Lack of human resources, particularly senior academic staff and university graduates, still places a major constraint on the quality and volume of agricultural research and development (R&D) output in Africa (Chapter 8, this volume) and hence on the supply of technological innovation in African smallholder agriculture. Despite many attempts to expand (MSc- and PhD-level) training programs in agricultural sciences across Africa, such programs remain relatively underdeveloped. Most postgraduate training programs in agricultural sciences in Africa are still very small in terms of student enrollment, and they themselves suffer from staff limitations, exacerbated by losses of qualified and experienced staff to retirement or more attractive job opportunities outside academia in Africa or elsewhere. Moreover, programs often have difficulty establishing a credible research culture because of lack of research facilities, institutional incentives, and funding.

Where PhD programs are offered, they are usually limited to research only and do not require coursework. Students from diverse and often weak MSc and undergraduate programs have limited or no opportunity to strengthen their disciplinary competencies. Development and delivery of PhD course learning materials require a pool of knowledge emanating from locally relevant research for which senior faculty in a range of disciplines is required. Investment in faculties of agriculture, and in particular in postgraduate programs in agricultural sciences, is critical to enhancing agricultural research and innovation and hence agricultural development across Africa.

This chapter identifies key challenges for universities and the higher-education sector in Africa south of the Sahara (SSA) and, more specifically, explores trends in African faculties of agriculture and their impact on postgraduate training programs. Selected mechanisms by faculties of agriculture and educational networks to respond to the identified challenges are presented and implications of the current trends within the selected faculties are discussed. Finally, the chapter provides lessons and recommendations for improving the quality of postgraduate programs at African faculties.
Faculties of Agriculture in a Changing World

Faculties of agriculture across Africa primarily have a mandate for teaching, research, and outreach, and for producing a core workforce to staff and run agricultural research, extension, and training institutions that support development. Nevertheless, lack of consensus on the role of universities, on the part of both faculty members and their institutions, continues to impede the pursuit of the mission of many universities (Hawkins and Osiru 2012). For many years, African universities, including faculties of agriculture, were labeled “ivory towers” and perceived as making an insignificant contribution to societal needs, including those of rural farmers (Chakaredza et al. 2008). The context underpinning the higher-education sector itself has changed significantly as a result of changes in funding availability, the revolution in information and communications technologies (ICTs), and policy changes that have led to a rapid expansion of universities across the region. These issues prompt a review of the current status of African universities—more specifically of faculties of agriculture—with a consideration for the need to “retool” them to address the demands of a changing world.1

Following independence, many African nations assumed that universities would primarily train candidates for the civil service and public professions, filling the gap left by departing colonial administrators and professionals (Cloete and Maasen 2015). In 1972, the Association of African Universities organized a conference that led to the Accra Declaration, calling all universities to become “development universities.” However, an economic downturn in the late 1970s and into the 1980s kept policymakers from reforming higher-education institutions and instead prompted them to reduce their expenditures and adopt a policy of diversifying the funding base for universities beyond just government funding (Hayward 2010). For universities, this reform of the education sector opened the door for the establishment of private universities and programs as universities sought for alternative sources of income. Parallel paid programs (discussed later in this chapter) and other commercial activities at public universities were used to generate much-needed income. Emboldened by the rapid increase in the demand for a university education, universities quickly increased in number, many colleges evolved into universities, and teaching institutions became colleges or universities.2

This trend occurred in many African countries. In Kenya, for example, the number rose from 6 public and 18 private universities in 2006 (Ngugi 2007),

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1 Note that, for the purpose of this chapter, “higher education” refers to university education or training contributing to the award of an undergraduate or postgraduate degree.

2 At independence, and for many years afterward, most African countries had only one public university, largely modeled on the British and French higher-education systems.
to 22 public and 24 private universities in 2013. In Uganda, the number rose from 5 public and 12 private universities in 2003, to 9 public and at least 30 private universities as of 2013. The danger with the proliferation of universities is that, with so many higher-education institutions, none is able to obtain a critical level of funding and staffing to deliver its mandate (Eicher 2004). Most of the private universities focus on humanities and social sciences, and only a few focus on natural and applied sciences. Nevertheless, some private universities have recently established faculties of agriculture, including postgraduate programs in agricultural sciences.

The massification of higher education—defined by Jansen (2003, 292) as “absolute growth in student enrolments, as well as a more egalitarian distribution of students”—was further brought about by the recognition that (higher) education was necessary for national economic growth and seen as a fundamental human right that should be available to all who aspire for such an education. The focus emanated from previous policy shifts to make available to all primary and then secondary education, with two major issues emerging: (1) demand from a growing pool of secondary school graduates required that universities were able to absorb and provide opportunities for eligible students, and (2) the shift in resources toward primary and, later, secondary education stretched the overall envelope of resources, including staff and infrastructure available for university education (Hayward 2010). So while in Africa the number of students in higher education more than tripled between 1991 and 2006 (from 2.7 to 9.3 million), funding for higher education has only doubled, unlike in the rest of the world, where higher-education funding has kept pace with student enrollment (World Bank 2010). In a study of 33 SSA countries, the World Bank noted that public expenditures per student at the higher-education level had fallen drastically, from US$6,800 in 1980 to $981 in 2007–2008 (World Bank 2009).

Based on prevailing trends in SSA, although actual primary and secondary enrollments have been much higher, tertiary enrollments have the highest rates of yearly growth (Table 9.1). The World Bank (2010) estimated that Africa would have 18–20 million higher-education students by 2015, which would require a doubling of the teaching capacity between 2006 and 2015. Although the majority of students favor humanities and social sciences, it is assumed that faculties of agriculture will also attract a growing student population. Nevertheless, agriculture’s share of overall student enrollments is

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3 This was also prompted in part by Millennium Development Goal 2a, which called for ensuring that male and female children everywhere would be able to complete a full course of primary schooling by 2015.
generally low across SSA (4.4 percent on average), ranging from 0.5 percent in Cape Verde to 7.1 percent in Rwanda (Table 9.2). The fact that science faculties, including faculties of agriculture, are more expensive (because they require larger investments to establish) may act as a constraint. Haramaya University in Ethiopia offers an example of the evolution of higher-education institutions in Africa over time (Box 9.1).

### Table 9.1 Enrollments in Africa south of the Africa by level of education, 1999–2012

<table>
<thead>
<tr>
<th>Level of education</th>
<th>1999 (millions)</th>
<th>2005 (millions)</th>
<th>2012 (millions)</th>
<th>Average yearly growth, 1999–2012 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>82.2</td>
<td>111.9</td>
<td>144.1</td>
<td>5.8</td>
</tr>
<tr>
<td>Secondary</td>
<td>21.6</td>
<td>31.5</td>
<td>48.6</td>
<td>9.6</td>
</tr>
<tr>
<td>Tertiary</td>
<td>2.3</td>
<td>3.9</td>
<td>6.3</td>
<td>13.9</td>
</tr>
<tr>
<td>Total</td>
<td>106.1</td>
<td>147.4</td>
<td>199.0</td>
<td>6.7</td>
</tr>
<tr>
<td>Share of tertiary in total (%)</td>
<td>2.1</td>
<td>2.7</td>
<td>3.2</td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Calculated by authors based on UNESCO (no date).

### Table 9.2 Number of tertiary students enrolled in agricultural programs, 2010–2012 average

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of students</th>
<th>Agriculture's share of enrollments (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benin</td>
<td>1,589</td>
<td>1.4</td>
</tr>
<tr>
<td>Burkina Faso</td>
<td>527</td>
<td>0.9</td>
</tr>
<tr>
<td>Cape Verde</td>
<td>51</td>
<td>0.5</td>
</tr>
<tr>
<td>Central African Republic</td>
<td>343</td>
<td>3.1</td>
</tr>
<tr>
<td>Congo, Democratic Republic</td>
<td>33,879</td>
<td>6.8</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>33,007</td>
<td>5.7</td>
</tr>
<tr>
<td>The Gambia</td>
<td>58</td>
<td>1.3</td>
</tr>
<tr>
<td>Ghana</td>
<td>9,304</td>
<td>3.3</td>
</tr>
<tr>
<td>Liberia</td>
<td>2,085</td>
<td>5.4</td>
</tr>
<tr>
<td>Madagascar</td>
<td>1,980</td>
<td>2.4</td>
</tr>
<tr>
<td>Mali</td>
<td>1,003</td>
<td>1.2</td>
</tr>
<tr>
<td>Mauritius</td>
<td>359</td>
<td>0.9</td>
</tr>
<tr>
<td>Mozambique</td>
<td>5,213</td>
<td>4.6</td>
</tr>
<tr>
<td>Rwanda</td>
<td>5,102</td>
<td>7.1</td>
</tr>
<tr>
<td>Tanzania</td>
<td>1,636</td>
<td>1.0</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>2,296</td>
<td>2.4</td>
</tr>
<tr>
<td>16-country average</td>
<td>6,152</td>
<td>4.4</td>
</tr>
</tbody>
</table>

**Source:** Calculated by authors based on UNESCO (no date).

**Note:** Averages were calculated based on one to three data points.
Haramaya University, Ethiopia

The first university in Ethiopia, Addis Ababa University, was established in 1950, and with its constituent colleges it remained Ethiopia’s only university for close to 50 years. In the past 10 years, however, several new universities have been formed, and many of Addis Ababa University’s colleges have expanded into fully fledged universities in their own right. Haramaya University College of Agriculture (originally the Alemaya College of Agriculture) made this transition in 1985, became a multidisciplinary university in 1996, and was renamed Haramaya University in 2006. From 1952 to 1968, the institution received substantial support from the United States Agency for International Development (USAID). Since 1997, the university has run a BSc program for students who work in the public sector and hold either agriculture or forestry diplomas from accredited colleges. The program’s objectives are to upgrade the skills of frontline, midcareer extension workers. The university was initially Ethiopia’s only higher-education institution offering MSc training in major agricultural specialties, and in 2002 it launched PhD programs. Haramaya University originally had the national mandate for both agricultural research and extension, but currently its research and extension activities operate under the umbrella of the Ethiopian Institute of Agricultural Research.

Haramaya University has ambitious plans for new BSc-, MSc-, and PhD-level degrees. Additionally, in collaboration with the International Food Policy Research Institute, a Center for Agricultural Research Management and Policy Learning for Eastern Africa (CARMPoLEA) was established. This regional center served as home to a capacity-building initiative to improve the management, organization, and leadership of agricultural research and policymaking and, ultimately, to support national and regional agricultural innovation systems. The center organized a series of workshops intended to respond to regional needs for knowledge and skills in the areas of agricultural research management and policy, including in-person and virtual courses, as well as targeted follow-up services, for researchers, policymakers, and other stakeholders in East Africa.

As of December 2014, Ethiopia had 31 public universities, many with infrastructure development still underway. Enrollment in the 2009/10 academic year comprised 203,455 students, plus intakes of 78,822 students in 2010/11 and 94,000 in 2011/12. National reforms have included curriculum revision; the development of new programs; and dedicated support of institutions focused on enhancing quality, such as the Higher Education Relevance and Quality Agency and the Higher Education Strategy Centre, in line with the 2009 Higher Education Proclamation. The Ethiopian government took other steps to enhance quality, although concerns remain that their implementation has been politicized, and questions have been raised as to whether the implementation process conforms closely enough with the Proclamation.

Sources: Blackie, Mutema, and Ward (2009); Areaya (2010); Haramaya University (2013).
Staffing, Infrastructure, and Funding Constraints

Staffing and Infrastructure

As faculties of agriculture respond to local and national demand for agricultural specialists as well as the need for broader knowledge to intensify agricultural production, MSc- and PhD-level programs have diversified, expanded, and increased in number. Nevertheless, the bulk of the student population (and hence the teaching load) at most faculties of agriculture in Africa is still concentrated in undergraduate programs (Table 9.3).

Staffing at faculties of agriculture varies greatly, indicating the relative strengths of the various faculties. A study (RUFORUM 2009) assessed staffing levels and postgraduate programs at six faculties of agriculture (Table 9.3). Staffing levels varied from 188 academic staff at Makerere University to 33 at the National University of Rwanda, which at the time of the study ran only one MSc program with an enrollment of 23 students but no PhD program. As of 2011, Egerton University in Kenya employed 121 academic staff and had 47 MSc students enrolled; Makerere University’s Faculty of Agriculture\(^4\) employed 63 PhD-qualified staff and had 108 MSc students enrolled. As of 2012, Lilongwe University of Agriculture and Natural Resources employed 143 academic staff, and all are expected to be PhD qualified by 2018 (Blackie, Mutema, and Ward 2009). Cloete, Bunting, and Maasen (2015) showed that the low proportions of PhD-qualified and senior academic staff were linked to low knowledge production at universities. In general, many universities have shifted away from offering the general programs common in the past toward more specialized programs. Several programs, however, are challenged by the low number of students—such as at Egerton University and the National University of Rwanda, which had 1 and 0 PhD students enrolled, respectively. Programs require a minimum number of students to be cost-effective. Academic staff members spend most of their time on the large number of BSc students enrolled, leaving little time for research-oriented activities.

Of particular importance, the pool of academic staff at faculties of agriculture is aging. The share of PhD-qualified higher-education researchers older than 50 years ranged from 14 percent in Burundi to 98 percent in Guinea (Figure 9.1). In close to 80 percent of the countries (21 of 27 countries sampled), the share of PhD-qualified staff over 50 years old was more than

\(^4\) Makerere University reorganized its faculties into colleges and departments in 2010; the Faculty of Agriculture is now under the College of Agricultural and Environmental Sciences.
<table>
<thead>
<tr>
<th>University</th>
<th>PhD</th>
<th>MSc</th>
<th>BSc</th>
<th>Total</th>
<th>No. of MSc. programs</th>
<th>No. of PhD programs</th>
<th>No. of BSc students</th>
<th>No. of MSc students</th>
<th>No. of PhD students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egerton University, Kenya</td>
<td>56</td>
<td>46</td>
<td>19</td>
<td>121</td>
<td>14</td>
<td>9</td>
<td>302</td>
<td>47</td>
<td>1</td>
</tr>
<tr>
<td>Makerere University, Kenya</td>
<td>63</td>
<td>103</td>
<td>22</td>
<td>188</td>
<td>9</td>
<td>8</td>
<td>1,175</td>
<td>108</td>
<td>39</td>
</tr>
<tr>
<td>National University of Rwanda</td>
<td>18</td>
<td>13</td>
<td>2</td>
<td>33</td>
<td>1</td>
<td>0</td>
<td>822</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>University of Zambia</td>
<td>18</td>
<td>17</td>
<td>0</td>
<td>35</td>
<td>4</td>
<td>4</td>
<td>450</td>
<td>24</td>
<td>8</td>
</tr>
<tr>
<td>University of Zimbabwe</td>
<td>23</td>
<td>29</td>
<td>10</td>
<td>62</td>
<td>4</td>
<td>3</td>
<td>452</td>
<td>42</td>
<td>na</td>
</tr>
<tr>
<td>Lilongwe University of Agriculture and Natural Resources, Malawi</td>
<td>58</td>
<td>70</td>
<td>15</td>
<td>143</td>
<td>8</td>
<td>2</td>
<td>900</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>Université d’Abomey-Calavi, Benin</td>
<td>55</td>
<td>15</td>
<td>2</td>
<td>72</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>53</td>
</tr>
<tr>
<td>University of Ghana</td>
<td>88</td>
<td>30</td>
<td>10</td>
<td>128</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>25</td>
</tr>
<tr>
<td>Université de Lomé, Togo</td>
<td>37</td>
<td>6</td>
<td>1</td>
<td>44</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
</tbody>
</table>

**Sources:** Calculated by authors based on ASTI (2014); RUFORUM (2009); and Blackie, Mutema, and Ward (2009).

**Note:** na = data were not available.
40 percent of all staff. Most of the current staff were recruited during the establishment of the faculties of agriculture in the 1970s and 1980s and trained abroad, often up to the PhD level; this cohort of staff is nearing or at retirement age. Later recruitments have generally been fewer and have benefitted less from overseas training opportunities because of limited funding for higher education.

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5 During the 1990s, USAID supported 9,128 developing-country students, 310 of whom were in agriculture; by 2000, this number had dropped to fewer than 1,700 (BIFAD 2003).
In most faculties of agriculture, BSc classes are overcrowded as a result of the increasing enrollments without the requisite increase in the number of staff or facilities. Classroom, library, and laboratory space per student is low, averaging 1.3 square meters in African public universities compared with 4–10 square meters at universities in Organisation for Economic Co-operation and Development countries (World Bank 2010). Basic classes are usually taken by all first-year students prior to the selection of electives in later years, which only exacerbates this situation. At Malawi’s Lilongwe University of Agriculture and Natural Resources (formerly Bunda College)—with a significantly increased first-year intake of more than 2,500 students in 2009—most classes comprised at least 250 students (Blackie, Mutema, and Ward 2009). At Makerere University, undergraduate classes often have more than 300—and even up to 500—students, especially for common courses (housed within structures planned for significantly lower numbers). Excessive class size, which is seemingly becoming more common, challenges faculty staff in terms of promoting discussion and group activities (Hawkins and Osiru 2012). Most postgraduate programs in agricultural sciences in Africa, however, do not suffer from overcrowded classrooms; they often have so few students as to lack a critical mass and be cost-inefficient.

Rather than each faculty attempting to offer a wide range of programs—and being unable to excel at any of them—it would seem to make more sense to cluster specialized postgraduate programs at national and regional levels. The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) has established centers of leadership that are now offering high-quality MSc and PhD programs jointly implemented by two or more of its 55 member universities. The programs are designed to include the full participation of faculty and stakeholders in the region and are a response to the articulation of demand by stakeholders in higher education (RUFORUM 2014).

Although most faculties of agriculture have ample PhD-qualified staff members (Table 9.3), undergraduate teaching is mainly being carried out by MSc-level staff and, in some cases, by postgraduate students. Staff pointed to the low salaries, limited opportunities for professional development (sabbaticals, postdoctoral fellowships, PhD training opportunities), and limited research funding as key constraints to their professional advancement (Blackie, Mutema, and Ward 2009). Moreover, some postgraduate programs surveyed had too few students enrolled for the programs to be cost-effective (RUFORUM 2009). Staff member-to-student ratios are low but highly
variable. Nevertheless, the challenge remains to upgrade the qualification and experience levels of the more junior staff. The challenges have encouraged the development of regional efforts to strengthen postgraduate training in the region, such as through the RUFORUM network.6

Access to basic infrastructure and reading materials remains a constraint. Overcrowding and lack of investment at faculties of agriculture and universities, in general, has resulted in poor access to library facilities (Kanyengo 2009). The University of Zambia, for example, opened in 1966 with 312 students and a planned doubling of its student population within five years. Nevertheless, the student body grew to more than 1,000 by 1970 and to 10,008 by 2014. The university’s library was forced to develop new strategies in response to the expanded student numbers, including employing students to work in the library; enhancing the use of electronic resources and databases, such as The Essential Electronic Agriculture Library (TEEAL) and Access to Global Online Research in Agriculture; moving resources from open shelves to a reserve collection to enhance student access to materials; restricting access to serial collections to postgraduate students; and increasing library opening hours. Other challenges included a lack of shelving, reading tables, reliable Internet connectivity, and insufficient funding. Similarly, libraries in Ghana and Uganda reported difficulty in sustaining the cost of subscribing to journals (Marty 2002; Were 2002), a key resource in conducting high-quality research.

**Funding**

Funding, or lack thereof, has been a key driver of reform at African universities. Following the policy changes in the late 1980s and early 1990s, which resulted in increased demand and enrollments at universities in general and faculties of agriculture in particular, African universities were forced to innovate by diversifying their funding streams. However, most faculties of agriculture struggled to balance the increasing demand for higher education with the need to improve quality, and many have grown beyond their financial capacity. Expenditure per student in Africa has declined by 30 percent over the past 15 years (World Bank 2009), raising concerns about the capacity of African universities to enhance the quality and relevance of training.

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6 RUFORUM, based at Makerere University, Uganda, is a consortium of 55 universities in 22 countries. Recognizing the important (and largely unfulfilled) role universities play in contributing to the well-being of small-scale farmers and economic development throughout SSA, RUFORUM’s mandate is to oversee graduate training and networks of specialization in the universities and countries in which it works (Chapter 10, this volume).
At the same time, only a quarter of all international aid to the education sector is spent on higher education. Of this support, less than a quarter goes directly to the African institutions; the rest is spent on scholarships and associated costs abroad (World Bank 2010).

Donor funding has evolved significantly over the years since independence. Initially, funding was often targeted toward support for infrastructure development, including the construction of buildings, laboratories, and libraries in the 1960s and early 1970s (DDRN 2010). This then evolved in the 1970s and 1980s into a combination of technical assistance to local African universities and long-term training at universities in donor countries. The focus shifted to strengthening the requisite human resources to support local research and build training institutions. An example was the Manpower for Agricultural Development program in Uganda, supported by USAID. As lessons from these programs emerged, programs were tweaked in response to challenges. One recurrent challenge was difficulty in getting students who received training to return to their sponsoring institutions, and equally to resettle them into their jobs. A second challenge was the focus of the research and results of programs provided by external universities were not usually directly applicable to the local contexts of the students being trained. Graduates often did not return to Africa and, when they did, resettlement remained a challenge. “Sandwich” programs, in which students do their PhD coursework and defense of their dissertation abroad, but their research at home, were designed to make the research experience and its outputs more relevant to the trainee and his or her sponsor, maintain the bond between the two, and at the same time contribute solutions to local development challenges in integrated agricultural research for development. Currently, the training and research support available is delivered in various ways, but is largely less institutionalized and mostly managed by the target beneficiaries as individual scholarships.

At the end of the 1980s, funding agencies began to rethink their support following a World Bank report that estimated the social rates of return to higher education to be lower than those of basic education (Psacharopoulos and Patrinos 2004). This was in line with World Bank suggestions that higher education was largely a “luxury” for Africa (Mamdani 1993). Subsequently, World Bank funding for basic education increased dramatically. Other donors followed this strategy and national governments were (implicitly or explicitly) advised to prioritize basic education over higher education. Donor funding to higher education increased slightly from the 1990s, but not to the levels needed to fill the gap left by
national governments or to meet the increased demand for higher education. Donor support to higher education in SSA stood at approximately US$600 million per year in 2010 (World Bank 2010). With highly fragmented support, it was difficult to undertake the type of longer-term initiatives needed to strengthen faculties of agriculture.

African universities have responded to the above challenges by adopting new management techniques, developing more demand-oriented curricula, creating new courses, and taking steps to strengthen public–private partnerships (Mihyo 2008). Other innovations have been through various mechanisms to strengthen fundraising, including privatization and outsourcing of services. Innovations have often exposed further challenges, however, and quality concerns have remained. Recognizing that government funding is stretched (World Bank 2009), today higher education is paid for through a variety of mechanisms, including tuition, examination, and other related fees that generate an average of close to 30 percent of university income—ranging from 5 percent in Madagascar and Zimbabwe, to 56 percent in Uganda, and 75 percent in Guinea-Bissau (World Bank 2010). However, although a large portion of financing for faculties of agriculture is from overseas development assistance, overall donor support to agricultural higher education and training in Africa has remained low (World Bank 2009). For example, the World Bank allocated only 20 percent ($170 million) of its agricultural budget in Africa (Eicher 2006). Despite this, African institutions have largely recognized the need to train students locally because (1) students would often not return from training abroad, and when they did they had difficulty fitting back into local conditions; (2) research undertaken during training at foreign universities was often not relevant to local problems; and (3) if the objective was staff development, staff would remain in the workforce for a significant part of the training period.

Many faculties of agriculture (like universities generally) have diversified their training programs. In addition, they have started to offer parallel (that is, duplicate) programs in the evening and on weekends in order to accommodate students with day jobs—an important and growing market (Box 9.2). Distance education and adult-learning programs have also been initiated in recent years. Unfortunately, teaching facilities and resources—including lecture rooms, library facilities, and teaching staff—did not increase proportionately with the number of students enrolled. In addition, faculty members often accept additional part-time employment at new faculties of agriculture.
Research and Postgraduate Degree Programs

Research undertaken by higher-education institutions is a significant and growing component of national agricultural research in Africa (Table 9.4). In 2011, on average, higher-education establishments constituted 25 percent of SSA’s national agricultural research capacity, up from 20 percent a decade earlier. Over this decade, agricultural research capacity at higher-education institutions grew much faster (6 percent per year, on average) than that at government and nonprofit agencies (2.6 percent per year on average). While much of the growth in full-time equivalent (FTE) researchers at universities is the result of an expansion of faculty staff, some of it may also be attributed to the fact that staff have begun to spend more time on research. In a study of eight flagship universities in SSA, Cloete, Bunting, and Maasen (2015) reported an increase in the number of MSc graduates from 2,268 in 2001 to 7,156 in 2011 and in the number of PhD graduates from 154 in 2001 to 367 in 2011.7 RUFORUM supported the training of more than 1,300 MSc students during 1992–2013 and 212 PhD students during 2008–2013 (RUFORUM 2014).

Box 9.2 A comment on parallel programs

A study commissioned by the Association for Strengthening Agricultural Research in Eastern and Central Africa and RUFORUM reported that several faculties of agriculture in the region are running parallel programs for paying students, a practice that boosts university finances. Students in these programs have special privileges in that they can choose their first preference for their degree programs, whereas regular students can be assigned to programs of little interest to them if their first choices are oversubscribed or they do not meet the minimum entry requirements. Students in parallel programs do not have to wait for government sponsorship processes and can enroll a year earlier than regular-entry students. An important outcome is that student enrollment in parallel programs takes priority to maximize the revenues generated, but the quality of the education suffers; it is common, for example, for a university administration to give directives on student numbers, ignoring available resources and capacity.

Source: Blackie, Mutema, and Ward (2009).

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7 The eight flagship universities involved were the University of Botswana, University of Cape Town, University of Dar es Salaam, Eduardo Mondlane University, University of Ghana, Mauritius University, Makerere University, and University of Nairobi.
Time allocated to research varies widely by faculty and staff members within faculties; on average, however, faculty members spend around 25 percent of their time on research (Beintema and Stads 2011). Notably, agricultural researchers within higher-education institutions generally have a far better educational profile compared with those employed within government and nonprofit agencies. In 2011, 52 percent of the researchers in the higher-education sector were PhD qualified, compared with an average of only 23 percent in the government and nonprofit sectors (Table 9.4).

Faculty members from relevant disciplines offer a valuable untapped resource in the conduct of multidisciplinary research, as do female scientists, whose participation has been low across the board (suggesting considerable gender disparity; Chapter 8, this volume). Thus, faculties of agriculture could play an even greater role in performing research and solving rural farmers’ problems, while at the same time ensuring that agriculture-related programs produce graduates with the required levels of skills and experience relevant to development needs.

Africa’s relative share of the global output of scientific research, measured in terms of international publications, was declining prior to 2002 (Tijssen 2007). For the period 2002–2008, this share increased from 1.6 to 2.2 percent, largely through international collaborations with non-African

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**TABLE 9.4 Agricultural researchers in selected African countries, 2001–2011**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>2001</th>
<th>2008</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of agricultural researchers employed at government and nonprofit agencies (FTEs)</td>
<td>7,260</td>
<td>8,281</td>
<td>9,412</td>
</tr>
<tr>
<td>Total number of agricultural researchers employed at higher-education institutions (FTEs)</td>
<td>1,769</td>
<td>2,565</td>
<td>3,179</td>
</tr>
<tr>
<td>Total number of agricultural researchers employed at higher-education institutions as a share of publicly employed researchers (%)</td>
<td>20</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>Share of PhD-qualified agricultural researchers employed at government and nonprofit agencies (%)</td>
<td>25</td>
<td>26</td>
<td>23</td>
</tr>
<tr>
<td>Share of PhD-qualified agricultural researchers employed at higher-education institutions (%)</td>
<td>48</td>
<td>53</td>
<td>52</td>
</tr>
<tr>
<td>Share of female agricultural researchers employed at government and nonprofit agencies (%)</td>
<td>na</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>Share of female agricultural researchers employed at higher-education institutions (%)</td>
<td>na</td>
<td>22</td>
<td>21</td>
</tr>
</tbody>
</table>

**Source:** Calculated by authors based on ASTI (2014).

**Notes:** Overall researcher data are based on 34 countries of SSA; sample shares for researchers by degree and gender are for 24 and 26 countries, respectively. Note that public agricultural researchers are defined here to include those employed in the government, nonprofit, and higher-education sectors. FTEs = full-time equivalents; na = data were not available.
partners (Tijssen 2015). At the same time, the share of researchers marginally declined, from 2.2 to 2.1 percent (Zeleza 2014). Low government support for university-based research—with available funding being allocated to recurrent expenditures (mainly staff salaries and utilities)—has not helped the situation. Funding for research has to be mobilized mainly from external sources. To date, few African governments have established competitive funds to support research at universities. Hence, most external funding for research is derived from foreign donors, which makes it more difficult for countries to set their own research agendas. As a result, many faculties of agriculture have established grant management offices to facilitate resource mobilization.

In particular, universities need to focus on developing and strengthening high-quality PhD and MSc programs in order to strengthen research and training. Huge challenges remain, including limited and unsustainable funding, low numbers of PhD-qualified staff to run training programs, and inadequate policy regimes to support a culture of research. Funding for publicly supported students in universities is usually paid as tuition at a rate that is often below the market rate for universities. Setting student tuition fees has become a political issue at many universities; those that receive government funding are often not allowed to set their own fees, which is seen as a political tool that few governments would want to lose control of.

Most universities still focus their primary efforts on teaching, followed by research (which is reinforced by eligibility criteria for career advancement); there is little incentive for academic staff to focus on the third facet of the university mandate, which is outreach. In addition, funding is a major limitation to the conduct of research in most African faculties of agriculture. This contrasts with the situation in Brazil, for example, where graduate programs are assessed for funding based on their research output (UNESCO 2009). Cloete and Maasen (2015) recommend that African governments must consider differentiating higher-education institutions because mandates are often contradictory; they cite Mohamedbhai’s (2012) review, showing that only five African universities—none of which is in SSA—were in the two main rankings of the top 500 universities worldwide. Hence, it may be more practical for universities to have multiple mandated areas.

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8 The five universities were the University of Cape Town, Stellenbosch University, the University of the Witwatersrand, Alexandria University, and the University of KwaZulu-Natal.

9 South Africa’s higher-education system has three categories of universities (Bunting et al. 2015): (1) traditional universities focusing on general academic and professional programs, (2) universities of technology focusing on vocational programs, and (3) comprehensive universities offering a mix of (1) and (2).
Postgraduate programs are the center for research at most universities, and research is coordinated through a school of graduate and postgraduate studies. Research at faculties of agriculture is usually based on discipline-related mandates, student training, and donor objectives. This is partly changing, as several universities have established various platforms, such as RUFORUM’s national forums, to ensure greater alignment and responsiveness to national research priorities. Although universities have significant staffing capacity compared with public agricultural research institutions, they are often unable to access sufficient public research funding. Ongoing efforts to address this problem include the restructuring of national agricultural research systems and the use of competitive funding mechanisms to separate research funding from its delivery. This allows other research actors, such as faculties of agriculture, to tap into national research funding. If universities are to actively pursue research, they must provide their staff with research facilities that meet international standards, such as laboratories, research fields, and access to up-to-date literature (UNESCO 2009); train them in research methods and in writing research proposals; and provide them with appropriate incentives.

Most PhD programs at African faculties of agriculture follow the old European model of delivering a PhD dissertation based on the candidate's own research, with no formal coursework required. This works when professors have only one or two PhD students at a time (and training is primarily one on one), but it becomes unmanageable with larger groups of students. Also, most European universities currently require formal coursework as part of their PhD programs, but the research-only model is still the most commonly used at many African universities. The research-only model is increasingly coming under scrutiny because the level of students entering universities is uneven. The low proportion of staff undertaking research (or qualified to conduct research) hinders the capacity of the faculties to support high-quality postgraduate training and has limited the scope of the programs, such that less contextually specific material is being used. In addition, many degrees still take longer than their prescribed duration; MSc programs usually take three to four years, rather than two, and a PhD program can take as long as six years.

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10 Thirteen national forums are currently operating in Burundi, Democratic Republic of the Congo, Kenya, Malawi, Mozambique, Rwanda, Swaziland, Tanzania, Uganda, Zambia, and Zimbabwe. They are designed to provide a platform for stakeholders to articulate demand for university services, advocate for change, and provide feedback on the utility of RUFORUM’s activities. The forums typically comprise member universities; policymakers; and representatives from farmers’ organizations, the private sector, and the national agricultural research and extension system (more information is available at www.ruforum.org).
Recognizing the need to enhance the quality of research and teaching at African universities, and in light of the low proportion of PhD-qualified staff at African faculties of agriculture, RUFORUM and its 46 member universities have initiated a model based on the US system, maximizing the regional comparative advantages of the different universities initiated between 2008 and 2013. The RUFORUM networking model has provided some important instruction for strengthening universities under the current weak public financing. Working in partnership with universities in Europe, the United States, and the United Kingdom, RUFORUM has worked with six universities to build seven regional PhD programs and has provided support and facilitated training for 212 PhD students (Table 9.5) and 211 MSc students since 2008. The programs have demonstrated the strength of networking capacity, highlighting the potential for matching weak and stronger universities, building cost-effective graduate programs, strengthening the internationalization of programs, improving staff engagement and curriculum review, creating partnerships with research institutions for graduate research, and supporting capacity building for newer universities.

RUFORUM has also shown that African faculties of agriculture can produce quality graduates within a specified and reasonable time-frame, which is a major concern in the region. Makerere University’s MSc
plant-breeding program is a case in point. Since its inception in 2009, the program has produced graduate students—within the specified timeframe of 24 months—with strong technical and practical skills, acceptance in peer-reviewed publications, and success in finding employment. This success has been possible because the program was designed to respond to market needs, is well linked to national plant-breeding programs and the emerging seed industry in the region, and has appropriate levels of well-qualified, full-time academic staff allocated to and invested in the program. The regional nature of the program allows it to draw students and staff from across Africa and to attract international scholars. The lessons from this MSc program, as well as from Makerere’s PhD plant-breeding and biotechnology program, have catalyzed the emergence of joint graduate training programs in SSA. These include, for example, the PhD program in agricultural and rural innovations, jointly run by Egerton University, Makerere University, and Sokoine University, which now also offers joint courses with three European universities (Montpellier SupAgro, the University of Copenhagen, and Wageningen University and Research Centre). Each year an average of 40 PhD students from Africa and Europe take joint field classes concurrently with online courses.

The RUFORUM model has led to other benefits, such as the infusion of new ideas into university research by attracting teaching staff from foreign universities. Several universities have been challenged by “inbreeding” in the sense that a majority of faculty are former students joining the teaching staff of their universities upon graduation. RUFORUM’s programs have also provided much-needed and affordable training for the smaller, often newer and private, universities that usually do not run postgraduate programs and have numerous staff in need of further education. New universities have enhanced the competitiveness of universities in terms of both teaching and research. The downside has been the exodus of staff from established universities to the newer ones as part-time teachers. Retired academics have also been reabsorbed into the newer private universities.

Programs that enhance the opportunity to share academic knowledge, talent, and experience will be critical in the future. As African faculties become more interconnected through increased access to ICTs, it is critical that they develop research cooperation that responds directly to the needs of African faculty. The longstanding cooperation that has supported and strengthened a variety of programs, such as the Norwegian and Swedish support to Sokoine University and the University of Malawi, and the Rockefeller Foundation’s support of Makerere University, will continue to be relevant. To date, research
cooperation has been limited to a few African universities (Shabani 2008), but RUFORUM is addressing this by facilitating regional learning through cross-country research among its member universities.

The advent of the African Union, the New Partnership for Africa’s Development, and the Forum for Agricultural Research in Africa has strengthened research cooperation among national agricultural research institutes in Africa, and universities need to be linked to these efforts (Chapters 1 and 9 this volume). Research is a powerful tool for strengthening the quality of teaching. In a study of three African universities in Kenya, Malawi, and Uganda, Hawkins (2010) found that most lecturers in faculties of agriculture had little or no formal training in learning theory or teaching, and hence their understanding of learning concepts, experiential learning, action research, and outreach concepts was highly variable. The study found that, for many staff, experiential learning was a process of practicing what had been learned or of experimenting. Outreach and action research were often viewed as processes for disseminating technology generated through conventional research, or as deeper engagement with other development stakeholders. Field attachments were highlighted as the key method for enhancing experiential learning. This being the case, universities and faculties maintain a variety of teaching and delivery methods, dependent on the individual staff involved. Younger staff members were more likely to attempt to incorporate group methods, including classroom discussions and student research on course material. Faculty members need to shift their focus from teaching approaches based on pedagogy to those based on andragogy (Table 9.6).

<table>
<thead>
<tr>
<th>Pedagogy</th>
<th>Andragogy</th>
</tr>
</thead>
<tbody>
<tr>
<td>The learner is dependent, and the teacher determines what is learned, when it is learned, and how learning is evaluated.</td>
<td>The learner is more independent, and the teacher encourages this independence and guides the learner.</td>
</tr>
<tr>
<td>The experience of the learner is not considered to be significant; teaching methods are didactic.</td>
<td>Experience is valued as a rich resource for learning and forms the basis of discussions and problem solving.</td>
</tr>
<tr>
<td>People learn what society expects them to learn; the curriculum is standardized.</td>
<td>People learn what they need to; the curriculum is organized around their needs.</td>
</tr>
<tr>
<td>Learning themes are organized around abstract disciplines.</td>
<td>Learning themes are organized around experiences, problems, or expected competencies.</td>
</tr>
</tbody>
</table>

Source: Hawkins (2010).
Tomorrow’s Faculties of Agriculture

Africa needs a far larger pool of talent in the agricultural sciences to support knowledge generation and its application to intensify and raise agricultural production and productivity. Faculties of agriculture and related sciences within the broader university context have a greater role to play both in training innovators and problem solvers and in creating knowledge to enhance the competitiveness of African agriculture. Integration of innovation into the research process will require universities to develop their collaboration with other partners—such as national and international research institutions, extension and rural development agencies, and the private sector—to ensure demonstrable outcomes (Chapter 13, this volume).

Higher-education institutions in Africa are rapidly increasing and expanding to meet the growing demands for higher education in the region. The prevailing general trends and developments apply equally to faculties of agriculture in Africa:

• Both the number and the size of higher-education institutions are expanding rapidly in Africa to meet the growing demand for higher education. Moreover, because such a low share of the African population has a higher degree (less than 5 percent compared with more than 40 percent in the more advanced developed countries), demand is expected to remain high for some time to come (that is, substantially above population growth). Meeting this demand will also require a significant increase in teaching capacity.

• Most higher-education institutions in Africa began with undergraduate education only, but many are now gradually beginning to offer postgraduate degrees. As a prerequisite for this upgrade, these institutions must substantially strengthen their research profile. In the years to come, growth in postgraduate education will most likely exceed growth in undergraduate education. The push toward the “development university” model has meant that some countries (such as Ethiopia and Kenya) are supporting the emergence of research-based universities.

• For the past few decades, public funding for higher-education institutions in Africa has grown far more slowly than the number of students enrolled. Higher-education institutions have tried to close this funding gap by mobilizing external funding (including student fees) and enhancing efficiency; however, according to many observers, the quality of the education programs has suffered.
Overwhelmed by the numbers of students and lack of funding and facilities, many higher-education institutions in Africa have been unable to properly address both their teaching and their nonteaching mandates.

Growth in funding of higher-education institutions (including faculties of agriculture) should be increased considerably, at least to match growth in student enrollments. Funding for nonteaching activities, such as research and outreach, should be decoupled from student enrollments and given dedicated funding in the form of government grants and contracts or competitive funding schemes. Faculties of agriculture need to be more competitive, for example, by marketing their success stories and developing the necessary capacity and databases to ensure that information on their status is more widely accessible. Modernization of teaching methods and curriculums should continue.

A closer look at the postgraduate programs of selected faculties of agriculture in East, Central, and Southern Africa reveals that many of these programs are too small to be cost-efficient or assemble sufficient critical mass to excel. This problem seems to be common in other parts of Africa as well. To some extent, these are typical growth issues that may disappear over time. Nevertheless, collaboration between national and regional faculties of agriculture is warranted in order to streamline, through clustering and specialization, the range of postgraduate programs being offered. This means that students completing their undergraduate degree may need to transfer to a different faculty of agriculture to pursue the postgraduate degree of their choice. In some cases this may mean that students will have to pursue postgraduate training in a neighboring country. At the same time, recipient programs will need to make the necessary arrangements for foreign students, including accommodations and visas. Such cross-institutional and cross-border collaboration has the potential to facilitate emergence of centers of leadership, as this will greatly increase the overall efficiency and quality of postgraduate training in agricultural sciences in the participating countries. Efforts should be made, however, to ensure that these regional “centers of leadership” are underpinned by networks to avoid a repeat of past incidences whereby higher-education institutions were ravaged by civil conflict and never recovered. Specialized postgraduate programs in agricultural sciences will also have an impact on the research profile of the participating faculties of agriculture. Rather than offering an overview of all research topics, faculties of agriculture may become national or regional specialists in certain thematic areas.
References


