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Higher Education and development: Prospects for transforming agricultural education in Uganda

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ABSTRACT
The higher education sector in Uganda has experienced tremendous improvements over the past two decades. It has also encountered numerous challenges that extend to the effects of massification on access, equity and quality. Through a review of existing literature and using international conventions and practices as benchmarks, this study gives an overview of the higher education sector in Uganda; it highlights productivity, production and utilisation of science, technology and innovations manifestations within the context of human capital development. With emphasis on agriculture education, the limitations discerned extend beyond scientific dependence and brain drain, to restrictions in scientific uptake and diffusion of new technologies across the value chain that have influenced the transition towards a knowledge based economy. The study concludes with prospects for an integrated system that will harness higher education as Africa engine for economic growth and development, whose relevance could apply across the sub-Saharan region.

Key words: Agriculture, higher education, knowledge production, science and technology

RÉSUMÉ
Le secteur de l'enseignement supérieur en Ouganda a connu des améliorations considérables au cours des deux dernières décennies. Il a également rencontré de nombreuses difficultés qui étendent les effets de la massification de l'accès, l'équité et de la qualité. Grâce à une revue de littérature existante et en utilisant les conventions et pratiques internationales comme références, la présente étude donne un aperçu du secteur de l'enseignement supérieur en Ouganda; elle met en exergue la productivité, la production et l'utilisation de la science, la technologie et les manifestations d'innovations dans le contexte du développement du capital humain. En mettant l'accent sur l'éducation agricole, les limitations relevées vont au-delà de la dépendance scientifique et la perte d'intelligence, à des restrictions de l'absorption scientifique et la diffusion des nouvelles technologies à travers la chaîne de valeur qui ont influencé la transition vers une économie fondée sur la connaissance. Cette étude découle sur les perspectives d'un système intégré qui canaliseront l'enseignement supérieur comme un moteur de croissance économique et du développement en Afrique, dont la pertinence pourrait être appliquée dans toute la région sub-saharienne.

Mots clés: agriculture, l'enseignement supérieur, la production de la connaissance, de la science et de la technologie

INTRODUCTION

Uganda's vision 2040 articulates the need *to have a transformed Ugandan society from a peasant to a modern and prosperous country within 30 years*. One of the key projects is to develop and implement a specific policy to attract and retain top rated professionals in the universities to make Uganda a centre of excellence in education in the region (Government of Uganda, 2013). The *Vision* underscores the need to emulate the Asian Tigers and other developed countries in harnessing the *demographic dividend*[1] as human capital to spawn a knowledge based economy. For higher education, this would derive from the 1992 White Paper (GWPE) development goal that seeks to promote advances in indigenous scientific and technological capacity needed to tackle development challenges and the pathway to national wealth creation through skills development.

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Over the past two decades participation in higher education within the Sub Saharan Africa region has improved substantially. Enrolment grew by more than 20 times from 200,000 in 1970 to more than 4.5 million by 2008 (UNESCO, 2010); and graduation rates have correspondingly increased. Nevertheless, gross enrolment ratios remain low, with only 8% of Africans enrolled in universities compared to 44% in Latin America and 95% in North America (UNDP, 2014)[2]. Moreover, the increase has come at the expense of quality with expenditure per student falling significantly. At the same time, research output remains the lowest in the world at less than 1% of the world share (World Bank and Elsevier, 2014). There is thus an urgent need to invest in higher education and for higher education to transform itself to produce the quality of graduates and knowledge needed to achieve the African Union Agenda, 2063.

Science, Technology and Innovation (STI) is critical for responding to the challenges of African development; more so for agriculture which is a core sector that contributes close to 30% of GDP in many developing and emerging economies.[3] Advances in STI in agriculture will elevate its performance and contribution towards economic development and poverty reduction. Universities have a key role to play in producing the next generation of the African workforce, including researchers/scientists, extension and advisory service practitioners, input dealers and other development practitioners that are expected to generate, translate, extend and share knowledge with rural farmers to increase agricultural productivity, agribusiness and incomes. Trained human resources in a wide range of topics, aligned to the Science Agenda for African Agriculture, are central to stimulating science-based technology innovation. Research has shown that returns to investment in Higher Education are around 20%, and in Africa closer to 30% (Borland *et al*., 2000; Montenegro and Patrinos, 2013; USAID, 2014).

Study rationale and objectives

Higher education has been put at the forefront of the knowledge –driven development agenda. The quality of human resources and the robustness of the national innovation system as key components within the knowledge driven economy is determined by the vibrancy of the higher education system of the country of assessment (World Bank, 2002). African higher education needs to be transformed so that it produces the graduates and research that will increase the use of science, technology and innovation for economic growth and ensure an Africa that is food secure. Investments must be targeted to ensure the development of strong local post-graduate programmes and to transform universities so that they use modern technologies applied to local situations to provide the human resources that Africa needs for tomorrow.

The focus on agriculture derives from the contention that within Africa it is at the forefront of the productive sector for several countries. According to Uganda's 2014 *Statistical Abstract*, agriculture contributes close to 23% of GDP and employs close to 72% of the working population. The 2008 *World Development Report* focusing on *Agriculture for Developmen*t noted that agriculture must be placed at the centre of the development agenda of developing countries as one of the fundamental pathways for reducing extreme poverty and hunger. Similarly, the elimination of poverty and hunger continues to be at the centre of global attention as articulated by the 2030 Sustainable Development Goals (SDGs) adopted by the United Nations General Assembly of September 2015.

Approach to assessment

This study was predominantly a desk review of documentation on higher education, economic development science and technology. Several studies have been undertaken to evaluate the link between higher education and economic development. Pillay (2010), draws lessons from three successful systems with implications for Africa; Cloete *et al.* (2011) elaborates the relationship between universities and economic development in Africa. These studies highlight the advancement and African education system dichotomy. They draw comparisons across different universities in Africa and highlight parameters of focus when assessing the contributions of university education to the development agenda at national level. Furthermore, the current study draws from the ground breaking concept of human capital investment as articulated by Schultz (1961). Schultz (1961) provides the basis for the contention that investment in higher education heralds an increase in the productive capacities of the labour force, and returns that extend beyond the private benefit.

Deriving from these and other studies, the study considers inputs, processes, outputs and international benchmarks for knowledge production and utilisation. Taking into consideration the need for special emphasis on agricultural higher education, the review targeted documentation that focuses on science and technology but more especially agricultural education. The study

[1] https://www.imf.org/external/pubs/ft/wp/2014/wp14143.pdf
[2] http://www.uis.unesco.org/DataCentre/Pages/country-profile.aspx?regioncode=40540&code=UGA
[3] http://data.worldbank.org/indicator/NV.AGR.TOTL.ZS

explored institutional, national and international documentation. Extensive internet search was utilised particularly for websites with education and agricultural databases. These included: World Bank, UNESCO Institute of Statistics, OECD and the Elsevier –Scopus database.

Institutional review explored institutional response in terms of capacities and potential for reform to meet emerging challenges. Specific focus was made to agricultural training, curricula review as well as modifications to the skills and management processes. At this level, one of the key parameters of focus was enrolments in STI (discipline) and under/graduate PhDs (level). The knowledge creation proxy has been established using the indicators of scientific output which includes: number of research publications; patents; and human resource engaged in R&D (AOSTI, 2013).[4]

The national level assessment focused on policy frameworks for higher education science and technology. The intentions outlined in the documentation were mapped against actual advances and the compliance status with international STI conventions as well as knowledge production. One of the key factors in the operationalization of the STI policy is financing. The review therefore reflects on financing higher education and the implications for advancement. Returns to higher education have been given special emphasis as a basis for advocacy for public investment in higher education.

The Higher Education system in Uganda, policies and practices

The foundation for the modern day education sector in Uganda is rooted in the 1992 Government White Paper on Education (GWPE). Based on the Education Policy Review Commission findings, the white paper outlines the aims and objectives of education as well as the pathways for improving the Ugandan education system. The White Paper underscores that 'education is a powerful tool for transformation of society' and that, "… No education system can be better than the quality of its teachers, nor can a country be better than the quality of its education.' (Government of Uganda, 1992, p. Xiii). Subsequent to the 1992 GWPE, the legislative and governance structure for higher education has been based on the Universities and Other Tertiary Institutions Act 2001 as amended (UOTIA). Salmi (2009) has argued that developing and transition countries are at risk of being further marginalized in a highly competitive world economy because their tertiary education systems are not adequately prepared to capitalize on the creation and use of knowledge. The state therefore has a responsibility to put in place an enabling framework that encourages tertiary education institutions to be more innovative.

Within Uganda, the national framework for the relevance and impact that higher education could have on national development still remains fluid. The national development agenda as outlined in the National Development Plans I & II and Vision 2040, does not explicitly place higher education at the centre of development. This is further aggravated by the absence of a comprehensive human resource requirement framework to guide enrolment and focus the universities' curriculum.

Nevertheless, advances continue, enrolment had increased by more than 800% from 15,000 in 1992 to close to 150,000 by 2011 (NCHE, 2013). However, gross enrolment remains at 4.38 % by 2014 compared to 1.96% in 1999 and the sub Saharan Africa average of 6% (UNESCO, 2010, 2015). Figure 1 shows the growth trend of higher education enrolments and the increase in number of institutions within post independent Uganda.

Out of the 39 licensed universities only 3 have comprehensive science based programmes and out of these only 2 offer agriculture and agriculture related disciplines. It is only Makerere University which offers the veterinary and animal science based programmes. The university system is still characterized by a mismatch between the student numbers and facilities. These capacity issues manifest through crowded classrooms, inadequate staff student ratios, obsolete equipment and challenges to the governance and management structures (Visitation Committee to Public Universities, 2007). In addition, the system is still plagued by access and equity limitations. The average staff student ratio was 1:23 by 2011, beyond the NCHE recommended ratios of 1:15. Only 11% of academic staff had doctoral level qualifications[5], 43% had Masters and 34% had Bachelor's degrees (NCHE, 2013).

Participation in higher education in Uganda has been broadened by students that undertake their studies outside the national system; which according to UNESCO by 2012 approximated 4696 spread across Europe, USA, South Africa and other regions[6]. In addition to scope, mobility demonstrates the

[4] See for example, The African Observatory of Science and Technology (2013), Assessment of Scientific Production in the African Union, 2005–2010

[5] This number increased from 549 in 2004 to 914 by 2011

[6] http://www.uis.unesco.org/Education/Pages/international-student-flow-viz.aspx

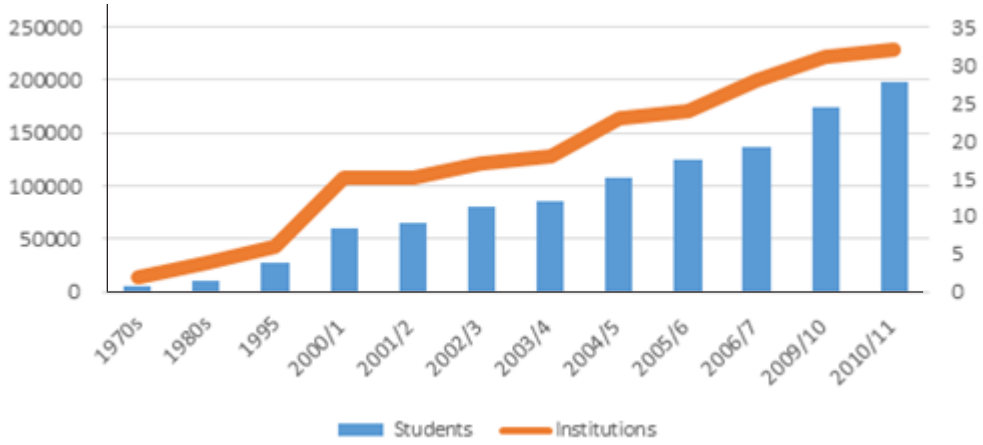


Figure 1: Growth trend of Institutions and students

inadequacies, capacity challenges and opportunities for the domestic education system. While student mobility enhances global interaction and enables students to access facilities and education systems that are not readily available at homes; it may suffocate the option to grow domestic institutional capacities in terms of curricular, academic and research facilities that would be more sustainable especially at graduate levels. It further bounds the potential for replication of R&D initiatives developed within local institutions under local environments which would promote faster diffusion of technologies, business and other market ideas when generated within similar environments.

Changes in Higher Education following changes in the 21st Century society

The 21st century has been characterized as the era of globalization and knowledge based societies. These two characteristics have been directed by advances in ICT development and utilization. The emergency of the concept of human capital as the predominant source of wealth and global competitiveness provides both opportunities and challenges for the human capital *factory*. Furthermore, the recognition of education as a tradable commodity by international trade bodies such as GATTS under the WTO have increased the individual and collective expectations from education. Intrinsically, they have also shaped the character of the higher education system, especially in developing countries such as Uganda. At the global level, there has been a surge in the adoption and increased use of ICT in teaching and learning; increased access to internet; social media and vast academic resources that are re-configuring both the academic and social ethos of the students.

Universities have responded by rethinking the way education is provided in order to meet both the perceptual and functional needs of the students. The changing global context has generated the need to create a different category of student who is equipped with what has been labelled as *21st century skills.* These will extend beyond disciplinary competence to include innovation, critical thinking and problem solving skills, as well as the capacity to manipulate the environment to meet individual and societal needs.

The approach has been to change the teaching and learning framework towards learner centred problem solving pedagogy. This not only places the learner at the centre of the learning process but ensures practical interface between the learner and real life situation. From outreach, the paradigm is increasingly shifting to knowledge transfer partnerships; in this case the communities with which students interact become active participants in both the learning process of the student through field attachments, internships and placements (Makerere University, 2008).

Within the organisational set up, new management systems have been defined that combine the business process re-engineering with the academe. The creation of flexible learning timeframes is one such example, parallel evening and weekend programmes have been developed to target different population segments. At the national level, governance and quality assurance structures have been established to ensure the comparability of the learning processes and outcomes- this includes accreditation of academic programmes and setting minimum standards requirements. At the regional level, initiatives have started to move towards harmonisation in diversity of qualifications; within East Africa for example, the higher education system is moving towards the East African Higher Education Qualifications Framework (EAHEQF) which will facilitate mobility across the region but with an increased potential for global mobility.

Higher Education and knowledge production: The Ugandan context

At the turn of the century it was acknowledged that within a globalised environment, the construction of knowledge economies and democratic societies will be dependent on education in general but tertiary education in particular. The influence of tertiary education extends beyond the creation of the intellectual capacity for knowledge production and utilization, to establishing the bedrock for the promotion of the lifelong-learning practices that are fundamental to the knowledge based economies. Countries therefore, are expected to structure their tertiary systems to enable them adapt to the changed realities and respond effectively to the changing global landscape (World Bank, 2002).

Knowledge production manifests in two main areas, research and development outputs that can be discerned from the number of publications produced; and the number of graduates produced from the University system particularly at graduate level. This section outlines the progress made in this area within the Ugandan tertiary education system.

Research output

Available 2015 data from the Elsevier-*Scopus* database demonstrates an increasing number of publications from Uganda (see Figure 2). However, a finer review reveals that only two universities, i.e., Makerere University and Mbarara University of Science and Technology feature at the fore front of the database. Other institutions mentioned in the database with Uganda as affiliation include Kyambogo University, Gulu University, Kampala International University, Uganda Martyrs' University and Uganda Christian University. By implication, out of the 35 public and private universities in Uganda, only 7 Universities have researchers associated with publications in the *Scopus* database. Furthermore, this is a pointer to the limitations in the per capita research output. This value was computed at 20 articles per million people in the East African region in 2012 up from 12 per million people in 2006 and 0.034 articles per million USD$ spent (World Bank & Elsevier, 2014). In contrast, the World Bank-Elsevier study notes that in 2012, between 7.5% and 16% of the different SSA regions' total outputs were amongst the world's top 10% most highly cited articles.

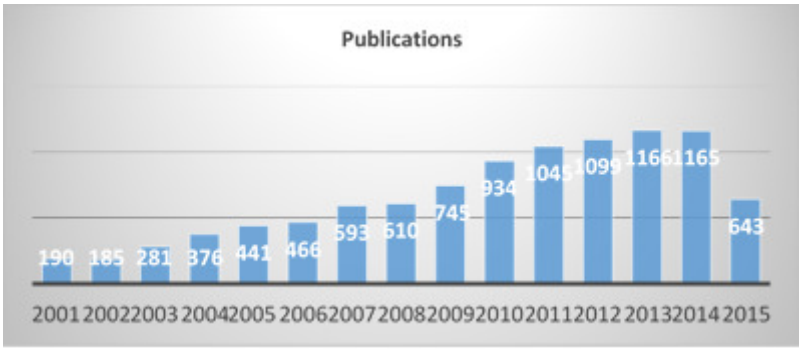
Apart from numbers and institutional affiliations, the bulk of the publications are from health and health related disciplines. For example, thirty six per cent (36%) of the publications affiliated to Makerere University focus on medicine, 11% on Agriculture and biological sciences and 9% on social sciences. The health related disciplines such as immunology, biochemistry and pharmacology constitute 18% of the total publications (see Figure 3)

Institutional affiliations and subject matter aside, the database reveals that there are a few individuals with high levels of research productivity. These individuals mainly from the Makerere University College of Health Sciences have in excess of 100 publications in the database. Yet even these do not feature in the most cited category within the African Union (AOSTI, 2014). The database further reveals that only 1 European Patent application had been made in June 2003 for the *Tublin based vaccine against trypanosomiasis*.

In addition to foreign initiation and affiliations, the African Union scientific production report notes that collaboration between AU members is infrequent, occurring in only 4.1% of AU scientific papers in 2005–2007 and in 4.3% of the papers in 2008–2010 (AOSTI, 2014). This implies limitations to replication of indigenous knowledge and home grown solutions to science and technology challenges at regional level.

Graduates as a factor of knowledge produced

High level skilled human resource is one of the fundamental tenets towards a knowledge driven economy. While there is limitation on comprehensive

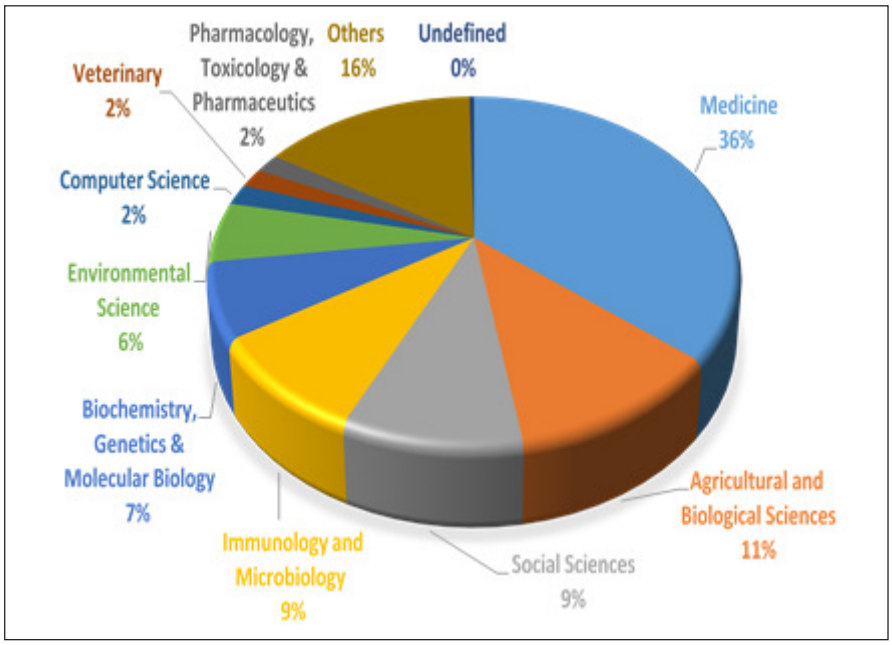


Source: SCOPUS database retrieved 10/08/15- 2015 values are half year performance

Figure 2: Number of Publications with Uganda as Affiliation (2001-2015)

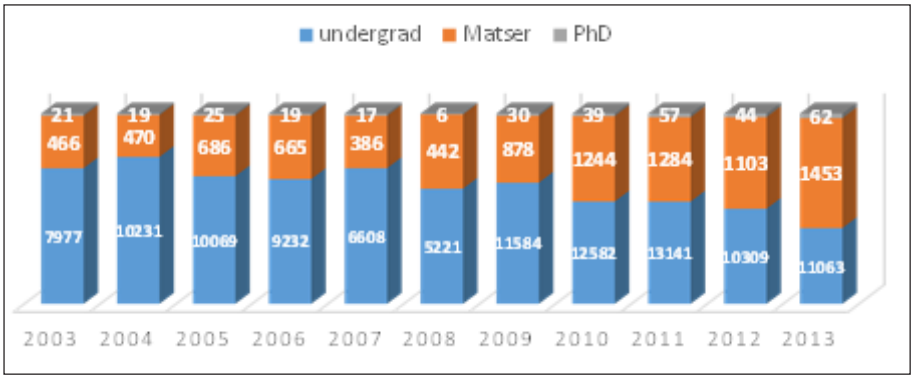
trend data for the number of graduates annually discharged on the Ugandan labour market from the different Universities, the UNCST 2012/13 status report reveals that the number of graduates increased by 6% between 2011/12 and 2012/13 from 36,838 to 39,112 respectively. Notable in this data was the marked increase in the number of Masters and PhD graduates at 35% and 49% respectively. Despite the impressive increase however, the PhD level represents only 0.3% of the total number of students graduating and the bulk of these still fall within the social science and humanities category.

Within Makerere University for example, graduate outputs over a 10 year period 2003-2013 shows that out of the 117,433 graduates produced, 36% were from the humanities while 22% were from science and technology disciplines. By level, the number of PhD graduates increased three fold from 21 in 2003 to 62 by 2013; Masters increased from 466 to 1453 in the same period. The number of graduates below the Masters' degree also increased from 7977 in 2003 to 11063 by 2013. Therefore, the proportion of PhD graduates only increased slightly from 0.2% in 2003 to 0.5% in 2013 (see Figure 4)



Source: Scopus database retrieved 10/08/15- 2015 values are half year performance

Figure 3: Uganda Affiliated Publications by Subject Area 2001-2015



Source: Makerere University Fact Book 2012/13

Figure 4: Makerere University Graduates by Level 2003-2013

[7] http://data.worldbank.org/indicator/SE.XPD.TOTL.GB.ZS/countries

Financing Higher Education in Uganda

Salmi (2009) World Bank study on the *Challenges Of Establishing World Class Universities* underscores that there is a general recognition that economic growth and global competitiveness are increasingly driven by knowledge and that Universities play a key role in that context. The role of government in this discourse cannot be over emphasised. Governments have the obligation to engender policies and establish a regulatory framework that will promote innovation systems. Furthermore, Government has the capacity for allocative efficiency which will target research, education and all the sectors as they manifest in the national economic framework.

For Uganda, budgetary support to higher education on average constitutes 10% of the education sector budget over a six year period. This compares to the 16% average allocation to the education sector as a whole; and 2.2% of GDP compared to the world average of 13% expenditure and 4.8% of GDP by 20117. And according to the NDP II Public support to higher education is computed at on 0.3% of GDP below the international recommended and assented to share of 1%. Table 1 gives a snapshot of national allocation to education and agriculture over a six year period.

From another perspective, government scholarship support has exclusively focused on undergraduate programmes to the disadvantage of postgraduate programmes which were abandoned in 1998. Yet it is the postgraduate programmes that broadly represent research, generation of new knowledge as well as knowledge transfer partnerships. Indeed scientific and technological breakthroughs are a preserve of research output dominated by graduate studies particularly at the doctoral level. Evidence of this can further be adduced from international University ranking systems such as the *Times Higher Education* by Thomson Reuters and the Academic Ranking of World University/ The Shanghai Index which have used research output as proxies for academic excellence. Closer home, the HERANA[8] 8 country study has used growth in graduate enrolment, funding for research and enrolment in science and technology as parameters that measure university performance.

Development partner support to Higher Education in Uganda: Implications for research

Complementary to government support for higher education is the external partner support for research and development. The UNCST science, technology and innovation status report 2012/13 puts government expenditure for R&D at 0.19% of GDP; while higher education R&D expenditure is 0.13% of GDP. Comparatively, the percentage of government R&D financed from abroad is computed at 66.1%. Within the government sector, out of for example, the Financial Year 2010/11, UGX 780 billion (US$ 232m) expenditure on R&D, ninety per cent (90 %) was outsourced and only 75.1billion (10%) going to in-house R&D (UNCST, 2014). These expenditure trends show a weak link between the Universities as potential suppliers and the government sector for R&D. It further underscores the concept of 'scientific dependence'; as explored by Hountondji (1990) noting that the teaching in African Universities does not reflect home grown science exploits and that:

> African universities (even if they unfortunately do not take it seriously enough)... whatever their special fields might be, everything that matters for them is located or taking place elsewhere. Elsewhere outside Africa are located the most fully equipped laboratories, the best universities and the most powerful research centres, the editorial teams and offices of the most prestigious scientific journals, the most complete reference libraries and publishing houses and world's major concentration of practicing scientists.

Table 1: Agriculture and Education VS Total National Expenditures Including Donor projects

National Budgetary Framework Sector Classifications	2009	2010	2011	2012	2013	2014
Agriculture	285	268	366.2	348	405.7	340.4
% Agriculture	6%	3%	4%	4%	4%	3%
Education	831.6	1,082.00	1,193.60	1,397.30	1,543.80	1,678.20
%Education	16%	14%	14%	15%	16%	16%
Total Expenditure less int.	5,155.30	7,729.80	8,332.90	9,301.50	9,786.70	10,584.40

Source: Ministry of Finance, Planning and Economic Development

[8] Higher Education Research and Advocacy Network under the Centre for Higher Education Transformation in South Africa focuses on 8 flagship universities in Africa

This scenario still rings true for the 21st century African University particularly in Uganda as exhibited by the various university rankings, citation indices and publications databases. Figure 5 is a snapshot of the foreign domination of funding of the research undertaken for the publications that appear in the Web of Science.

Returns to Higher Education, a reflective overview

From the emergence of the human capital theory developed by Adam Smith (1776) and championed by Schultz (1961) and Gary Becker (1962), higher education has been viewed as an investment which should have both costs and benefits. In the context of returns, the costs incurred in order for an individual to attain education vis a vis the benefits accruing as a result of this education, are overriding. The OECD *Education Indicators in Focus* reveals that, for higher education, the net present value equivalent of public benefits outweighs the public cost. This ranges from 300% more than the cost in USA and Germany to approximately 50% in Turkey (OECD, 2012). These returns whether public or private have economic, productivity and social dimensions.

Furthermore, recent studies have revealed that returns from tertiary education are higher in Sub-Saharan Africa (SSA) 21.9%, and agrarian economies 22.1% when compared to the lower levels of schooling in these areas, (Montenegro & Patrinos, 2013). For example, Bloom *et al.* (2006) has shown that increasing enrolment by one percentage point, increases Gross Domestic Product (GDP) by between one and three per cent every year (Bloom *et al.*, 2006). Tertiary education directly influences national productivity which is a major determinant of living standards and a country's ability to compete in the globalization process (World Bank, 2002). This is because higher education combines both the production and service arenas of development, knowledge generation, utilization and transmission (Bloom *et al.*, 2006). Moreover, foreign direct investments are more likely to manifest where there is skilled human resource. The proxy for this is an effective education system, and tertiary education plays a vital role.

From the agricultural perspective, the positive effect of education on productivity world-wide has been considered sizeable; research by the Reimers & Klasen (2013) reveals that an additional year of schooling for the whole population could raise land productivity by approximately 3.2 per cent. The findings that returns are higher in technologically advanced countries, underscores characteristics of adoption and adaptation that are germane to higher education. Quoted by the World Bank (2014) The Food and Agricultural Organisation asserts that it is higher education and a well-educated population that bolsters development through provision of food security and a strong agricultural base.

Yet investment in higher education alone is not adequate to create national innovation system that will spur economic development. This requires establishing an appropriate web of systems that will capture the knowledge producing organizations in the education and training system; the appropriate macroeconomic and regulatory framework, including trade policies that

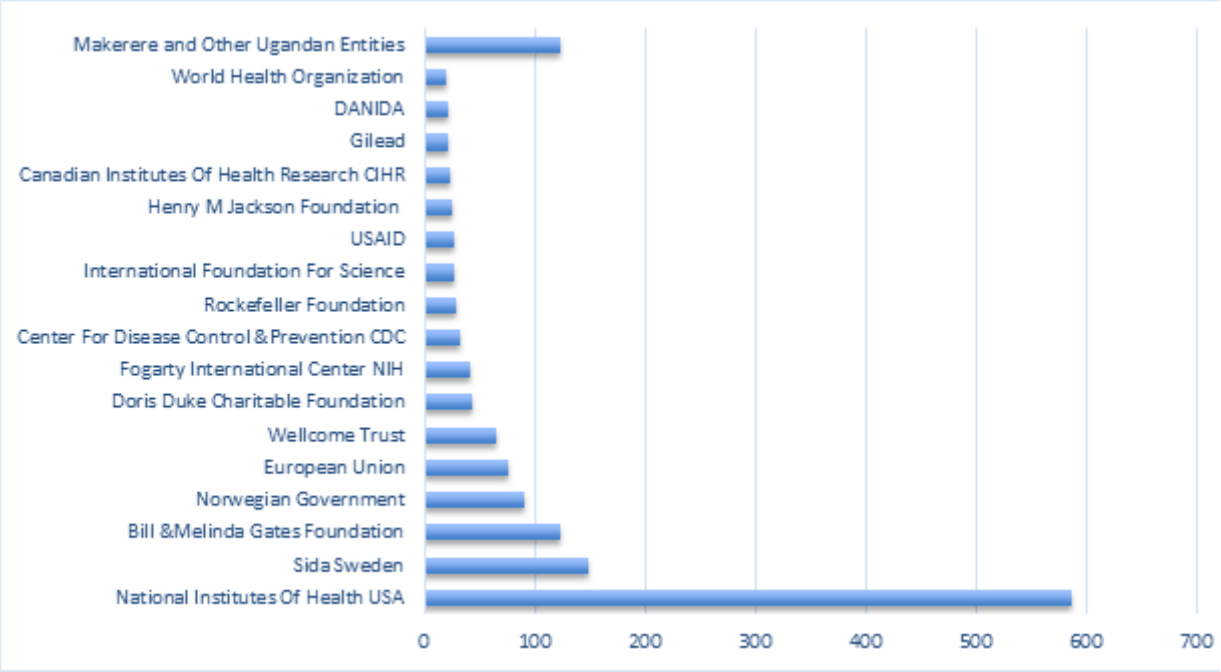


Figure 5: Financing of Research Output- Web of Science 2008-2014

affect technology diffusion; innovative firms and networks of enterprises; adequate communication infrastructures; and other factors such as access to the global knowledge base and establishing market conditions that favour innovation, (World Bank, 1999 *quoted* in (World Bank, 2002).

The Agricultural Higher Education System in Uganda

At the regional level, NEPAD and African Union in response to the widely recognized crisis situation of African Agriculture adopted the Comprehensive African Agriculture Development Programme (CAADP) in 2002. The CAADP identified agricultural research, technological dissemination and adoption as fundamental to development of agricultural systems in Africa. The CAADP focus has been to increase arable land, enhance productivity and evolving capacities that improve access to markets.

The NCHE database shows that by 2011 Uganda had only three other tertiary/non-degree awarding institutions focusing on agriculture, forestry and fisheries. These are public institutions with an enrolment of 1625 students which is 3% of the total other tertiary institution enrolment and 0.8% of the total higher education enrolment for the academic year 2010/11. Considering agriculture alone, this represents 2% of other tertiary institution enrolment and 0.4% of higher education. This situation has been exacerbated by the national trend of converting other tertiary institutions into Universities. The system therefore creates institutional and enrolment shortfalls as exhibited by the conversion of Arapai and Busitema Agricultural Colleges as well as Gulu District Farm Institute into university establishments without adequate substitutes.

The NCHE 2013 report further reveals that enrolment in the agricultural colleges constituted 1% of the total enrolment in 2011. For Makerere University alone, out of the total enrolment of close to 40,000 at all levels, enrolment in agriculture and related disciplines at close to 1926 represents 5%. This position however, may be in line with the global position of the education spectrum where agriculture accounts for 2% of graduation rates in SSA, Latin America and the OECD (see Table 2). Yet unlike the OECD or Latin American countries, agriculture contributes close to 30% of GDP and more than 60% of the population is employed in the agricultural sector in SSA. There are two major reasons for limited interest for pursuit of academic qualifications in Agriculture.

First, are the supply bottlenecks: universities and other institutions have inadequate capacity to handle large numbers of students. The bottlenecks range from academic staff shortages for the variations in the agriculture discipline; and research infrastructure,

Table 2: What do students study? University graduation rates in Africa and the World (2008-2010)

	Education, Humanities and Arts	Social Science Business and Law	Science	Engineering, Manufacturing & Construction	Agriculture	Health &Welfare	Service	Other
Sub-Saharan Africa	26%	44%	12% (3%ICT	4%	2%	5%	0%	7%
North Africa	22%	51%	8% (1%ICT)	10%	1%	6%	1%	1%
Asia	23%	30%	6%	20%	4%	9%	4%	4%
Latin America	23%	38%	7%	9%	2%	13%	3%	5%
OECD	25%	37%	10% (3%ICT)	11%	2%	11%	40%	1%

Source- African Economic Outlook 2012

laboratories and equipment as well as other reagents and consumables. This is further affected by the pedagogy for teaching science subjects as one of the key concerns in understanding science and technology both at lower and university education levels.

Second, is that agriculture has not been fronted as a profitable career path largely because the bulk of the agricultural sector is based on small holder farming systems that are subsistence in nature. For example, only 8% of students categorised as science and qualifying for University admission applied for a degree programme in the College of Agriculture and Environmental Sciences at Makerere University and only 1% applied for BSc. Agriculture as their first choice. This figure is much smaller if all the 61,479 eligible 'A' level students are considered and compares to 2,752 for the single Bachelor of Laws programme in the School of Law or Engineering which has more than 3500 applicants. This is an indication that agricultural education does not command as much prestige as other programmes. It is further a pointer for the need to re-brand agricultural education, undertake extensive career guidance; present an image that will appeal to the younger generation, if the NDP II target of agriculture labour productivity of USD 6790 gross domestic product per worker is to be achieved.

The World Bank (2014) study highlights the challenges associated with this mismatch which are applicable to the Ugandan situation. First, the entire agricultural sector is already struggling with being unable to attract qualified young people; second, the industry is unable to utilize its growth potential due to lack of adequate human capital; and third, the individual is unable to find employment despite having attained qualifications. The discussion concludes with the contention that Universities must support enquiry based and student-centered teaching and learning approaches that will ensure that graduates are entrepreneurial and have capacity to solve local problems.

CONCLUSIONS AND RECOMMENDATIONS

This study set out to establish the status of the higher education sector in Uganda within the global context of knowledge based economies. It emerges that the sector is still beleaguered with challenges of access, quality and output. Financial investment in higher education remains low and with the substantial enrolment growth, the per-capita expenditure on higher education has reduced significantly. The interface between education, agriculture, science and technology or industry with a comprehensive suite of interventions that will deliver economic growth is yet to be adequately articulated. Significantly, although agrarian, requirement specifications for an effective agriculture education across the value chain still needs additional focus. This is against a background of continued low enrolments in agricultural programmes and the contention that sub-Saharan Africa is at the bottom scale of agricultural productivity (USDA).

Several areas of focus emerge from the discussion on the higher education system in Uganda. These provide the scenarios that could be adopted if a turnaround in the sector is to be realised. The proposals range from disciplinary focus to a systemic review of the link between higher education and economic growth and development. Outlined below are the possible options for strengthening the higher education system in Uganda. These proposals are not only based on self-assessment as highlighted from the sections above but they also borrow from lessons that have been applied in other education systems at regional and global levels.

1. Structure higher education, science, technology and innovations at the fore front of the national development agenda. Evidence of this will manifest in the policy direction and strategies on higher education featuring in the national development documentation. Both the NDP I and II do not feature higher education as an 'engine of development'. This notion championed by Manuel Castells and quoted by Cloete *et al*. (2011) provides an analysis framework for the role of the university within a knowledge based economy and the wealth creation vision that Uganda aspires to in Vision 2040. Cloete's pact that places the university within a broader community perspective needs to be examined in identifying the key areas of focus, it will also be a basis for holding the institutions accountable for the knowledge production outputs and how these impact on economic growth and development.

2. There is need to nurture the linkage between the industrial sector, farming communities and the academe. Government and the industrial sector generate research thrusts for universities world-wide. The notion that academic potential for research to facilitate industrial and government agency activities is resident within universities should be maximally exploited. Government should legislate and provide policy direction in home grown solutions and publications. This will improve the academic and research capacities of the institutions, enhance sustainability as well as encourage domestic innovation and technology transfer.

3. There should be a strategic intent at national level to finance research and development as well as stimulate national and regional collaborations for

research to promote local adaptability and reduce scientific and financial dependence.

4. *Grow your own timber,* establish and sustain credible publishing houses for scientists at local and regional levels. Adopt mechanisms that will ensure that the knowledge produced is accessed by scientists across the globe. This will involve creating credible publication outlets for African research output, the concept of brain gain through linkages with Ugandans in the diaspora for publication is a clear benefit that will enable local researchers to gain access to high impact journals and thus raise the knowledge country's knowledge index. Targets should be set for the academe for research output and production.

5. Several international conventions exist for monitoring R&D output, these among others include the African Union Observatory of Science and Technology, as well as the university ranking systems such as Thompson Reuters. However, for Ugandan institutions there is no binding framework for provision of information to such agencies. As a consequence, the visibility of research output and other academic indicators is intermittent and or non-existent. There should be a mechanism to compel institutions to provide information as part of their accountability.

6. Operationalise the provisions of national and international conventions and intents. Several of the initiatives to take higher education, science and technology have already been documented. There is therefore need to scrutinize and consolidate these initiatives as assented to by government and documented. For example, the AU Science, Technology and Innovation Strategy for Africa 2024 (STISA-2024) approach that involves defining the African priorities for development, transformed into flagship programmes and the generation of research agendas out of these programmes would provide a fundamental shift in higher education, S&T in Uganda.

7. The concept of differentiation should be promoted by the higher education system in Uganda through the National Council for Higher Education. Establishing viable research universities that understand the local context as well as fit within the global arena will enhance the higher education system in Uganda. Some universities should be designated as teaching universities while others are facilitated to become research intensive. This is because Uganda higher education system is similar to other education systems should realise that universities are expected to be the bedrock of scientific inventiveness and governments should make sure that their top universities are operating at the cutting edge of intellectual and scientific development (Salmi, 2009).

While the foregoing options are applicable to the Ugandan context they have implications for the wider higher education perspective in Africa. Indicatively, they highlight gaps in policy and regulatory frameworks to support higher education, science and technology. They underscore the need to establish and institutionalise regional blocks focused on higher education. These regional blocks will create forums to initiate dialogue on how higher education S&T can be harnessed to facilitate adoption and adaptation of modern technologies to local development needs.

At the institutional level, efforts should be made to continuously construct and update narratives that anchor higher education in the development agenda. Focus on higher education as a discipline across the continent needs to be re-examined. Issues of returns to investment in higher education within knowledge based economies need to be supported with empirical evidence. By implication therefore, governments and institutions should make it their business to promote evidence based decision making for higher education in the respective countries.

The African Union as well as the regional blocks should initiate collective learning and bargaining with international development assistance agencies to channel resources to initiatives that have higher returns to investment. International development agencies should be encouraged through policy direction and guidance to unlearn: 1) the policies that were dominated by structural adjustment programmes at the end of the 20th century; and 2) the current practices of fragmented access to resources and support for R&D. Targeted support will need to be channelled to high impact areas such as agriculture, industry and the service sector.

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The author of this paper hereby declares that there are no competing interests in this publication.

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