Pardey et al. 2006). This requires an intimate knowledge of local farming systems which must be captured in the content of agricultural training activities (Eicher 2006:3). Often such work is undertaken by university researchers. For example, agriculturalists at the University of Zimbabwe produced an appropriate packet of soybean seed, fertilizer and soil inoculant for small farmers and persuaded local agro-dealers to market it. The result has been to raise soybean production in Zimbabwe from 395 MT in 1995 to 12,000 MT in 2004, and to prompt the Ministry of Agriculture to initiate a nationwide oil seed program based on the use of this packet (Mpepereki 2007).

Third, universities have the capacity to generate new knowledge through research. As seen above, research produces high rates of return. About half of the agricultural scientists in developing countries work in universities[13] and devote about a fourth of their time to research (World Bank 2004a: 78). Universities often can carry out agricultural research and extension at little extra cost by using existing staff and faculties (e.g., libraries, laboratories, demonstration farms). Graduate student academic research has been shown in other countries (e.g., Brazil, India, Denmark) to be a low cost way to expand the pool of available research. Thus, greater support for postgraduate level AET is an effective means of increasing research output in Africa (Eicher 2006:3, 32). African agricultural faculties also seem to house considerable latent potential for additional research. For example, African universities carried out only 19 percent of public agricultural research and development in the year 2000, as compared with 43 percent in OECD countries in

1993 and two-thirds in U.S. universities in 2000 (Beintema and Stads 2006, Beintema, et al. 1998).

4. AET development was a key part of strategies in countries that grew agriculture successfully.

Agricultural education and training systems formed an essential component of the development of agriculture in a wide range of advanced and middle income countries. These include Denmark, Japan, the Netherlands and the United States, as well as Brazil, India, and Malaysia (Eicher 2006). Even where it was not initially a factor (e.g., fish farming in Chile; fish processing in Uganda), agricultural education played a central role in maintaining competitiveness as these industries matured (World Bank 2006a).

Reviews of these and other international experiences have emphasized the importance of cumulative investment in human capital for agriculture. "New science-based agricultural technologies have flowed from and were preceded by many decades of investment in human capital and related institutional innovation. This has been an iterative and interactive development process without a clearly conceived blueprint. . . . Institutional innovation seems to depend on prior human capital accumulation, just as technological innovation does. . . . Both are embodied human capital. . . . Anyone who does not now appreciate what the quality of the human agent means to productivity growth and development has missed one of the most important dimensions of the economic literature over the last 20 years" (Bonnen 1998:272–274).

In summary, the case for investment in agricultural education and training appears compelling in both theory and practice. "Knowledge and information are powerful tools in the processes of change. The strengthening of human capital and the production of knowledge . . . are perhaps the most important elements in agricultural development strategies" (Haug 1999:271). Put succinctly, agriculture leads growth in many parts of rural Africa, but investments in human capital and infrastructure lead agriculture (World Bank 2002:20).

3 African Agricultural Education and Training in Perspective

Agriculture has been practiced in Sub-Saharan Africa for millennia. It provided a shared basis for community interaction and inspired both culture and religion. Lessons learned were incorporated into local wisdom and passed on from one generation to the next through oral traditions. As a result, indigenous knowledge of agriculture in Africa has a long, rich, and proven tradition that extensively predates the colonial era.

THE COLONIAL ERA

During the 20th century, colonial administrations began to shift from their initially extractive methods into more production-oriented economic strategies. With this change, they began to create educational programs to impart to local populations the technical skills needed to support the establishment of productive activities. Agriculture was among the first sectors to benefit from this attention. Initial activities in agricultural training were limited to short courses for African employees in colonial administrations who were responsible for the promulgation of modern production practices, monitoring animal health, and compliance with colonial regulations. As a demand for higher skill levels was manifested within the colonial governments, secondary-level vocational education was established. Gradually post-secondary courses were created, beginning with the certificate courses at Makerere College (Uganda) in 1924, which were followed by diploma courses in 1933 (Obua 2006:5). An important milestone in Francophone Africa was the establishment in 1967 of the *École inter-États de sciences et médecine vétérinaires* in Senegal, which served as a training center for the region.

As African nations gained independence, many of them adopted socialist orientations that emphasized state-managed production through public enterprises. The newly independent governments thus became heavily engaged in the management of agricultural production and marketing. Capacities for the training of agricultural technicians for public service employment were established under ministries of agriculture. However, vocational education in agriculture at the secondary level was reserved largely for rural youth who had been excluded from the educational system. In this way, an essentially bifurcated system of agricultural education emerged, in which post-primary vocational education was targeted at the sons of traditional farmers, and post-secondary agricultural education was

designed to lead the sons of the middle class into public employment. This dual legacy, and the separate expectations associated with each branch of it, has hindered the development of agricultural education in Africa to the present.

POST-INDEPENDENCE

Following the end of the colonial period and the rise of national independence in the mid-20th century, African governments sought to create educational opportunities for citizens who had generally been given little access to education. Between the 1960s and 1980s, many new universities with agriculture faculties were created in Sub-Saharan Africa (see Chart 3.1). Development partners, such as USAID and the Rockefeller Foundation, strongly supported these efforts to create high-quality educational programs.

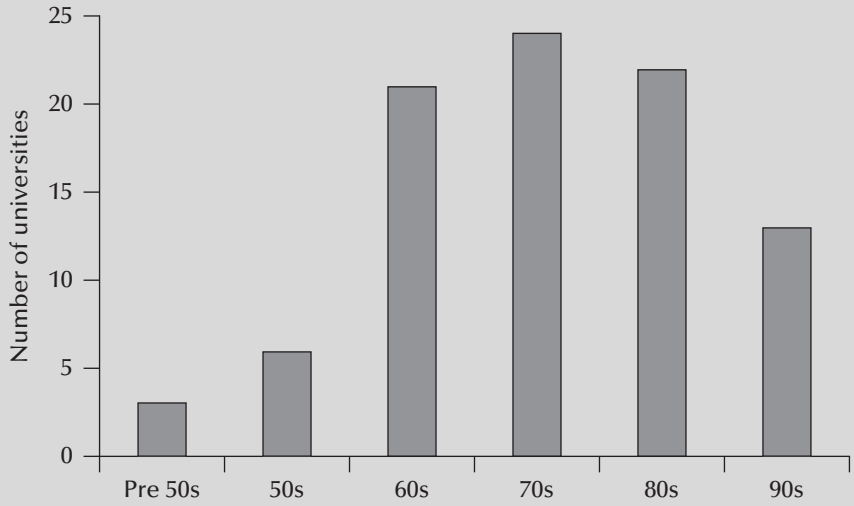
This momentum slowed in the 1980s, when many African economies entered a period of economic stagnation, and the availability of public resources for educational expansion was constrained. Efforts to restart economic growth on the continent led to the structural adjustment policies of the 1980s and 1990s, in which public expenditure was often curtailed and public employment was cut back in the effort to eliminate deficit financing. Even as public demand for access to higher education was intensifying, governments often found that they had created a higher education system temporarily beyond their financial means to maintain. The solution was to freeze staff salaries and cut back sharply on nonsalary expenditures for libraries, research, laboratory equipment, and facilities maintenance. Consequently, overall spending on education in Africa declined from 5 percent of GDP in 1990 to 4.5 percent in 2002. Likewise, higher education expenditure per student fell from USD 6,300 in 1980 to just USD 1,200 in 2002 (Darvas 2007:32).

Crisis often creates opportunities for significant reforms that would not be possible under normal conditions. This has certainly been true for African higher education. During the 1990s, African universities learned to carry out strategic planning, worked to diversify their sources of revenue, pursued networking more aggressively, and began to reach out to communities and the private sector. The explosion of private universities that started in the late 1990s has introduced competition, which has sparked innovations in academic structures, curricula, and content. As economic growth returned to much of the region in the 21st century, a useful foundation of institutional reform and revitalization is emerging that provides opportunities on which to build.

AGRICULTURAL EDUCATION IN AFRICA TODAY

Secondary-level AET. Secondary-level AET tends to be a minuscule part of technical and vocational education and training (TVET), which itself

Chart 3.1 Establishment of Universities with Faculties of Agriculture or Veterinary Sciences in SSA by Decade



Source: Beintema, Pardey and Roseboom 1998.

represents a small share (perhaps 3–5 percent) of total secondary enrollment. Moreover, national vocational training systems, themselves small and ineffective, are almost everywhere focused on industrial and service occupations, as if skills were not of critical importance in the agricultural occupations that employ the vast majority of the labor force (Atchoarena and Gasperini 2003:246).

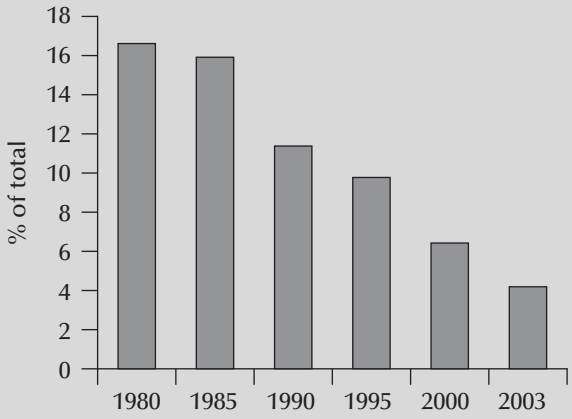
Tertiary-level AET. Africa now houses roughly 300 universities. Three-quarters of African countries offer some tertiary-level training in agricultural sciences. At least 96 public universities teach agriculture and natural resources management. Of these, 26 are in Nigeria, 10 in South Africa, six in Sudan, five in Kenya, and three in Ghana. Nineteen separate faculties of veterinary science exist in 13 countries, five of them in Nigeria alone (Temu et al. 2003:3; Beintema and Stads 2004, Beintema et al. 1998:56). In short, extensive institutional infrastructure for agricultural education and training has been put in place.

Postgraduate Level. Postgraduate education is a newer and less well-established aspect of African higher education. In *The African Experience with Higher Education* (Ajayi et al. 1996), the subject is barely mentioned until the final pages of the book—and then largely from a forward-looking erspective that emphasizes the need for regional collaboration in postgraduate training. Recently, however, it has acquired vitality and attracted attention as the labor market demand for postgraduates has begun to heat up, the costs of overseas postgraduate programs have become prohibitive, and their content has become less relevant to Africa. For example, Bunda College of Agriculture in Malawi now boasts 13 MSc programs and 6 PhD programs. Regional collaboration in postgraduate training also seems to have reached the takeoff point, with various new collaborative programs underway in Eastern, Southern, and Western Africa (Fine 2007; Tongoona and Mudhara 2007).

DONOR ASSISTANCE TO AFRICAN AGRICULTURE HAS DECLINED SHARPLY

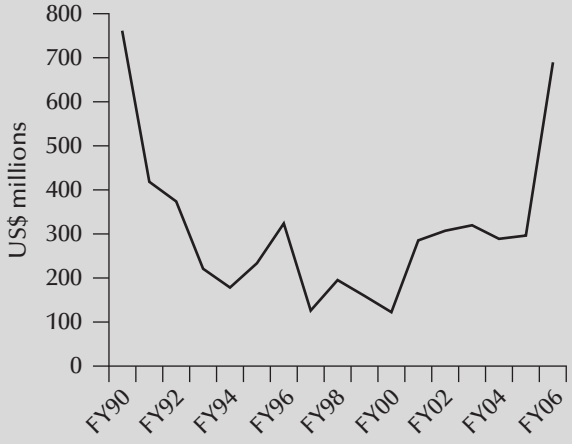
Between 1992 and 2002, per capita development assistance to Africa fell by 22 percent, from USD 36.10 in 1992 to USD 24.50 in 1997 before rebounding somewhat to USD 28.20 in 2002 (Commission for Africa 2005:109). Within declining total donor assistance to Africa, aid to the agriculture sector has dropped precipitously (Eicher 2006: 6). The share of total bilateral development assistance awarded to agriculture is shown in Chart 3.2. Donor support for agricultural development in Africa reached a high of USD 1,229 million in 1990, and then declined steadily to a low of USD 454 million in 2001. World Bank assistance for agriculture in SSA followed a similar trend (Chart 3.3), but recovered in 2006 as the Bank's Africa Action Plan began to direct more resources toward the agricultural sector. On balance, however, agriculture received a diminishing portion of a shrinking development assistance pie during this period.

Chart 3.2 Bilateral Assistance for Agriculture, 1980–2003



Source: Pardey, *et al.,* 2006.

Chart 3.3 World Bank Lending for Agriculture in SSA, 1990–2006



Source: Agriculture and Rural Development, World Bank.

Multiple factors account for the decline in donor support for African agriculture. First, Africa's growing political constituencies tend to favor the burgeoning urban areas. Second, the 1980s shift from project-based to structural adjustment lending reduced donor interest in specific-sector investments. Third, a false sense of complacency also took hold as the Green Revolution appeared to offer limitless, science-based solutions leading to an elimination of the food production problem (Atchoarena and Gasperini 2003:29). Fourth, the decline in support for agriculture was offset in the 1990s by increased donor financing for basic social services—education and health—under the banner of poverty reduction strategies (Eicher 2006:2).

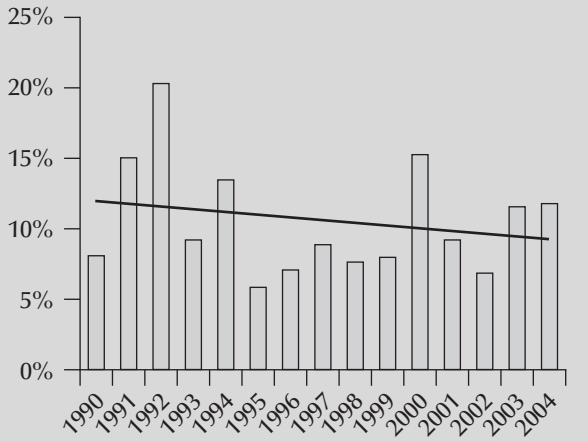
However, these strategies did not give enough attention to how these poverty-reducing interventions were to be sustained, or to the potential of agriculture to contribute toward this sustainability. A development strategy based solely on expanding rural social services and food aid is unreliable because it fails to stimulate agricultural growth and rural income generation (Eicher 2006:6).

SUPPORT FOR AGRICULTURAL EDUCATION AND TRAINING IN AFRICA HAS DISAPPEARED

Donor funding for the agriculture sector encompasses a wide range of activities—pest control, fertilizer distribution, livestock development, irrigation expansion, introduction of new crops, post-harvest storage, producers' associations, farm credit, etc. Within this range of activities, some donor funding has also fostered agricultural knowledge and information systems (AKIS), or the three legs of the "knowledge triangle," i.e., agricultural research, extension, and agricultural education. But investments in AKIS have clearly been secondary, decreasing over time and averaging less than 10 percent of total ODA (see Chart 3.4). Moreover, this modest support for the knowledge triangle has become severely imbalanced. Since 2002, funding for research has risen sharply, but assistance to extension and AET remains essentially stagnant (see Chart 3.5).

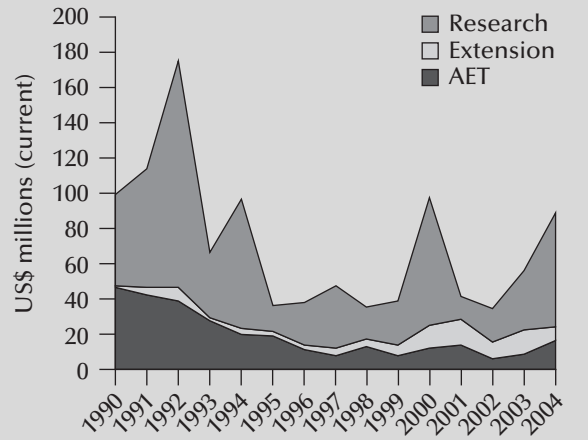
Development assistance for all types (formal and nonformal) of agricultural education and training (AET) has declined over the past 15 years. These investments in human capital formation averaged just 4.1 percent of development assistance for agriculture from 1990–1994, but fell to 2.2 percent in 1995–1999 and 2.1 percent from 2000–2004. Assistance for *formal*

Chart 3.4 Investments in Research, Extension and AET as a % of ODA for African Agriculture, 1990–2004



Source: OECD Creditor Reporting System Aid Activity Database.

Chart 3.5 ODA to AET, Research and Extension in SSA, 1990–2004



Source: OECD Creditor Reporting System Aid Activity Database.

AET was even a smaller percentage of donor funding for African agriculture. Between 1995 and 1999, it averaged only 1.6 percent, and then declined to just 0.7 percent between 2000 and 2004.[14] In short, donor interest in agricultural education and training in Africa has essentially evaporated.

Donor withdrawal has been especially pronounced in postgraduate training for agriculture. For example, in 1985 USAID provided scholarships to 250 Africans for overseas training in agriculture, but had reduced it to only 8 percent of that number in 1998—just 20 scholarships (Eicher 1999:47; InterAcademy Council 2004:171). Sadly, during the

Box 3.1 World Bank Assistance for Agricultural Education Has Been Minimal

Historically, the World Bank invested heavily in agricultural education projects. Between 1964 and 1990, the Bank financed 41 projects supporting 60 institutions in 25 countries worldwide. However, the 1990s saw a major change, and a 1998 review of World Bank lending for the AKIS triangle revealed severe imbalances. Postsecondary agricultural education received just 2 percent of the World Bank's USD 4.8 billion of global investment from 1987 to 1997, whereas agricultural research and extension received 98 percent of the total. Bank financing for agricultural higher education was awarded to just three African countries during that decade.

A review of 42 Bank agricultural projects in Africa conducted in 2006 showed much the same pattern. Agricultural education and training absorbed only 6 percent of Bank assistance for research, extension, and AET between 1998 and 2006, thus leaving 94 percent for research and extension. All 42 projects included some form of agricultural training, but only seven projects provided financing for agricultural education. Two of those (Ghana and Ethiopia) accounted for 80 percent of the total lending for agricultural education in Sub-Saharan Africa in the period reviewed. Between 2000 and 2006, the Bank provided only USD 9.5 million for agricultural education in Africa, an average of just USD 1.4 million per year.

Source: Rygnestad et al. 2006:6.

years of donor-funded postgraduate fellowships, the emphasis was always on the training of individuals rather than on building local capacities for postgraduate training.

Smaller OECD countries are now the main funders of AET in Africa

Most of the financial support for formal AET now comes from smaller OECD countries. A survey of donor support for AET conducted for this study showed that 11 of 18 development assistance organizations provided only minimal or no support for AET in Africa (see Annex 4 for details). Six donors together contributed more than 80 percent of the modest total of USD 21.5 million in development assistance approved for formal AET in Africa between 2000 and 2004. Thus, an average of USD 4.2 million per year supported agricultural education in that region during the first five years of this decade. Of these, the largest single donor was Belgium, followed by Ireland, Germany, and Portugal (OECD CRS Database, 2006). Clearly, AET does not figure on the current agenda of the major development assistance agencies.

Reasons for the decline in donor support for AET

Several factors contributed to the decline in donor support for AET. First, donors had good reason to believe that the institutional structure for AET had been put in place, needs had been addressed, and they could turn their attention to other seemingly more urgent challenges (Eicher, 1999).[15] This view may be understandable from historical perspective. The number of universities in SSA increased from around 20 in 1960 to 160 by 1996 (Beintema 1998 in Eicher 1999:27). The output of agricultural graduates quadrupled from the early 1960s to the mid 1980s (World Bank 2004a:78). Multiple types of agricultural training schools were established, such as in Senegal in the 1960s (Atchoarena and Gasperini 2003:261).

Donor fatigue, the magnitude of the institution-building task, and perceived low economic rates of return to expensive higher education also contributed to waning donor interest in tertiary-level agricultural education (Eicher 2006:3). However, the main reasons were the rising cost of overseas postgraduate training, questionable relevance of the training received, and low returnee rates from overseas postgraduate training programs. Donors became concerned with the high percentages of students who either did not return home after degree completion, or emigrated soon after returning home. By some estimates, fewer than a third of those who graduate return to the home country. In 2004, an estimated 40,000 Africans with PhD degrees lived outside the continent (El-Khawas 2004 in Tongoona and Mudhara 2007:3). "The perception of capacity building as a mere exercise of generating a prescribed stock of human skills at a given

point in time easily leads to a "training-fallacy" trap, where one faces the striking puzzle of the paradoxical coexistence of a growing number of unemployed national university graduates, sizable outflows of the best qualified national brains, and sustained inflows of tens of thousands of expatriate experts. . . . The above-mentioned paradox highlights probably the most critical dimension of the capacity building problem: the capacity of African economies to create opportunities for attracting and retaining high-level local skills in productive use" (Dione, 1997:613).

The ultimate cost of the donor pullback from postgraduate training overseas has been to distance African professionals from knowledge networks, global information resources, and the cutting edge of technology transfer. All these are necessary for a functioning agricultural innovation system, and they will need to be addressed if agriculture is to grow in Africa.

Government funding of AET tended to follow donor trends

African governments also cut back on their own funding for agriculture. The growing concentration of citizens in urban areas shifted their political equation away from rural constituencies, and perceptions of agriculture as an old-fashioned occupation generated negative public attitudes. However, donors reinforced this shift through a combination of incentives, conditionalities, and counterpart contribution requirements. Together these factors inevitably bent government budgets in the direction of donor funding priorities. For example, the government of Kenya allocated more than 10 percent of its budget to agriculture in the 1970s, 7.5 percent in the 1980s, 3 percent in the 1990s, and 3.1 percent in 2003—about 0.7 percent of GDP (World Bank 2005a:84). Likewise, in Ghana the share of the total government budget given to agriculture fell from 12.2 percent in 1980 to 4.1 percent in 1990, and then to just 1.0 percent in 2002 (Akroyd and Smith 2007:5).

Trends in government budgetary allocations for agriculture in 14 countries of Sub-Saharan Africa are presented in Table 3.1 and aggregated in Chart 3.6.[16]

The result is a human resource deficit

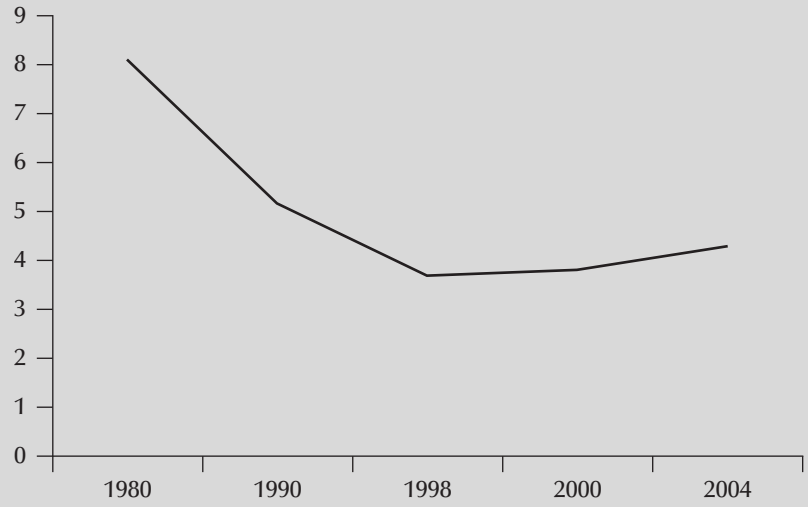
In summary, the initial achievements of the 1970s and 1980s in institution building gave way to neglect during the 1990s and beyond. This has left the legacy of a severely depleted human resource pool in African agriculture. A study of 27 African countries found that investments in agricultural research declined in half of these countries during the 1990s (IFPRI 2004). The huge potential for women professionals to upgrade farming systems in which women producers play a major role remains largely untapped (FAO 1999), with women

Table 3.1 Agricultural Expenditure as a Percentage of Total Government Expenditure, 1980–2004

	1980	1990	1998	2000	2004
Botswana	9.71	6.47	4.91	4.18	4.17
Burkina Faso	5.47	5.83	5.07	6.57	6.50
Cameroon	2.22	4.06	2.87	2.81	3.10
Côte d'Ivoire	3.40	2.97	4.81	4.18	5.47
Ethiopia	6.89	4.91	4.26	6.55	2.25
Ghana	12.23	4.10	3.26	2.57	1.29
Kenya	8.42	6.03	4.32	4.82	4.99
Malawi	10.17	11.10	6.83	4.30	5.47
Mali	8.31	2.33	4.62	4.84	9.17
Nigeria	2.80	2.91	1.71	1.58	6.03
Togo	7.03	3.51	1.59	1.78	1.88
Uganda	6.99	3.91	1.09	4.00	4.02
Zambia	22.97	2.91	4.39	3.27	2.82
Zimbabwe	7.03	11.18	1.82	1.76	2.92

Source: World Development Report 2008, data annex.

Chart 3.6 Trend in Agricultural Expenditure as a Percentage of Total Government Expenditure for 14 Countries of Sub-Saharan Africa, 1980–2004



Source: Table 3.1 on previous page.

comprising just 18 percent of African agricultural scientists (Stads and Beintema 2006). Only one in four African researchers currently possesses a PhD degree.[17] Fortunately, this era of disregard may now be passing into history.

UNDERFINANCING OF AFRICA'S AGRICULTURE SECTOR APPEARS POISED TO CHANGE

Recent signs may signal a turnaround in donor assistance to agriculture and to agriculture training. ODA to SSA increased from USD 11 billion in 2001 to almost USD 20 billion in 2003 (OECD Creditor Reporting System).[18] Aid to agriculture jumped from USD 454 million in 2001 to USD 752 million in 2004. In 2005, the Commission for Africa Report called for a doubling of international development assistance to Africa by 2010, with priority for science, technology, and human resource development. In response, the Bank's lending for agriculture more than doubled from USD 287 million in 2004 to USD 685 million in 2006. Although donor commitments in 2006 fell back somewhat from their 2005 levels, this upward trend could regain momentum. For example, USAID recently introduced a global initiative to increase postgraduate scholarships in agriculture and capacity-building grants to rebuild university faculties of agriculture (USAID 2003a).

In the Maputo Declaration of 2003, African heads of state pledged 10 percent of their GDP for agriculture sector investments. This implies a fourfold increase in current levels of budgetary support. Yet even a doubling of government funding for the agricultural sector would enable a range of worthwhile initiatives.

Donors followed suit in 2005 with a renewed commitment to Africa in general and to agriculture in particular. The recommendations of the Report of the Commission for Africa, *Our Common Interest,* called for particular emphasis on agriculture. The G-8 meeting in July 2005 at Gleneagles, Scotland adopted the Report and agreed to double aid to Africa. NEPAD's *Framework for African Agricultural Productivity* pointed to the difficulty of maintaining human capital in agricultural support systems and suggested an inadequacy of investments in human capital. It called for a "radically new approach" to restore the quality of graduate and postgraduate agricultural education and training (NEPAD/FARA 2006:7). The Africa Commission report also served as a major reference for the World Bank's Africa Action Plan. The Plan calls for development, in the medium term, of a base of critical agricultural human capital through expanded investments in agriculture science and technology and through support for tertiary institutions including agricultural education (World Bank 2005b: 42–43).

In addition, seven American foundations have formed a Partnership for Higher Education in Africa and pledged to invest at least USD 200 million over the next five years in support of African universities that are "on the move."[19] More to the point, the Gates and Rockefeller Foundations recently formed a separate partnership, called the Alliance for a Green Revolution in Africa (AGRA), to invest USD 1 billion in efforts to improve African agricultural productivity over the coming five years. The Alliance's first major grant provided USD 20 million to the African Center for Crop Improvement at the University of KwaZulu-Natal in support of a regional postgraduate program in plant breeding.

However, it is not yet clear whether these additional resources for agriculture in Africa will benefit AET. Certainly the case for rebuilding AET systems is compelling in view of their seminal role in agricultural development elsewhere in the world and the neglect they have suffered in Africa. If additional investment in agriculture materializes, it will create strong demands for improving the scope, relevance and quality of agricultural skills. The key question is: *How should these additional funds be used?*

4 Constraints on Building AET Capacity

At a time when different profiles of graduates are needed to lead agricultural development in Africa, neglect has eroded the relevance and quality of AET outputs (graduates, research, technical advice) in numerous countries. This neglect provides an opportunity for strategic rethinking and innovation in the process of rebuilding AET capacities. The AET systems currently in place suffer from five main weaknesses: declining enrollments, professional isolation, narrow and outdated curricula, inadequate staffing, and insufficient pedagogical inputs. Each is discussed in sequence below.

AET ENROLLMENTS ARE DISTORTED AND DECLINING

A new generation of agricultural professionals is needed to replenish the pool of human resources that is being depleted by brain drain, AIDS, and retirement; to support the expansion of local postgraduate programs; to assist the growth of commercial agriculture, to maintain technical independence, and to exploit the economic opportunities inherent in new types of agriculture. However, it is not clear from what sources they will come.

This challenge may be more qualitative than quantitative. The percentage of all tertiary-level graduates in the field of agriculture in Africa (5.2 percent) is almost four times higher than levels prevailing in Europe (1.4 percent) and the United States (1.2 percent).[20] It is also considerably higher than the graduate shares found in the more recent agricultural powerhouses of Brazil (1.8 percent) and Chile (3.8 percent). This suggests that perhaps Africa's greatest need with regard to human resources for agriculture is not larger numbers of graduates, but rather a better distribution of graduates across the various levels of tertiary education, with particular attention to postgraduate output. To explore this point, let us look at the technical education pyramid in Africa.

Africa's technical education enrollment pyramid is unbalanced

Agriculture forms part of—and is supported by—the science and technology disciplines that comprise the broad field of technical education. As applied knowledge and technological innovation become more important for global economic competitiveness, nations

have begun to look at their "technical education pyramid" (Basant and Chandra 2006:13). This is the distribution of enrollments across the various levels of technical education, i.e., post-secondary technical, non-university polytechnic-type technical, university science and technology (sciences and engineering), and postgraduate (undifferentiated).[21] This composition of the supply of technical graduates represents a nation's collective capacity for utilizing science and technology in its development.

Data for enrollments at these four levels of technical education are available for only 15 African countries. These are compared with other developed and developing countries in Table 4.1. Countries are

Table 4.1 Percent of Technical Education Enrollments in Total National Enrollments, ISCED Levels 4–6, 2004 or Closest Year

Country	Level 4	Level 5B	Level 5A STE	Level 6
Mozambique	31	0	69	0
Jordan	26	17	49	8
Sweden	43	4	48	5
United States	0	47	48	5
Kenya	0	49	43	8
Ghana	38	19	42	0
Eritrea	37	23	40	0
Colombia	37	23	40	0
Switzerland	47	11	37	4
Ethiopia	60	0	37	3
Iran	40	23	36	1
Japan	32	31	34	2
Korea	20	46	33	1
South Africa	50	16	32	2
Ireland	30	38	30	3
***Sub-Saharan Africa*[1]**	***50***	***19***	***29***	***2***
United Kingdom	50	20	26	3
India*	38	31	26	5
Chile	54	21	25	0
Turkey	54	23	23	1
Australia	61	13	23	3
France	55	20	22	4
Mauritania	65	12	20	2
Botswana	62	14	15	9
Mali	84	2	14	0
Uganda	37	46	13	3
Mauritius	37	52	10	1
Rwanda**	74	16	10	0
Lesotho	10	80	9	1
Burundi	41	52	7	0
Congo	87	7	6	0

Sources: UNESCO Institute for Statistics; World Bank *EdStats*; Teferra and Altbach 2003.

Note: An entry of 0 percent indicates either that no program of this type exists in the country, or that its enrollments were less than 0.5 percent. STE = Science, Engineering, Health and Agriculture enrollments only at 5A level.

ISCED Classifications:

Level 4 = technical/vocational programs that straddle the boundary between upper secondary and post-secondary; transitional; 6 mo. – 2 yrs.

Level 5 = first stage of tertiary education:

5A is academic preparation for advanced degree with a minimum of 3 years of study;

5B is practically oriented and occupationally specific with 2 or 3 years duration.

Level 6 = leads to an advanced research qualification (i.e., a master's or doctoral degree).

[1] Based on 15 Sub-Saharan African countries in this table only.

*Authors' calculations derived from UNESCO data, Agarwal (2006) Figure 13, and Basant & Chandra (2006) Table 4.

** Authors' calculations derived from UNESCO data with STE division based on information provided in Rwanda higher education websites.

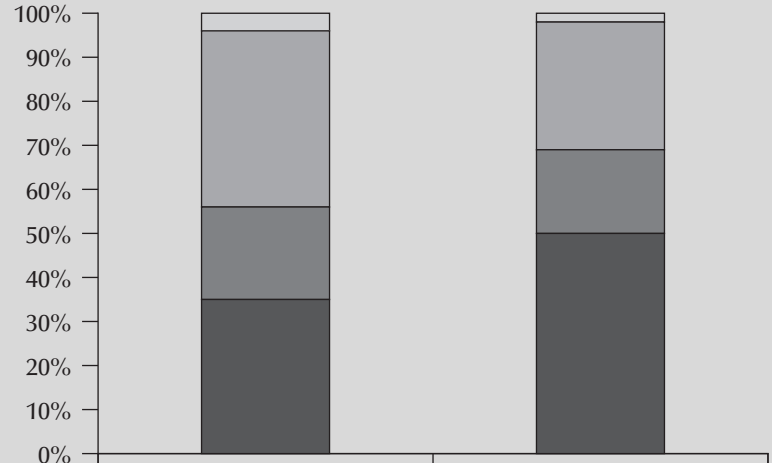
ranked by the share of their technical education students who are enrolled in university-level science and technology fields because this is thought to be the most critical level of the technical education pyramid in terms of triggering increased innovation and productivity within a national economy (Yusuf and Nabeshima 2007; Evenson 2004).

The African pyramids for technical education derived from the table above differ from those that characterize the most economically competitive countries in the world. The *Global Competitiveness Ranking 2006–2007* lists 127 national economies according to their perceived business competitiveness.[22] Technical education pyramids were calculated for four of the top 10 ranked countries (Switzerland, Sweden, United Kingdom, United States) for which this information was available. These are contrasted with the average for Sub-Saharan Africa in Chart 4.1. Three things stand out from this table. First, African countries accommodate a much larger portion of technical education enrollments at the lower levels of this pyramid than do the highly competitive countries. Second, the highly competitive countries attract a much bigger share of university students into science, technology, and engineering fields than do African countries. Third, the highly competitive countries also entice a comparatively larger portion of students to enroll in postgraduate studies.[23] Given that the tertiary-level gross enrollment ratio (GER) for the highly competitive countries is roughly 10 times higher than the level prevailing in Africa, this translates into a substantial quantitative as well as qualitative advantage for the highly competitive countries.

The implications for African countries seem clear. *First*, they should strive to increase university enrollments in science and technology fields at the cost of university enrollments in the social sciences and humanities. Specifically, this requires a strong general secondary education that will prepare graduates for entry to higher levels of the pyramid. *Second*, countries need to work harder to establish and nurture local postgraduate programs.

Countries such as Kenya and Ghana have succeeded in achieving a progressive balance within the technical education pyramids they have put in place, although Ghana needs to give more attention to postgraduate programs. These two countries match fairly well with the average profile of the four highly competitive countries. At this point, their primary challenge would seem to be increasing their tertiary-level GER without modifying the shape of their technical education pyramid. However, nations such as Burundi, Congo, Lesotho, Mali, Mauritania, Rwanda, and even

Chart 4.1 Technical Education Pyramid for 4 Most Competitive Countries and 15 Sub-Saharan Africa Countries



	4 competitive nations	Sub-Saharan Africa
Level 6	4	2
Level 5A STE	40	29
Level 5B	21	19
Level 4	35	50

Source: Table 4.1.

Mauritius are encouraged to find ways of shifting technical education enrollments to higher levels of the pyramid. In general, countries are advised to work on improving the profile of their technical education pyramids before they embark on aggressive university expansion campaigns. The issue is not so much the quality and relevance of education versus the quantity of students, but rather achieving and maintaining the right balance between the two as the overall system evolves.

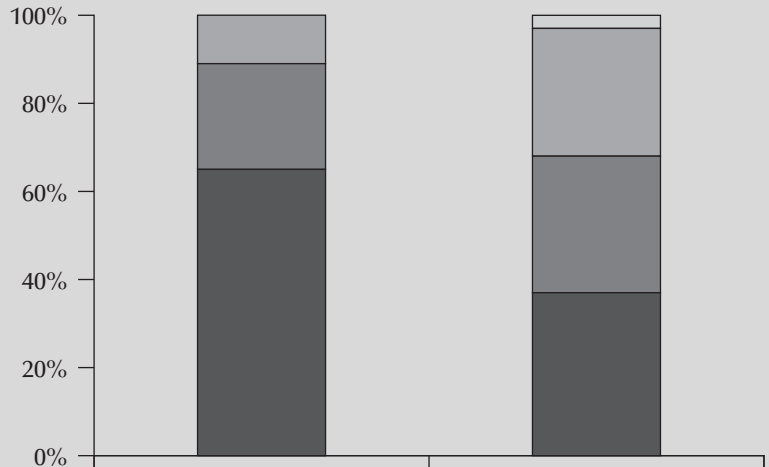
Within Africa, similar divergence is observed between Francophone and Anglophone countries (Chart 4.2).[24] Anglophone nations have gone further than their Francophone peers in placing technical education students into the higher levels of university science and technology and of postgraduate studies. Francophone countries are urged to expand technical enrollments at the upper levels of their pyramids. Greater attention to the development and expansion of national postgraduate programs should also be a high priority for the Francophone countries.

The pyramid specific to enrollments in agricultural education and training should ideally approximate employment opportunities in the labor market. The wide base would correspond to training of producers through nonformal and secondary level vocational education, the smaller middle band of the pyramid would reflect practically skilled agricultural technicians at the post-secondary certificate and diploma level (e.g. extensionists, NGO specialists, marketing representatives, and program managers), and the narrow apex would represent agricultural professionals trained at the degree level and above. The FAO suggests that the ratios in this pyramid should be 12 technicians and 40–100 producers trained for each university graduate (Rowat, FAO, 1980). However, in many countries this pyramid is top-heavy. For example, Burkina Faso produces just 3.6 technicians and only 0.32 young producers for each university graduate (Zonon 2006:46).[25] Astonishingly, this implies that fewer agricultural producers are trained in Burkina Faso than university graduates in agriculture.

Enrollment patterns are especially distorted by gender

Underlying most organizational cultures and behaviors is a gender dimension that is rarely taken into consideration. Gender inequality is a constant theme in any analysis of agricultural development in Sub-Saharan Africa, and is thus relevant to the study of AET systems that participate in the development process (Blackden et al. 2006; Quisumbing 2003). Although women play multiple roles in agriculture

Chart 4.2 Technical Education Pyramids for Francophone and Anglophone Countries in Africa



	Francophone	Anglophone
Level 6	0	3
Level 5A STE	11	29
Level 5B	24	31
Level 4	65	37

Source: Table 4.1.

and account for more than half of agricultural output in the continent (and three-quarters of food production), they have continuously received a less-than-proportionate share of investment in agriculture, particularly in terms of interventions relating to education, extension, capacity strengthening, empowerment, and market access (Alawy 1998; Frank 1999; Haug 1999).[26] Recognition of these facts is seldom a visible component in AET institutions. Thus, women are underrepresented as students, instructors, extension agents and researchers, while agricultural innovation processes are hardly ever targeted to female users (Beintema 2006).

In general, women account for one out of every five students in the agricultural sciences. In Benin, 20 percent of the students in the Colleges of Technical Agricultural Education and only 5 percent of the teachers are women (Ogoudedji 2006:2). The situation is just as challenging in Ethiopia (see Box 4.1). At the tertiary level, in Cameroon at the Faculty of Agronomy and Agricultural Sciences 22 percent of students were female, but almost half of these (44 percent) were concentrated in the faculty of economics and sociology, not in agricultural sciences (Fontem 2006:32). In Mozambique, women within the Faculty of Agronomy and Forestry accounted for 28 percent of undergraduates and 35 percent of the graduates in 2005 and 2006, and a third of the teaching staff were female. Less than one-fifth of students at the Agrarian Institute of Boane are women (Gemo 2006:16,19, 31).

But this is not a stagnant situation. Between 1991 and 2000, women's share of enrollments in Ethiopian agricultural sciences rose from 14 to 20 percent (Stads and Beintema 2006). Sokoine University of Agriculture in Tanzania provides an impressive example of what can be accomplished in this area. It increased its graduate output of women tenfold over the past decade and raised their share in Sokoine enrollments from 17 to 29 percent (Sibunga 2007).

Gender bias has deep roots. Young women are generally not encouraged to focus on science—particularly biology and agricultural science—in secondary school. As a result, African female participation rates in agricultural sciences in universities are roughly half of those in other fields. A UNESCO survey in 1998 found than only 8 percent of agricultural faculty members were women, compared with more than 50 percent in many European

Box 4.1 Agricultural Education and Gender Inequities in Ethiopia

Gender inequities persist in Ethiopia's education system, despite recent national efforts to encourage schooling among the female population. At the primary level, gross enrollment rates are more than 20 percent higher for boys than for girls, with 76 percent of boys enrolled nationwide and only 55 percent of girls as of 2003 (WDI 2006). Girls who do enroll are more likely to drop out, with the highest number of dropouts in grade one. This enrollment problem carries over into the formal AET system. Across the country's 25 agricultural technical training centers, females accounted for only 11 percent of the enrolled students and 9 percent of graduated students in 2005. Female instructors accounted for only 6 percent of the total instructors in these centers in the same year (MoARD 2006, 2005).

Similar gender imbalances appear at the university level. In Haramaya University's School of Graduate Studies, a part of the College of Agriculture, female graduates accounted for fewer than 3 percent of the total graduates over the period 1979–2003. This underrepresentation of female students in graduate studies is the result of a very low female student population in undergraduate programs—7.6 percent during the same period (Kassa 2004a).

But statistics reveal only half the picture. Consider the technical education curriculum for agriculture from a gender perspective. The curriculum contains few, if any, courses on issues such as household nutrition, sanitation, and hygiene—areas in which women play a vital role and which are critical to household welfare, as empirical evidence from across the region has repeatedly demonstrated. Moreover, the curriculum provides few gender-specific career tracks for female students entering public service. Female students are expected to work in farmer technology centers and interact with farmers—primarily male and often senior to them in age—as would their male counterparts, defying the traditional conventions and norms of local communities. Little effort is made to use AET and female AET graduates as a means of effecting change in rural livelihoods through gender-specific impact pathways (IFPRI 2007).

Source: Davis et al. 2007:49–50.

countries (InterAcademy 2004:170). The consequence is unused human capacities and reduced program effectiveness.

Student interest in agriculture is waning

Even though one-fifth of Africa's economy and four-fifths of its people depend on agriculture for their livelihoods (Commission for Africa 2005:45), this does not automatically translate into a popular demand for AET. Despite the extensive infrastructure built over the past four decades, student interest in agriculture is waning as students seek careers associated with urban lifestyles and a wider range of chances for work. For example, in Kenya only 20 candidates applied for agriculture as a first choice in 2005, compared with a combined capacity to accept 120 BSc students in two public universities (Ministry of Education, Kenya. 2006:265). At the secondary level, fewer students are choosing agriculture as an option, 40 percent compared with over 50 percent in the past. Of the students choosing agriculture, only one out of four (24 percent) intends to seek an agricultural occupation following graduation (Vandenbosch, et al. 2006:67).

In part, this lack of interest reflects the urban background of many students. In Mozambique, the majority of students enrolled in technical agricultural schools come from an urban, not a farm, background (Vandenbosch 2006:99). Moreover, substantial numbers of students enroll in agricultural institutions because they are unable to find a place in the regular secondary schools that provide preparation for university studies. Agricultural secondary education is consequently used to provide them with the equivalent academic qualifications needed to apply for university admission (Vandenbosch 2006:95). At the tertiary education level, students often matriculate in faculties of agriculture because they are unable to enroll in the disciplines of their choice, and are simply waiting for the chance to transfer into a more desirable academic program (Noragric 2006:4). Even when they graduate with degrees in agriculture, they may not seek employment in this area. In short, students follow the educational pathways they believe are most likely to lead to employment. In many cases, these paths do not lead to agriculture.

Several studies point to the need to combat the widespread perception of agriculture as a second-rate profession (Noragric, ibid.). Both students and parents tend to equate agriculture with hand-tool farming, and to see it as a dead end in terms of employment aspirations. Thus, parents strive to equip their children with the educational qualifications necessary to leave farming. Similarly, selection for university admission is generally based on a rank ordering of academic qualifications, with agriculture well down the list of student preferences. As a result, large numbers of university students end up assigned to agriculture without having chosen it. This creates problems of motivation and professional commitment (Muir-Leresche 2003:10). Thus, a "change of attitude towards agriculture" is critical, according to the Uganda National Agricultural Education Policy document. The reference here is in part to secondary schools that treat agricultural work assignments as a "punishment" for unruly students, thus deterring them (and their classmates) from considering agriculture as an occupation (Rivera 2006:20).

Agriculture enrollments show declining shares at all post-secondary levels

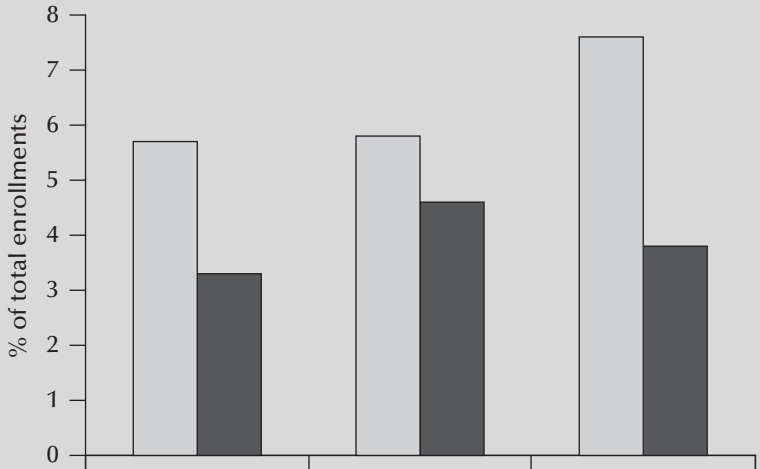
Between the early 1980s and early 1990s, enrollments in agriculture as a share of total enrollments fell from 5.7 percent to 3.3 percent at the pre-degree (technician) level, from 5.8 to 4.6 percent at degree level, and from 7.6 to 3.8 percent at postgraduate level. The declines were thus 42 percent, 21 percent, and 50 percent for technician, degree and postgraduate levels, respectively (see Chart 4.3).

Pre-degree for technicians

Provision of tertiary agricultural education tends to be skewed in favor of universities rather than polytechnics, technical institutes, and vocational colleges. AET investments favor university graduates at the expense of technical and vocational programs. Analysis of 20 technical colleges in forestry found that reduced government support for technical training has virtually eliminated certificate courses and substantially reduced diploma courses. Certificate graduates averaged 260 a year in 1996–1998 but fell to less than a dozen annually in 1999–2002.[27] Diploma graduates averaged 190 a year in 1996–1998, but just 150 annually in 1999–2002 (see Chart 4.4) (Temu ibid.:5, 10–11, 14).

The limited evidence available also suggests that similar trends may have occurred in other agricultural disciplines at the pre-degree level. For example, applied agriculture engineering in Ghana

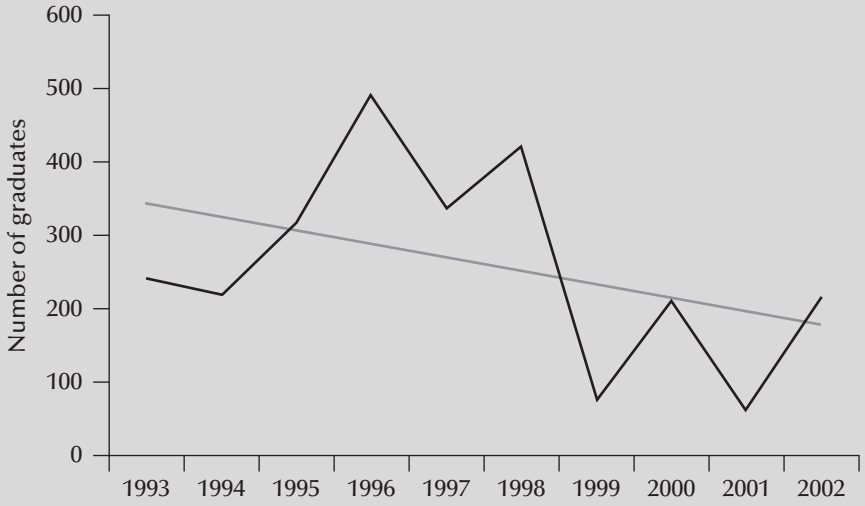
Chart 4.3 Agriculture Enrollments as a % of Total Enrollments by Level, Early 1980s and 1990s



	Level 5 (cert. diploma)	Level 6 (degree)	Level 7 (post grad.)
□ Early 1980s	5.7	5.8	7.6
■ Early 1990s	3.3	4.6	3.8

Source: Beintema et al., 1998. Data are for 19 countries (excluding Nigeria and South Africa).

Chart 4.4 Graduates from Forestry Technician Training (Certificate and Diploma) 1993–2002



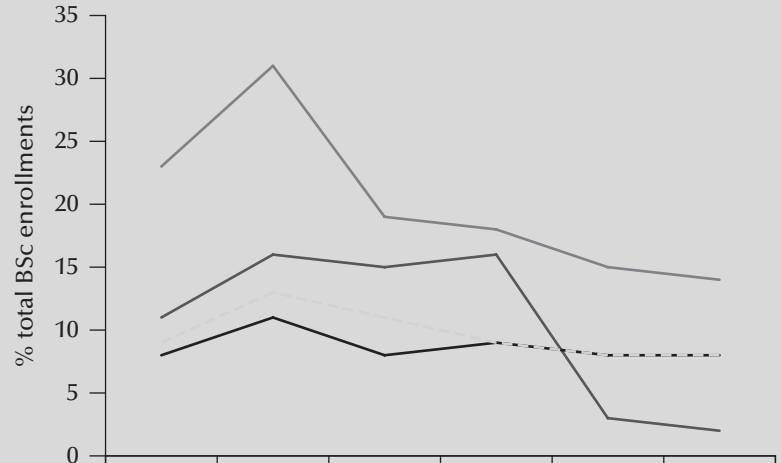
Source: Temu 2005: 6. Data are from seven reporting African institutions.

dropped from 7 percent of total polytechnic enrollments in 1996–1997 to just 1 percent in 2004–2005.[28]

Degree level

In 19 countries (excluding Nigeria and South Africa), the share of student enrollment in agriculture out of total tertiary enrollments was 5.8 percent in the early 1980s and had declined to 4.6 percent in the early 1990s. However, in absolute numbers agricultural enrollments increased 49 percent, from 7,417 in early 80s to 11,045 in early 1990s (Beintema, et al. 1998: 27). In Kenya, enrollment in BSc agriculture in Kenyan public universities declined as a share of total enrollment from 23 percent in 1996–1997 to 14 percent

Chart 4.5 Kenya: Agriculture Enrollments in Public Universities as a % of Total BSc, 1996–2004



	1996/7	1998/9	1999/0	2001/2	2002/3	2003/4
Agriculture	23	31	19	18	15	14
Horticulture	9	13	11	9	8	8
Engineering	8	11	8	9	8	8
Ag. education	11	16	15	16	3	3

Source: Kenya, Statistical Abstracts, various issues.

in 2003/04. Over the same period enrollments in agricultural education declined from 11 percent to 3 percent (see Chart 4.5) (Republic of Kenya, Central Bureau of Statistics, *Statistical Abstracts,* various issues).

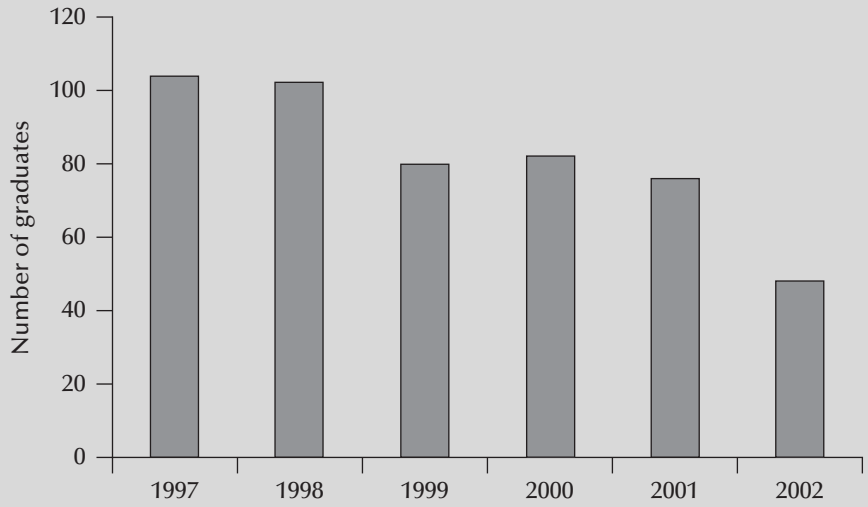
Data also hint at low completion rates among enrolled students. In 19 countries, graduations as a percentage of total enrollment in agriculture sciences decreased from 36.2 percent in early 1980s to 25.8 percent in the early 1990s (Beintima, ibid.). In Nigeria between 1999–2005, federal university enrollments in agriculture totaled 20,870 students (7 percent of total enrollment) but produced only 3,090 graduates (World Bank 2006). These data suggest that either students transferred out of agriculture once enrolled, repeated their studies and thus delayed graduation, or dropped out disproportionately to other faculties. This result is not surprising given the prevailing practice of assigning students to disciplines based on their ranking in university admissions examinations, and widespread negative public perceptions of agricultural careers.

Postgraduate programs

A review of postgraduate education in economics found that "graduate training in any meaningful sense appeared to have collapsed in most African universities. The causes were lack of funds, civil disorder, loss of good staff, deteriorating faculties and equipment and a massive expansion of undergraduate enrollment" (Fine 1997 in InterAcademy: 174 and Eicher 2006: 50–51). Only one-half of African faculties of agriculture offer postgraduate degrees, and most of these were established in the past decade. Thus, local capacities for producing professionals at the highest level are young and still developing.

In the early 1990s, 11,000 students were enrolled in tertiary agriculture courses in 19 countries, but only 3.5 percent were pursuing postgraduate degrees (Beintema 1998:25). Ten countries reported no postgraduate agriculture students at all. For 19 countries, total enrollment in postgraduate agricultural programs was 491 in the early 1980s, and this fell to 387 in the early 1990s, a decrease of 21 percent (Obwona and David 2001:1). A similar survey showed a 54 percent drop in postgraduate degrees in forestry conferred between 1997 and 2002 (Temu et al. 2005), as portrayed in Chart 4.6. Taken together, these data suggest that the pipeline for agricultural professionals is shrinking.

Chart 4.6 Forestry Graduates with MSc and PhD, 1997–2002



Source: Temu, et al. 2005 (data from 13 African universities).

AET INSTITUTIONS ARE ISOLATED AND FRAGMENTED

AET institutions are characterized by isolation. This isolation distances them from global knowledge resources and also from information and experience available within their own countries. As a result, AET institutions are unable to play the roles envisioned for them within the framework of agricultural innovation systems.

Isolation also compromises the relevance and quality of AET outputs. External linkages tend to be weak and poorly developed. "The separation between government, industry and academia stands out as one of the main sources of inertia and waste in Africa's knowledge-based institutions" (Juma 2006). Establishing meaningful institutional linkages—knowledge networks, public-private partnerships, system coordination mechanisms—constitutes one of the main challenges to AET systems (Rivera 2006:41). AET also suffers from administrative fragmentation by its placement under different governmental authorities, and from institutional fragmentation through the proliferation of multiple, under-resourced institutions that lack a systemic framework.

AET systems lack strategic alignment to national development priorities

Agriculture is a key reference point for poverty reduction strategies in many African countries, but there is no notable AET strategy to generate the leaders and managers needed to implement the agricultural components of these national strategies. This has been specifically noted in Mozambique (Givá 2006:iii) and in Burkina Faso (Zonon 2006:46). In a survey of seven countries, only one had an explicit AET strategy. The exception was Uganda which has developed a National Agricultural Education Strategy and an Agricultural Education and Training Policy (Rivera 2006:14; Obua 2006:13, 36, 37).[29] Some training institutions (e.g., Bunda College in Malawi) have developed their own strategies. Notably, Jomo Kenyatta University of Agriculture and Technology has a well developed strategic plan for 2004–2014 (Blackie and Woomer 2005:20).

AET systems suffer from weak linkages with stakeholders, employers, and the productive sector

There is clearly a disconnect between AET and private sector needs. Weak articulation and analysis of demand means that the market for AET graduates is not well defined (Vandenbosch 2006:106). "Linkages for creating dynamic systems of agricultural innovation frequently have been absent. . . . The lack of interaction results in weak articulation of demand for research and training . . ." (World Bank. 2006a). What jeopardizes AET in Mozambique is a lack of dialogue between AET institutions and the productive sector. Employers and companies are

only involved marginally in defining learning contents and quality standards (Givá 2006:iii, 9). The same lack of ties with producers and producer organizations applies in Ghana (Kwarteng 2006:31). A great deal has been written about the establishment of linkages between research, extension, and AET, yet the review of tertiary AET institutions in seven countries found all to have poor links with research and extension institutions (Rivera 2006:26). Cameroon reportedly lacks formal ties between AET institutions and research institutes, even though research stations are dispersed throughout the country near various AET institutions (Fontem 2006:16). In Kenya, the isolation of secondary-level agricultural education manifests itself in lack of interaction with the communities in which they are located and with the agricultural extension service (Ngesa 2006:70,73).

Key informants in the IFPRI study (Davis et al. 2007) suggest that most AET organizations suffer from a work culture that does not promote intensive networking as part of common practice. The problem is reflected in the traditional approach to conceptual and theoretical instruction that does not promote exposure to other actors, ideas, or processes within the agricultural innovation system. It can also be observed in the weak Internet infrastructure found throughout most AET organizations, characterized by poor hardware and software, insufficient resource allocations for maintenance, user restrictions for students, and an absence of consistent institutional access to online services.

Several ongoing experiments suggest the emergence of new mechanisms and cultures aimed at facilitating greater network formation in AET. For example, in Mozambique the Ministry of Education and Culture intends to create an academic credit system that will encourage students to transfer between universities and colleges (and to carry their credits with them), thereby bringing curricula toward a common level and possibly allowing students to link learning and research activities between academic staff at more than one AET institution. Similarly, academic staff are being encouraged to explore joint appointments, secondments, and deputizations between AET organizations as a means of meeting human resource constraints while also building academic networks between individuals and organizations. Students, in the meantime, are finding new opportunities for practical apprenticeships in the private and NGO sectors. In the agricultural research community, competitive grant schemes are emerging with the potential to increase linkages with the private sector and NGOs. However, most of these networks revolve around linkages among similar organizations and individuals, and do little to exploit the synergies associated with nontraditional linkages (Davis et al. 2007).

AET systems are poorly connected to international sources of knowledge

One of the greatest handicaps for African science and education is its remoteness from global sources of scientific literature. As a result, students graduate without knowing the most recent findings and methods in their areas of specialization (InterAcademy Council 2003:178). AET institutions often lack access to international sources of knowledge (e.g., scientific journals), and linkages with the Consultative Group on International Agricultural Research (CGIAR) system, international partners, and other international agriculture networks. Budget limitations produce an almost universal lack of computers and Internet access. Frequently only one or two computers can be found at agricultural colleges and they are usually reserved for administrative purposes. Even if one or two computers were available to students and staff, no budget is provided for accessing the internet. "In agricultural colleges, the so-called 'digital divide' is more often a gaping chasm" (Rivera 2006:26). The review of agricultural tertiary education found that four of seven countries (Ghana, Malawi, Mozambique, and Uganda) had established some international linkages, mostly with overseas universities. Only one country (Uganda) had reportedly established links with international research organizations (Rivera: ibid.).

Isolation often results from overcentralized or divided administration

The lack of communication channels and productive relationships between AET institutions, public research and extension is attributable in part to the fact they frequently operate under different ministries (Gemo 2006:7, 11–12). Some AET institutions are placed under ministries of agriculture, whereas others operate under ministries of education. This makes coordinated policies and funding difficult. Too often, agricultural education falls between the floorboards of agricultural policy and educational

policy. In Nigeria, three federal universities of agriculture operate under the Ministry of Education, while 16 federal colleges of agriculture function under the Ministry of Agriculture (World Bank 2006b.) The same situation exists in Cameroon, with six universities under the Ministry of Higher Education and 18 agricultural colleges under the Ministry of Agriculture and Rural Development. (Rivera: 49–50). In Burkina Faso, five separate ministries administratively supervise the different types of agricultural training. Reportedly there is no relationship between them, and no consultation mechanism between supply and demand (Zonon 2006:46, 53).

In Ghana, the three sides of the education-research-extension triangle pursue their respective agendas without recourse to the others' roles in national agricultural development. The Ministry of Food and Agriculture prepares its policies without involving the Ghana Education Service, which would need to adapt curricula accordingly (Kwarteng 2006:29). In part, isolation occurs because AET institutions are not autonomous and do not have end-users on their governing boards. Granting AET institutions autonomy, especially at the degree level, and placing employers, producers, and other stakeholders on their curriculum committees and governing boards can be powerful incentives to link training with market demand.

In short, the key to developing an agricultural innovation system is "... to figure out how to build country level agricultural knowledge triangles that are operationally linked to farmer organizations, the private sector and the regional and global scientific communities" (Eicher 1999:41).

AET CURRICULA TEND TO BE OBSOLETE AND DISASSOCIATED FROM THE ECONOMY

Curricula are often outdated

At the tertiary level, curricula often are likely to be rigid and unchanging. In Cameroon, curricula in tertiary AET institutions are inflexible, outdated, and dictated by ministries; they have not been revised for 20 years (Rivera 2006:49, Fontem 2006:16). Curricula at the two post-secondary agriculture institutes in Senegal reportedly are conservative, theoretical, and falling behind in new knowledge. No interdisciplinary studies are provided (Rivera 2006:54). Curricula in tertiary institutions in Uganda still focus on producing graduates for public service, for which there is presently little demand (Rivera 2006:55).

Curricula may be narrowly focused on production

Innovation systems in agriculture require broad-ranging skills. "With respect to agricultural education, an effective innovation system requires a cadre of professionals with a new skill set and mindset. Technical expertise needs to be complemented with functional expertise in (for example) markets, agribusiness, intellectual property law, rural institutions, and rural finance—which will place strong demands on educational systems" (World Bank 2006a: xiii). The "new" agricultural professional must be market-oriented, able to learn and adapt, able to innovate and solve problems, and able to listen and communicate. Transforming agricultural higher education requires a more generalist orientation with an emphasis on problem solving (Noragric 2006:5).

In order to make a greater impact on increased rural productivity and growth, AET curricula should cover more than simply production technology.[30] The current reality is that in parts of Africa, up to 42 percent of total rural income comes from nonfarm sources, and this trend appears to be increasing rapidly (DFID 2005:7). In order to adapt to these changing circumstances, AET curricula should expand to include agri-business, entrepreneurship, rural finance, agricultural processing, food processing and marketing, post-harvest technologies, distribution of agricultural products, and the sustainable use and conservation of natural resources (Vandenbosch 2006:19, 50, 101). Unfortunately, recent curricula revisions often do not take this broader view into account. In tertiary education, although the structure and content of AET curricula are under discussion in many places, few institutions have so far made the major changes required to produce significantly different types of graduates.

Premature specialization sometimes occurs

The need for problem-solving generalists is apparent, but most Anglophone curricula at the tertiary level are narrow and highly specialized (Muir-Leresche 2003:18). A greater infusion of interdisciplinary and cross-disciplinary studies at the

undergraduate level would help to broaden student perspectives in order to appreciate the variety of physical and social interactions that characterize agriculture within a specific agro-ecological zone. In some cases, deeper specialization could be left for postgraduate studies.

Of particular concern are the "basic" Agricultural Schools in Mozambique, which admit students after grade 7 and provide three years of training. The schools are roughly equivalent to lower secondary education. A common timetable in the first year is followed by two years of specialization in one of four areas: agriculture; agriculture plus livestock; agromechanics; and machinery. Few graduates from the basic level are formally employed (except as primary teachers), yet they lack the practical skills needed for self-employment in agriculture.[31] Most graduates aspire to continue their studies in upper secondary general education (Givá 2006:13–14) but they are at a disadvantage in competing for places because of the specialized curriculum they have received (Vandenbosch 2006:55).

NUMEROUS COUNTRIES FACE CRISES IN AET STAFFING

Staff qualifications are problematic at many AET institutions

The rapid recruitment of junior lecturers to teach the rising numbers of students, combined with the loss of better qualified academic staff to more rewarding opportunities, has eroded staff qualifications at numerous AET institutions. The lowest staff qualification levels found in the country case studies were in Rwanda (7 percent PhD) and Mozambique (14 percent PhD). The proportion of faculty without advanced degrees was 47 percent in Mozambique and 51 percent in Rwanda (Rivera 2006:19). In addition, several country studies noted that teaching staff in agriculture often do not have practical experience in skills application or business management.

Cameroon, on the other hand, appears to have well-qualified academic staff. Almost two-thirds of the academic staff at the Cameroon University of Dschang Faculty of Agronomy and Agricultural Sciences hold PhDs (Rivera 2006:19, 28). Uganda (Makerere) and Ghana also have more than 40 percent of staff with PhDs.

A survey of agricultural researchers in 26 African countries was conducted by IFPRI in collaboration with ASARECA, CORAF, and several national agricultural research organizations between 2001 and 2003. Known as ASTI (Agricultural Science and Technology Indicators), it profiled the quantity and quality of agricultural researchers within each country's principal public sector agricultural institutions. A summary of these results is presented in Annex 6.

The ASTI survey identifies Burkina Faso, Côte d'Ivoire, and Senegal as possessing the best trained pool of agricultural researchers, with roughly half of all public researchers holding PhD degrees. Within national higher education systems, the best trained agricultural staff can be found in Burkina Faso (92 percent PhDs), Mauritania (82 percent PhDs), and Côte d'Ivoire (84 percent PhDs). Notably, Nigeria and Togo house the highest share of total agricultural researchers within their higher education systems, where one out of every three can be found.[32] On average for the 26 countries surveyed, just 29 percent of all agricultural researchers possess PhDs, but 50 percent of all university-based agricultural researchers have PhDs. Thus, university agricultural staff excel in quality although they may be lacking in quantity. But the potential for upgrading staff qualifications within the public sector is visible.

Notable contrasts can be observed between the high-level human resources of the agricultural sector in 11 Anglophone and 10 Francophone countries. The Anglophone countries have a slightly higher share of all agricultural researchers within their higher education systems (21 percent versus 15 percent). This is to be expected in light of the Francophone tradition of dividing teaching and research among separate institutions. On the other hand, university-based agricultural researchers in Francophone countries are somewhat better trained, with 60 percent of them holding PhDs against 48 percent in Anglophone universities. However, the possibilities for professional networking and institutional linkages would appear to be better among Anglophone countries, given that they possess nearly four times as many total agricultural researchers as the Francophone countries.

Staff shortages are common

In almost all countries, qualified teaching and administrative staff are in short supply. FARA has documented widespread shortages of professional staff in national agricultural research and extension

systems (FARA 2006). *Furthermore, it estimates that 60 percent of agricultural professionals currently employed in the public sector will reach retirement age in five to eight years.* A sizable percentage of academic positions remains unfilled in many institutions (Rivera 2006:17). For example, a survey of agricultural economics programs in 11 universities found that only 60 percent of established academic posts were actually filled (Obwona and Norman 2001:7).[33] The seven country studies of tertiary-level AET undertaken for this report document a steady decrease in academic staff and a steady increase in student enrollments, generating a growing number of students per staff. The result is a sharp increase in academic workloads, which reduces time for research, student meetings, and course preparation.

High levels of staff turnover can be a serious issue

In tertiary AET, only two of the seven countries reviewed showed relative stability in their teaching force. The average experience of instructors in Ghana and Uganda was from 15–20 years. In Malawi and Rwanda, it was less than six, a suggestion of high turnover (Rivera 2006: 19). Since 1990 there has been an exodus of senior academics in Malawi to NGOs, the private sector, and international positions. Low pay is cited as a principal cause (Harawa 2006: 9). The same applies to teachers at midlevel agricultural schools in Mozambique (Vandenbosch 2006:72). Ethiopia reportedly has to recruit 250 to 350 new graduates annually just to replace those leaving their teaching posts at the ATVET colleges, an astonishingly high rate of about 30 percent annual attrition (Vandenbosch 2006:71; Merkorios 2006:33). Anticipated turnover is implicit in an aging professorate. Many of the current teaching staff were trained abroad before the 1980s and are now facing retirement. In Malawi, for example, most teachers in the agricultural colleges are over age 50. Staff retirements and the challenge of recruiting replacement staff are commonly voiced concerns throughout African higher education (Darvas 2007).

The causes of staff loss have frequently been tied to comparative wages and opportunities, but studies in half a dozen African countries have found that nonwage factors are also important for staff retention. These include working conditions, class sizes, teaching loads, participation in decision making, teaching resources, and professional advancement factors, e.g., recognition, promotion, and access to inservice and further studies (Tettey 2006; Vandenbosch 2006: 75). Much attrition could be reduced by streamlining administrative procedures and instituting performance-based remuneration (Tettey 2006: ii–iv).

Brain drain is a major part of the cause

Africa's intellectual capital in AET is being seriously eroded. Existing capacity is insufficient in many cases to reproduce itself through the training of a new generation of professionals. Virtually all the faculties of agriculture and forestry in East and Central Africa are under financial stress, and are losing senior staff to NGOs and the private sector, undermining their capacity to offer high-quality local MSc and PhD degree training (Eicher 1999:36, 41). Migration of skills occurs from lower- to higher-income countries. One country can experience a human resource crisis while a neighbor becomes well staffed. The faculty of agriculture at the University of Zimbabwe has lost almost half its academic staff to universities in South Africa over the past seven years (Tongoona and Mudhara 2007:2).

Agriculture in Sub-Saharan Africa still loses scientists and teachers (especially the most productive and experienced) as fast as they are trained, at the alarming annual rate of 7 percent for NARS research officers with university degrees. During the economic crisis of 1975–1983, an estimated 25 percent of the researchers employed by the Ghanaian NARS left for overseas employment. Topping this record, the leading agricultural research institute of Senegal (ISRA) lost an incredible 18 percent of its scientists in 1987 alone. The overriding cause of such high loss rates of the best brains is the inability of African governments to create an enabling professional environment and working conditions that reward professional excellence and pay competitive salaries (Dione 1997:613–614). Some of this is also due to high levels of dependence on donor funding and the staff crisis that occurs when this funding ends. For example, the end of a World Bank agricultural project in Niger in 1998 prompted an 85 percent budget cut and forced a significant reduction in research staff. (Stads, Kabaley and Gandah 2004:1). Similar shocks have been reported at the completion of World Bank agricultural projects in Madagascar, Mauritania, and Togo (see ASTI Country Briefs Nos. 6, 15, and 16).

HIV/AIDS exacerbates teacher attrition

Agricultural faculty members are being lost prematurely owing to HIV/AIDS, and this further exacerbates an already inadequate staffing situation (USAID 2003a:14). A survey of ministries of agriculture found that absenteeism due to illness and time spent attending funerals was seriously affecting the ability to implement their programs (Topouzis 2000:6). The Rockefeller Foundation estimates that as many as 20 percent of the students trained through the Regional Universities Forum for Eastern and Southern Africa program have since died from AIDS (USAID 2003a: 14). The capacity of institutions, including training, to implement agricultural and rural development programs has been weakened substantially by morbidity and mortality among the most productive age groups (Topouzis 2000: 6).

TEACHING METHODS AND FACILITIES ARE OFTEN INADEQUATE

Teaching methods are overwhelmingly traditional

In the countries studied, most teaching in agricultural education is comprised of "chalk and talk" presentations of theory and facts. The instructors deliver knowledge and information to students as passive recipients. Students have little opportunity to develop technical competencies, problem-solving experience, or organizational skills (Rivera 2006:20). Adhering to the linear model of technological innovation, the graduates then go out to instruct farmers on what they should do, with the risk that the classroom instruction may not be relevant to the specific problems confronted by the farmers.

Fortunately, some notable exceptions exist and demonstrate that change is possible. Among these bright spots is the École des Cadres Ruraux Banbey, Senegal, which conducts training in agricultural enterprise management using commercial case studies (Rivera 2006:27). Another notable innovation is a rescheduling of the academic calendar at Bunda College in Malawi to mimic the crop cycle, starting the academic year with the planting season and concluding at post-harvest (Harawa 2006:22). A third positive example can be found at the Centre for Distance Education of the Faculty of Agronomy and Animal Science in Cameroon, which offers two-year diploma programs in animal and crop production plus management of agricultural enterprises (Fontem 2006:20–22).

Practical instruction receives insufficient emphasis

Hands-on training for students is minimal, work placements are limited (but receiving increasing attention), and no country offers job placements services to graduating students (Rivera 2006:20). Work placements are essential, not a luxury, for Africa. They expose students to actual problems of production, processing, and marketing. They connect classroom teaching with the real world. But available school farms tend not to be used much or well (Ghana, Kenya), and practical lessons are limited (Kenya, Rwanda) (Vandenbosch 2006:79; Ndejuru and Calixti 2006:66). In addition, guidelines are missing for assessment of practice and examinations ignore practical lessons (Kenya, Ngesa 2006:70,73; Rwanda, Ndejuru 2006:67). If a subject is not examined, students and parents will tend not to take it seriously. Supervision of practical training is weak. Learners are left alone without any guidance, no demonstrations, few explanations, and farm work is not linked with academic learning objectives (Vandenbosch 2006:76). However, some refreshing exceptions exist. In Ethiopia, students undertake an eight-month apprenticeship as part of their training (Vandenbosch 2006:79). In Mozambique, a substantial component of the curriculum at the new Polytechnic Institute of Chokwe consists of field practices during the students' first two years (Rivera 2006:27).

Learning infrastructure is deficient

Provision of adequate learning-related facilities and equipment is one of the greatest challenges that AET systems face. When budgets are tight, the last item to be cut is staff salaries. Thus, budget cuts fall most heavily on maintenance, equipment, teaching supplies, and building programs. Several observers tell of "asset stripping" in AET institutions (Wallace and Nilsson 1997:13). Ethiopia and Kenya report serious shortages in instructional materials, in part because teachers have not been taught how to develop them (Merkorios 2006:34; Ngesa 2006:69,72). Laboratories tend not to be adequately equipped in Rwanda (Ndejuru 2006:66) and are reportedly obsolete in Malawi (Harawa 2006:21). In Mozambique,

the Eduardo Mondlane University Faculty of Agronomy has increased sharply the number of students, but its infrastructure remains the same as at independence in 1975 (Gemo 2006:39).

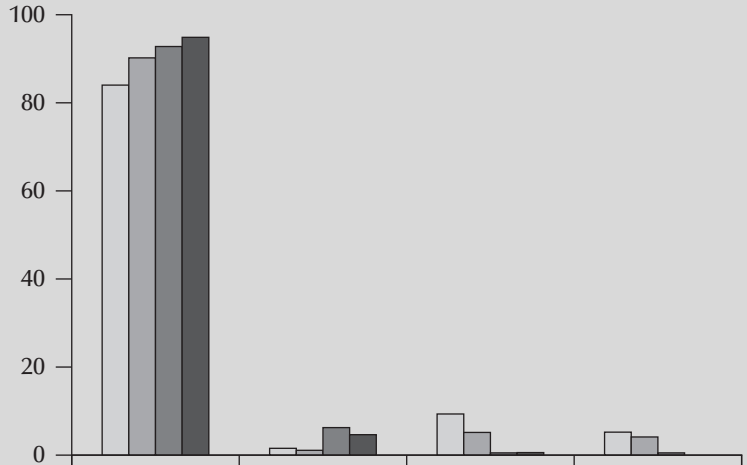
Where infrastructure is expensive and highly specialized, sharing facilities is a promising solution. In Kenya, Biosciences eastern and central Africa (BecA), is demonstrating the effectiveness of this strategy. Formed in 2005 to develop bioscience research and produce technologies that improve small-farmer productivity, BecA consists of a common biosciences research platform, with research, training, and support services located at the International Livestock Research Institute in Nairobi. This facility serves as a hub for a regional network of laboratories and other nodes that agree to make their facilities available for regional use. Also, attention to institutional inequalities in infrastructure through conscious resource reallocation—such as the RUForum's program of "nurturing grants" for its less well-endowed institutional members—can serve to initiate a process of redress that is likely to lift staff morale.

Although laboratory equipment may be antiquated and in short supply, this is not to suggest that it is broken or neglected. In many agricultural laboratories, remarkable efforts are made to ensure that ancient equipment remains operational. Laboratory technicians responsible for equipment maintenance in these settings are generally motivated by reasonable career ladders, opportunities for job-related training, and a clearly defined set of responsibilities. A similar approach to the management of academic staff might generate improved performance.

Insufficient budgets and overdependence on public financing result in poor facilities

Funding of higher education generally kept pace with the growing numbers of universities and students during the 1960s and 1970s, but retrenchment in domestic support meant that budgets have fallen well below the growth in students since the 1980s (InterAcademy Council 2004:170). For African universities a whole, real spending per student declined from USD 6,300 in 1980 to USD 1,200 in 2002 (Beintema, et al. 1998; Darvas 2007). Insufficient budgets, in turn, are often the result of excessive dependence on diminishing government and/or donor financing. In Ghana, for example, the tertiary AET institutions generate little in the way of nongovernment resources (see Chart 4.7).

Chart 4.7 Ghana: Sources of Financing in Various Tertiary AET Institutions, 2005 (% of Total)



	Govt.	Donors	Students	IGA
U. Cape Coast	84	1.5	9.5	5
U. Ghana	90	1	5	4
Kwadaso A.C.	93	6	0.5	0.5
Ejura A.C.	95	4.5	0.5	0

Source: Kwarteng 2006:16–18.

IGA = internal income generating activities; A.C. = agricultural college

But at the same time, all institutions except Ejura Agricultural College report a decreasing trend in government financing. The resulting "cash crunch" is self-evident.

In summary, AET supply is often out of synch with labor market demands in terms of knowledge and practical competencies, especially agribusiness, basic management, and problem solving. In some countries, well qualified teachers and professionals are available for AET, specifically at universities and agricultural colleges in Cameroon, Ghana, and Uganda. However, these are exceptions to the prevailing pattern. In general, post-secondary AET is not realizing its potential contribution to agricultural development because of (1) lack of linkages with research and isolation from knowledge sources; (2) external problems, such as fragmented organizational responsibilities for AET; and (3) internal problems in terms of underfunding, unattractive working conditions, and consequent staff depletion. African universities ultimately will be responsible for replenishing the stock of human capital in their research and extension services, and for providing them with the broader set of skills necessary to grow agriculture in the 21st century, but they are ill-prepared to train the continent's next generation of agricultural scientists, professionals, and technicians (Eicher 2006: 33). As stated by NEPAD in its Framework for African Agricultural Productivity, "... Urgent action must be taken to restore the quality of graduate and postgraduate agricultural education in Africa" (NEPAD 2006:12).

5 What Guidance Can Global Experience Provide?

What does global experience tell us about development of AET systems? Global experience shows it is possible to build productive and financially sustainable AET and research systems (Eicher 2006:42). [34] Both the USA and Japan established highly effective decentralized public research and training systems that dealt with problems of microecologies and, in effect, stimulated marketlike forces (Ruttan 2001 in Eicher 2006:12). Denmark mounted a highly competitive agricultural system on public investment and the refusal to erect tariff barriers to competition. The Netherlands system of agriculture emphasizes public-private partnerships and the ability to learn from experience.

More recently, developing countries such as India, Malaysia, Brazil, and the Philippines have established productive AET systems. The Indian system of state agricultural universities has been highly successful, as is the University of the Philippines Los Banos. In addition, the agricultural research systems in Brazil and Malaysia have been built on close linkages with higher agricultural education. A review of these and other experiences points to the importance of six factors.

MOBILIZE POLITICAL SUPPORT

Mobilizing and sustaining political support for AET investments is simultaneously the most important and most difficult issue to address in designing and financing a system of agricultural development institutions (Eicher 2006:29). Both the USA and Japan developed wide-based support for AET systems through decentralization that mirrored market forces and built strong farmer associations. In addition, case studies of four developed countries point to the importance of internally motivated and executed reforms. For example, an active 16-year lobbying effort accompanied the Green Revolution in India (Eicher 2006:34). In West Africa, Senegal and Côte d'Ivoire host vibrant farmers' associations that have played strong lobbying roles. In Uganda, the recently established National Universities Forum Uganda Ltd. states that one of its objectives is to push for a greater political commitment to agricultural development. The Forum is a legally registered organization, which brings together three public universities, two private universities, the National Agricultural Research Organization, the National Agriculture Advisory Services, the Ministry of Agriculture, the Uganda Farmers

Federation, and the Uganda Professional Agriculturalists Association (Bekunda et al. 2007). Such a linking is an important step towards the establishment of a national agricultural innovation system.

PUBLIC INVESTMENT IN AET IS ESSENTIAL

Public investment in capacity building has been essential for creating the scientific leadership necessary to implement each country's strategy for agricultural development. Africa's allocation of an average of just 2.4 percent of government budget is distressing in a continent where about 60–80 percent of the people depend on the rural sector for jobs, food and income. (Fan and Rao 2003 in Eicher 2006:30). By comparison, India spent 10–20 percent of government budget on agriculture in the 1970s, and Malaysia spent 20 percent (Jenkins and Lai 1992 in Eicher 2006:30). Significant public investment in higher agricultural education played an important role in Denmark's transformation from a grain-dependent to a diversified agribusiness exporter (Eicher 2006:25). One of the important lessons of the Malaysian success story is that the government can play a critical role in investing public funds (Eicher 2006:17). State financial support was essential in India in establishing and operating state agricultural universities (SAU). But today the states finance 80 to 85 percent of SAU budgets (Eicher 2006:20). Public sector investments have been strategically important in both research and human capital improvement in Brazil (Eicher 2006:24). In spite of its huge contributions to the expansion of agricultural exports, the Brazilian Agricultural Research Enterprise (EMBRAPA) still receives 97 percent of its budget from public sources (Roseboom 2004 in Eicher 2006:24).

REFORMS NEED SUSTAINED COMMITMENT OVER DECADES TO PRODUCE RETURNS

International experience shows that building a system of core AET institutions is a process of capacity accumulation that takes sustained commitment over multiple generations to produce returns (Eicher 2006:30). It took Brazil, India, Japan, and the United States 40 to 60 years to develop a productive and financially sustainable system (Eicher 2006:30). India's development of agricultural research was supported by long-term donor assistance to build an agricultural knowledge system (Eicher 2006:21). The University of the Philippines at Los Baños–Cornell University academic partnership has lasted 50 years (Eicher 2006:14). EMBRAPA's success story reminds African scientists that much depends on sustained efforts over a period of 30–40 years (Eicher 2006:24). The Rockefeller Foundation discovered that 20 years was too short a time to build strong and effective universities (Court 1993). Determined commitment throughout the ups and downs of leadership, institutional and political changes is needed (Eicher 1999:30, 43, 50). In Africa, the value of sustained commitment is visible at Sokoine University in Tanzania, where a 30-year collaborative effort by the governments of Norway and Tanzania has succeeded in building a solid professional institution. Today Sokoine boasts a well-trained complement of staff in a range of agricultural and natural resource fields, good facilities, and an active farmer-oriented research program. Notably, it now trains the bulk of the country's agricultural and natural resource professionals.

INTEGRATED ADMINISTRATIVE STRUCTURES ARE DESIRABLE

The administrative separation of research and higher education in many African countries cripples the development of national agricultural innovation systems (Eicher 2006:10). Where possible, minimizing the transaction costs of coordination between research, extension and training can pay handsome dividends. Integrating oversight responsibility for the agricultural innovation system under a single administration has worked in the United States and several other countries. It would be counterproductive to promote a single model of agricultural higher education, but the U.S. model of the land grant universities, where elements of agricultural education, research, and advisory services are subject to a common governance and management structure, has borne fruit in several cases. This approach was not successful at the University of Nigeria, but proved effective at Ahmadu Bello University (Nigeria), in part as a result of strong local political commitment. (ibid.). In India, the transfer of state extension and research to state agricultural universities was resisted initially, but proved successful in the long run.

MASSIVE CAMPAIGNS TO DEVELOP HUMAN CAPITAL HAVE WORKED

The research-extension model of agricultural development represents an incomplete and unsustainable model of technology generation when no consideration is given to human capital replenishment from local and regional universities (Eicher 2006:30). In fact, ambitious programs for the development of human capital have helped determine the success of national agricultural research systems. A major buildup of human capital was a central feature of India's drive to forge a productive agricultural research, extension, and education system. The Rockefeller Foundation awarded 90 short-term travel grants to Indian scientists and teachers to visit agricultural colleges and experimental stations in the USA between 1959 and the early 1980s. India sent more than 1,000 Indians for advanced training in agriculture and natural resources to the United States during the 1960s and 1970s (Lele and Goldsmith 1989 in Eicher 2006:20).

In the 1960s, the Brazilian government, in partnership with USAID, strengthened undergraduate programs in Brazil's agricultural universities and trained more than 1,000 academic staff. In 1970–1971, more than 900 Brazilian graduate students were studying agricultural sciences in U.S. universities (Swanson 1986 in Eicher 2006:22). The results of Brazil's human capital improvement are impressive. At the University of Fortaleza in the Northeastern State of Ceará, only 2 percent of the faculty had advanced degrees in 1963. A decade later, 82 percent of the faculty held advanced degrees (Sanders et al. 1989 in Schuh 2006 in Eicher 2006: 23). When EMBRAPA became operational in 1973, it took the difficult strategic decision to upgrade the quality of its scientific staff by retaining only half of the 6,700 employees in the old agricultural research system. EMBRAPA used a USD 100 million World Bank loan plus its own funds to send 500 agricultural researchers for PhD degrees. It then spent 20 percent of its total budget from 1974–1982 on training programs in Brazil and abroad. In the late 1970s and early 1980s, EMBRAPA had an average of more than 300 researchers enrolled each year in postgraduate training programs. Today half of EMBRAPA scientists hold a PhD degree. These are the scientists and professionals who have contributed significantly to the impressive growth and diversification of Brazilian agricultural exports over the past three decades.

Aggressive human resource development programs have paid long-term dividends for Brazil, Malaysia, and India. Why not for Africa?

INCENTIVES ARE NECESSARY TO RETAIN STAFF

How to retain staff in the sector and in the country once they are trained? The critical issue is having a professionally rewarding environment as a means of attracting postgraduates to return to Africa and stay. In Brazil the University Reform Act of 1968 tied promotions to higher graduate degrees and other academic performance criteria on agricultural higher education (Eicher 2006:23). The Malaysian government focused on designing an incentive structure to mentor and retain scientists rather than trying to attract members of the Diaspora to return home (Eicher 2006:16). Malaysia used monetary (subsidized automobile and housing loans) and nonmonetary incentives (free travel to Mecca) to reward and retain scientists. Research officers in Malaysia have opportunities for overseas study after one to three years on the job (Eicher 2006:31). In addition, shifting enrollment toward women students has helped. Now 34 percent of the agricultural researchers are female, and local family ties make them less likely to emigrate than males (Eicher 2006:16). Chile has also developed a system of institutions and incentives to reward and retain agricultural scientists. Chile has 16 universities with agricultural research capacity, and they form extremely important components of the national agricultural research system. The handful of agricultural researchers in Chile's four universities in 1960 had grown to over 300 in seven universities by 1995. Competitive research grant programs represent a large share of research funds for universities, and they have reportedly been instrumental in staff retention (Roseboom 2004 in Eicher 2006:31).

6 Priorities for Modernizing Agricultural Education and Training

Based on the foregoing analysis, seven common priorities are proposed for consideration by government officials, institutional managers, and donor representatives who desire to modernize agricultural education in Africa: creating political will, establishing productive external linkages, rebalancing the AET enrollment profile, adapting curricula to the "new agriculture," replenishing and retaining human capital, mobilizing finance, and achieving gender parity. Each is discussed in sequence below.

GENERATE POLITICAL WILL TO SUPPORT AGRICULTURE

First and foremost, unflagging efforts are required in order to generate the political will needed to elevate the priority of agricultural development on national agendas. India's Green Revolution was accompanied by 16 years of active political lobbying in order to maintain the political will required to see the effort through to a successful conclusion (Eicher 2006). As noted earlier, producer associations in Japan, Brazil, and the United States have all played key roles in creating and maintaining political support for agricultural development policies. How can political will be created? Three activities hold the key to success.

Educate the public

People (and politicians) cannot support what they do not understand. The key institutional actors, both public and private, in the agricultural sector are the logical parties to take on the task of public education concerning the importance of agriculture in the national economy. AET institutions, particularly universities, are especially well-equipped to do this as the result of their above-average communication skills, their knowledge networks, and their research capabilities. Most national newspapers contain a periodical supplement on education; AET staff should ensure that agricultural education gets its fair share of such news coverage. Television and radio talk shows are equally appropriate channels for public education. And the message should not be simply that agriculture is important for the nation's welfare, but that the study of agriculture and the pursuit of agricultural professions is one of the main means of improving performance in the agricultural sector.

Create capacities for lobbying and join forces with other stakeholders

Politicians respond to political pressure. Whenever stakeholders can join forces, their capacity to apply such pressure increases. Farmers' organizations in Denmark, Japan, and the United States all played important roles in keeping agricultural policy issues highlighted in the political arena (Eicher 2006), and similar associations in Senegal are beginning to constitute a formidable lobbying presence. In some cases, networks or confederations of rural development NGOs may be able to add their voices to those of producer associations to strengthen their impact. At the same time, national stakeholder platforms for dialogue such as those fomented by RUForum can orchestrate the views of agricultural professionals and technicians. Meanwhile, "top-down" efforts by NEPAD and FARA can seek to transmit similar messages through the highest levels of government.

Sustain these efforts for a decade or more

As noted earlier, building agricultural capacities, generating the right innovations in technology and organization, and ultimately achieving progress in the agricultural sector is a multigenerational process. Long-term commitment is required, and persistence is likely to be the greatest virtue. The impressive accomplishments at Sokoine University of Agriculture in Tanzania are largely the result of 30 years of determined efforts by university leaders, government officials, and key development partners. In agriculture, quick successes are rare, but incremental progress is not unusual. The secret lies in staying the course.

BRING AET INSTITUTIONS INTO THE NATIONAL AGRICULTURAL INNOVATION SYSTEM BY ESTABLISHING BETTER INSTITUTIONAL AND MARKET LINKAGES

AET, as stated Chapter 3, tends to be inward looking and insular—isolated from markets, from research and extension, and from international knowledge sources. As a result, it falls far short of fulfilling its potential to energize national agricultural innovation systems (Davis et al. 2007). What can be done to break AET's isolation?

AET systems should align themselves with national agricultural priorities and market requirements

Such alignment requires better information about labor market needs and trends in agricultural employment. This information is exceedingly rare in Sub-Saharan Africa. Therefore, institutions should consider setting up permanent mechanisms for monitoring the job market and adapting their curricula in response to changing employment opportunities (e.g., as the result of major public policy initiatives) and to shifting skill demands (e.g., due to market opportunities and technological advances) (Vandenbosch 2006:102). In particular, more systematic data are needed on graduates through tracer studies to ascertain the external productivity of training.

Sokoine University of Agriculture in Tanzania is one of the few AET institutions to have surveyed its graduates and their employers for feedback on graduate performance in employment (Sokoine University 2005).[35] In 2004, it commissioned tracer and employer studies for all of its nine major academic programs. The tracer studies found that, although the public sector remained an important employer, accounting for roughly one out of every three graduate hirings over the years, public employment opportunities were seen to be stagnating as the result of limitations on the government workforce, the privatization of state farms and parastatal industries, and plans for the outsourcing of some extension services. To a large extent, the bulk of public hiring in the agricultural sector was found at the local government level as the result of government's decentralization policies. Reflecting strong economic growth averaging 6.9 percent over the past six years, the private sector has emerged as an important source of agricultural jobs, absorbing 20 to 35 percent of all graduates—with the notable exception of agricultural extension. The NGO sector appeared as a smaller but growing employer of 10 to 20 percent of agricultural graduates. With the exception of forestry (32 percent), unemployment rates across agricultural disciplines were generally in a reasonable range of 5 to 8 percent. On balance, the demand for agricultural graduates in Tanzania is expected to remain steady over the next several years, with the majority of jobs involving some type of producer advisory service (either public or private) at the local government level. However, in many cases these services go beyond the traditional

Table 6.1 Percentage Distribution of Sokoine University of Agriculture Graduate Employment, 2005

PROGRAM	No. of respondents	Employed by				In postgraduate studies	Unemployed
		Govt agencies	Private sector	NGOs	Teaching institutions		
Agricultural Economics & Agribusiness	137	30	37	19	6	8	—
Agricultural Education & Extension	95	36	2	8	45	3	5
Agricultural Engineering	93	33	36	12	10	—	8
Agriculture, Agronomy, Horticulture	84	63	9	25	—	—	4
Animal Science	36	22	nr	nr	nr	nr	17
Food Science and Technology	246	34	37	8	—	—	11
Forestry & Environmental Science	124	32	18	12	—	4	32
Home Economics & Human Nutrition	151	62	11	13	4	4	6
Veterinary Medicine	40	26	nr	nr	nr	nr	8

Source: Sokoine University 2005.

nr = not reported

extension focus on farm production to embrace credit, marketing, processing, natural resource management, and other complementary activities. Sokoine's tracer study results are summarized in Table 6.1.

Although Tanzania is but one of among 45 countries in Sub-Saharan Africa, it may be taken as somewhat representative of those particular countries—13 in total—that have averaged 5 percent economic growth or more over the past five years.[36] Many of these countries (but not all) have adopted similar policies of downsizing and decentralizing government services, privatizing former government enterprises, providing incentives for private sector development, and reducing barriers to trade and investment. In most of these strong-growth countries, anecdotal reports confirm that labor market demand for agricultural graduates is rising in the areas of agribusiness, credit and marketing, product processing, natural resource management, and rural community advisory services. Based on the Sokoine study, the main areas of projected employment growth and stagnation for agricultural graduates in Tanzania are highlighted in Table 6.2.

The projections in Table 6.2 above reflect the growing diversity in labor market demand as job prospects in the private sector increase. This trend extends beyond Tanzania into the region, where private sector opportunities are stimulating the reorganization of faculties of agriculture and the development of new departments, laboratory capacities, and curricula. For example, Makerere University has created a College of Agriculture and Natural Resources Management. Within this dynamic context, particular attention is being given to agribusiness, food technology, and agricultural engineering. Two distinct thrusts are observed: (1) the incorporation of molecular biology into crop science, horticulture, and animal production; and (2) the emergence of natural resources management as a combination of soil science, forestry, water resources, rangeland management, and environmental science.[37]

Table 6.2 Projected Employment Area Trends for Agricultural Graduates in Tanzania, 2005

PROGRAM	High growth areas	Moderate growth areas	Stagnant
Agricultural Economics & Agribusiness	Agribusiness.	Agricultural policy; teaching; rural credit programs.	
Agricultural Education & Extension	Agribusiness.	Local govt. extension; marketing; environmental conservation; banking and credit; NGO extension.	Ministry extension services; secondary-level teaching.
Agricultural Engineering	Irrigation; water management.	Local governments; mechanized agriculture; food processing.	Ministries; parastatals.
Agriculture, Agronomy, Horticulture	Agricultural processing; flower industry; seed industry; bio-technology.	Agricultural credit; produce marketing; natural resources management.	Ministries; parastatals.
Animal Science	Local governments	Range management	Ministries; parastatals.
Food Science and Technology	Food processing; food quality control; beverage production; food analysis; preservation.	Analysis, certification and standards.	Ministries; parastatals.
Forestry & Environmental Science		Natural resources management; government forestry. Environmental education.	
Home Economics & Human Nutrition	AIDS nutrition in govt. and NGO programs.	District Council development officers; NGO community health programs.	Teaching; ministries.
Veterinary Medicine	Local governments; livestock production.	Private sector; self employment meat inspection; artificial insemination.	Ministries; parastatals.

Source: Sokoine University 2005.

Employer surveys also generate important feedback on the relevance of AET curricula and content. In the Sokoine study, employers across a range of agricultural disciplines underscored the following areas as needing greater emphasis within current agricultural education and training programs in order to generate more productive graduates:

- Entrepreneurship
- Practical training for applied skills development
- Information and communications technology literacy
- Oral and written communication skills
- Additional elective subjects to enable greater graduate specialization.[38]

Overall, countries need to achieve better strategic alignment of AET curricula with national agricultural priorities (Rivera 2006:13, 36). One way to do this would be to create discussion platforms among stakeholders for setting national priorities in AET vis-à-vis agriculture development plans in each country. For example, RUForum has encouraged the creation of a national forum in each of its member countries as a mechanism for accelerating the flow of information, building consensus around strategic priorities, improving coordination among agricultural institutions, and lobbying for political attention to agriculture.

Integrate AET institutions within national and regional agricultural innovation systems

From an innovation systems perspective, the concern is that AET institutions are generally too

weakly incorporated into agricultural innovations systems for them to fulfill their potential as innovation agents. The current organizational structures, behaviors, and beliefs have their roots in a rather mechanistic application of the linear vision of science (described earlier) that does not adequately account for the uniqueness—the inherent differences in markets, institutions, history, governance, and culture—of each country. As a result, policies in both agriculture and education focus almost exclusively on science-based strategies to boost yield and output through what amounts to simple technology package transfers to smallholders. Yet in a vibrant innovation system, efforts to promote agricultural development would be more broadly defined as a combination of institutional endeavors to develop innovation clusters, value chains, contracting arrangements, information networks, and other systems that bring together *technological* improvements in production, processing, and distribution with *organizational* improvements in how information and knowledge are exchanged among various actors in these systems, and with *policy* changes that create favorable incentives and institutions to promote change (Davis et al. 2007:42). In short, institutional networking in all its forms allows AET institutions to enter the innovation system and play an active part in it.

Because innovation systems obtain their energy and ideas through interactions, networking is the glue that joins them in common endeavors. Networks in all their forms (national forums, subregional organizations, professional associations, institutional partnerships, and collaborative postgraduate programs) offer three specific benefits to their participants: (1) they help to overcome scientific isolation; (2) they enable broader mobilizations of capacity than would otherwise be possible; and (3) they play an important quality assurance function through information sharing and peer review. Network linkages can be backward to the secondary, technical, and primary education subsectors, forward to employers and producers, and lateral to other types of AET institutions.

The ideal management arrangement would be to have all three sides of the knowledge triangle under one administration, as is done in the American land-grant model. However, institutional domains are too well established in most African countries for this to be feasible. Eicher recommends that the ministry of agriculture should be given responsibility to implement at least two of the three core components (education, research, extension) because the transaction costs are high when these components are managed by separate ministries (Eicher 2006:38). Modified organizational arrangements that put all AET institutions under a single authority, rather than divided among different authorities, could facilitate coordination. But on the whole, ministries of agriculture have proved inappropriate bodies for the administration of education programs (Wallace and Nilsson 1997:19; Atchoarena and Gasperini 2003:26).

More importantly, governance structures of AET institutions should be modified to provide for greater institutional autonomy and increased participation by stakeholders. Granting more management autonomy to AET institutions introduces the flexibility required to shape responsive, agile, and innovative institutions. Placing employer and producer representatives on their governing bodies, particularly at the tertiary level, can provide a powerful incentive to link training with market demand.

Access to international knowledge sources is becoming increasingly easy, but often requires external assistance

Access to global information resources on agriculture, for example, can be much improved in spite of limited access to computers and/or connectivity through subscriptions to The Essential Electronic Agricultural Library (TEEAL), developed by Cornell University with assistance from the Rockefeller Foundation. This annually updated collection of 140 of the world's major agricultural journals from 1993 to 2005 is available either as a local area network (LAN) mounted on a 300 GB external hard drive for USD 3,500 or as a set of 460 compact discs for USD 5,000. Where connectivity is available, the Access to Global Online Research in Agriculture (AGORA) program offers inexpensive linkages to 3,000 scientific journals covering a range of agricultural fields (Eicher 2006: 44–45). These services are supplemented by OARE, an online database of 1,000 journals covering disciplines related to the environment and its management. Launched in 2006 by the United Nations Environmental Program and Yale University, it contains the outputs of three dozen publishers.[39]

Box 6.1 Mali Agribusiness Incubator

The Mali Agribusiness Incubator is designed to assist entrepreneurs in agriculture-related efforts. Its goal is to facilitate the integration of modern technologies into Malian agricultural practices. The initiative is a partnership between an agricultural research organization, Institut d'Économie Rurale, and a higher education institution, Institut Polytechnique Rurale. The Incubator is staffed by seven professionals with diverse disciplinary backgrounds who recently received graduate training through USAID sponsorship. It is organized into three operational sections: Plant Biotechnology, Engineering, and Innovative Outreach. Initial activities focus on improved post-harvest storage, disease-free seed production, soil analyses, a disease diagnostic clinic, and shea butter export. The Incubator responds to a perceived disconnect between teaching, research, and extension activities, and their general isolation from small-scale farmers.

Source: Authors.

The Bunda Agricultural College in Malawi has clear policies promoting interconnections with research organizations (Harawa 2006:21). Makerere University has forged formal links through memorandums of understanding with, among others, national agricultural research organizations, IFPRI, FAO, and the African Research Consortia (Obua 2006:21). In Ghana, formal ties have been established between AET institutions and research institutions. An example is the development of new cassava varieties, in which Ghanaian universities have worked closely with the Council for Scientific and Industrial Research and the Ministry of Food and Agriculture (Kwarteng 2006:31).

Better linkages to markets and end-users will go a long way toward addressing a unique challenge in African AET—overcoming skepticism about the value of agricultural careers that distorts current enrollments.

ASSESS AND REBALANCE AET ENROLLMENT PROFILES

Technical education pyramids

In Chapter 4, the concept of a "technical education pyramid" was introduced. The agricultural sciences can be viewed as a constituent "slice" of this pyramid. Although some guidelines have been given (e.g., FAO), there is no universal prescription for how this pyramid should be shaped. What is critical is to realize that the shape of the pyramid is a policy variable that can be monitored, evaluated, and modified to suit a nation's needs. Governments and their ministries should know what the shape of their pyramid is, and should have an opinion on whether the current shape is appropriate for supporting future human resource needs. Mozambique is one country that has sought to put in place a technical pyramid for agriculture that supports its local, provincial, and national development strategies (see Box 6.2).

Box 6.2 Creating an Agricultural Education System in Mozambique

The government of Mozambique is working to construct an appropriate technical education pyramid for agricultural education. The first building block was the Faculties of Agronomy and Veterinary Medicine at Eduardo Mondlane University, which date from Independence in 1976. They were complemented by the introduction of diploma-level training provided by the Agrarian Institute of Chimoio (1976), the Agrarian Institute of Boane (1986), and the Agrarian Institute of Chokwe (2004). Next, private higher education was authorized in 1996 and led to the establishment of the Catholic University and the Mussa Bin Bique University to serve the center of the country, both of which offer diploma and degree programs in agriculture. Then, applied programs in agriculture were initiated at two new agricultural polytechnics in 2006. Finally, a Masters program in Rural Development was launched at Eduardo Mondlane University in 2006. In this way, a geographically dispersed system of public and private institutions offering agricultural education at various levels has sequentially been put in place.

Source: Authors.

REORIENT CURRICULA AND MODERNIZE TEACHING METHODS

Agricultural innovation requires a cadre of professionals with a new skill set and mindset (see Introduction). Agricultural education needs to move away from a mere transfer of information to the development of skills in accessing and applying available information for agricultural problem solving. As stated by the InterAcademy Council (2004:182): "The overall objective of universities in revising and reorienting their agricultural undergraduate curricula should be to produce graduate scientists who are able to conceptualize, implement and direct projects with producers; analyze ecological and conventional food production systems; integrate biology, economics and ecology in food systems; use systems approaches for complex problems; analyze policies on agriculture and food as they relate to sustainability; and process the right values toward people and the environment." Multidisciplinary approaches are called for that address the needs of the various producers, including those in subsistence, market-oriented, and commercial agriculture (Orden 2004).

In the medium term, efforts to improve AET in Sub-Saharan Africa might emphasize interventions designed to develop further the innovative capabilities of the region's human capital base. Such efforts would focus on the provision of learning opportunities geared to the specific needs of different actors in the innovation system, rather than on traditional benchmarks set by academic standards or the public service. This would entail linking AET training and research agendas more closely to the needs of different user communities (such as smallholder farmers, rural traders, agroprocessors, and consumers), fostering stronger linkages between formal AET organizations and national extension systems (in all their plurality—public, private, and NGO), exploring new ways of leveraging expertise and resources from international research organizations and foreign universities, and working to meet the needs of private industry (IFPRI 2007).

Specific policies and programs would concentrate not only on improving formal AET organizations, but also on expanding post-secondary technical training institutes, inservice 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 need to recognize private provision of AET as a necessary complement to the formal, public sector AET system.

Curricula

An immediate step toward improving AET systems in Sub-Saharan Africa might be to realign the visions and mandates of AET institutions with national development aspirations by promoting new types of educational programs that are less encyclopedic and more strategically attuned to the different needs of social and productive actors. In countries with extreme resource poverty and weak research capabilities such as Ethiopia and Mozambique, the comparative institutional advantages of the AET system may be strategically maximized by rethinking visions and mandates—and the functions and roles that follow from them—relative to the country's development objectives. The goal here is to move the AET system into closer, more productive relationships with other actors within the innovation system (Davis et al. 2007).

Curricula need to be broadened to cover not only farm production but marketing, alternative crops, post-harvest technologies, agribusiness, resource management for sustainability (e.g., rainwater harvesting, conservation tillage), and pertinent soft skills. These reformed curricula should also be framed by the government's strategic priorities for future agricultural development. Teaching programs are becoming demand-responsive, as seen in some AET institutions, but major reorientation is still required in most cases to address new and emerging needs.

Given the decline in public sector employment in most African countries, curricular reorientation should incorporate both market-oriented and smallholder agriculture. Students should be exposed directly to farmers' circumstances. First, the focus needs to be on more practical "hands-on" training, with emphasis on competencies achieved and not on time spent in class. Second, the modes of training should shift from time-based, lengthy training that mirrors the system of general education toward shorter learning modules that add up to some form of certification. Third, development of training programs needs to be more participatory, involving not primarily AET experts but those who can articulate demands, i.e., producer organizations, NGOs,

commercial employers, researchers, and extensionists. Fourth, allowances must be made for adapting training content to local agro-ecological zones and indigenous knowledge (Vandenbosch 2006:101-102; Wallace and Nilsson 1997:34).

From an innovation systems perspective, evidence suggests that the distribution of innovative capabilities among individuals is highly skewed. Even though there are few methods to measure traits such as learning ability, task commitment, and creativity, it is generally accepted that not all individuals possess these traits together (Renzulli 2003). And because the distribution of innovative capabilities is skewed, it is often effective to design education and learning systems that are sufficiently responsive to different individuals possessing different combinations of different traits (Reis and Renzulli 2003).

One implication is that educational approaches and learning philosophies applied to AET in Africa need to accommodate different types of individual needs and learning styles. For example, tertiary education systems might consider diversifying away from well-structured degree programs centered solely on traditional disciplines, and moving into a wider offering of programs. These might range from short, applied courses to short-term professional training to long-term multidisciplinary degree programs (Davis et al. 2007:13).

Building such a menu for AET in Africa will require flexible policies and practices, such as employment regimes in which underperforming professionals can be fired and good professionals promoted; reliance on foreign expertise only to the extent that the foreign experts build competencies among local instructors; and governance cultures and organizational environments that foster innovation (Davis et al. 2007:14).

In Sub-Saharan Africa, various AET institutions have moved in the direction of updated, broadened curricula. At the regional level, the African Network for Agricultural, Agroforestry and Natural Resources Education (ANAFE) has been assisting university faculties, particularly in West Africa, to undertake undergraduate curriculum reviews and develop new instructional manuals. One notable effort to tackle these deficiencies is the professional upgrading programs developed for extension workers by local universities with assistance from the Sasakawa African Fund for Extension Education. Focusing on midcareer professionals, the program offers a reformed interdisciplinary curriculum leading to BSc and MSc degrees that emphasize technology transfer, participatory methods, and respect for local knowledge. To date, a dozen Anglophone and Francophone universities have participated (Muir-Leresche 2003:6; Kwarteng 2006:7; Maguire 2000:9). Similar curriculum modernization efforts are underway in Eastern and Southern Africa with encouragement from ASARECA and RUForum.

Institutional-level curricula reforms are gaining momentum. The Rwanda Institut Supérieur d'Agriculture et d'Élevage has adopted a competency-based curriculum to replace its classical programs (Makelele 2006:32–33; Rivera 2006:24). Tanzania's Sokoine University of Agriculture has conducted extensive tracer studies and employer surveys for all of its courses as the basis for institution-wide curricula reforms.[40] All four tertiary AET institutions surveyed in Ghana have made efforts to introduce more relevant courses, including a new degree in agribusiness at the University of Cape Coast, and post-harvest technology studies, agricultural business studies, and entrepreneurship at the University of Ghana. Content in nontraditional agriculture includes beekeeping, mushroom cultivation, and rearing *grasscutters,* small animals that are a local source of meat (Kwarteng 2006:11–12, 30; Rivera 2006:28). Malawi has introduced agribusiness and emphasizes self-employment and entrepreneurship (Rivera 2006:28). The Faculty of Agriculture at Makerere University has responded to the demands of the labor market by introducing new agricultural degree programs, including agribusiness management, agricultural land use and management, and horticulture (Obua 2006:36). Kenya's Jomo Kenyatta University of Agriculture and Technology has similarly adjusted its course offerings. Finally, the University of Pretoria has set up interdisciplinary degree programs in natural resources by combining the faculties of agriculture with that of natural sciences. The University of KwaZulu-Natal has taken similar steps to create an interdisciplinary study program in food security (see Box 6.3).

The revision of curricula for the midlevel training component of the Agricultural Technical and Vocational Education (ATVET) program in Ethiopia displays elements of good practice.

Box 6.3 Interdisciplinary Food Security Studies at the University of KwaZulu-Natal, South Africa

The University of KwaZulu-Natal's postgraduate Food Security Programme is a unique initiative that cuts across disciplines to train Africans actively involved in food security programs and research. Since its beginning in 2001, students from 10 African countries have participated. Currently 23 students are enrolled. Students begin their training with an interactive two-week course facilitated by 15 disciplinary specialists. The introductory module explores the diversity, complexity, and interrelatedness of food security issues. Transdisciplinary course modules on food production, storage and access; nutrition; sustainable livelihoods; food security information systems; simulation modeling; and food security research methodologies are offered through workshops and digital learning. Compulsory coursework components include public policy analysis, project design, and project evaluation. Students also take elective options from various disciplines and conduct research on food security. The program has drawn disparate academic staff together and strengthened their collaboration around complex food security issues. Graduates are expected to find employment in food and agricultural research, policy formulation, agricultural extension, teaching and training, and food aid monitoring. See www.ukzn.ac.za/foodsecurity.

Source: Authors.

Practical training has been strengthened by identifying the most essential skills in the professional courses, defining corresponding qualification standards, and establishing assessment methods. After one year of trial implementation, the content was revised based on inputs from various stakeholders. Graduate competencies were then specified (Vandenbosch 2006:52–54). In Kenya, innovations in both curriculum and pedagogy have been combined by the Baraka Agricultural College (see Box 6.4).

A few agricultural institutions have demonstrated effectiveness in preparing their students for careers in production agriculture. One compelling example is the Songhai agricultural training center in Porto Novo, Benin, which enables 65–70 percent of its graduates to settle into agriculture. The center is locally owned and privately managed. It has a capacity of 225 boarding places and offers training in small-scale farming, farm management, and agricultural teaching. About 20 percent of the trainees are women, and 60 percent of the trainees come from rural areas. The instruction favors application with more than 75 percent of instructional time devoted to practical subjects. Innovations in the training include creation of a business center of agricultural products, a soybean marketing chain, and organization of a credit program to

Box 6.4 Innovations in Teaching at Baraka Agricultural College in Kenya

One private institution in Kenya incorporates innovations in curriculum and pedagogy on several levels. Baraka Agricultural College, a private institution operated by the Fransciscan Brothers, focuses mainly on entrepreneurship and self-employment. Students undertake commercial operations on individual, 10-square-meter plots of land with a loan from the college. They keep proper records of production and expenses, employ the appropriate husbandry practices, purchase inputs, and sell the produce. The students then repay the loan and keep the net income. The learner-based approach to practice is also reflected in four-month field attachments for each student. The college collaborates with the ministries of agriculture and livestock, NGOs, and community-based organizations in arranging these attachments. In recognition of its achievements, Kenya's Ministry of Agriculture has seconded four of its staff to the institution. The college also provides learners with practical skills needed for income generation, such as making jam, yogurt, and bread (Ngesa 2006:65–68). See www.sustainableag.org.

Source: Authors.

help trainees establish themselves after training (Ogoudedji 2006:3, 46–48). Other institutions that have encouraged students to develop business plans and helped them to obtain financing for business start-ups include the Botswana Agricultural College, the University of Swaziland, the agricultural polytechnics in Mozambique, and Makerere University.[41]

Another example of good practice is at the Hargaz Agro-Technical School in Eritrea, a nongovernment agricultural technical school operated by the Franciscan Brothers. Management has a clear concept of the skills required by graduates in horticulture and animal science. Instruction has a practical orientation, with students undertaking field projects and daily work in the field with crops or animals. Students make daily observation and recording of their projects. When a problem is encountered, students are directed to ask classmates, then advanced students for help before approaching the teaching staff. The school also offers short courses for mostly illiterate farmers in irrigation techniques and equipment.

Makerere University has also undertaken a noteworthy effort to introduce targeted, flexible short courses for producers. Its Continuing Agricultural Education Center offers short-term training, outreach programs, workshops, and seminars to extension workers, agribusiness, and receptive farmers (Obua 2006:11). Many view it as a model for the provision of agricultural education outside of the formal diploma and degree programs.

Open and distance learning (ODL) offers great potential for increasing flexibility in the use of educational resources. In Meru, Kenya, the Methodist University has put together a six-month distance education program for agricultural professionals and farmers that addresses specific commodities and includes occasional hands-on workshops.

Teaching Methods

As slow as the pace of curricular reform may be, curricula are nevertheless changing faster than teaching methods. The techniques employed by academic lecturers are particularly resistant to change and are badly in need of retooling. They are generally assimilated by instructors through years of classroom lecture experience as students with "the sage on the stage" approach to teaching. More often than not, junior lecturers are forced to learn their craft through trial and error.

Modern pedagogy emphasizes that the teacher or professor is no longer the "font of all wisdom" but is rather a facilitator providing students with the inspiration to explore for themselves the ever-expanding oceans of knowledge. The educator's role should be to promote analytical skills, self-esteem, a sense of personal competence, and the capacity to participate in community and national affairs, as well as to build interpersonal trust and satisfaction (Muir-Leresche 2006a). The use of case studies can help to teach these qualities.

Regrettably, postgraduate programs do not normally include training in teaching techniques, use of instructional materials, or lesson planning, and institutions rarely take the initiative to make up for these oversights. One exception is Ethiopia, where the higher education system has set up pedagogical resource centers within each university in order to improve the effectiveness of the teaching and learning processes. With technical assistance from the government of the Netherlands, these centers offer workshops to build up teaching skills, professional development through self-paced learning, and instructional equipment for academic staff.

Fortunately, this problem is increasingly being recognized and engaged. For example, Makerere University and RUForum have partnered to produce an inservice short course for academic staff that emphasizes personal mastery of the "soft skills" needed to facilitate interactive classroom learning. The 12-module course covers a range of communication, class management, and social-psychological skills. It has been successfully piloted with 26 staff, and its instructional materials are available through RUForum for use by other institutions (Kibwika and Hagmann 2007).

Another useful reference for adapting pedagogy to new labor market demands is the manual for university instructors developed by ANAFE (Muir-Leresche 2006a). The manual gives educators practical ideas on how to implement small changes in their teaching approach to classes without necessarily having to wait for major institutional reforms in support of new pedagogical approaches. The ideas it presents are generic and relevant to all areas of education, but its examples have been developed for specifically for agriculture, agroforestry, and natural resources.

Spark student and public interest in agriculture

Progress in agriculture will be much slower if AET institutions cannot attract motivated and well-prepared students. The prevailing African view of agriculture as the "occupation of last resort" needs to be challenged and changed. Changes to institutional admissions processes that would allow students to choose agricultural studies, rather than be "assigned" to them, would be a good place to start. Guest lecturers representing the spectrum of agricultural employment, field trips, and student attachments would also help. AET leaders could also cultivate media contacts and create annual prizes to attract public attention. Concerted efforts are needed to explain to the general public that national development occurs through agriculture, not in spite of it.

Most importantly, students should be offered a menu of career options under the rubric of agriculture so they can see the breadth of its application. Career paths might be structured around agricultural marketing, post-harvest storage and processing, agribusiness, natural resource management, rural finance, and others. In some cases it may be beneficial to recast agricultural education in more modern and appealing terms. For example, the University of Mauritius enhanced its agricultural curriculum with agribusiness and food technology content. Likewise, a new master's program in Agriculture Information and Communications Management sponsored by the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) seeks to redefine agricultural extension as a communications and knowledge management profession. Such restructuring may help to rekindle student interest in agricultural careers.

REPLENISH HUMAN CAPITAL THROUGH LOCAL POSTGRADUATE PROGRAMS

The capacity to generate highly trained human capital for agriculture is constrained by limited opportunities for postgraduate study and imbalanced donor support for this goal (see Chapter 3). Investment in agricultural research networks has received much more donor funding than postgraduate training (IFPRI Seminar on Capacity Building for Agricultural Development 2006). Meanwhile, staff attrition due to brain drain, AIDS, and retirements is thinning the pool of AET teaching staff. Replenishing this pool through study-abroad programs is a declining option, as tropical agriculture recedes from the curricula of universities in Northern Hemisphere countries, the cost of overseas postgraduate studies rises, and donors remain resistant to large-scale scholarship programs. The only viable strategy is for Africa to grow its own experts.

Strengthen and expand national MSc programs

The key element in this strategy is to strengthen and expand national MSc programs. This is where the "capacity to build capacity" resides. It enables future rural advisory personnel to learn to solve problems, and future researchers to hone their investigative skills while adding to their country's stock of knowledge. Increased numbers of highly trained African agricultural specialists are needed to support agricultural commercialization, to staff research and extension systems, and to rejuvenate AET systems, especially at the tertiary level. The success of agricultural development in other developing countries, noted earlier, depended in part on massive programs of staff training (e.g., Brazil, India, and Malaysia). Much of this was achieved through the managed growth of national MSc. programs. Encouragingly, this process seems to be getting underway with the establishment of more than 15 new MSc programs in agriculturally related subjects within Eastern and Southern Africa over the past three years.

Lay the foundation for PhD programs

A large number of PhD degree holders in agriculturally related fields will be needed—at least 1,000 over the next 15 years—to staff these expanding MSc programs and to replace existing staff who will be lost to brain drain, AIDS and the imminent wave of retirements. This sizeable undertaking should be started immediately by using a combination of (1) existing national PhD programs of good reputation; (2) the emerging offering of collaborative regional PhD programs; (3) existing "sandwich" PhD programs; and (4) strategically chosen overseas PhD programs. As these doctoral candidates complete their dissertation research on local

topics, a significant addition will be made to existing knowledge on African agriculture, and dependence on foreign technical experts will be reduced.

Tackle the conundrum of incentives for staff retention

Expanding the supply of trained African agricultural scientists will not suffice by itself. It will be necessary to address also the root causes of high attrition and low retention among academic staff. Low pay is a clearly a factor. Real faculty salaries fell by 30 percent between 1980 and 1988 and have continued to decline in most countries. In Nigeria, university faculty salaries in 1991 were only 10 percent of their level in 1978 (InterAcademy Council 2004:171).

Various studies have found that a conducive professional environment may be just as important as income to many academicians (Eicher 2006:31; Tettey 2006). This applies particularly when the work environment enables a recent PhD holder to maintain the currency of the intellectual capital that he or she has acquired through doctoral studies and to put these skills to use. Measures that address this need are joint appointments of recent PhDs with institutions abroad, twinning and mentoring, start-up research grants, sabbatical leaves, and rapid career advancement (InterAcademy Council 2005:177, 180–181). Continuing professional development opportunities, such as those provided to graduates of the regional postgraduate program for University Science, Humanities and Engineering Partnerships in Africa located at the University of Cape Town, would help to keep staff engaged while maintaining their intellectual capital.

Incentives (in salary or in-kind) or public recognition for good performance in teaching and research can also help to retain productive staff. Internal decision making within AET institutions could be streamlined so as to reduce staff time spent in committee deliberations and to enable quicker decisions on staff requests for appointment, promotion, conference attendance, study leave, new course approval, etc. (Tettey 2006). In addition, administrative systems that allow educators and trainers to participate in management and decision making contribute to better staff motivation (Vandenbosch 2006:104).

Competitive funding opportunities for teaching innovation or research often inject creative energy and commitment into working environments by providing staff with the means to obtain a measure of professional satisfaction through the combined pursuit of personal and institutional interests. Competitive funds for developing postgraduate courses and building university research capacity have worked well in countries as diverse as Argentina, Chile, Ghana, Mexico, Tunisia, and Vietnam. Senegal's National Agricultural Research Fund, a competitive mechanism established in 1999 for funding agricultural research by public, private, NGO, and university organizations, has increased institutional collaboration and made research more demand-responsive (Stads and Sene 2004:7). RUForum's competitive grants program for staff and postgraduate student research is generating the excitement of intellectual discovery as it fosters farmer-oriented, interdisciplinary, problem-solving research.

African higher education institutions have traditionally emphasized scientific publications as a main criterion for academic promotion. This requirement has created an incentive system that encourages pure science and esoteric publication while ignoring problem-solving science. For university research to contribute more directly to solving the challenges of national development, the present incentive system for promotion will need to be modified. For example, the Jomo Kenyatta University of Agriculture and Technology in Kenya weighs intellectual property contributions (i.e., applied science patents) highly in the consideration of staff merits for promotion. This has paid off with the university registering 26 patents in the past five years (Ng'ethe 2007).

Brazil, China, Malaysia, Chile, and India have all succeeded in creating attractive working conditions, stemming brain drain, and attracting back home professionals who emigrated (InterAcademy Council 2004:181; Eicher 2006:31). It is not easy, but it can be done (see Box 6.5).

MANAGE FINANCES PROACTIVELY

The grim picture painted earlier about lack of facilities and equipment in AET is largely the consequence of inadequate financing, which, in turn, results from overdependence on dwindling public financing and reduced gap-filling by donors. Since the mid-1980s, AET institutions at all levels have suffered sharp cuts in real budgets. Decapitalization and "asset stripping" have taken

Box 6.5 The Challenge of Changing Organizational Culture

An organizational culture can be defined as a set of basic assumptions that are developed by a group in the process of learning how to deal with external adaptation and internal integration (Schein 1984). The set of assumptions is considered valid by the group if it has worked well enough in the past (by whatever standards the group may choose to assess it). This organizational culture is then taught to new members of the group as the correct way of approaching problems within the organization. In essence, organizational cultures define what an organization can and cannot do. As a result, they can either facilitate or impede innovation.

The above definition stresses that (1) an organizational culture is a set of beliefs, not values or behaviors; (2) it is invented by a group in the early days of the organization and is then passed on to newcomers; (3) building the culture takes time because it requires the repeated use of specific approaches to successfully tackle similar problems; and (4) 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).

Organizational cultures can also change suddenly, for instance, when the organization faces a major crisis or a massive induction of new members. But even when a large number of people are hired by an organization, it is often the case that the newcomers are expected to adapt to the prevailing culture. Only through repeated failures will the organization reexamine the assumptions and form new ones, even though the new assumptions will still be influenced by the ones they replace. In short, the evolution of organizational culture is a slow and path-dependent process. Among society's various institutions, the university is notoriously resistant to change.

A number of external and internal factors influence the emergence of an organizational culture. The external factors relate to the perception the founding group has about the environment and about how to survive in it. Internal factors concern the group's perception about how to organize relations among the organization's members so that the organization can survive while minimizing internal conflicts. The challenges of external adaptation are related to the development of a consensus about the organization's mission, objectives, and the means to achieve them. The internal factors are related to the development of common language and concepts, the establishment of the group's frontier—especially the criteria to exclude members—and the definition of power structures and incentives.

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

Implicit in this discussion is the idea that significant change is needed in the cultures and behaviors that characterize AET institutions in Africa. This includes a need to transform the cultures and behaviors of AET systems from those driven by traditional sets of beliefs about what AET can and should do—educating for scientific excellence, for example—into cultures and behaviors that allow for greater innovation—educating to create new applications of existing knowledge and information, products and processes, and organizational structures and management.

Source: Davis et al. 2007:17.

place (Wallace and Nilsson 1997:19) AET institutions face the unenviable but inevitable task of trying to perform well within a shrinking resource envelope (Atchoarena and Gasperini:263). There are three ways to address this challenge.

Make more efficient use of existing resources

Efficiency gains enable more to be accomplished with the same amount of funds, or the same outputs to be achieved at lower cost. One way to

achieve economies would be to outsource services, such as student cafeterias, and operate them on a commercial basis. For example, the Bunda College farm has been commercialized, i.e., turned into a limited liability company. It now breaks even instead of creating losses (Harawa 2006:12). Most resources in AET, as in other levels and types of education, are consumed by staffing costs, and these are the last to be cut. Consequently, making more efficient use of teaching time can be an effective way to do more with given resources. In one extreme illustration, an AET institution in Madagascar clearly has considerable scope for economizing. The EASTA (École d'Application des Sciences et Techniques Agricoles) under the Ministry of Agriculture has five classrooms, three workshops, a plot of land for experimental work and 33 staff, including three permanent trainers plus six or seven part-time trainers, but only 20 students. On the other hand, Cameroon provides a good example of progressive improvement in making more intensive use of its teaching staff, as seen in Table 6.3 below.

In general, the ratios of staff to students in agricultural faculties appear to be on the low side, averaging between 1:8 and 1:12 (Rivera 2006:19), but may reflect staff time devoted to nonteaching activities such as research and extension. Economies may be possible without sacrifice of quality. However, there is a thin line between quality and efficiency. Care must be taken not to push efficiency campaigns too far, as excessive class sizes are antithetical to quality instruction, particularly in laboratory or field-oriented sciences.

Another area for achieving efficiencies is to reverse (or avoid) fragmentation of AET institutions. The political pressure to open new universities is relentless. As a result, tertiary AET institutions have proliferated across the continent. Whether there is justification for having six public agriculture-related faculties in Cameroon, five in Ghana, and five in Kenya is an open question. Belgium, with a population of 10 million, has four universities with faculties of agriculture while its neighbor, the Netherlands, with 16.5 million people, has only one—a world-class university of agriculture at Wageningen (Eicher 2006:34; Eicher 1999:40–41). Fragmentation in Africa dilutes available resources, compromises quality, and prevents the achievement of scale economies. Ultimately this fragmentation makes the establishment of rewarding professional environments more difficult and impedes the emergence of strong centers of specialization.

AET institutions can mobilize nonpublic resources

At present, most AET institutions depend overwhelmingly on government financing, which in many cases is decreasing. Various means can be used, including income generation through fees from trainees, particularly where there is excess popular demand, offering short courses for employees to be paid by employers, and sale of agricultural products produced by students. The review of tertiary institutions in Mozambique concluded that the current low student fee structure results in a high financial burden for the government at a time when AET institutions and enrollments are expected to increase. It called for a review of the fee structure and for increased income from productive activities (Gemo 2006:41–42). It is essential in income-generating activities that the AET institutions are able to keep and use the funds generated or there will be no incentive to do so (Vandenbosch 2006:103–104). Senegal, in particular, seems to have been successful in diversifying its sources of funding. All post-secondary AET institutions reportedly are diversifying their training offerings to generate increased revenues (Rivera

Table 6.3 Staff-Student Ratio, Faculty of Agronomy and Agricultural Sciences (FASA), University of Dschang, Cameroon

	Teaching staff	Students	Students per staff
1995/96	85	373	4:1
2000/01	77	664	9:1
2005/06	58	660	11:1

Source: Rivera 2006:50.

2006:54). Bunda College has started a parallel academic program to admit additional qualified private students who pay a commercial tuition fee. However, the fee (USD 970) is still only 15 percent of the estimated cost per student. The semipublic Natural Resources College, on the other hand, charges USD 2,900 equivalent for its diploma program and raises 62 percent of its budget from student fees. Produce from its farm activities contributes another 5 percent (Harawa 2006:12–13).

Persuade donors to finance operating costs

Efforts at achieving efficiency and mobilizing nonpublic resources will help, but they are unlikely to be sufficient. Donors should be prepared to fund the *operating and equipment maintenance costs* that are essential for retaining skilled staff and enabling them to work productively. Examples of such recurrent costs include Internet access, performance incentives for staff, and laboratory maintenance. Donor financing of recurrent costs would be justified for the following reasons. First, AET is an integral part of strategies to develop agriculture. Second, it has a high payoff (Chapter 1), but has been neglected. Third, recurrent financing in AET is actually an investment in capital formation, the human capital necessary to make research, extension, and other high-priority activities succeed. Based on these considerations, the World Bank recently decided to lift its restriction on the use of its funds for recurrent expenses.

ACHIEVE BETTER GENDER BALANCE IN AET GRADUATES

Chronic underinvestment in the knowledge and skills of women is a particular handicap for African agriculture. Women play a dominant role in African agriculture and produce more than half of the agricultural output in most countries. Women head 31 percent of rural households, make up 42 percent of the agricultural workforce, and spend 13 hours a day on agricultural and food preparation activities (FAO 1995). Despite women's importance in agricultural production, agricultural extension and training focus almost exclusively on males, and services are provided largely by men.[42]

This omission inhibits opportunities for agricultural investment, growth, and income. For example, Udry et al. (1995) have shown that farm productivity is increased when women receive the same advisory services as men. Yet FAO studies found that women farmers receive only a 5 percent share of extension services, and that professional training was almost exclusively directed to males (Haug 1999:268). In Ethiopia's ATVET colleges, which are training the country's next generation of agricultural extension agents, just 9 percent of graduates and 6 percent of staff are women (Davis et al. 2007:49). Why do female researchers make up less than 10 percent of the agricultural research staff in twelve countries in Africa? Why do a large number of African countries make so little use of the intellectual power of women to address their fundamental problems in science and technology? (Eicher 2006:35). Is this not relevant to Millennium Development Goal No. 1 concerning the reduction of hunger, or No. 3, regarding the equality and empowerment of women? The answers to these questions undoubtedly are complex, but include problems of supply resulting from underenrollment of women in secondary-level sciences and tertiary AET institutions.

Recognition of the bias against women is rarely visible in AET organizations and policies. Thus, women are underrepresented as students, instructors, extension agents, and researchers, while agricultural innovation processes are rarely aimed at female users (Beintema 2006). Francis (2006:5) describes this as a policy blind spot:

> "It is noteworthy that the recommendations for improving food and nutrition security in Africa are generally silent on empowering women in science and agriculture. Where mention is made of women, the focus is on targeting women producers by providing tools that make their work lighter or by viewing them as passive receptors of technological advances."

Targeted recruitment policies, affirmative action initiatives, academic enrichment programs, and earmarked scholarships could be used to boost female enrollments. Riley suggested the following measures to achieve gender balance in Malawi: sensitizing curricula, aggressive recruitment policies, provision of adequate accommodation for female students, quota systems, recruitment of more women lecturers, and retention of women students by monitoring dropout records by gender, and introducing anti-sexual harassment policies (Riley 1995 in Wallace and Nilsson 1997:9–10). These

measures are likely have relevance beyond Malawi and deserve to be tested systematically in order to ensure that a country's best minds are engaged in its development efforts. Muir-Leresche (2006b:59) provides a more extended list of interventions, which are summarized in Annex 5.

Several important initiatives to increase gender mainstreaming in the agricultural professions are currently underway in Africa. In 1990, Winrock International launched a program to enhance the prospects of African women agriculturalists. To date, 37 women from nine African countries have been awarded scholarships to pursue degrees at the BSc or MSc levels. As of 2004, a total of 15 scholars had completed their degrees. Another innovative project to assist women is the African Women Leaders in Agriculture and Environment (AWLAE). The project is based in Wageningen University and is funded by the Dutch government. It currently supports 20 women from 12 African countries who are doing their PhDs at Wageningen on topics related to food in Africa and the impact of HIV/AIDS on agriculture (Eicher: *ibid.*). The Female Scholarship Initiative, initiated by Makerere University in Uganda and funded by the Carnegie Corporation, might serve as a model for initiatives elsewhere. It provides full scholarships of USD 1,200 each to 19 women of limited income to pursue studies in agriculture, so far with encouraging academic results (Obua 2006:18–19). RUForum has adopted a similar approach within Eastern and Southern Africa, awarding 40 percent of its 170 postgraduate fellowships to women.

The demand for women agriculturists also needs to be stimulated through programs to recruit many more women into agricultural extension and research programs (Vandenbosch 2006:103). Two relevant initiatives are: (1) the Rockefeller fellowships for enhancing the Careers of East African Women Scientists[43] funded by Rockefeller and Syngenta Foundations and administered by the CGIAR Gender and Diversity Program; and (2) the Normal E. Borlaug International Agricultural Science and Technology Fellows Program[44] funded by USAID for African Women in Science and managed by FARA and CGIAR Gender and Diversity Program. The new Strengthening Capacity for Agricultural Research and Development in Africa (SCARDA) program recently launched by FARA to buttress African national agricultural research systems includes the objective of raising the proportion of women researchers within these systems to 33 percent by 2012.

7 Approaches Vary by AET Level

What can be done at the various levels of agricultural education and training in Africa to build momentum in the face of existing constraints? Different strategies will need to be pursued at each educational level.

AET AT THE SECONDARY LEVEL

Agricultural secondary schools account for a minuscule proportion of students in formal secondary education across Africa. Therefore, they cannot expect to receive much attention from policymakers. Some of the institutions have excellent programs and results, particularly those run by NGOs and church agencies. A good scenario would be for them to be left to themselves to identify their own markets, mobilize resources, and allocate them to their priorities. Where public secondary agriculture schools cannot be adequately supported or have consistently poor results, then perhaps their programs should be converted into general secondary schools, which are less expensive to operate. After all, this is what parents and students seem to want most.

Prevent premature specialization, especially in lower secondary education

Lower secondary level typically enrolls youth around age 12–15, too young for specialized skills development. In fact, those who complete lower secondary may not even be of legal working age where such regulations exist. Lower secondary is more properly part of basic education. Education at this level should concentrate on giving students a solid foundation in reading, math, and science along with a capacity for problem analysis (Johanson and Adams 2004:9). Specialized vocational training should be eschewed at this stage. With regard to vocational programs at the junior secondary level such as the "Basic" Agricultural Schools in Mozambique (see paragraph 4.39), it would be preferable to convert these basic agriculture schools to general first-cycle secondary schools. This would be more cost-effective, would provide an improved foundation of basic education, and would correspond better to the aspirations of the students and parents.

Avoid upper secondary serving as an alternative path to university and emphasize acquisition of specific competencies for properly selected trainees

Similarly, at the upper secondary level many students and parents choose agricultural schools as a second choice when access is denied to academic secondary education. They aspire to pursue further education, which in the past meant access to better-paying jobs. Thus, students often are uninterested in the agricultural content and have no intention of pursuing careers in agriculture. This is a waste of resources because AET—with smaller class sizes, and higher equipment and maintenance requirements—costs more per student than general secondary education. Priority in these circumstances should be to expand the number of places in general secondary education rather than in agricultural secondary schools.

Secondary-level AET institutions face a dilemma. Are they "shadow" academic secondary schools, giving an alternative second chance for general secondary education to those denied address to it? Or, are they training people for work in agriculture? This suggests that it is highly important in secondary-level AET to (1) survey labor market demands and opportunities; (2) trace the labor market outcomes of past graduates; (3) and use this information to define or refine the goals of the institution.

The keys to success in upper secondary AET institutions seem to be clear purpose; close knowledge of market requirements; careful selection of students to ensure interest; provision of practical training that avoids "forced labor" assignments and emphasizes problem solving; strong, independent management; and assistance to graduates in getting established as farmers.

Introduce greater flexibility in the length of courses

Instead of lengthy (e.g., three-year) time-based programs that parallel the general secondary school structure, the recommended approach for secondary-level AET is to introduce short, modular, competency-based programs that deliver skills needed in the market. In effect, this means the provision of lifelong learning opportunities for target populations of interested youth and adults, not just those in the formal school system. Shorter courses would also help to reduce dropouts and accommodate the training needs of diverse populations, while providing learning opportunities for progressive farmers.

AET AT THE TERTIARY LEVEL

Tertiary AET is the principal means for replenishing the stock of human capital in African agriculture. Four actions are highlighted for priority attention at this level.

Reforms in curriculum and teaching methods are the most immediately useful undertakings

Curriculum reform will be the most important initial intervention. Reforms are needed within existing academic departments with regard to content, as well as within institutions in terms of new departments and mechanisms for interdepartmental coordination and collaboration. Infusions of new knowledge, technologies and hands-on learning are overdue. To be most effective curriculum reform should be linked to labor market surveys. It may be helpful to think of curriculum structure from the perspective of T-skills (Lynam, personal communication, May 2007). The horizontal bar represents the breadth of "soft" skills that need to be considered: problem solving, teamwork, communication skills, ICT capability, etc. The vertical bar symbolizes the depth of competence needed in a disciplinary area. Today's graduates need skill sets that combine both the horizontal and vertical dimensions of the curriculum.

To help graduates get a foothold in the "new agriculture," various African universities encourage business development. The University of Swaziland and the Botswana College of Agriculture offer practical courses on entrepreneurial projects, in which business plans are put into practice using a revolving credit fund, with students retaining 75 percent of the profits. Projects have consistently generated profits since 1995, and reportedly students have been more motivated to start their own businesses after gaining confidence through these projects. In West Africa the École Nationale Supérieure d'Agriculture (Senegal) provides three months of additional entrepreneurial training following graduation, during which project plans are prepared. Financing is available for implementation of the plans for two years at 13 percent interest. In Mali, an agricultural research

organization, Institut d'Économie Rurale, and a higher education institution, Institut Polytechnique Rurale, have joined hands to establish the "Mali Agribusiness Incubator" (see Box 6.1) to help agricultural entrepreneurs integrate modern technologies into local agricultural practices (Muir-Leresche 2003:9). Beyond Africa, Costa Rica's EARTH University prepares graduates to start up agricultural enterprises. Its program contains a strong emphasis on values development, environmental management, and community service (Juma 2006:13). Key elements of the EARTH University approach to learning are reportedly in the process of being adapted and tested by Makerere University.

Modify institutional governance structures for greater institutional flexibility and increased responsiveness to stakeholders

Governance of public institutions is generally centralized at the national level in Africa, which means that decision making and approval authority remain with the central government (Rivera 2006:16). Centralized governance tends to slow decisions, limit flexibility, distort incentives, and stifle initiatives. It may also mean overcontrol. At the tertiary level, it is appropriate to provide greater autonomy to institutions and install governing councils that include representatives of all stakeholders, especially end-users (e.g., agricultural businesses, research institutions, and extension organizations). Greater autonomy would free the institutions to raise resources and find their markets. Accountability mechanisms need to be introduced simultaneously with greater autonomy, including transparent processes for decisions and clear systems for financial accounting and audits. So far, of the countries studied, only Senegal and Uganda have moved in the direction of decentralizing governance systems for tertiary AET (Rivera 2006:17).

Balance agriculture enrollments between degree, diploma, and certificate to ensure adequate numbers of competent technicians

The market for agricultural labor resembles a pyramid with a few theoretically trained agricultural specialists at the top, a sizable number of diploma or certificate technicians in the middle, and a mass of producers at the base. This suggests that there is a need to supply the market in proportion to demands, specifically: more technicians than professionals. Agricultural technicians are needed for public and NGO extension services, for agricultural suppliers, management and operation of companies, and producer organizations. Most jobs for agricultural technicians do not require university degrees. In fact, a BSc in agriculture may be unsuitable for technicians, containing excessive theory at the expense of practical application.

The earlier analysis showed that the balance between outputs at degree, diploma, and certificate levels, in some cases, was becoming distorted (see Chapter 4). Mozambique has taken positive steps since 2004 to address its AET system imbalance, creating two new agricultural polytechnics, one additional agricultural institute and several regional technology centers (Gemo 2006:28). The polytechnics give their students a strong dose of practical skills training and offer them academic certification options after two, three, and four years of schooling. They also provide work attachments at the recently created regional technology centers intended to evaluate technologies for rural development in different parts of the country.

Recruit more women students

The reasons for having larger numbers of female agriculturalists, and the benefits associated with this, were clearly stated in Chapter 6. It now remains to set targets for improving women's representation among agricultural students, academic staff, researchers, and extensionists. Efforts to make agriculture a more attractive career option will contribute toward this goal, and targeted scholarships would accelerate the gender balancing process.

AET AT THE POSTGRADUATE LEVEL

Strengthen the quality and expand MSc degree programs within Africa

Local training has several advantages in contrast with overseas training. It embodies greater relevance to local and national agricultural problems, it strengthens local capacities, it expands the knowledge and research resources available to support local agricultural development, and the incremental buildup of local graduate programs will serve as an insurance policy if a donor discontinues

scholarships for overseas study (InterAcademy 2005:174). However, existing national postgraduate programs usually go only to the level of master's degrees. And some graduate programs have suffered an erosion in quality (see Chapter 4). Aggressive staff development programs will contribute directly to solving this problem. An appropriate goal would be to have all standard MSc programs operational in Africa within 10 to 12 years.

Nurture regional centers of specialization

Regional centers of specialization are warranted by (1) the need to train small numbers of experts in specialized areas that can only be justified through subregional collaboration; and (2) the staff development needs of small countries that cannot afford to set up and maintain a wide range of postgraduate programs. In these cases, such postgraduate training will have to take place outside national boundaries, at regional or international levels. As a second choice, national institutions of high quality could be tapped, for example:

- African Centre for Crop Improvement, University of KwaZulu-Natal, South Africa
- École Nationale Supérieure d'Agriculture—Senegal
- Sokoine University of Agriculture, Tanzania

At the master's degree level, African regional initiatives such as the Collaborative Masters in Agricultural and Applied Economics (CMAAE) program may be appropriate. Collaborative regional graduate training programs are more difficult to establish, but not less important. A study by CMAAE on research and training linkages among departments of agricultural economics in the region revealed that almost all departments had linkages with institutions outside Africa, but only a few had linkages with other AET institutions in East and Southern Africa (Tongoona and Mudhara 2007:13). Thus, regional collaboration presents itself as a largely untapped resource, not only for staff development but also for fostering agricultural innovation systems.

Regional programs make sense where fixed costs are high and demand is clear but insufficient to reach a critical mass in each country, e.g., narrowly specialized technical fields, emerging new cross-disciplinary areas, small nations. Regional programs promise economies in assembling a critical mass of specialists. One hub location can serve the graduate training needs of a larger regional watershed (InterAcademy Council 2004:174). Minimum conditions for regional undertakings are: (1) common problems and needs across regions; (2) demonstrable economies of scale; (3) insufficient national training base, i.e. absence of duplication; (4) staff/management buy-in at the host institution that may have other national priorities; and (5) availability of financing to allow participation by non-host countries. As an example, the BecA center in Nairobi could be used by the subregion for research and capacity building in biotechnology, which requires expensive facilities and equipment. It would not be efficient to duplicate such a costly facility in each of the countries of the region (Tongoona and Mudhara 2007:9).

Due to their cost and specialization, all African PhD programs should be viewed from the outset of the planning process as regional programs. Promising fields for regional postgraduate programs are biometrics, biogenetics, applied plant pathology, applied entomology, agricultural engineering, soil science, and environmental microbiology (Tongoona and Mudhara 2007:16).

Financing is a key to success. Adequate start-up support is required for design, launching, and fine-tuning of the operations. Experience suggests that successful regional PhD programs will need long-term donor commitment, which best takes the form of consortia of multiple donors with complementary interests. The importance of long-term donor commitments for sustained success is demonstrated by the African Economic Research Consortium (AERC). Endowment funds are being explored to ensure sustainability in the agricultural economics MSc program for Eastern and Southern Africa. Other key factors for success are the availability of competitive scholarships to ensure quality students and open, merit-based incentive systems for staff (Tongoona and Mudhara 2007:19, 24).

Pitfalls in regional programs have to be kept in mind. Building another layer of educational institutions can be risky, divisive, and expensive. Ideally, they should evolve from existing, strong national institutions and not be created anew (InterAcademy Council 2004:175). Civil unrest in Côte d'Ivoire and Zimbabwe highlights the danger of concentrating capacity-building programs in some countries. Failure of the regional MSc program in agricultural economics at the University of Nairobi as a result of withdrawal of donor funding

is also instructive (InterAcademy Council: *ibid.*) Even through donors may underwrite a regional AET institution for a decade or longer, national political leaders have been reluctant to continue the program after foreign assistance terminated (Eicher 2006: 34–35). This suggests that local ownership needs to be nurtured from the planning stage onwards.

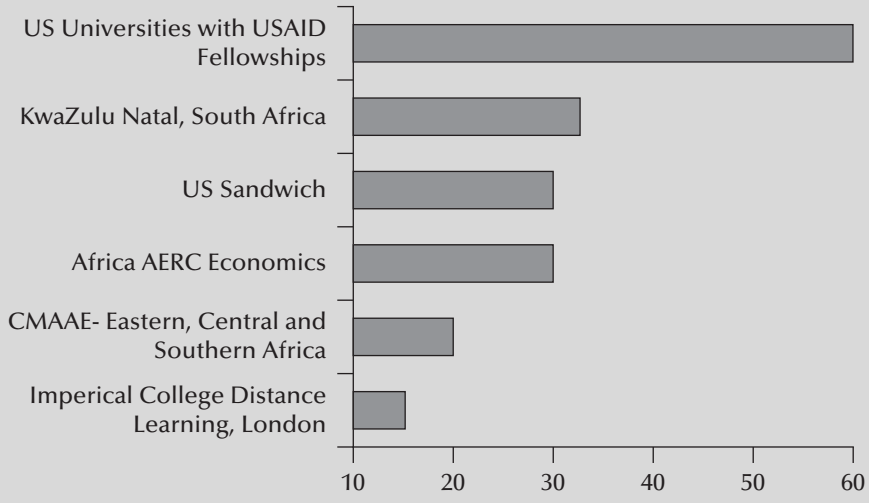
Lay the foundation for PhD programs through staff development

This report recommends a sizable investment in the postgraduate training of Africans with a view to replenishing the depleted human resource pool. A goal of 1,000 new agricultural PhDs over the next 15 years might be appropriate (Eicher 2006: 41). This would increase by 60 percent the current numbers of agricultural scientists in African higher education institutions (see Annex 6). This sizable increase is necessary as a means (1) to ensure that most MSc training would be available in strong postgraduate programs within Africa within a decade; (2) to lay the foundation for regional PhD programs; and (3) to supply human resources prepared to contribute to emerging agricultural innovation systems. In doing so, upwards of half these awards could usefully be earmarked for women agricultural professionals.

But where and how should these 1,000 new PhDs be trained? Inevitably, the solution will involve a combination of national programs, regional centers, and training outside the continent. In terms of cost-effectiveness, the order of preference for *where* would be first in national institutions, second in regional centers of excellence, third in more advanced Third World countries, and fourth in industrial countries. The costs of postgraduate training differ substantially according to place and mode of training, as shown in Charts 7.1 and 7.2. Thus, a wide range of choices is available to governments and donors alike.

In fact, the process of establishing collaborative regional PhD programs has already begun. With assistance from RUForum, four new PhD programs started in August 2007: (1) Biotechnology and plant breeding at Makerere University; (2) Food Science and Nutrition at Jomo Kenyatta University of Agriculture and Technology; (3) Dryland Resource Management at the University of Nairobi; and (4) Aquaculture and Fisheries Science at Bunda College in Malawi. These programs will comprise coursework during the first two years, followed by dissertation research. Programs will be based at the lead universities noted above, but will be supplemented by staff from other member universities and perhaps from overseas if necessary expertise is not available within the region. These are clearly

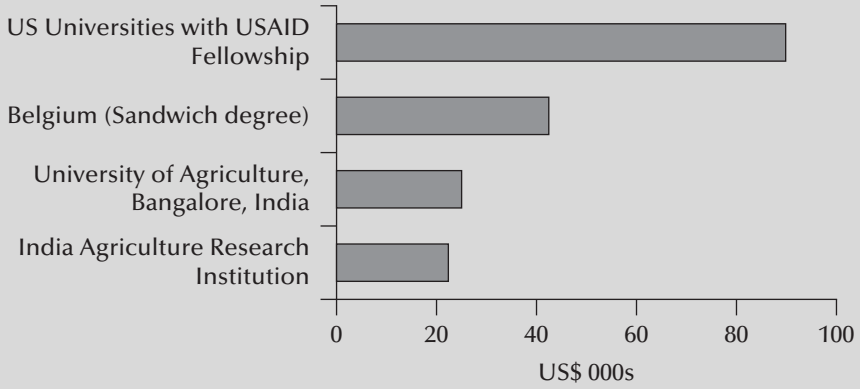
Chart 7.1 Estimated Total Cost of MSc. Degrees in Agricultural Economics, Various Countries (US$ Thousands)



Source: Eicher 2006: 53.

Note: Estimated duration two years.

Chart 7.2 Estimated Total Cost of PhD Degrees in Agricultural Economics in Various Countries, 2006



Source: Eicher 2006: *ibid.*

Note: Estimated duration three years, except Belgium, which is four.

groundbreaking initiatives that will require sustained commitment and financing from universities and development partners if they are to reach their full potential.

Creative partnerships to develop academic programs at the MSc level are also underway in Sub-Saharan Africa. The example of a joint MSc degree in Rural Development delivered by University College, Cork, Ireland and Mekelle University in Ethiopia is described in Box 7.1 Similarly, Cornell University will partner with Bahir Dar University in Ethiopia to offer a Master of Professional Studies

Box 7.1 Joint MSc Degree in Rural Development Delivered by University College Cork (Ireland) and Mekelle University (Ethiopia)

Building on relationships generated through several years of research collaboration, University College, Cork, Ireland, and Mekelle University in Ethiopia have developed an inventive joint MSc program, which combines characteristics of a sandwich program with the use of distance learning. The program is provided on a part-time basis over a two-year period to mid- and senior-level rural development professionals in governmental and nongovernmental organizations. Students learn through a combination of workbooks written by both universities; short periods of intensive on-campus teaching at Mekelle delivered by staff of both universities; short field visits; monthly tutorials provided by Mekelle University staff; computer-based lab study for subjects such as statistics, research methods, and geographical information systems; and jointly supervised MSc theses based primarily on fieldwork in Ethiopia. The program was developed to address the country's urgent need for rural development professionals with multidisciplinary skills capable of promoting rural development in the context of pervasive poverty, persistent food insecurity, and increased market orientation. The program recently completed its first cycle, graduating 20 students who were awarded a joint degree conferred by both universities, and a second cycle is ongoing. Plans to expand the program to Haramaya and Hawassa Universities in Ethiopia are under discussion.

Key design characteristics of the program include the mixed delivery mechanisms, the experiential nature of the learning process whereby learning is rooted in the daily reality of rural development issues, the capacity-building and quality control elements imparted through the collaboration of the two universities, the low-cost nature of the program (allowing at least five students to be trained in Ethiopia for the cost of one student studying full-time in Ireland), and, crucially, the avoidance of brain drain. The program offers a model which appears widely replicable, including progressively greater use of Web-based delivery methods as technology availability permits.

Source: Authors.

degree program in agriculture and rural development that focuses on watershed management. Another Cornell University initiative will assist the University of Ghana to launch a new PhD program in plant breeding.

Training outside the region is inevitable because of limited regional capacity

Support for collaborative regional programs has to face squarely the issue of absorptive capacity. Regional centers of excellence have the capacity to undertake only a fraction of the massive staff development at the PhD level recommended here. When this capacity is exhausted, preference could be given to Third World countries that have developed high-quality AET systems, such as India, Malaysia, and Brazil. As seen in Chart 7.2, the costs of PhD training are substantially lower in Indian AET institutions of high quality than in American or European institutions. The last option would be training in advanced industrial countries, preferably for highly specialized skills, possibly using methods discussed below to reduce the costs.

Different modes such as sandwich training could keep costs in check and minimize brain drain

"Sandwich training" [45] has been used for almost two decades by universities in Africa in cooperation with overseas universities. The purpose of sandwich training is to reduce the cost of graduate programs, increase the percentage of students who return home after degree completion, and build the capacity of African universities to deliver some of the initial coursework (Eicher 2006: 36). The costs of "sandwich training" are considerably lower than full-time residence abroad, both at the master's and doctoral levels (see Box 7.1). Sandwich training can also reduce brain drain among trainees. To put that benefit in perspective, it is worth remembering that more African scientists and engineers are working in the United States than in all of Africa (El-Khawas in Tongoona and Mudhara 2007:2,3).

Sandwich training also has its drawbacks. It is best suited for students carrying out field research rather than laboratory work, which may require expensive equipment and supplies. Other problems include delays in degree completion if local research funds are not available and high transaction costs in managing the system, including dual reporting and joint supervision (Eicher: *ibid.*; also InterAcademy Council 2004:177). Finally, difficulties may include unclear procedures for conferment of a joint degree and lack of a common accreditation system (Tongoona and Mudhara 2007:3). Still, the sandwich method has worked well at Wageningen University, which over the past five years has produced more than 200 Africans with MSc and 50 with PhDs (InterAcademy Council: *ibid.*).

Harness the potential for distance education and online provision

Perhaps the most intriguing feature from Chart 7.1 is the low cost of a master's degree via distance learning through the Imperial College in London. The College (formerly Wye College) pioneered distance education courses for Africa in agricultural and rural development in the 1980s. At present about 250 of its 800 students are African nationals residing in Africa, and 21 of its 86 graduates in 2005 were African (Eicher 2006: 48).

Substantial potential exists for Web-based distance education. Technically and pedagogically, it should be possible increasingly for students and employed professionals to undertake postgraduate degrees via ICT. "Online degrees," although not inexpensive, are increasingly common in industrialized countries. Many of these programs adhere to strict accreditation standards to ensure quality. Major universities in the West are entering the market. There is no reason why students in Sub-Saharan Africa should not benefit from this trend, provided bandwidth is sufficient, financial assistance is available, and local quality assurance is in place (InterAcademy Council 2005:179; see also World Bank, 2002). The impending completion of the East Coast fiber-optic cable around Africa holds the promise of more bandwidth in the near future for most coastal countries.

In 2005 CGIAR inaugurated a distance learning initiative, the Global Open Food and Agriculture University (GO-FAU). GO-FAU develops course modules in agro-economy and agribusiness and makes them available to partner institutions (Eicher 2006:48). Some universities are already using ICT to enhance educational quality, including the encouragement of students to form "human capital chains" through the use of e-mail (InterAcademy Council: *ibid.*). The limitations of prohibitive distances and poor infrastructure are minimized when communication is achieved through the Internet.

Box 7.2 Master's Program in Agricultural Information and Communications Management

At the initiative of the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), an innovative master's program in agricultural information and communications management has been launched at Haromaya (ex-Alemaya) University in Ethiopia, Makerere University in Uganda, Sokoine University in Tanzania, and the University of Nairobi in Kenya. The program seeks to provide agricultural advisory service workers with information and communication skills that will help them to view extension work as a communication and knowledge management profession. In the process, these skills will enable professionals to better contribute to and participate in an agricultural innovation system. The curriculum is oriented toward employment in technical publications, Web site management, media communications, computerized agricultural information systems, ICT applications to management, and archives management. The program will include a two-year MSc degree course, a one-year postgraduate diploma course, and a course module that can be included as an elective within existing MSc programs. Future plans calls for distance education delivery as well. Web site: www.asareca.org/rain.

Source: Authors.

Within Africa, capacities for distance education and e-learning are being steadily put in place. Jomo Kenyatta University of Agriculture and Technology is producing low-cost computers and emphasizing ICT literacy among its students. Africa University in Zimbabwe has developed good e-learning facilities on its campus. In Ethiopia, the International Livestock Research Institute is constructing its Domestic Animal Genetic Resources Information System (DAGRIS) as a Web-based source of information on selected indigenous farm animal genetic resources such as cattle, sheep, goats, chicken, and pigs. DAGRIS is designed to facilitate the organization and dissemination of information on the origin, distribution, diversity, present use, and status of indigenous farm animal genetic resources from past and present research results. Another Ethiopia-based initiative is a partnership between Haromaya (ex-Alemaya) University of Agriculture and IFPRI to establish a Center for Agricultural Research Management and Policy Learning for Eastern Africa (CARMPoLEA). Through face-to-face and virtual courses, this Center seeks to improve the management of agricultural research and research policymaking within this region.

Videoconference also offers innovative ways to access knowledge and expertise. With support from the Rockefeller Foundation, ACCI students at University of KwaZulu-Natal discuss lecture materials and proposals with collaborators at Cornell University through videoconferences (InterAcademy Council: ibid.). The Collaborative Masters in Agricultural and Applied Economics (CMAAE) is exploring the use of e-learning to increase the coverage, flexibility, and quality of its program (Tongoona and Mudhara 2007:22)

8 The Time to Act Is Now[46]

Agricultural education and training has been demonstrated to be a vital, but much neglected, component of agricultural development in Africa. It is undervalued, underresourced, and underprovided. Human capital in agriculture has been depleted by long term neglect. Market-driven agriculture and agriculture innovation systems place new demands on the knowledge and skills of those working in the agricultural sector. Continuing neglect of AET risks constraining agricultural recovery, economic growth, and poverty reduction. Countries in Sub-Saharan Africa are therefore called upon to address the shortcomings of current approaches to human capital formation in agriculture and to train a new generation of agricultural professionals. This goal is not amenable to a quick fix. Long-term, patient support is needed from government, AET institutions, and development partners over 20 years or more.

TOWARD AN AET STRATEGIC FRAMEWORK

Given that quick solutions are unavailable and that reforms inevitably will take time to produce results, what can be done in the short term? What interventions should be given top priority? The first step should be to convene representatives of the agricultural innovation system (i.e., government policymakers, agricultural researchers, private sector entrepreneurs, NGO rural advisory staff, AET institutional leaders, agricultural suppliers, and credit providers) for a collective exercise in priority setting. The following six elements of a possible strategic framework could form the basis for such a discussion:

Short term

1. Modernize teaching methods and curricula at the tertiary level, along with the necessary teaching inputs.
2. Improve institutional linkages (e.g., strategic partnerships, professional networks, collaboration incentives) and knowledge access (e.g. TEEAL, AGORA, computers).
3. Persuade development partners to fund essential operational and equipment maintenance costs.
4. Conduct labor market studies and establish a labor market monitoring capacity.
5. Work to make the agricultural professions attractive employment and career options, while recruiting many more women into this field.

6. Create networks and associations that can champion the cause of agriculture, and learn lobbying techniques to generate supportive political will.

Long term

1. Rebalance AET enrollments in favor of diploma, degree, and especially postgraduate programs.
2. Strengthen and expand strategic MSc programs, including associated staff development, so that all standard MSc programs for agriculture are available in Sub-Saharan Africa within 10 years.
3. Broaden the foundation for regional PhD programs by launching a major program of postgraduate fellowships to train 1,000 PhDs, initially abroad and eventually at home, over 15 years.
4. Take a more proactive approach to AET financing by improving the efficiency of resource use, increasing income generation from nonpublic sources (e.g., market-oriented short courses), and persuading donors to finance operating costs.

Much of this could be implemented partly or fully through various types of multi-donor competitive funds at national and regional levels.

Table 8.1 Matrix of Key Actions and Responsibilities

Levels: \ *Actors:*	Government/politicians	Institutional managers	Development partners
Education	▪ Educate the public on agriculture's role in national development and value agricultural professions. ▪ Rebalance the technical education pyramid. ▪ Promote/accept regional collaboration partnerships. ▪ Establish quality assurance mechanisms for higher education.	▪ Curriculum reform to include practical skills mastery and soft skills. ▪ Pedagogical reform to emphasize facilitation of learning, problem solving. ▪ Increase female enrollments. ▪ Improve student admissions procedures to favor student motivation. ▪ Link curricula to the labor market.	▪ Give greater funding attention to diploma level education. ▪ Help build capacities for information access, e.g., TEEAL, AGORA. ▪ Underwrite fellowships for women. ▪ Encourage curricula experimentation and pedagogical retooling. ▪ Develop capacities for distance education and online learning.
Research	▪ Increase overall levels of research funding. ▪ Establish competitive research funds. ▪ Outsource more public research to universities.	▪ Curriculum reform to build applied and soft skills. ▪ Pedagogical reform to emphasize facilitation of learning, problem solving. ▪ Revise incentive and promotion systems to encourage applied research and private sector collaboration.	▪ Contribute to competitive learning, innovation and research funds. ▪ Support increased bandwidth for tertiary institutions.
Institutional management	▪ Award greater autonomy to institutional management. ▪ Modify institutional governance to include greater stakeholder representation. ▪ Establish coordination mechanisms between Education and Agriculture.	▪ Create stakeholder platforms to set systemwide priorities. ▪ Establish clear career ladders for academic staff. ▪ Carry out periodic employer surveys and graduate tracer studies.	▪ Agree to fund operating expenses. ▪ Support experimental incentive systems designed to increase individual and institutional innovation.
Financing	▪ Provide budgets on the basis of strategic goals and performance rather than historical precedent or equity.	▪ Provide budgets for periodic professional updating of staff. ▪ Pursue public-private partnerships.	▪ Join long-term consortia to support collaborative regional postgraduate programs. ▪ Fund 1,000 PhD scholarships.

Source: Authors.

To advance these goals, the following roles and responsibilities are proposed for political leaders and government officials, for institutional managers, and for development partners. These are also summarized in Table 8.1.

THE ROLE OF NATIONAL POLITICAL LEADERS

National political leaders, especially those within governments of African countries, are urged to take the following priority steps to strengthen the basis for agricultural education and training:

1. As stated by the InterAcademy Council, "Today, the lack of political commitment in the State House is the biggest single missing ingredient in building a strong and productive agricultural science base in Africa" (InterAcademy Council 2004:183). Africa's human capital challenge calls for *renewed and sustained African commitment*. As seen from international experience, long term commitment is essential for achieving breakthroughs derived from reforms (Chapter 5; Eicher 2006:33).
2. Political, civil, and academic leaders should increase the *attractiveness of agricultural careers by advocating their importance* for national development to the public, by creating new career paths that open a wider range of employment opportunities, and by stimulating student and parental interest in agriculture as a profession (see Chapter 6).
3. Ministry officials should *outsource a part of public research funds* to tertiary AET institutions. Not only will this be a cost-effective use of research funds (see Chapter 2), it will also counter staff attrition by helping to create an attractive professional environment for teaching staff. The best mechanism for doing this would be through competitive funds, which also help to retain staff.
4. Ministry and institutional leaders should *increase female enrollment* in AET institutions by such measures as establishing quotas, providing earmarked scholarships, arranging mentors, reducing sexual harassment, and ensuring that AET institutions have appropriate facilities to accommodate women (see Chapter 6). To stimulate demand, countries should institute preferential hiring policies for women in research and extension institutions.
5. Government leaders and ministry officials should *devolve authority* to AET institutions and subject them to governance by stakeholders. This will allow them to take more initiative, find their niche markets, and mobilize additional resources.
6. Governments should provide incentives and rewards for AET staff and *introduce diverse staff retention measures*, such as merit pay, transparent promotion procedures, continuing professional development opportunities, and administrative streamlining. Where possible, *integrate AET institutions* under the same public institutional authority.
7. Governments should *avoid proliferation,* or atomization, of AET, which dilutes resources and drives down quality. Government should *base public financing on strategic goals and performance in achieving them* rather than historical precedent or equitable sharing.

THE ROLE OF AET INSTITUTIONAL MANAGERS

At the institutional level, reforms in these priority areas would generate multiple benefits:

1. *Create fora among stakeholders* for setting priorities in AET vis-à-vis agriculture development plans, building institutional linkages, and nourishing information networks.
2. *Improve student selection* procedures so that only those with a personal interest in agriculture are admitted.
3. *Consult stakeholders, particularly private sector employers,* on program definition and conduct periodic employer surveys and tracer studies to assess the effectiveness of AET programs.
4. *Link curricula to the market* for graduates. One way to link supply with market demand could be to focus on growth areas or "niches" in commercial agriculture. AET institutions could (1) identify a niche agricultural initiative in the country, such as pyrethrum or coffee in Rwanda, cut flowers in Kenya, or fish exports in Uganda; (2) analyze the supply chain, including human resource requirements; and (3) develop teaching programs to address the needs. This modest approach could help energize AET and serve two important objectives:

orient AET to market trends and stimulate renewed student interest as they see chances for employment on the horizon.
5. Where possible, *introduce interdisciplinary programs* at the undergraduate level, e.g. natural resource management. Training must be practical, require contact between students and a range of producers, and focus on solving actual production problems.
6. Budget and provide for *periodic professional updating* of staff.
7. *Create a conducive professional environment* for staff, including the definition of clear career ladders and a streamlining administrative procedures to reduce the inefficient use of time by staff.
8. *Mobilize additional resources* and use them for upgrading staff conditions, teaching, and research.

THE ROLE OF DEVELOPMENT PARTNERS

As illustrated in Chapter 6, numerous innovative experiments, pilot programs, and individual cases of success in agricultural education and training can be found across the African continent. What is needed now is to build on these experiences, adapt them to each country, and replicate them across the continent. The resources of African countries will not be adequate for this task (InterAcademy Council 2004:184). Development partners are therefore asked to make long-term financing commitments to help interested governments replenish their human capital and strengthen the performance of their agriculture innovation systems. Actions by donors are recommended in seven priority areas:

1. The most immediate intervention is to rebuild the human capital base in agriculture—to increase the quality and number of high level agricultural professionals by means of *postgraduate fellowships* to attain the goal of 1,000 new PhDs in agriculture within the next 15 years. This must be preceded by assessment of current supply capacity, a feasibility study, and detailed plan with interested governments and donors. Initially, doctoral studies would be largely overseas, but would gradually be undertaken in Africa as capacities are developed.
2. Ensure gender rebalancing within the above staff development programs, and establish *female scholarship programs* at the secondary and undergraduate levels to attract more women into agricultural sciences.
3. Support donor consortia for, say, a dozen specialized collaborative *regional PhD programs,* starting with four—one for each major region—on a trial basis over a period of five years.
4. Fund the *operating and equipment maintenance costs* that are essential for retaining skilled staff and enabling them to work productively. This could include "incentive goods" such as sabbatical leaves for African academic staff who were trained 15 to 20 years ago, funds to attract visiting professors, seminars, and mini-travel grants to ensure that academic staff attend one national or regional conference annually and one international conference every three years. Funding is also needed for upgrading libraries and vehicles for field research, and rebuilding university farms.
5. Finance access to *international sources of information* by funding electronic innovations (TEEAL, AGORA, etc.) at key AET institutions, and by financing the facilities and equipment necessary for increased bandwidth and computer facilities and networks.
6. Finance *competitive grant funds* for tertiary institutions to undertake peer-reviewed research. A competitive *fund for institutional development* could also stimulate initiatives based on school/college/faculty own-generated development plans. The difficulties of administering these funds in small countries would need to be addressed. (InterAcademy Council 2004:173).
7. Finance *experimentation with new modes* of agricultural education and training that make use of information and communication technologies, including online degrees and various types of distance learning.

CONCLUSION

In examining the role and future potential of agricultural education and training systems in Sub-Saharan Africa, this report relies in part on an agricultural innovation systems perspective to make its case. This view is a relatively new application to the study of developing country agriculture, and the body of empirical work that precedes

this report is still small. Thus, efforts are yet in early stages of development to link empirical analyses of innovation systems in developing country agriculture with recommendations that can inform policymakers (Davis et al. 2007).

This report has pursued this goal. However, further analysis of AET from an innovation systems perspective is needed. Likewise, more political discussion is necessary on how to produce extension agents, researchers, educators, and skilled producers in sufficient quantity to boost agricultural productivity and output, *and* of sufficient quality to play an active role in a changing agricultural scenario. This implies closer consideration of the more nuanced challenges of strengthening innovative capabilities among both individuals and institutions; creating organizational cultures in AET that are sufficiently open and dynamic to facilitate change; and building innovation networks, partnerships, and linkages to foster an accelerated flow of ideas, greater adaptation, and use of available information and knowledge. Ultimately, it must be recognized that interventions designed to strengthen AET systems are a long-term undertaking. Only through an enduring commitment to change can AET systems contribute to the development of more dynamic agricultural economies that engage farmers, entrepreneurs, extension agents, researchers, and many other actors in a wider system of innovation.

Annex 1. NARS and AKIS Frameworks in Relation to Agricultural Innovation Systems

Defining feature	NARS	AKIS*	Agricultural innovation system
Purpose	Planning capacity for agricultural research, technology development, and technology transfer.	Strengthening communication and knowledge delivery services to people in the rural sector.	Strengthening the capacity to innovate throughout the agricultural production and marketing systems.
Actors	National agricultural research organizations, agricultural universities or faculties of agriculture, extension services, nonprofit institutions, private companies, and farmers.	National agricultural research organizations, agricultural universities, faculties of agriculture, extension services, farmers, NGOs, and entrepreneurs in rural areas.	Potentially all actors in the public and private sectors involved in the creation, diffusion, adaptation, and use of all types of knowledge relevant to agricultural production and marketing.
Outcome	Technology invention and technology transfer.	Technology adoption and innovation in agricultural production.	Combinations of technical and institutional innovations throughout the production, marketing, policy research, and enterprise domains.
Organizing principle	Using science to create inventions.	Accessing agricultural knowledge.	New uses of knowledge for social and economic change.
Mechanism for innovation	Transfer of technology	Interactive learning	Interactive learning
Degree of market integration	Nil	Low	High
Role of policy	Resource allocation, priority setting.	Enabling framework.	Integrated component and enabling framework.
Nature of capacity strengthening	Infrastructure and human resource development.	Strengthening communication between actors in rural areas.	Strengthening interactions among actors; institutional development and change to support interaction, learning, and innovation; creating an enabling environment.

Source: World Bank, 2006a.

* As defined by FAO and World Bank 2002.

Annex 2. The Landscape of Agricultural Education and Training Institutions Included in This Study

The purpose of AET is to enable agricultural producers to realize higher returns on their labor and investments. Sometimes this is done directly through farmer training. More often this is achieved indirectly by educating extension staff, by developing researchers, or by building the technical capacities of producer organizations and input suppliers (Wallace and Nilsson 1997: 37). Essentially, AET targets three distinct groups in the agricultural sector labor market: farmers (subsistence and commercial), extensionists and other support personnel (public and private), and researchers. These target audiences are reached through different levels and types of AET, ranging from informal farmer training to secondary-level agricultural colleges that prepare farm managers and extension specialists to postgraduate faculties of agriculture, where researchers are trained.

Secondary-level AET. Secondary-level agricultural education and training[47] is highly diverse across the countries of Sub-Saharan Africa (SSA). Generally, secondary-level AET makes up only a tiny fraction of total secondary school enrollments. In Kenya, the secondary schools offer agriculture as an option and are the main sources of secondary level AET, providing courses to more than 106,000 students. Ethiopia has 25 ATVET Colleges enrolling almost 37,000 in training for agricultural occupations as district extension agents. Mozambique has a few basic and medium-level agricultural schools at lower and upper secondary, respectively, enrolling about 4,000 students. Benin supports four agricultural colleges enrolling about 2,400 students plus centers for rural promotion for nonformal training. The AET landscape is diverse in Rwanda, with 22 secondary-level schools offering agriculture education and graduating 890 trainees per year. These institutions have nine different types of names, from "agricultural school" to "secondary school" and "school group." Burkina Faso has only one agricultural college, but a total of 16 other AET institutions under five different ministries. Table 1 shows some of the diversity in types and orders of magnitude.

Tertiary AET. As defined here, tertiary AET includes certificate, diploma, and degree qualifications at the post-secondary level. These are offered in universities (agricultural universities and faculties of agriculture and related subjects in multipurpose universities), agricultural colleges, polytechnics and agricultural institutes. Table 2 shows the types of institutions studied.

Postgraduate AET. Postgraduate AET is offered within SSA in some of the tertiary AET institutions, and at specialized regional centers. Table 3 lists the main collaborative regional postgraduate programs.

Table 1 Types and Dimensions of Secondary Level AET, Selected Countries

Country	AET institution	Number	Enrollment	Graduates
Benin	Colleges of Technical Agricultural Education (CETA)	3	960	240
	Agricultural College Medji of Sekou (LAMS)	1	1,400	350
	Centers for Rural Promotion			
Ethiopia	Midlevel Agricultural Technical Vocational Education (ATVET)	25	36,800	10,840
Mozambique	Basic agricultural schools	8	2,480	
	Midlevel Agricultural Institutes	3	1,700	
Rwanda	Diverse schools for agriculture, veterinary and forestry, lycées, and secondary schools.	22		890

Source: Drawn from case studies for Vandenbosch.

Table 2 Tertiary AET Institutions Included in Background Study

Country	University & faculties of agriculture & veterinary science	Agricultural colleges	Polytechnics	Higher institutes	Other
Cameroon	6	18			
Ghana	5	5	3		
Malawi	1	1			
Mozambique	3		2		3
Rwanda	1			1	
Senegal				2	7
Uganda	2	1			1
TOTAL	17	26	5	3	11

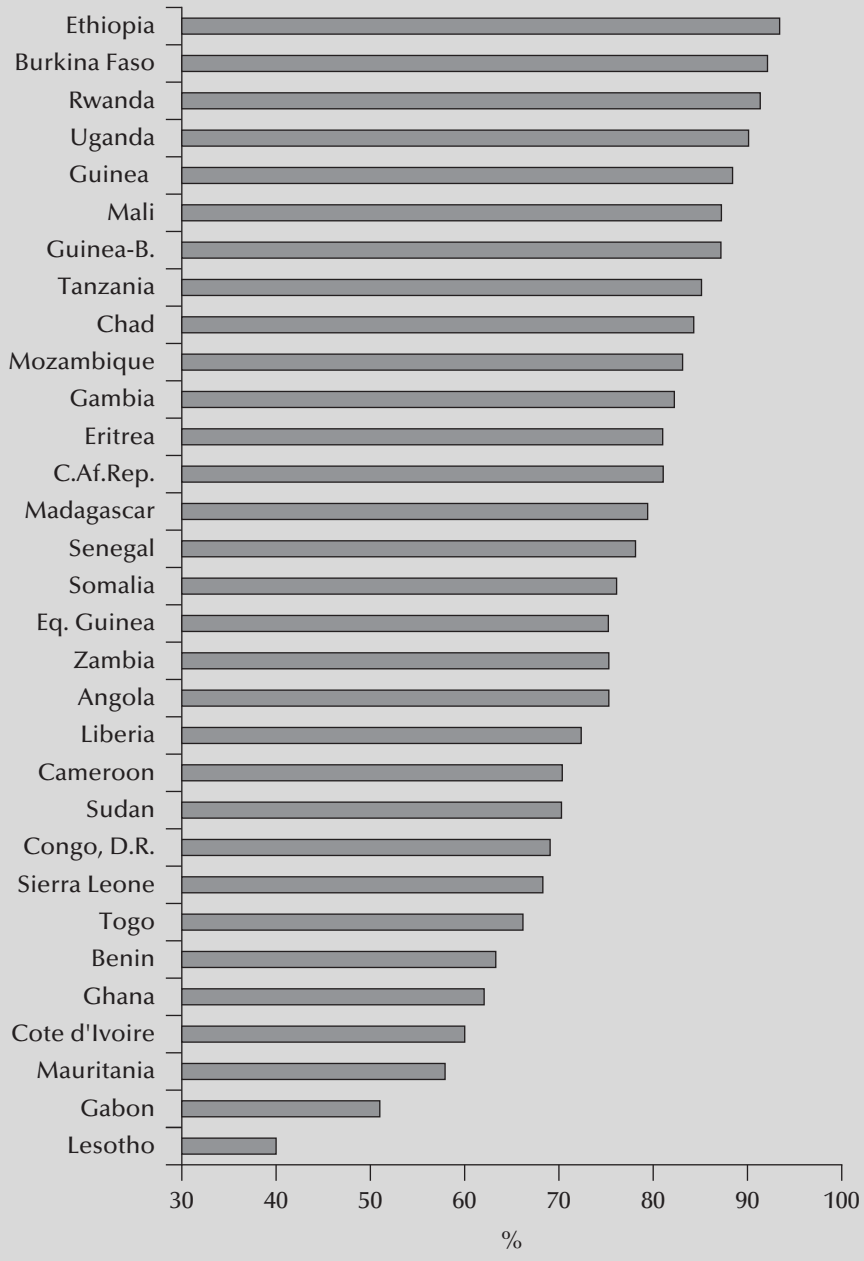
Source: Drawn from case studies for Rivera. Unfortunately, enrollment and graduation statistics were not available.

Table 3 Regional Postgraduate Programs in Agriculture

Program	Location	Field	Qualifications
Africa Regional Partnership Program in Insect Science	International Center for Insect Physiology and Ecology (ICIPE), Nairobi, Kenya	Insect Science	PhD
Agribusiness	Africa University, Mutare, Zimbabwe	Agricultural economics	MSc
Agricultural Information and Communications Management	Haromaya University, Ethiopia Makerere University, Uganda Sokoine University, Tanzania University of Nairobi, Kenya	Agriculture	MSc
Aquaculture and Fisheries Science	University of Malawi	Fisheries	MSc, PhD
Agricultural and Resource Economics	University of Malawi	Agricultural economics	MSc, PhD
Biotechnology and Plant Breeding	Makerere University	Crop Production	MSc, PhD
Collaborative Master of Science in Agricultural and Applied Economics (CMAAE)	Various.	Agricultural economics	MSc
Dairy Science and Technology	University of Zimbabwe	Animal production	MSc
Dryland Resource Management	University of Nairobi, Kenya	Natural Resource Management	MSc, PhD
Food Science and Nutrition	Jomo Kenyatta University of Agriculture and Technology, Kenya	Food Technology	MSc, PhD
General Agriculture	University of the Free State	Agriculture	MSc
Land and Water Resource Management	Sokoine University, Tanzania	Natural Resource Management	MSc
Plant breeding and biotechnology	African Center for Crop Improvement, University of KwaZulu-Natal, South Africa	Crop Production	PhD
Plant Breeding and Seed Systems	University of Zambia	Crop Production	MSc
Research Methodology	Jomo Kenyatta University of Agriculture and Technology; University of Malawi	Agriculture	MSc
Rural Development	Eduardo Mondlane University	Agriculture	MSc
Sasakawa Africa Fund for Extension Education (SAFE)	Winrock International, Bunda College, Malawi	Extension	BSc or MSc
University Science, Humanities and Engineering Partnerships in Africa (USHEPiA)	University of Cape Town, South Africa	Science and Engineering	PhD and MSc

Source: Tongoona and Mudhara: 2007; RUForum Newsletter, March 2007.

Annex 3. Percentage of Total Employment in Agriculture



Source: Based on ILO, 2003.

Note: For economies with a share in agricultural employment over 40 percent.

Annex 4. Summary of Donor Support for Agricultural Education and Training

Donor	Level of AET funding	AET program priorities	Geographical focus	Comments
African Capacity Building Foundation	Minimal.	Agricultural economics at present	Sub-Saharan Africa	Financing has been limited to USD 2.2 million for a collaborative MA program in agricultural economics.
African Development Bank	Unclear.	Farmer training, ministry and educational institution capacity building.	Sub-Saharan Africa	Project financing data is reportedly not organized in a way that permits sector reporting.
Belgium	Significant. Averages USD 800,000 a year	General technical and vocational education, including agriculture; farmer training for food production within food security and rural development projects.	Benin, Burundi, DRC, Mali, Mozambique, Niger, Rwanda, Senegal, Tanzania, Uganda	Agriculture and food security are a lesser priority, to which 10 percent of Belgian ODA is allocated.
Canada (CIDA)	None.			Reportedly no likelihood of AET involvement.
Denmark (DANIDA)	Significant.	Farmer training through district level training centers; institutional strengthening for farmer services.	Benin, Burkina Faso, Kenya, Mozambique, Tanzania, and Uganda	No financing for formal AET at the secondary or tertiary level.
France	Sizeable. Averaged USD $2.3 million between 1999 and 2003	Farmer training, technical training, university education	Francophone Africa, Ethiopia	Primary emphasis on farmer training.
Finland (FINNIDA)	Minimal or none.	None apparent.	Ethiopia, Kenya, Mozambique, Tanzania, Zambia	Works through Finnish NGOs and directly with partner organizations in Africa on environmental preservation, human rights, and good governance.
Germany (InWEnt, GTZ)	Sizable. USD $3.3 million in 2004	Short training courses for self-help organizations serving farmers; direct training of farmers; and training of agricultural researchers.	Benin, Burkina Faso, Cameroon, Ethiopia, Ghana, Kenya, Malawi, Mali, Mozambique, Namibia, Rwanda, Senegal, Tanzania, Uganda, Zambia	Support for broadly defined AET takes precedent over research and extension. In 1999 switched from supply-driven training to demand-driven courses based on participatory processes.
Ireland	Significant. Averaged USD $700,000 a year between 2000–2004	Farmer training; extension agent training	Ethiopia, Lesotho, Mozambique, Tanzania, Uganda, Zambia	Irish Aid policy for agriculture defined in 2001 emphasizes improved farmer services
Japan JICA	Moderate.	General vocational and technical education, including agriculture; farmer training	Ethiopia, Ghana, Kenya, Malawi, Senegal, Tanzania, Zambia	Agricultural assistance focuses mainly on food crop research, farmer training, post-harvest technology and environmental protection.

Donor	Level of AET funding	AET program priorities	Geographical focus	Comments
Netherlands	Minimal or none.	None apparent.	Benin, Burkina Faso, Cape Verde, Eritrea, Ethiopia, Ghana, Kenya, Mali, Mozambique, Rwanda, Senegal, Tanzania, Uganda, Zambia	Works primarily through Dutch international NGOs that focus on education, health, environmental protection, and employment creation.
Norway (NORAD)	Modest, but may grow.	AET following the EARTH University model.	Ethiopia, Tanzania, Mozambique, Madagascar, Malawi, Mali	Often works through NGOs.
Portugal	Significant. Averaged USD $600,000 a year between 2000–2004	General vocational and technical education, including agriculture; selective higher education	Angola, Cape Verde, Guinea-Bissau, Mozambique, Sao Tome and Principe, and occasionally others such as Ethiopia and DRC.	Assistance guided by *Uma Visáo Estratéica para a Cooperação Portuguesa* of 2006.
Sasakawa Africa Fund for Extension Education	Sizable. USD 5 million in 2003	Technology transfer; extension agent degree education; farmer training	Benin, Burkina Faso, Ethiopia Ghana, Guinea, Malawi, Mali, Mozambique, Nigeria, Tanzania, Uganda	Jointly operated by Nippon Foundation in Japan and Carter Center in USA. Goal is to transfer available technology to small farmers while upgrading extension agents and reforming university curricula.
Sweden (SIDA)	None.			Education sector assistance dedicated to basic education.
United Kingdom (DFID)	None.			Not addressed under its education or agriculture programs. Its December 2005 policy paper *Growth and Poverty Reduction: The Role of Agriculture* identifies eight priority actions for DfID, but none of them includes human capital development.
United Nations (FAO)	Minimal.	Farmer training; educational materials development	Sub-Saharan Africa	No apparent investment in building national level capacities for agricultural education and training.
United States (USAID)	Minimal.	Farmer training, producer organizations, strengthening institutions for agricultural education.	Ghana, Kenya, Mali, Mozambique, Uganda, Zambia	Funding for AET constituted just 1 percent of total funding for agricultural research, extension and education in Africa over 1995–2004. See July 2004 *USAID Agriculture Strategy: Linking Products to Markets.*

Source: Authors.

Annex 5. Suggested Actions That Would Help Tertiary Institutions to Recruit, Retain, and Promote Professional Women

- Establish policies that acknowledge the dual role of women (as both professionals and homemakers).
- Reduce the stress of more committee work and greater non-research-track demands.
- Provide mentoring (especially with regard to contract negotiation, workloads, priorities, performance, and career track.
- Recognize broader experience when appointing women and setting salaries.
- Broaden the weighting of the service component in promotion criteria.
- Address both overt and subtle harassment of women.
- Develop more practical and service-oriented curricula that appeal more to women and are more in keeping with the needs of 21st-century graduates.
- Address the stigma attached to affirmative action appointments and reduce the bias against women where affirmative action is not a factor.
- Consider offering flexible work schedules to both women and men.
- Set up crèche and after-school care facilities for both staff and students.

Source: Muir-Leresche 2006a:59.

Annex 6. Distribution of Highly Skilled Human Resources for Agricultural Research and Education Within and Among Countries of Sub-Saharan Africa

Country	No. of public sector agric researchers (FTEs)	Percent of public sector agric researchers with PhD	No. of agric researchers in higher education (FTEs)	Percent of agric researchers in higher education	Percent of higher educ agric researchers with PhD	Percent of all PhD agric researchers in higher education
Botswana	101	28%	17	17%	34%	17%
Burkina Faso	261	50%	16	6%	92%	10%
Burundi	77	11%	19	25%	45%	50%
Congo	135	33%	28	21%	64%	29%
Côte d'Ivoire	161	46%	25	16%	83%	22%
Eritrea	86	5%	13	15%	26%	44%
Ethiopia	742	9%	80	11%	19%	19%
Gabon	54	29%	12	22%	38%	23%
Gambia	48	8%	6	13%	21%	25%
Ghana	475	31%	83	17%	58%	25%
Guinea	269	15%	28	10%	36%	20%
Kenya	822	27%	138	17%	58%	27%
Madagascar	202	23%	9	4%	63%	11%
Malawi	146	24%	16	11%	38%	15%
Mali	300	30%	31	10%	48%	14%
Mauritania	98	17%	8	8%	87%	29%
Mauritius	147	12%	6	4%	33%	10%
Niger	109	24%	17	16%	64%	29%
Nigeria	1,352	34%	513	38%	48%	35%
Senegal	151	46%	29	19%	24%	9%
South Africa	1,029	35%	158	15%	55%	19%
Sudan	780	34%	225	29%	37%	24%
Tanzania	542	26%	90	17%	72%	31%
Togo	98	39%	33	34%	75%	39%
Uganda	245	31%	51	21%	36%	19%
Zambia	179	19%	20	11%	57%	25%
Total:	***8609***	***29%***	***1671***	***19%***	***49%***	***25%***

Source: ASTI/IFPRI.

Principal Research Works

COMMISSIONED BY THE WORLD BANK ON AGRICULTURAL EDUCATION AND TRAINING IN SUB-SAHARAN AFRICA

1. Davis, Kristin, Javier Ekboir, Wondimsiamregn Mekasha, Cosmas Ochieng, David Spielman, and Elias Zerfu. 2007. *Strengthening Agricultural Education and Training in Sub-Saharan Africa from an Innovation Systems Perspective: Case Studies of Ethiopia and Mozambique.* Research commissioned by the World Bank. Washington, D. C.: International Food Policy Research Institute.
2. Eicher, Carl K. 2006. *The Evolution of Agricultural Education and Training: Global Insights of Relevance for Africa.* Unpublished paper commissioned by the World Bank, AFTHD.
3. Langrock, Ines. 2006. "Typology of Agricultural Knowledge and Innovation Systems (AKIS) in Sub-Saharan Africa." Study commissioned by ARD, the World Bank. Department of Applied Economics, University of Minnesota.
4. Rivera, William. 2006. *Transforming Post-Secondary Agricultural Education and Training by Design: Solutions for Sub-Saharan Africa.* Unpublished paper. World Bank, Washington, D.C. Based on country case studies in:

   Cameroon, by Dominic Fontem
   Ghana, by Joseph Kwarteng
   Malawi, by Rebbie Harawa
   Mozambique, by Helder Gemo
   Rwanda, by Makelele Kilyobo
   Senegal, by Abdou Gueye and
   Uganda, by Joseph Obua

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6. Stulpinate, Lina. 2005. "Annotated Bibliography on Agricultural Education and Training in SSA." Unpublished document by the World Bank, Washington, D.C.
7. Tongoona, P. and M. Mudhara. 2007. "Regional Training Strategies for Post-Secondary Agricultural Education in Sub-Saharan Africa: When Do They Work and How Should They Be Done." University of KwaZulu-Natal. Unpublished paper commissioned by the World Bank, Washington, D.C.
8. Vandenbosch, Tom. 2006. *Post-Primary Agricultural Education and Training in Sub-Saharan Africa: Adapting Supply to Changing Demand.* Nairobi: World Agroforestry Centre (ICRAF). Based on country case studies in:

   Benin, by Georges Ogoudedji
   Burkina Faso, by Abdoulaye Zonon
   Ethiopia, by Alemayehu Merkorios
   Kenya, by Frederick Ngesa
   Mozambique, by Nicia Givá and
   Rwanda, by Emile Ndejuru

9. Zuidema, Larry. 2007. "Agricultural Education and Training in Africa: An Economic Justification for Investments." Unpublished paper commissioned by the World Bank, Washington, D.C.
10. Eicher, Carl. 2007. "Investment in Agricultural Education and Training in Africa." Unpublished paper commissioned by the World Bank, Washington, D.C.

Notes

EXECUTIVE SUMMARY

1 The interrelated importance of education, research, and extension in enhancing agricultural production and reducing rural poverty is well recognized in many developing countries. However, evidence suggests that the traditional education-research-extension "triangle" may be increasingly ill-equipped to respond to the new opportunities and challenges now associated with agriculture in Sub-Saharan Africa (Kroma 2003; Tadesse 2003). The entry of new actors, technologies and market forces, when combined with new economic and demographic pressures, suggests the need for more comprehensive approaches to strengthening agricultural education, research, and extension (IFPRI 2006).

CHAPTER 1

2 This section draws heavily on Zuidema (2007).
3 At the moment, Rwanda is reportedly leading national implementation of CAADP within the region.
4 The following paragraphs are drawn largely from Davis et al. 2007.
5 The interrelated importance of education, research and extension in enhancing agricultural production and reducing rural poverty is well recognized in many developing countries. However, evidence suggests that the traditional education-research-extension "triangle" may be increasingly ill-equipped to respond to new opportunities and challenges in sub-Saharan African agriculture (Kroma 2003; Tadesse 2003). The entry of new actors, technologies and market forces, when combined with new economic and demographic pressures, suggests the need for more innovative approaches to strengthening agricultural education, research and extension (IFPRI 2006).
6 A country's innovation system can be strong even when its NRS is weak. Ecuador and many Central American countries, for example, have weak NRSs but strong innovation systems that have enabled them to develop competitive production clusters in fresh fruits and vegetables. On the other hand, the Soviet Union of the 1970s and 1980s had a strong national research system and a weak innovation system (Davis et al 2007).
7 Definitions: "Agriculture" is meant here in its broadest sense, including crop production, forestry, fisheries, and veterinary science. "AET" signifies agricultural education and training. "Agricultural education" is defined as that provided to beneficiaries by formal educational institutions normally leading to an official qualification (certificate, diploma, or degree.) "Agricultural training" focuses on the acquisition of competencies for application in the labor market. It is provided by either formal or nonformal institutions, is generally short-term in nature, and does not normally lead to a formal qualification.
8 Shown on the first page of the bibliography.
9 Nonfarm skills training was covered in earlier research by Johanson and Adams on *Skills Development in Sub-Saharan Africa,* World Bank, 2004.

CHAPTER 2

10 IFPRI 2007; Commission for Africa Report: 229; FAO 2000; Vandenbosch: 12–13; ILO, *Key Indicators of the Labour Market: 2003;* ILO, *World Employment Report 2004–2005:* 133.
11 In 2005, the World Food Program fed 43 million Africans, double the number that it assisted in 1995 (ASARECA 2007). The number of chronically undernourished in Africa is projected to rise from 180 million in 2004 to 300 million in 2010 (FAO 2004). Global warming may accelerate this trend.
12 Technology, human capital and institutional innovations tend to be complementary inputs in production, but it is impossible to separate their relative influences with much accuracy. (Bonnen 1998: 272–274.)
13 Some universities in Africa have a large stock of agricultural scientists with MSc and PhD degrees. For example, in 1995, there were 550 African scientists with a PhD in agriculture employed by universities, more than the 360 in the government agricultural research agencies in Eastern and Southern Africa (Myrema 1997 in Eicher 2006:3 and in InterAcademy Council 2004:173)

CHAPTER 3

14 Declining donor support for AET mirrored broader negative trends in development assistance for technical and vocational education and training (TVET) in general. The causes are identified as (1) a strong critique of publicly provided TVET contained in the World Bank's 1991 policy paper on this topic; (2) the growing concentration of donor and government effort on the universal provision of basic education; (3) the high priority placed on poverty reduction contained in the Millennium Development Goals; and (4) rising awareness of the importance of the informal economic sector for employment in Africa and consequent shifts in skills development assistance towards nonformal training in business and financial management. In the case of the World Bank, total financing for TVET in Africa dropped by 40 percent during the 1980s and 1990s. As a share of the Bank's lending portfolio for education in Africa, investments in TVET plummeted from 22 percent in the 1970s to just 5 percent in the 1990s (Johanson and Adams 2004: 19–25).

15 A contributing factor may also be found in the organizational structures of donor agencies (including the World Bank), which tend to parallel the ministerial sectors of the governments with which they work. Agricultural education is a multisectoral issue that does not fall neatly into either the education or the agricultural sector. Thus, it rarely finds strong advocates within the ministerial cabinets of government or development assistance organizations. Instead, it tends to "fall through the cracks" between the mainline sector programs.

16 In an earlier study, Fan and Saurkar (2006) show that between 1980 and 2002 agriculture's share of GDP in Sub-Saharan Africa fell from 18.8 to 16.7 percent and agriculture's share of total government spending declined from 6.4 percent to 4.5 percent.

17 However, 70 percent of agricultural researchers held postgraduate degrees, a substantial increase from 43 percent in 1971.

18 Some observers have suggested that the sudden rise in development assistance was a temporary response to the events of September 11, 2001 and subsequent arguments that terrorism is spawned by underdevelopment.

19 The members are the Carnegie, Ford, Hewlett, Kresge, MacArthur, Mellon, and Rockefeller Foundations (www.foundation-partnership.org). Some of this assistance benefits faculties of agriculture.

CHAPTER 4

20 Data from UNESCO Institute of Statistics, obtained from EdStats (World Bank). Data for only 12 African countries were reported.

21 These classifications correspond to the ISCED levels used by the UNESCO Institute of Statistics: Level 4 straddles the boundary between upper secondary and post-secondary; in this table it is limited to technical or vocational programs of 6 months to 2 years duration. Level 5 represents the first stage of tertiary education; 5A is preparation for advanced degree with a minimum of 3 years of study and in this table only science, technology and engineering (STE) enrollments are used; 5B is practically oriented and occupationally specific with two or three years' duration. Level 6 leads to an advanced research qualification (i.e., a master's or doctoral degree).

22 On this scale, African countries accounted for 9 out of the 10 bottom-ranked economies, and 19 out of the last 26. South Africa was the highest ranked economy on the continent at 48th place (World Economic Forum 2006).

23 The reason may be the earlier establishment of graduate programs in the four competitive countries.

24 Geographically, PhD programs were established earlier in Eastern and Southern Africa than in West Africa. More than two-thirds of the 37 PhD programs in West Africa were started in or after the 1990s. In contrast, three-fourths of the 26 PhD programs in Southern Africa and 62 percent of the 12 PhD programs in East Africa were established before the 1990s (Beintema, personal communication, 2007).

25 This pattern also contrasts with ratios in the broader set of technical education of which AET is a part. Based on 16 Sub-Saharan Africa countries, technical upper secondary accounted for 29 percent of total enrollments at that level, 11 percent at postsecondary nondegree level, and 17 percent at degree level. UNESCO Institute for Statistics and World Bank *EdStats*.

26 Farm plots run by women have been found to have 20 to 40 percent lower yields than those run by men, but when women receive the same levels of education, experience, and farm inputs as men, they can increase yields of some crops by 22 percent (Rosegrant et al. 2005).

27 However, enrollments in BSc forestry increased as students pursued the more prestigious university degrees (Temu 2005:9).

28 National Council for Tertiary Education. *Statistical Digest of Polytechnics*. Accra, Ghana: Ministry of Education and Sports—various years.

29 In Ghana, a draft AET policy prepared by the Ministry of Agriculture is awaiting discussion and ratification by the Ministries of Agriculture and Education (Kwarteng 2006).

30 The region's only two master's degree programs in agricultural education are located at the University of Swaziland and at Egerton University in Kenya.

31 Students get few practical skills despite the specialization. Most of the basic agriculture schools have no equipment and facilities to provide practical teaching.

32 The number of higher education research units increased in many countries, but their individual capacity remained small. More than 40 percent of the 86 agricultural higher education research units in Nigeria and Sudan employed fewer than five full-time equivalent researchers in 2000 (Beintema and Stads 2004).

33 The situation in agriculture seems to closely parallel high vacancy rates experienced in science and technology. For example, the College of Science at KNUST, Ghana, has a 63 percent staff post vacancy rate with only 99 out of 268 posts filled. Likewise, the vacancy rate for science technicians in the College is 55 percent (Menyeh: 2005).

CHAPTER 5

34 This section distills the findings in the commissioned study by Carl Eicher, 2006, "The Evolution of Agricultural Education and Training: Global Insights of Relevance for Africa," unpublished document, The World Bank. The document reviews the development of AET capacity in four industrial and four developing countries outside Africa. Available at www.worldbank.org/afr/teia.

CHAPTER 6

35 In 2001, the Institute of Development Studies of the University of Sussex conducted tracer studies of 2,500 university graduates from 1980, 1987, 1994, and 1999 in Malawi, Tanzania, Uganda, and Zimbabwe. It found that unemployment rates among graduates were quite low and that most graduates were generally employed in their field of university studies. Agriculture was the main exception where between 25 and 50 percent of graduates reported that they were employed in non-agricultural jobs. This disconnect between training and employment was reportedly due to the limited number of attractive jobs in the agricultural sector, where public agricultural officers are frequently posted to remote rural areas (Al-Samarrai and Bennell 2003).

36 Angola, Botswana, Chad, Congo, Ethiopia, Mali, Mozambique, Nigeria, Rwanda, Sierra Leone, Sudan, Tanzania, and Uganda.

37 John Lynam, personal communication, April 2007.

38 Virtually identical recommendations emerged from a 2003 tracer study conducted by the University of Dar es Salaam (Mkude and Ishumi 2004: 316).

39 TEEAL web site: www.teeal.org; AGORA website: www.aginternetwork.org; OARE web site: www.oaresciences.org.

40 Studies available at www.suanet.ac.tz.

41 Currently under consideration at Makerere University.

42 An emerging exception is Mozambique. In 2002 the Ministry of Agriculture undertook a national diagnosis of gender inequities in agriculture. This in turn produced various proposals for ways in which rural research, extension and

education activities might empower women. In 2005 a National Research Fund was established by the Ministry of Science and Technology to stimulate applied research. One of its criteria for proposal evaluation is the potential benefit for rural women.

43 This program offers two years of mentoring by a senior scientist, training in team management and leadership skills, funds for presentation of research at a major scientific conference, and linkages to global networks of women scientists: www.genderdiversity.cgiar.org/resource/women_fellowships.asp.

44 www.fas.usda.gov/icd/borlaug/westafrica.htm.

CHAPTER 7

45 In which the candidate does coursework abroad for about one year, but returns home to do thesis research.

CHAPTER 8

46 Action on AET cannot be considered in isolation from the wider context of the education and training system as a whole, or in isolation from developments within the national agricultural innovation system.

ANNEX 2

47 Also termed "post-primary" agricultural education and training, or various forms of education and training available to primary education graduates, including vocational education, technical training, and general secondary education. (Vandenbosch: 10)

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