

The Role of Higher Education in Building a Sustainable African Society

¹NYERERE, J., ²O. MFUNE, ³D. FUH, ⁴N. SULEMANA, ⁵E. MUTISYA,
⁶G. YIRAN, ⁷O. FADAIRO, ⁸J. AMEYAW, ⁹A. ODINGO

¹ Department of Education Management, Policy and Curriculum Studies,
Kenyatta University, Kenya

² School of Natural Sciences, Department of Geography and
Environmental Studies, University of Zambia, Zambia

³ School of African & Gender Studies, Anthropology & Linguistics,
University of Cape Town, South Africa

⁴ Department of Agricultural Extension, Rural Development and Gender
Studies, Faculty of Agribusiness and Communication Sciences,
University for Development Studies, Ghana

⁵ Graduate Program in Sustainability Science-Global Leadership
Initiative, University of Tokyo, Japan

⁶ Department of Geography and Resource Development, University of
Ghana, Ghana

⁷ Department of Agricultural Extension and Rural Development,
University of Ibadan, Nigeria

³ Department of Silviculture and Forest Management, Kwame Nkrumah
University of Science and Technology, Ghana

¹ Department of Geography and Environmental Studies, University of
Nairobi, Kenya

*Email: omfune@yahoo.com

Abstract

Africa has a shared history and the common challenges of slow economic growth, and inadequate response to the issues facing the continent that include youth unemployment, food insecurity, environmental degradation and conflict. The provision of relevant and quality education is considered key to responding to these challenges and improving the livelihoods of millions of Africans. As a result, African nations are now emphasizing the importance of higher education, scientific research and innovations in a bid, not only to industrialize and increase the pace of economic development, but also to meet the social aspirations of their populace while

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at the same time, ensuring the wellbeing of the environment. In short, increasingly, African nations see higher education, science and technology as critical to the achievement of sustainable development. As a result, in recent years, there has been a focus on ensuring that the wealth of knowledge generated within universities is relevant to sustainable development and most importantly, this knowledge is shared so that society in general can benefit from university scientific and technological expertise. In this vein, this paper examined how selected African universities have embraced the notion of sustainable development in their curricula, research and community engagement in order to contribute towards building sustainable African societies. Further, the paper analysed the science, technology, and innovations of policy initiatives put in place for higher education in Africa, initiatives aimed at promoting sustainable development. The paper focused on universities in three African regions: Eastern (University of Nairobi), Southern (University of Zambia) and West Africa (University for Development Studies in Ghana). The paper shows that since the 1990s, universities in Africa have not only embraced sustainable development(SD) in the teaching and learning, but have also gone beyond the walls of their universities to engage with communities in their search for solutions to the numerous problems faced in African societies. Their efforts, however, were constrained by inadequate funding to support research and technology development. Further, while policy support for higher education, science and technology prevailed, such support, in most cases, ignore teaching strategies aiming to teach creative thinking, instrumental to sustainable and resilient societies. The scientific excellence emphasized leans more towards research and not as much focus was given to teaching excellence which is key in building a resilient society.

Keywords: Higher Education, Sustainable development, Environment, Policy, Science, Technology, Innovations

Introduction

Increasingly, the role of universities and other higher education (HE) institutions as drivers of innovation and sustainable development (SD) is gaining ascendancy in sustainability debates and development policies. Historically, scholars and policy makers have always been intrigued with the role of HE, science and technology in human progress. Often, HE has been associated with innovation and technological advancements (Grimpe and Fier, 2010; Camison and Fores, 2010; Etzkowitz et al, 2008). Universities, in particular, are seen as engines of innovation, which in turn spur industrial and economic development. Debates concerning the role of HE in economic development have usually taken place in the context of two theories seeking to explain the key determinants of economic growth (Mwamadzingo, 1995). These are the demand pull theory and the science push theory. Whereas the demand pull theory emphasizes market forces as the main determinant of technological innovations leading to economic growth, the science push theory recognizes science as the determinant of industrial innovations. Those who see science as the main determinant of innovation and economic growth emphasize the primary and crucial role of HE institutions, as centres of science and technological innovation in fostering economic development. It is argued that the role of universities in the innovation process for development is natural (Mwamadzingo, 1995) because of their competence in undertaking basic and applied research, their reservoir of knowledge and ability to recruit young talent. Moreover, according to Cloete *et al.* (2013), there is an underlying assumption that the university is the only institution in society that can provide an adequate foundation for the complexities of the emerging knowledge economy. In this regard, it is argued that with the enhancement of Universities' capabilities and the right mix of policies, industrialization could occur even in developing regions such as Africa (Lall, 1992)

While the role of HE in fostering economic growth and industrialisation has been widely recognised, it is important to note that since the emergence of the concept of SD in the late 1980s (WCED, 1987), human society has moved beyond simply viewing economic growth as the most important sphere of human progress, to consider the social and environmental dimensions as well. This balanced type of development, which integrates these three dimensions (economic, social and environmental) is captured in the notion of SD. The Brundtland Commission describes SD as a type of development that strives to meet the

needs and aspirations of the present generation without compromising the ability of future generations to meet theirs (WCED, 1987). Sustainable development tasks us to consider two important elements in our quest to build a sustainable society - the needs of the present and future generations, and the wellbeing of our environment (Devkota, 2005; Carvalio, 2001; Mebratu, 1998). Simply put, SD emphasizes the need to develop and use our resources equitably (within and between generations) without damaging the ecological systems that support human welfare.

Although it has its critics, since its entrance in development literature, it has been endorsed by a variety of actors, including governments, businesses, academics and Non-Governmental Organizations (NGOs). The quest to achieve a sustainable society has become a priority goal for many countries globally. As a concept that emerged as a result of disillusionment with the narrow conception of development (as economic growth), it is clear that beyond simply fostering innovation and industrial advancement, SD requires new ways of engaging human progress. These must be ways that lead to the economic and social progress of humanity within the ecological limits of our biosphere. Achieving this is surely one of the most challenging goals of our times. In SD literature, HE, science and technology, have once more emerged as key to tackling this goal.

While literature sees the link between education and SD as explicit, it is essential to see how HE institutions have embraced the notion of SD in their curricula, research and other programmes. In particular, in this paper, we are concerned with how African universities have positioned themselves to facilitate this process of building sustainable societies through sustainability-related science and technology curricula, research, teaching and engagement with the wider society. Further, we examine in this paper, the type of constraints that these universities face in their quest to facilitate SD. Lastly, we close our discussion of the subject by analysing national policies in support of the role of HE, science and technology in SD. This paper, coming at the end of the UN decade of education for SD is important as it gives insights into how African universities are emerging as facilitators of SD and the constraints they face in this quest. Further, the paper gives insights into the state of HE, science and technology policy in support of SD in Africa. In order to examine these issues, the paper draws on the experiences of three African universities from three countries (Zambia, Kenya and Ghana). Further, some regional examples of collaborative efforts seeking to foster SD through science and technologies

are also used. The paper derives its materials from discussions with sustainability experts from the selected universities, authors' observations and secondary sources such as policy documents.

Higher Education and Sustainable Development

The role of education in SD is so crucial that the United Nations designated the decade between 2005 and 2014 as the UN Decade of Education for Sustainable Development. UNESCO (2004) notes that education for SD implies including sustainability issues in teaching and learning such as climate change, disaster risk reduction, poverty reduction and sustainable consumption. SD requires a participatory type of teaching and learning that motivates and empowers learners so as to change behaviour and take action for SD. It is evident here that the United Nations sees education as a tool for spurring SD, but to do so, educational institutions must embrace SD in all their activities. In the context of HE institutions, in particular, it is argued that beyond teaching and learning, their contribution towards building sustainable societies can also emanate from engagement with communities, research outputs and development of green technology that can ensure a balanced type of development. As Hill and Birch-Thomsen (2005:13) point out, for universities to achieve their role of fostering SD, they need to be more proactive and to serve society beyond the ivory towers of scientific knowledge. They argue that in a broader context, the role of universities and other HE institutions should not only be to link theory with practice, but also to allow for potential transformations, act as watchdogs of society and be responsible to the broader community beyond formal education.

In Africa, the role of HE in SD has also received support from the AU. The AU aims at a complete revitalization of HE in Africa, with the emergence of strong and vibrant institutions profoundly engaged in fundamental and development-oriented research, teaching, and community outreach. The AU's second decade of education for Africa 2006-2015 Plan of Action, emphasizes the role of knowledge and innovation in the world economy, and thus the role of HE as a core resource base for Africa's SD. In particular, AU recognizes that HE has the potential of providing African-led solutions to African problems in the spirit of Africa's collective vision. This can be achieved through the promotion of research and original knowledge production in HE; and the promotion, development and assurance of quality in African HE in all its dimensions, including

facilitating mobility of students and staff; increased involvement of universities in the continent's development efforts; and ensuring appropriate levels of funding for the HE sector. This, according to AU's second decade of education for Africa 2006-2015 Plan of Action, requires the development of a new social contract between HE in Africa and African states that advance academic freedom with responsibility, institutional autonomy, public accountability, improved access, stakeholder participation and adequate resourcing; as well as the development of appropriate policies to address issues of global significance and impact, including innovation, science and technology advancement. The position of UNESCO and the AU shows how much importance is attached to the role of HE in SD. In the sections that follow, we examine how individual universities are articulating these roles. The individual universities considered here are the University of Zambia, University of Nairobi and University for Development Studies in Ghana.

University of Zambia - Zambia

The University of Zambia is the oldest and largest University in Zambia. Since the 1990s when the concept of SD gained ascendancy in development literature, the university emerged as one of the leading institutions in the promotion of SD. Through the Department of Geography and Environmental Studies, the university showed its commitment to SD by establishing a degree programme in environmental and natural resources management which has the notion of SD as its core concept. While the development of this degree programme in the 1990s was a milestone in the teaching and learning of sustainability, major developments were to occur between 2000 and 2012 when the notion of SD was embraced in fields as far -ranging as engineering, law, philosophy and applied ethics, agricultural and mineral sciences.

The university's commitment towards SD has also seen significant changes in the teaching approaches and its relationship with government, industry and communities. For example, the Department of Geography and Environmental Studies, apart from running its traditional environmental and natural resources management courses introduced a programme aimed at building the capacity of Zambian planners in planning for sustainable cities and towns. The programme is a result of collaboration between the government and the University and has also received support from donor organisations and NGOs. The programme uses a problem based approach

in its teaching and learning process. A strong component of the programme is its field-based learning that allows MSc students engage in community and district planning projects. Since its inception, the students in the programme have engaged in sustainable planning projects aimed at helping government and communities improve the living conditions in urban informal settlements in Lusaka.

While clearly, the University of Zambia appears to have taken a leading role in facilitating the building of a sustainable society, there are also many ways in which the university is not fulfilling its potential. Two areas in which the university is lagging behind are research and technology development. The notion of SD offers great opportunities for academics to engage in research focused on finding solutions to various sustainability-related problems such as resource degradation, climate change, urban environmental problems and low agricultural productivity. However, although some academics have been engaged in research focused on development of climate-smart agriculture, sustainable water resources management and biodiversity conservation, in reality, research outputs have been rather modest in comparison to the university's potential. Similarly, while resolving some of the sustainability challenges require that universities play a leading role in development of green technology such as alternative or renewable energy technologies, the university is still far from being a leader in the country in this quest. The main constraints that the university faces in leading in research and technology development include lack of funding for research, poor laboratory and research facilities as well as heavy teaching loads for faculty members that leave little room for research.

University for Development Studies - Ghana

In Ghana, HE commitment to SD is well exemplified in academic programmes run by the University for Development Studies (UDS). At UDS, the sustainable society theme runs throughout all academic programmes run by the university. A unique feature that strengthens the university's resolve to facilitate the building of sustainable societies is the way the programmes are organised and delivered. As part of its efforts to blend the academic world with that of the everyday life of the society members in order to provide meaningful interaction between the two, the university instituted a third trimester programme that runs for eight weeks during which students are sent to live and work with the communities on

SD issues. Lecturers are also assigned to supervise the students as they work with these communities. Prior to community engagement, students are trained in participatory community development approaches, research methods, community entry techniques and other techniques vital for engaging communities in problem solving work. During their engagement with communities, sustainability issues are integrated in the programme through prioritization of indigenous ecological knowledge systems and community needs in the design of field research and programmes developed with the community. As key outputs of their community engagement, students develop, together with their host communities, local action plans based on available community knowledge and resources. In some cases, they leave a report of their activities with the community.

The UDS programme is a good example of how some African universities are striving to blend academic learning with field-based problem-solving skills and community engagement in order to facilitate the building of sustainable and resilient societies. The need for sustainability educators to engage communities is also well-acknowledged by Hill and Birch-Thomsen (2005) who argue that such engagements should lead to identification of appropriate development options and strategies in partnership with communities. Beyond these, by allowing students to work in groups for at least eight weeks of the year, the programme also allows students to develop leadership and teamwork building skills necessary for fostering a new breed of graduates that can take a lead in the quest for sustainability.

While UDS, through such programmes has positioned itself to be a leader in facilitating the achievement of SD in Northern Ghana, there are major constraints that the university is facing in the implementation of such an ambitious programme. First, the increasing number of students over the years has increased the student/supervisor ratio in the field-leading to a lowering of contact hours with students during fieldwork. Further, the third trimester places an extra demand on the time and energy of faculty members which may affect conventional research output. Lastly, it is argued that the programme is proving to be an extra drain on a limited resource purse.

University of Nairobi - Kenya

Like the University of Zambia and UDS in Ghana, SD is a major theme at the University of Nairobi. For example through its Department of Geography and Environmental Studies, the university has several programmes at the undergraduate level and postgraduate level that pursue environmental sustainability issues. At undergraduate level, the programmes introduce students to the principles of environmental conservation and management, while at post graduate level they carry out in-depth studies on various aspects of environment as well as the importance of planning with environment for SD. Though still inadequate, there is integration of fieldwork to support theories as well as multi-disciplinary and trans-disciplinary approaches in teaching, research and supervision. However, more training would serve a great deal to sharpen the tools and methodologies of the academic and technical staff in such courses.

Another innovative programme that shows the University of Nairobi's commitment towards SD is the PhD in Dry Land Resources Management which seeks to build the capacity of African resource experts in managing dry land resources in order to achieve sustainable livelihoods for people in arid and semi-arid regions of the continent. The programme, taking place in the context of a regional initiative of Regional Universities Forum for Capacity Building in Agriculture (RUFORUM), brings together African scholars from a variety of backgrounds such as economics, veterinary medicine, agriculture, development studies and introduces them to interdisciplinary research relevant to SD. The programme has a strong focus on understanding the local context, indigenous knowledge and the role of technology such as remote sensing and geographical information systems in sustainable natural resources management.

The three programmes outlined above are only a few examples of what universities in Africa are currently engaged in to foster SD. What is evident, however, in these three cases is that universities have not only embraced sustainability issues in their curricula, but have also focused on fostering links with communities as end-users of HE services. This allows the student to weave their theoretical learning with practice and helps in developing contextual and relevant skills for SD. The institutions do it in different ways. While at the University of Zambia, this is evident in the spatial planning programme involved in community planning, at the UDS,

all students in all programmes have this element of community engagement.

Perhaps, one area that universities in Africa need to attend to, in their quest to foster SD, is strengthening their links with firms and industries. Areas where links can be fostered include infrastructure, joint technology development programmes, communication and knowledge sharing mechanisms. While universities can profit from such links in the context of infrastructure development and access funds for research and technology development, industries can benefit from products of commercial value that emerge from research and development. Moreover, today new technologies require high degrees of academic interaction in basic research and cooperation among people with diverse specializations and advanced science and technology environments for their full benefits to be realized. Frequently, it has been argued, that centres of commercial innovation generally profit from links with universities (OECD, 1984). For example, Jaffe (1989) points to the positive effects of university research on local industrial research and development spending as well as on the local rate of innovation. Similarly, Michaela (2000) explains that most developed countries like those in North America have achieved long-standing relations between universities and industry, a domain that higher learning institutions throughout the world are now encouraged by their governments to pursue.

Regional HE Initiatives towards SD

While the three cases given above are examples of what individual universities have been engaged in, there is also a growing realisation that SD is not just a national or local issue but also has a regional character. Thus, while on the one hand, addressing SD questions requires action at the level of a single university or several national universities, at times, it requires that national universities and other science and technology institutions partner with other institutions in the region or outside Africa. Thus, there is now an emerging trend where African HE institutions are building regional consortiums and other partnerships in HE, science and technology linked to SD. Apart from the RUFORUM programme already noted in our discussion of the dry land resource programme at the University of Nairobi, such partnerships include the ESDA programme and the initiatives undertaken by the AU.

The ESDA Initiative

More recently, eight African universities have partnered with Africa Development Bank (AfDB) and the United Nations University (UNU) in Tokyo to develop SD-related curricula in the context of a programme called Education for Sustainable Development in Africa (ESDA). These universities are the University of Zambia, University of Nairobi, Kenyatta University, University for Development Studies, University of Ibadan, University of Cape Town, Nkwame Nkrumah University of Science and Technology and the University of Ghana. A cornerstone of all the programmes is their emphasis on sustainability, a participatory approach to teaching, community engagement and interdisciplinarity. The programmes address sustainability issues in the three development sectors; the mining, rural and urban. The ESDA programmes also seek to address some of the shortcomings of conventional teaching methodologies through its emphasis on fieldwork, participatory approaches, and trans-disciplinarity as well as multidisciplinary approaches in teaching, research and supervision, which are core in ensuring that the education programmes respond positively to the goals of sustainable development. The ESDA programme also encourages collaboration with communities and industries as a way of ascertaining that the knowledge gained is passed on to the relevant sections of the society.

IST-AFRICA and PAU Initiatives

Among the continental efforts towards fostering the role of HE, science and technology in SD, is the Regional Impact of Information Society Technologies in Africa (IST-Africa) which seeks to link ICTs with sustainable development, and the Pan African University Initiative. IST-Africa is a multi-stakeholder initiative focused on reducing the digital divide in Sub-Saharan Africa (SSA). Perhaps, in this programme, African countries and their partners seem to have taken the advice of the former United Nations Secretary-General, Kofi Annan, who in November 2002 said that "while ICT cannot address all of Africa's problems, it can do much to place Africa on a firmer industrial footing... and strengthen the continent's human resources, with training that leads to sustainable livelihoods". The IST-Africa initiative is supported by the European Commission (EC) and focuses on among other things: skills transfer to support research capacity building & science and technology development in Africa; and community building to support European Union (EU)-African research cooperation. It

is a collaborative initiative between International Information Management Corporation (IIMC) of Ireland as Coordinator, and HE, science and technology institutions from more than ten African countries. Among these countries are Kenya, Mozambique, Uganda, Namibia, Botswana, Rwanda, Egypt and Tanzania.

The aims of IST-Africa are to support the implementation of the Africa-European Union Partnership on Science, Information Society & Space; to strengthen the research dimension of the information society policy dialogues between the EC and African countries and key regional organization , to enhance the analysis of African ICT policy and research priorities, including long-term perspectives and recommendations for future Africa-European Union cooperation initiatives, and identification of matching counterpart funding and raising wider awareness of African research capacity. The initiative also seeks to promote participation of African organizations in the ICT themes and to increase the visibility of mutual research technology and development potential. Opportunities to showcase relevant research capacity are provided through annual IST-Africa conferences.

Besides IST-Africa, the AU also adopted the Pan African Union (PAU) initiative at its 20th Ordinary Session of the AU Summit of Heads of State and Government, under the theme “Pan-Africanism and African Renaissance” held in Addis Ababa, Ethiopia. The PAU was adopted as a continental research and postgraduate training institution operating in all the five regions of Africa, North, West, Central, East, and Southern. The PAU project is underway in four institutions representing North, West, Central, and East African regions. The University of Ibadan in Nigeria is hosting the West Africa node, focusing on life and earth science, including health and agriculture; in the East African region, the Jomo Kenyatta University of Agriculture and Technology in Kenya hosts basic sciences, technology and innovation; Algeria in North Africa hosts the water, energy sciences and climate change; while the Central Africa node, concentrating on governance, humanities and social science, is based in the University of Yaoundé in Soa, Cameroon. The project is yet to take off in Southern Africa because a proposal to site the Southern Africa node on the Indian Ocean island of Mauritius was deemed ineligible as Mauritius is said to fall into the continental body’s Eastern Africa region (Tongai, 2013).

Furthermore, to advance the cause of SD, the African leaders at the same Summit, endorsed the creation of an African Observatory on Science, Technology and Innovation. At the opening of the summit Nkosazana Dlamini Zuma, chair of the AU Commission, said that “education and skills development is at the heart of our regeneration efforts. The Pan-African University and the general expansion of our higher education sector will equip young people with critical abilities to drive innovation, sciences, entrepreneurship, research, social development and industrialization” (Sawahel, 2013). The summit adopted the statute of the Pan-African University or PAU, as a continental research and postgraduate training institution operating in all regions. The meeting also approved the creation of a Pan-African Intellectual Property Organization to promote research in universities and the transfer of new technologies to the industrial sector.

Policy and Institutional Support to Foster the Role of African Universities in SD

The gap between the potential for innovation in Africa and what is realized is in fact an opportunity that requires realignment and strengthening of a country’s innovation systems, a supportive environment and strong national as well as regional strategies. Research has shown that a country's ability to create and utilize new and innovative technologies for development is determined by the level of its research activities, as well as its policies and programmes that promote research and technology transfer. Over the past three decades, many African countries have endeavoured to develop policies that support universities’ role in SD. Policy support towards supporting the role of HE in SD in Africa has largely gone towards the development of science and technology policies with links to SD.

For the three universities considered in this paper, notable policies are briefly examined below.

Kenya

In Kenya, the overall responsibility for policy development related to HE, research and development lies within the Ministry of Education which has been delivering these services through the National Council for Science and Technology (NCST). NCST’s mandate includes development and implementation of the country’s Science and Technology Innovation (STI) Policy, research development, research authorization, and

coordination of technical education. Policy priorities include: strengthening the national STI standing and its competitiveness; improving the quality, relevance, equity and access to HE and technical training; promoting evidence-based policy making and national development; encouraging private sector participation in STI and technical education; enhancing capacity of the national STI system towards demand driven STI, quality HE and technical education services, and effective use of existing talents and facilities; as well as promoting excellence, creativity, innovation and investment in STI, HE and technical education.

In its Vision 2030, a road map to economic development, Kenya recognizes the role of education and training as one of the key social sectors in the transformation of the society (The Government of the Republic of Kenya, 2007). Kenya has thus committed herself to providing globally competitive quality education, training and research to her citizens for development and enhanced individual wellbeing. In partnership with the private sector, the Government of Kenya recognizes the need to increase funding to enable institutions of higher learning to support activities envisaged under the economic pillar and be a regional centre of research and development in new technologies.

Despite the critical role STI plays in national development, Kenya has been facing challenges that include lack of effective coordination between the various actors, lack of harmonization of research policies, and limited research funding (0.6 percent allocation of GDP, though what is disbursed is much less). Other challenges include a de-linked STI from development, limited appreciation for the role of STI, limited research and especially applied research, inadequate mechanisms and arrangements for dissemination and utilization of research findings, absence of an up to date research bank of inventories and directories of what has been done or is being done. In addition, there is limited demand-driven and collaborative research between universities/research institutions and private sector/industries, weak institutional capacity in terms of human resources and equipment, inadequate prioritization of research vis-à-vis goals, aspirations and commitments (Republic of Kenya, 2005).

To overcome these challenges, the country, in January 2013, strengthened the capacity by elevating the NCST to Kenya Commission for Science, Technology and Innovation (NACOSTI). In addition, the government has proposed an ambitious budgetary allocation of 2% of the

country's GDP for research and development, an allocation that is double the recommended 1% of GDP. This is aimed at achieving the goals of improved STI for resilience and SD. What is not clear, however, is how this funding will be distributed among HE institutions.

Zambia

In Zambia, the policy on HE, Science and Technology seeks to promote and exploit science and technology as an instrument for developing an environmentally-friendly indigenous technological capacity in sustainable socio-economic development to improve the quality of life in Zambia (GRZ, 1996). Its goals include enhancing linkages between technology research institutes, the private as well as the public sector in order to encourage demand-driven research and development; developing and sustaining a national scientific and technological capacity and providing highly skilled human resource for increased productivity in the economy; fostering national and international linkages for enhanced technology transfer; and facilitating the acquisition, adaptation and utilization of foreign technology.

Despite the country's efforts to develop policies supportive of HE's role in SD, funding for research and development by the Government and private sector has been limited and this has greatly contributed to the poor performance of innovation in Zambia. Weak linkages between the research system, government and industry are another contributing factor. If fully realized, Zambia's STI policy is intended to serve individuals' social and economic wellbeing, enhance the utilization of abundant natural resources and improve the quality of the Zambian community. This is expected to be achieved through liberalization and autonomization of research institutions, promotion of individual initiative, partnership and to encourage market demand-driven research and development.

Ghana

Ghana created the Ministry of Environment, Science and Technology, out of the Ministry of Industry, Science and Technology to promote, manage, as well as coordinate and harmonize the science and technology policies and institutions. This is a big step in placing science and technology initiatives in the mainstream of Ghana's government machinery. The STI policy launched in 2012 seeks to harness the nation's

total science and technology capacity to achieve national objectives of poverty reduction, competitiveness of enterprises, sustainable environmental management and industrial growth with its specific objectives being to; facilitate mastering of scientific and technological capabilities, provide the framework for inter-institutional efforts in developing STI and programmes in all sectors of the economy, to provide the basic needs of the society, and create the conditions for the improvement of scientific and technological infrastructure for R & D (Republic of Ghana, 2012).

The priority themes underpinning Ghana's National STI Policy are: promoting competitiveness in productive sectors of the economy; creating job opportunities and employment; expanding industrialization; enhancing the quality of life through innovation; developing scientific human resources; expanding infrastructure; promoting an information society; optimizing on the sustainable use of the natural and environmental resources; and commercializing research findings. Ghana's development plans have integrated STI applications in socio-economic development. However, the premium placed on science and technology as the main drivers of development has not been high in the eyes of policy makers and managers of the nation's resources. The proportion of the nation's budget allocated to science, technology and innovation has been low. It has fluctuated between 0.3% and 0.5% of the Gross Domestic Product (GDP), well below the target of 1% of the country's GDP.

It is worth noting that the policy initiatives in all the three countries mainly focused on scientific excellence which leans towards research and not as much focus has been given to teaching excellence. Understandably, focus on excellence in research has become popular because it is often used as a measure of funding for public HE in many countries especially in the Organization for Economic Cooperation and Development (OECD) countries (Wespel et al., 2013). It seems that African countries are following in this tradition. Moreover, research excellence is what is often used to determine the position of an institution in university rankings. It is thus not surprising that a vast majority of policy initiatives concentrate on research-related factors such as merit in research, the innovativeness and feasibility of the proposed research project(s), and the utility of the outcomes. Notably, the role of teaching-learning excellence has been relegated to a subordinate position (Wespel et al. 2013). It is worth noting that even in HE quality assurance initiatives, teaching is not usually among the assessment

criteria in most universities. This, however, need not be the case as teaching excellence is also critical to fostering the role of HE in SD. Africa may need to learn from institutions that have placed as much premium on teaching excellence as on research excellence. Examples of institutions that have excelled in such an endeavour include Spain's International Campus of Excellence initiative (excellence in research and in teaching are weighted equally high); Ireland's Programme for Research in Third-level Institutions (impact on teaching and learning is one of four major assessment criteria); South Korea's World Class University Programme (aims at creating new faculty environments, including teaching improvement); and Germany's Excellence Initiative (effects of research on teaching are one criterion among 15 different criteria) which include quality of teaching.

Conclusion

Although SD is one of the most influential concepts today, achieving it is also one of the most challenging goals of our times. In Africa, in particular, where a host of problems including poverty, unemployment, environmental degradation, lack of access to clean and safe water, HIV/AIDS and other diseases have besieged the populace more than anywhere else, this is a topic that will continue to be important for years to come. Certainly, the task of building African societies that are sustainable and resilient to such social, economic and environmental ills is daunting. Such a task requires that the efforts of a variety of actors including governments, NGOs, businesses and higher educational institutions are brought together. In this paper, our concern is mainly the role of HE, and science and technology in SD. The paper considers HE institutions such as universities as very important centres of innovation which can bring benefits across all three pillars of SD: economic, social and environmental. Moreover, producing high-level expertise to create, access, adapt, consume, and disseminate knowledge, which universities are known for, is all critical for SD.

To properly position themselves as leaders in SD, African universities need to make changes to their way of doing business. In our case studies, it is evident that African universities have made some important changes in their programmes to embrace sustainability issues in their research and teaching agenda. Since the 1990s, new curricula, primarily dealing with sustainability issues have emerged. Further, conventional programmes that have had nothing to do with environmental

sustainability, are increasingly integrating sustainability issues in their teaching and learning processes. We have seen in this paper that such changes, however, need not only occur in curricula, but also in teaching approaches and engagement with basic and applied research aimed at resolving today's societal ills. Teaching must embrace new participatory and problem solving elements to contribute towards SD. Further, universities must also go beyond their walls and engage with the main end-users of their services; communities and industries. At the policy level, the paper points to the efforts made by selected countries in Africa to support HE institutions in implementing science, technology and innovations for sustainability. This is in recognition of the major role HE plays in SD through research, science, technology and innovations initiatives. Meanwhile the policies are yet to address the role of curriculum implementation and teaching excellence in quality research.

While some important strides have been made in integrating SD in university programmes, it is also clear that African universities still lag behind their counterparts elsewhere across the globe in their contribution to cutting edge research and technology due to a variety of limitations. This in turn, has left Africa as passive recipients of technological innovation. Only a few universities, such as those in South Africa appear to be competing well with other universities from other continents in this sphere. African countries need to build their curricula and STI infrastructure to create domestic technology solutions to local development challenges, as well as to support the transfer, adaptation and dissemination of technology for SD and resilience. Of course, when considering the contribution of African universities to cutting edge research and technological developments, it is important that we acknowledge the vast diversity and size of the African continent including existing inequities in economic development. The academic landscape of the continent is equally diverse. While some universities, such as those in South Africa are well-integrated into the global scientific community, in some countries HE institutions are only beginning to be established. In between are fair-sized HE systems (e.g. universities in Nigeria, Ghana and Kenya). The vast majority of universities in Africa, however, face a range of challenges that limit their ability to satisfactorily contribute to such developments. Underfunding, in particular, has left many African universities with inadequate infrastructure and insufficient resources for research and development. Thus, for many universities, while they are aware of their role in SD, they are often

preoccupied with their own internal problems revolving around these issues (Mwamadzingo, 1995).

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