

**Case studies on RUFORUM Regional PhD
Dryland Resource Management, Soil and Water Management, Food Science and
Nutrition, Plant Breeding and Biotechnology and Agricultural and Rural Innovation
training programs**

By

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List of Acronyms

AGRA	Alliance for a Green Revolution in Africa
ARD	Agricultural and Rural Development
ARI	Agricultural and Rural Innovation
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
BPS	Board of Postgraduate Studies
CAADP	Comprehensive Africa Agriculture Development Program
CAVS	College of Agriculture and Veterinary Sciences
DAAD	German Academic Exchange Service
DAQA	Directorate of Academic Quality Assurance
DRC	Democratic Republic of the Congo
ECSA	Eastern, Central and Southern Africa
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
ICT	Information Communication Technology
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KENAFF	Kenya National Farmers Federation
MOU	Memorandum of Understanding
NARS	National Agriculture Research Systems
NGOs	Non-governmental Organizations
PDF	Portable Document Format
R & D	Research and Development
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture
SSA	Sub-Saharan Africa
SUA	Sokoine University of Agriculture
USD	United States Dollar

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Summary

Since 2008, RUFORUM has launched seven regional coursework based PhD programs which are hosted at different member universities. RUFORUM engaged a consultant to conduct case studies of five programs namely, PhD Dryland Resource Management hosted by University of Nairobi, Soil and Water Management at Sokoine University of Agriculture (SUA), Food Science and Nutrition at Jomo Kenyatta University of Agriculture and Technology (JKUAT), Plant Breeding and Biotechnology at Makerere University, Agricultural and Rural Innovation at Egerton University, Makerere University and at SUA. The study focused on what is in place, demands for the training programs, implementation progress and issues, outputs, outcomes and impacts. In addition, the study was to identify what needs to be done to strengthen the existing programs, identify what is not in place and make suggestions on how to address the gaps in both the current and future RUFORUM regional PhD training programs. The study was conducted between April and May 2014 and involved deskwork review and in-depth discussions with Program Coordinators and Chairpersons of the host Departments, Deans of Faculties and Schools, Directors of Academic Quality Assurance and Board of Postgraduate Studies and sample employers. Data were also collected from students and teaching staff using semi-structured questionnaires. Key findings are provided below.

1. Demand for the programs

- a. There is demand for the programs and as of 2013, over 350 applications had been received from 13 countries in Eastern, Central, Southern and West Africa. Demand in the initial calls as reflected by number of applicants and wider regional representation was higher than in subsequent ones, an element which may be attributed to unavailability of scholarships.
- b. So far, the five programs have collectively enrolled 166 students from 12 countries. However, over 184 qualified applicants have not been trained due to financial constraints.
- c. Further, the region needs professionals to replace those close to retirement age, research activities have focused on a few topics and staples, targeted limited agro-ecologies and yet the evolving environmental and biotic challenges need to be addressed on a continuous basis. Thus demand for the programs exists.
- d. Programs are mostly attracting students within the 30-39 and 40-49 age brackets who make up 49 and 41% of the total trained, respectively. Further, employees of the public agriculture education, research and extension organizations make up 89% of the total and the rest are from the private

sector. Faculty at graduate assistant, tutorial fellow, assistant lecturer and lecturer grades based in 14 universities and located in 9 African countries make up 36% of the total trained. Further, senior officers in the Ministry of Agriculture and Livestock and researchers make up 36 and 16% of the total respectively.

- e. With the exception of Agricultural and Rural Innovation and Food Science and Nutrition programs where females are well represented, the five programs have mainly registered male students who constitute 59% of the total trained.

2. Factors favoring enrollment and unique attributes of the programs

- a. **Relevance:** The programs are relevant and meet the needs of the professionals, namely; to acquire discipline depth and fundamental skills needed for upward career mobility, to expand career opportunities and enhance performance in current positions. Also, by focusing on science for development, the programs are contributing to development in the region.
- b. **PhD by coursework and research approach:** Singled out by all students, lecturers, employers and university management was the PhD by coursework and research approach. Coursework is important for imparting discipline depth, fundamental skills and promoting interactions among students and with lecturers. Because the program is structured, completing study within 4 years was seen as relatively fast as opposed to PhD by research only.
- c. **Team teaching:** The RUFORUM regional programs engage professionals from multiple institutions in teaching and supervision of students with the benefit of expanding the knowledge pool beyond the host university human resources. Also, attaching students to relevant institutions where they are mentored and practicals skills enhanced is another unique attribute of the programs which was hailed by the students. Requirement for publishing research findings was seen as important in enhancing skills in scholarly publication.
- d. **Regional scope:** The regional aspect and linkages with other universities was identified as unique by students, teaching staff and university management and has the advantage of bringing students from the region together, enhancing sharing and peer learning in addition to providing opportunities to establish networks. Further, training within the region was seen as relatively cheap when compared to training overseas, research conducted address national and regional challenges, offers the flexibility to raise funds for tuition as one continues with studies and also attend to family

matters. Thus, it is important to maintain the coursework and thesis approach, the regional aspect, team teaching and linkages with other institutions and relevance of the programs. These factors appear to have a bearing on the success and sustainability of the programs.

3. Curriculum and delivery

Overall, the curricula were rated adequate in content and depth and relevant to the students professions to either a great extent or to a very great extent. In addition, curricula offer flexibility in terms of areas of specialization, allows for certain courses to be taken in any RUFORUM member universities, admit students with diverse academic backgrounds and emphasize the use of multiple and modern approaches to facilitate learning although the extent to which these are being used vary among programs and with room for improvement.

4. Academic Quality Assurance Measures and availability of critical inputs for quality tertiary education training

a. Directorates of Academic Quality Assurance

All universities hosting the regional programs have academic quality assurance units in place, Directorates of Academic Quality Assurance have been established and monitoring of quality of programs, inputs, delivery and outputs is ongoing though at different levels of sophistication. Although, the universities have credit accumulation and transfer systems in place these need to be harmonized. In all the universities hosting the RUFORUM regional programs, self evaluation systems are in place but external systems are not.

b. Staff teaching the programs and availability of facilities essential for quality tertiary training:

All the staff teaching the programs hold doctorate degrees coupled with long teaching experience. For three programs, majority of teaching staff are close to retirement age and there is need to train a new generation of professionals. In addition, the host universities have reasonably good facilities and investment in modern training tools including equipment, information communication technology infrastructure and services essential for quality tertiary training which should contribute to the success and sustainability of the programs. This is important because students cited credibility of the universities tended to influence enrollment in the programs.

5. Result of running the RUFORUM regional programs

a. Trained highly qualified graduates

The five programs have registered 166 students and 25 have graduated with doctorate degrees and a further 17 are likely to graduate in 2014. Employers in universities, research institutions, Ministry of Agriculture and Livestock and the Private sector were interviewed. There was consensus that the graduates are well equipped with discipline depth and fundamental skills especially communication, knowledge in relevant policies, holistic view of issues, leadership and team building skills. Further, owing to the strength of the Agricultural and Rural Innovation Program in empowering farmers, Private Sector suggested that the program be cascaded to Masters and Bachelors degree levels.

b. Publications

High quality research is being conducted and research findings have been published in peer reviewed journals. Fourteen students have collectively published 41 articles and publications are expected to grow to at least 340, a significant contribution to knowledge and will also enhance the profile of the universities. Further, lecturers have benefited from publications, supervision of students and participation in scientific forums and this will contribute to upward career mobility of the staff.

c. Networks established

Enhanced networks were reported by students, lecturers, outreach communities and the universities at large and networking is likely to bring universities to closer and more productive relationships with other actors in agriculture sector.

d. Catalyzed desirable changes in the host universities

Influenced shift towards offering PhD by coursework and research: Running the programs has influenced the shift towards offering PhD by coursework and research, wide use of modern tools to facilitate learning and consultative approach in curricula development and review.

Fostered the development of centers of excellence and increased the profiles of the host universities: For instance, SUA is attracting attention from International communities, the Tanzania Government, stakeholders in agriculture and other sectors. SUA attracted significant funds from AGRA for purchase of equipments for the soil science laboratory and is now playing a key role in sample analysis for the public, generating income and is a referral laboratory for fertilizer analysis. The university is in the process of having the laboratory accredited by the Tanzania Bureau of Standards and is also in discussions with the Tanzanian Government to define modalities for establishing a commercial laboratory. Similarly, the University of Nairobi is attracting more attention from International communities and as a result of hosting

the Dryland and Resource Management program, it attracted funding from USAID in support of Center for Sustainable Drylands Ecosystems and Societies. The grant supports students' research, student exchange, seminars and short courses in addition to catering for faculty research.

6. Research being conducted by the RUFORUM regional programs

Research relevant to the region in terms of enhancing sustainable use of resources, increasing productivity for enhanced livelihoods and also to inform policy is being conducted. Examples:

- a. Interventions by Soil and Water Management program is putting emphasis on indigenous drought tolerant crops coupled with enhancing soil fertility through promoting use of nitrogen fixing leguminous crops, appropriate crop rotation, intercropping, optimized fertilizer rates and use of planting pits to improve water use efficiency.
- b. The Plant Breeding and Biotechnology program is focused on improving nutrition and yields of indigenous early maturing and drought tolerant crops through breeding for enhanced resistance to insect pests, other disease causing agents and improving soil fertility through biological nitrogen fixation. Development of elite materials will result in generation of public goods with immense potential to enhance food security in the region and beyond.
- c. Similarly, the students in Dryland and Resource Management program are conducting research in the dryland ecosystems in multiple countries in the region and with a focus on important dryland tree species of medicinal value, those used as fodder and wild fruits and on wildlife-human conflicts. The research findings will inform policy on matters pertaining to sustainable dryland management for enhanced livelihoods.

7. Challenges and issues

- a. For lecturers, it was a challenge teaching PhD students for the first time and it required investing significant amount of time to develop learning materials. Also, heavy workload in both teaching and supervision of students was cited. Further, semester dates for RUFORUM member universities are not synchronized and this tended to limit availability of staff for joint-teaching.
- b. Funding was another constraint cited by most programs and to some extent contributed to compromising use of some learning approaches, especially engaging guest lecturers from institutions in the region and practical components.

- c. The programs have registered a decline in enrollment and yet 53% of the admitted applicants have not been trained due to financial constraint faced by would be students. The programs were designed to graduate students in 3-4 years and this has been achieved to some extent. However, graduation rate has declined.
- d. The programs are attuned to gender mainstreaming but because the human resource pool is dominated by males, the females constitute only 41% of the total trained mainly.

8. Conclusions

- a. The RUFORUM regional PhD training programs are innovative, relevant to stakeholder needs, are in demand and have trained 166 high caliber scientists. Faculty based in 14 universities and located in 9 African countries have been trained. In addition, the infrastructure and visibility of the host institutions have been enhanced. Also, senior officers in the Ministry of Agriculture and Livestock, Research Scientists and Private Sector employees have been trained. In essence, RUFORUM regional training programs have trained high caliber scientists for faculty to train more professionals to serve the African continent, trained research scientists for research and extension bodies and also provided a pool of highly trained technical experts to guide development process and policy frameworks.
- b. The initiative has also influenced the move towards offering PhD by coursework and thesis, contributed to improving quality of research and tertiary training and fast tracked the establishment of Directorates of Academic Quality Assurance in host universities.
- c. The training programs have engineered development of elite varieties of drought tolerant indigenous crops, contributed to approaches for sustainable use of natural resources for enhanced livelihoods, addressing challenges of climate change and food insecurity in the region.

9. Recommendations:

Recommendations targeting on-going programs

1. The PhD Dryland Resource Management , Plant Breeding and Biotechnology and Soil and Water Management programs have been running for over 4 years. ***It is recommended that the curricula be reviewed and emerging issues incorporated and depth of coverage scaled down to create more time for hands on activities. Similarly, Food Science and Nutrition curriculum be reviewed to ensure that it incorporates courses with a focus on communication, entrepreneurship,***

management, leadership, team work, field exposure and more hands on activities and also diversify learning approaches.

2. The programs are imparting discipline depth and fundamental skills but graduation rate is low, ***it is recommended that students' research be monitored more closely to address bottlenecks to fast track completion of studies and if necessary offer the programs on alternate years.***
3. Teaching staff in at least three programs encountered challenges during implementation. ***It is recommended that more support be accorded to teaching staff through short courses, more field exposure to facilitate further contextualization of learning materials and enhance staff mobility to reduce workload.***
4. All programs are taught by highly qualified and experienced faculty members but noting the advanced age distribution for staff teaching Soil and Water Management, Agriculture and Rural Innovation at SUA and Dryland Resource Management, ***it is recommended that a new generation of professionals be trained.***
5. Female enrollment is low and constitute 41% of the total trained. ***It is recommended that the universities rebrand agriculture programs, review curricula and incorporate courses targeting the youth and also take lead in providing career guidance to secondary school students and marketing the programs to spark more interest in professions in agriculture.***
6. ***Most programs have encountered financial challenges and also registered decline in enrollment. For programs which have been running for at least 4 years it is recommended that some courses be offered online to increase access by more people. Further, there is need to mount an aggressive fund raising campaign to ensure sustained support for the program to cater for scholarships, support staff mobility and experiential learning.***

Recommendations targeting future programs

7. Sub Saharan Africa (SSA) loses significant amount of produce from postharvest related losses which result from use of inappropriate agronomic practices, poor handling during and after harvest. There is need to address skill gaps in the area of postharvest handling. Further, most smallholder farmers in SSA do not add value to their products and as a result do not derive full benefit from their produce. Agricultural value addition transforms primary products into products of greater worth, with a longer shelf-life and earn producers more income. It is recommended that **postgraduate program with a focus on post harvest handling, value addition and agribusiness be initiated.**
8. Exploration for minerals especially in the arid zones are on the increase in Eastern, Central and Southern Africa and mining activities are underway. These activities are likely to promote environmental degradation. Further there are concerns over piling amounts of e-waste which are threatening human and environmental health by releasing harmful substances. Inappropriate and unsafe management practices related to collection, handling, recycling and disposal of end-of-life of e-wastes is common. Studies conducted by Kenya Industrial Research and Development Institute in hotspot dumping sites in Nairobi revealed high levels of toxic heavy metals in the soil and water. This has a bearing on sustainable resource management, human health and food security. The threat is real and a stakeholders' conference was convened in Nairobi in May 2014 to discuss issues of e-waste. In light of emerging environmental challenges, **it is recommended that postgraduate training with a focus on environmental degradation, conflict resolution and e-waste be initiated.**
9. Agriculture in SSA is mostly rain-fed and with the challenges arising from climate change, many governments are putting emphasis on irrigated agriculture as entry points for integrated farming for crop, livestock and fish production. The move is aimed at addressing food insecurity, creating wealth and employment. Water is already a scarce resource and there is need to have irrigation systems and designs that are water efficient. **It is therefore recommended that the postgraduate training program offered at SUA be upgraded to PhD level with focus on Irrigation Engineering and emphasis on advanced design of irrigation infrastructure, including use of appropriate software.**
10. Stakeholders raised concerns over the aging farming population and need to attract youth into agriculture. To some extent, this can be achieved by encouraging irrigated as opposed to rain-fed

production, incorporating courses targeting the youth including putting emphasis on farming as a business, commodity exchange and warehouse structured grain marketing, emerging livestock species, Urban and Peri-Urban agriculture and designing appropriate machines for smallholder agriculture to ease drudgery in land preparation, planting, weeding, threshing, drying, grating, milling and other processes. This could spark interest in the youth to engage in farming. In the future, **it is recommended that training probably at diploma level with a focus on design fabrication of appropriate implements for production and food processing equipments be initiated.**

11. Livestock is an important source of protein, manure and draught for crop production and source of livelihood for millions of families. However, livestock productivity is low mainly due to seasonality and poor quality of feed and incidences of pests and diseases. Support in postgraduate training in Animal and Veterinary Medicine would enhance the use of resources at the University of Nairobi Faculty of Veterinary Medicine in support of livestock production. ***It is recommended that efforts be made to inject modern digitalised laboratory equipments to enhance diagnostics, support postgraduate training especially in leather science, artificial insemination and fertility management, surveillance and control of zoonotic diseases and also promote use of modern reproductive technologies especially ovum pickup and embryo transfer***

1: INTRODUCTION

1.1 Importance of agriculture and human resource situation in Sub-Sahara Africa

Agriculture is the backbone of most countries in Sub-Saharan Africa (SSA) economies, accounting for up to 40% of GDP, 15% of exports and 60-80% of employment (World Bank, 2008). Production is mainly in the hands of smallholder farmers who are often marginalised and, as a result, their productivity is low. Most countries in SSA are food insecure and locked in poverty. For the SSA countries to achieve the first Millennium Development Goal of reducing the number of hungry and poor people by 50% by 2015, smallholder farmers must register significant increase in agricultural productivity. This requires effective and well supported research and development institutions, a vibrant private sector, and a pool of specialists with the capacity to use knowledge and technologies within an effective agricultural innovation system. These highly skilled professionals are needed across the value chain. They will be innovative, fully integrated into

the global knowledge system, and with the skills to adapt technologies and advances in business and science into local contexts. Finally, they will be leaders who advance strong institutions nationally and regionally.

Available data, as reported by Drame'-Yaye' (2011), show that the share of agriculture in total enrollments in tertiary institutions in SSA is low and well below the strategic needs of the nations (World Bank, 2008). As depicted in table 1 (adopted from ANAFE, 2011), for some countries yearly growth in enrollment has declined for several important reasons. In the past, the public sector was the major employer of agriculture graduates but, with budget constraints, the civil service has reduced its intake of new graduates. The training provided to agriculture graduates has not equipped them with entrepreneurial skills to assist them start their own business and create employment. Some have been absorbed by Non-Governmental Organizations (NGOs) and by private businesses in agriculture input supply, agro-processing and food retail outlets (Blackie *et al.*, 2009). But they are poorly prepared for these new niches and are perceived to lack core skills and competences. Recent studies (Drame'-yaye' *et al.*, 2011) have reported limited skills and competencies in the graduates, specifically poor communication and limited managerial capacity, lack technical laboratory and field skills, adequate financial management, ability to

Table 1: Tertiary enrollment statistics in 21 selected Sub-Saharan African countries, 1999-2007

Country	Total enrollments in tertiary education			Total enrollments in agriculture at the tertiary level			Share of agriculture in total enrollments	
	Number	Yearly growth (%)	Years	Number	Yearly growth (%)	Years	%	Yearly growth (%)
Bukina Faso	33,459	30	1999-2007	321	-	2007	1.0	-
Burundi	17,061	34	1999-2006	392	-	2002	3.7	-
Cameroon	120,298	11	1999-2006	696	4	2004-2006	0.6	-0.1
Congo	12,456	4	1999-2003	380	-8	2001-2002	3.1	0.0
Eritrea	4,612	3	1999-2004	416	9	1999-2004	9.0	0.3
Ethiopia	210,456	38	1999-2007	17,884	33	1999-2007	8.5	-0.1
Ghana	140,017	22	2003-2007	3,019	8	2000-2004	4.3	0.0
Guinea	42,711	51	2003-2006	4,670	204	2004-2006	10.9	2.8

Kenya	102,798	4	2000-2004	6,969	5	2000-2001	7.4	-0.1
Lesotho	8,500	16	1999-2006	356	36	1999-2006	4.2	0.2
Madagascar	58,313	11	1999-2007	1,362	10	2005-2007	2.3	-0.1
Malawi	6,458	13	1999-2007	490	-	1999	15.4	-
Mauritius	16,773	17	1999-2006	318	-1	1999-2006	1.9	-0.4
Mozambique	28,298	29	1999-2005	1,477	0	2004-2005	5.2	-1.4
Namibia	13,185	0	2001-2006	298	9	1999-2003	2.5	0.3 ^a
Sierra Leone	9,041	17	2000-2002	1,360	315	2000-2001	15.3	10.4
South Africa	741,380	2	1999-2006	13,452	8	2000-2006	1.8	0.1
Swaziland	5,692	2	1999-2005	345	4	1999-2006	6.1	0.1
Tanzania	51,080	28	1999-2001	2,417	15	1999-2005	4.7	-0.3
Togo	18,455	11	1999-2001	166	-	2000	1.1	-
Uganda	88,360	24	1999-2004	1,403	11	1999-2004	1.6	-0.1

Source: Modified from Kruijssen (2009). Notes: - indicates that data were not available, "Years" indicates the earliest and most recent year for which data were available; yearly growth rates are for the same years as agricultural enrollments. ^aData are for 2001-03)

write proposals and reports. This has been reinforced by findings of RUFORUM sponsored study in Southern and Eastern Africa (Ekwamu *et al.*, 2010) which showed the need to enhance fundamental skills in communication, practical experience and report writing. Further, ASARECA demand study has pointed the need for graduates to be equipped with additional skills with a focus on farmer training, management, agricultural value addition and entrepreneurship (Blackie *et al.*, 2009). The unemployment situation and limited career development opportunities for agriculture graduates have in a sense contributed to making profession in agriculture appear 'unattractive'.

The above scenario reflects a gap in training programs in most universities in Africa and disconnect between curricula and the needs of the industry. Several studies (Africa-U.S. Higher Education Initiative, 2008, BIFAD, 2014, Ekwamu *et al.*, 2010, NASULGC, 2008, World Bank, 2008) have pointed the need to innovate the curricula to enhance quality, relevance and flexibility in response to sensitivity of stakeholders. The African Universities have the ultimate responsibility to train a new generation of agricultural

professionals with different skill sets in line with labor demands and also develop scientific capital for the African continent.

1.2 Tertiary training in Sub-Saharan Africa

As captured by Hayward and Ncayiyana (2014), the number of universities in SSA has increased rapidly and the region accounts for 1500 private and public universities. Similarly, university enrollments have grown too fast, from under 200,000 in 1970 to an estimated ten million in 2014; for most public institutions, this has been without corresponding allocation of resources. The rise in enrollment is compounded by the introduction of parallel programs where self-funded students are encouraged to enroll because tuition constitutes a significant proportion of university budgets. Rise in enrollment has resulted in high staff-to-student ratio. Generally, most public universities in SSA continue to operate under challenging environment including financial constraints, limited physical facilities and supply of modern equipment and shortage of faculty members. This is exacerbated by the fact that average age of faculty members is high due to hiring freezes, budget cuts and limited pool of new PhD as reported in the Africa-U.S. Higher Education Initiative (2008).

1.3 Regional Universities Forum for Capacity Building in Agriculture (RUFORUM)

In 2004, the Regional Universities Forum for Capacity Building in Agriculture, a consortium of 33 universities in Eastern, Central and Southern Africa was established. RUFORUM's mission is to strengthen the capacities of universities to foster innovations responsive to demands of smallholder farmers through the training of high quality researchers, the output of impact-oriented research and the maintenance of collaborative working relations among researchers, farmers, national agricultural research institutions and governments. It is a strong voice for higher agriculture education in Africa. In partnership with member universities and other organizations, RUFORUM is championing a new initiative for regional postgraduate training. Through the initiative, RUFORUM is positioning her network to engage and contribute to The Comprehensive Africa Agriculture Development Program (CAADP), the framework for revitalizing African

agriculture and Africa's economic recovery. The initiative will provide the required institutional capacity and also build the human resource for driving CAADP agenda.

1.3.1 RUFORUM Regional PhD training programs

The aim of the RUFORUM regional PhD training programs is to build Africa's next generation of agricultural scientists and also contribute to redress challenges facing agricultural tertiary education in SSA. The target is to produce high caliber scientists to: provide highly trained faculty to train more professionals to serve the African continent, train scientists for the National Agriculture Research Systems and other research and extension bodies and technical experts to guide development process and policy frameworks. The launch of PhD training programs was also informed by findings of the study by Blackie and Woolmer (2005) which revealed that through the interventions of Rockefeller Foundation Program on Agricultural Resource Management, postgraduate training at Masters level had been strengthened and graduates were supporting smallholder farmers. In addition, the study found that the capacity of some of the universities had been strengthened and could mount PhD programs in identified critical areas. To address the identified gaps, the study recommended establishment of centers of excellence (CoE).

The RUFORUM programs engage stakeholders in identifying gaps and the design of new regional PhD programs which are not available in most universities. The programs are based on both coursework and research. They combine discipline depth with new courses which impart fundamental skills. In addition, the initiative advocates for adoption of emerging modern approaches and technologies including e-learning to train, puts emphasis on joint resource mobilization, joint training and cross-learning among universities in the region and beyond. The training programs are guided by the RUFORUM (2005) Strategic Plan. Since 2008, RUFORUM has launched seven regional PhD programs whose details are provided in table 2. Because no single university has the critical mass to launch the new programs on its own, the Center of Excellence model was adopted for all except Agricultural and Rural Innovation (ARI) program which is building the capacity for the three African partner institutions simultaneously. As reported by Hellstrom (2013), the CoE model puts emphasis on resource concentration and is an important instrument for capacity building, stimulating innovations and generating scientific excellence. RUFORUM coordinates the implementation of these programs and their regional nature is depicted in figure 1. The programs opened their doors to the first students at different times and some have been running for over 5 years. In April 2014, RUFORUM engaged a consultant to conduct case studies of the programs.

Figure 1: Regional nature of RUFORUM PhD programs (Adopted from Ekwamu *et al.*, 2010)

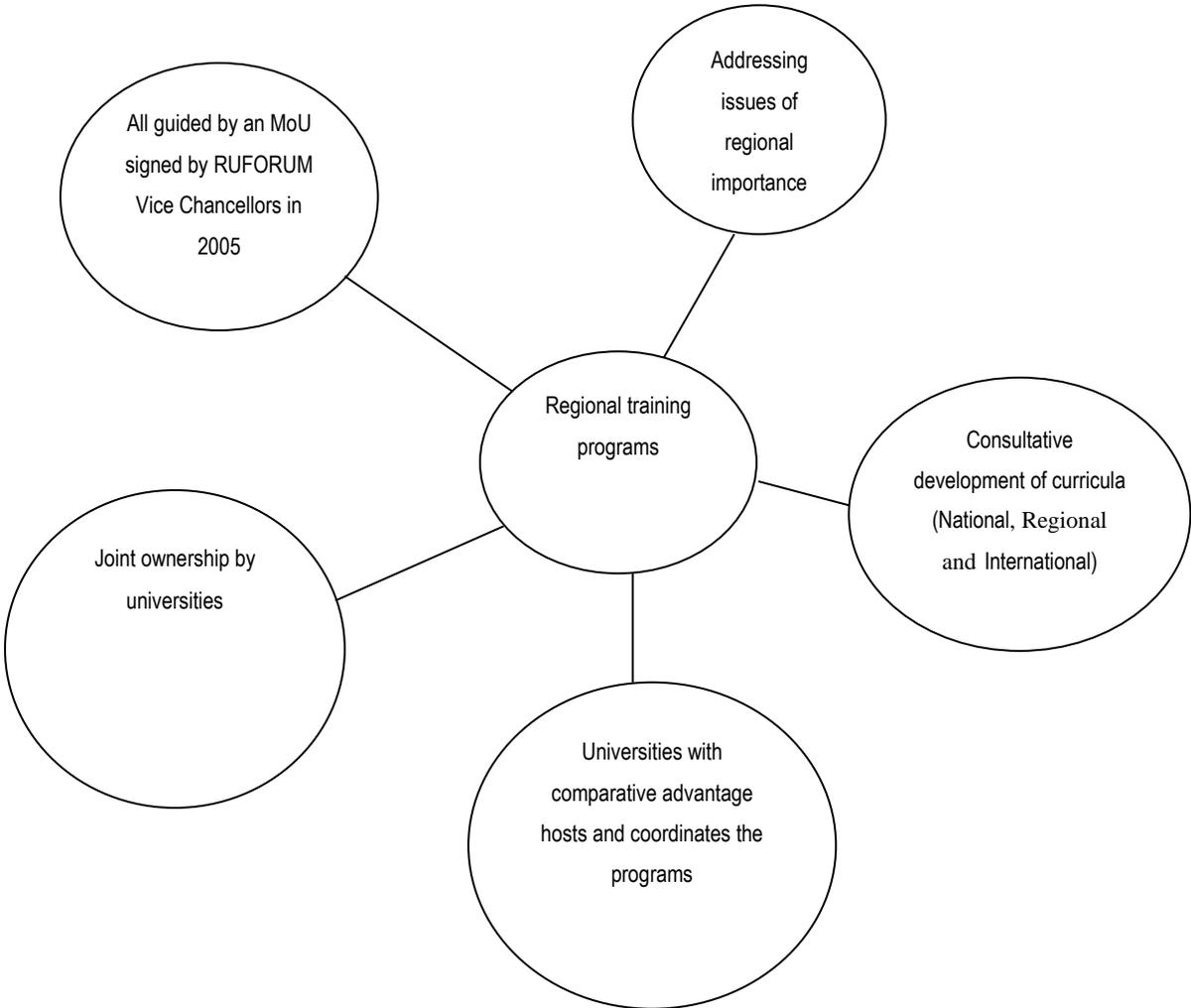


Table 2: RUFORUM Regional PhD training programs and the hosting universities

Name of program	Year started	Hosting university, country
PhD Dryland Resource Management	2008	University of Nairobi, Kenya
PhD Food Science and Nutrition	2013	Jomo Kenyatta University of Agriculture and Technology, Kenya
PhD Agricultural and Rural Innovation Studies	2012 2013	Makerere University, Uganda; Egerton University, Kenya, Sokoine University of Agriculture, Tanzania
Plant Breeding and Biotechnology	2009	Makerere University, Uganda
PhD Soil and Water Management	2010	Sokoine University of Agriculture, Tanzania
PhD Agricultural and Resource Economics	2009	Lilongwe University of Agriculture and Natural Resources
PhD Aquaculture and Fisheries	2009	Lilongwe University of Agriculture and Natural Resources

1.4 Scope, objectives and approach of the case studies

The study was conducted between April and May 2014 and it focused on five programs, namely PhD in: Dryland Resource Management, Soil and Water Management, Food Science and Nutrition, Plant Breeding and Biotechnology, Agricultural and Rural Innovation. The study focused on what is in place, demands for the training programs, implementation progress and issues, outputs, outcomes and impacts. It also identified what needs to be done to strengthen the existing programs, and what is not in place. Finally the study incorporated suggestions on how to address the gaps in both the current and future regional PhD training programs. In undertaking the study, the consult focused on the questions below:

Objectives of the Study

1. Who is demanding these regional programs and why?
2. What are the factors that ensure the success and sustainability of the regional programs?

- a. What is the value of the regional training programs?
 - b. What does it take to produce pro-active and skilled graduates from regional PhD training programs
 - c. How can the regional PhD training programs be supported more effectively?
 - d. How and to what extent are the harmonised QAMs being taken up by the universities for the regional PhD training programs?
3. How can regional PhD training programs be institutionalized in the universities and yet still maintain their “regionality”?
 4. What have been the outputs, outcomes and impacts of the regional PhD training programs on the students/graduates, on the hosting university, and on the national /international agricultural research systems associated with the training programs?
 - a. How and to what extent is the implementation of regional programs catalysing any desirable changes in universities?
 - b. What changes in the agricultural sector are taking place in the countries as a result of the graduates input into the systems?

The study also looked at PhD in Animal and Veterinary Medicine at the University of Nairobi to identify gaps and issues to inform investing into livestock sector.

Approach and sample size

The study involved deskwork review and collection of primary data. The consultant visited the five universities hosting RUFORUM Regional PhD programs and held in-depth discussions with Program Coordinators and Chairpersons of the host Departments, Deans of Faculties/Schools, Directors of Academic Quality Assurance and Board of Postgraduate Studies. Discussions were also held with sample employers of agriculture graduates including Universities, National Agriculture Research Institutes, Private Sector, Ministry of Agriculture and Livestock. Primary data was collected by administering a semi structured questionnaire either online or face-to-face to all students registered for specific programs and the academic staff teaching the program. The proportion of students and teaching staff respondents are provided in table 2a. Primary data was analyzed using Statistical Package for Social Sciences version 22. The analyses involved estimating frequencies and cross tabulations for various variables. Findings of each case study are provided in subsequent chapters.

Table 2a: Students and teaching staff respondents of the PhD regional training program case studies

Name of Program	Student respondents as percentage of total registered	Number of teaching staff respondents
Soil and Water Management	42	7
Dryland Resource Management	30	5
Plant Breeding and Biotechnology	32	2
Food Science and Nutrition	83	4
Agricultural and Rural Innovation at:		
Egerton University	22	2
Sokoine University of Agriculture	30	5
Makerere University	12	0

2: PHD SOIL AND WATER MANAGEMENT PROGRAM

2.1 Background and Program design

The program is hosted by Sokoine University of Agriculture (SUA) in Tanzania and was initiated in response to request by Vice Chancellors of the RUFORUM member universities to launch a joint regional PhD training program to address key gaps in soil and water management. The aim of the program is to train competent graduates with the capability of managing soil and water resources. This program supports The Comprehensive Africa Agriculture Development Program processes especially Pillar 1, focusing on sustainable land management and reliable water control systems and Pillar 4 which focuses on agriculture research, technology dissemination and adoption. SUA was selected to develop and host the program due to its comparative advantage in the disciplines of soil and water management. The university was already offering masters programs in Irrigation Engineering and Management, in Soil Science and Land Management and also in Land Use Planning and Management.

The students are registered for four years to undertake one year of coursework and then proceed to conduct research, which lead to development of a thesis. Students are allowed to graduate in three years. Coursework consists of three categories of courses; common core, specialized and electives. Students must take all six common core courses while the specialized courses are taken by those who opt for a given area of specialization. Additional courses are selected from the electives to enable students pursue a minimum of 16 credit hours of PhD level courses. Students can proceed to the research component after successfully completing their coursework (including passing examinations for all courses), and developing a research proposal which the student presents and is approved at the department as well as Faculty Postgraduate Committee levels. After approval of the research proposal, students are released to undertake research in their home countries. The curriculum for PhD in Soil and Water Management program was developed by key stakeholders and was subsequently approved at both the departmental and faculty levels. It was approved by SUA senate in 2009. This program is being implemented jointly by the Department of Soil Science and the Department of Agricultural Engineering and Land Planning.

2.2 Implementation progress and demand

The Sokoine University of Agriculture senate approved PhD Soil and Water Management program in 2009 and immediately engaged in creating awareness of the program using various channels, including websites. The demand for the program was evident with over 50 applicants from eight countries (Kenya, Uganda, Ethiopia, Malawi, Tanzania, Rwanda, Mozambique¹ and Zambia). After securing financial support, the program opened its doors to the first students in 2010. RUFORUM provided sponsorship for 8 students while Alliance for a Green Revolution in Africa (AGRA) supported 20 students. As the group of 28 students was relatively large, SUA management decided to admit the AGRA supported students in two cohorts of 10 students each in 2010 and 2012. The first cohort of AGRA supported students reported in October 2010 while those supported by RUFORUM reported one month later. Thus in 2010, a total of 18 students were admitted (one did not report and another discontinued studies during the first year). Currently, a total of 24 students drawn from seven countries and consisting of seven females and 17 males are registered for the program (Table 3). Six students in the first cohort have submitted theses and are likely to graduate in 2014 while 10 are writing up. The 8 students in the second cohort have completed coursework and are in the final stage of refining their research proposals.

Table 3: Students registered in PhD Soil and Water Management as of April 2014

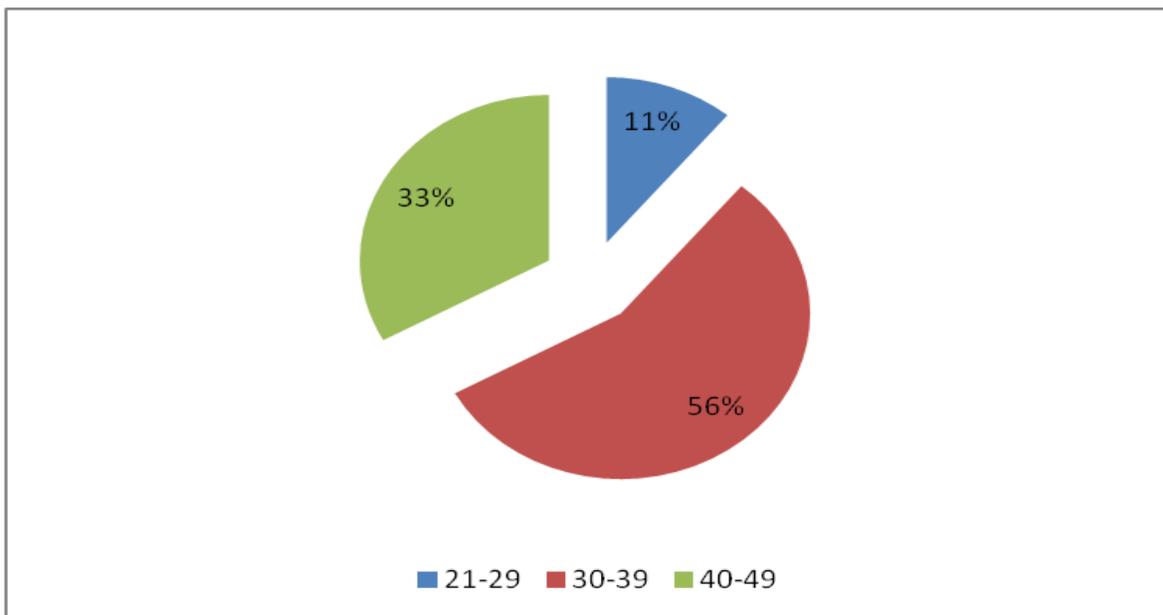
No. of Students	Gender		Countries of Origin
	Male	Female	
4	4	0	Ethiopia
5	1	4	Kenya
5	5	0	Malawi
1	1	0	Rwanda
3	3	0	Tanzania
2	1	1	Uganda
4	2	2	Zambia

2.2.1 Characteristics of students enrolled in the program

The questionnaires were administered to all 24 students registered at SUA and 10 (42%) responded. Most of the respondents (56%) are within the age bracket of 30 to 39 years and the age breakdown of the students is shown in figure 1b.

¹ The two applicants from Mozambique did not meet admission requirements.

Figure 1b: Age of the students (in years) registered in PhD Soil and Water Management April 2014



The majority (71) of the registered students are males. Females represent only 28% of the respondents. The program is fully attuned to gender sensitivity but qualified female applicants have been few. Out of the seven females registered in the program, four are Kenyans. Efforts to attain gender and regional balance are underway and SUA has admitted female students in the Soil Science Masters degree program and hopes to tap into these graduates to boost representation of females at PhD level.

The students have diverse education background at both Bachelors and Masters degree levels. Most (70%) hold Masters degree in Soil Science while 30% specialized in agronomy, agro forestry or watershed management. Further, the postgraduate degrees were obtained from 8 universities located in Ethiopia, Malawi, Tanzania and Kenya (Table 4).

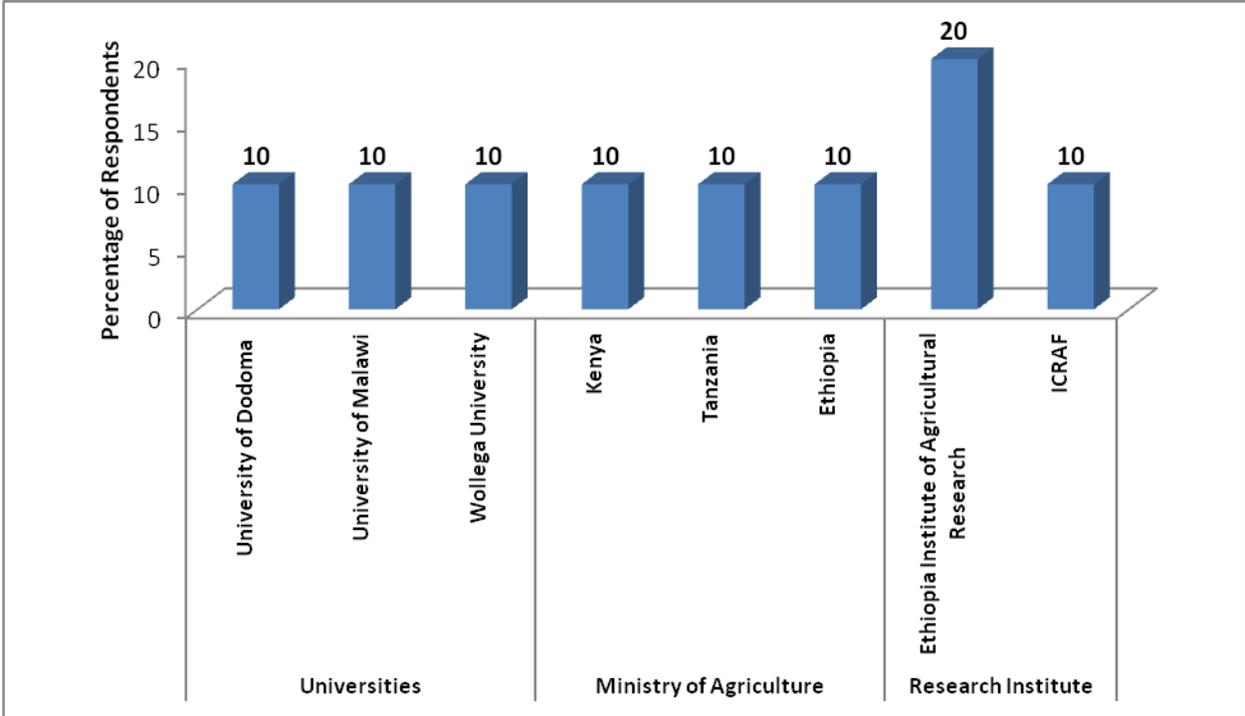
Table 4: Education background of PhD Soil and Water Management students and universities which awarded the Masters degrees

Education background at	% of students	Universities which awarded the degrees
Masters degree level		
Soil Science	70	Egerton University, Haramaya University, University of Nairobi, Sokoine University and University of Malawi

Agro-forestry	10	Bunda College
Watershed Management	10	Hamasia University
Agronomy	10	Haramaya University

Nine of the respondents were employed before registering for the program. About 30% were researchers, an equal proportion were involved in agriculture information diffusion and 40% worked in universities at lecturer or assistant lecturer levels as shown in figure 2. The employees of the Ministry of Agriculture and Research Institutes hold senior positions (including Head of Soil Science Laboratories, Principal Agriculture Research Scientist, Research and Department Head, Senior Agriculture Officer, Senior Agriculture Research Officer and Soil and Water Management Researcher). This indicates the program is training senior staff in the agriculture sector. To undertake studies, three of the students resigned while 60% were accorded study leave, an indication of strong support for the latter by employers.

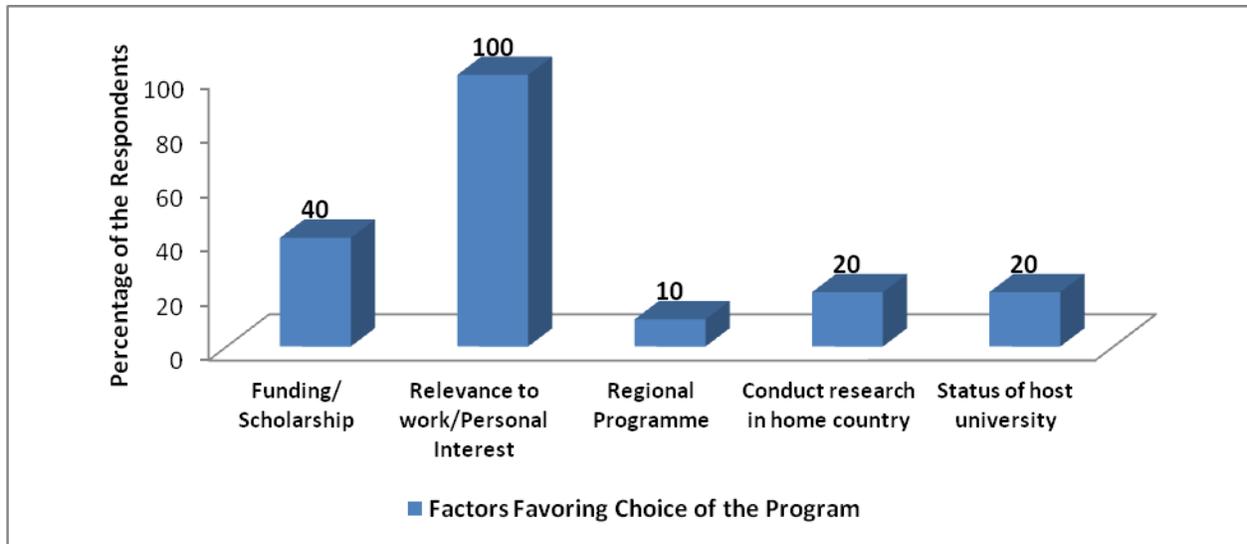
Figure 2: Employers of students registered in PhD Soil and Water Management program



2.2.2 Factors favoring enrollment in the Program

The students identified several factors which influenced their choice of the program and these are shown in figure 3. The relevance of the program and need for in-depth understanding of the discipline, need to enhance skills for improved job performance and increased upward career mobility were the key factors. Thus majority of the respondents are training primarily to enhance knowledge and address skill gaps relevant to their professions. Other factors include credibility of the host institution, availability of scholarship and flexibility to conduct research in home countries. The regional aspect which is seen to offer opportunities for networking was also important.

Figure 3: Factors which influenced enrollment in PhD Soil and Water Management program



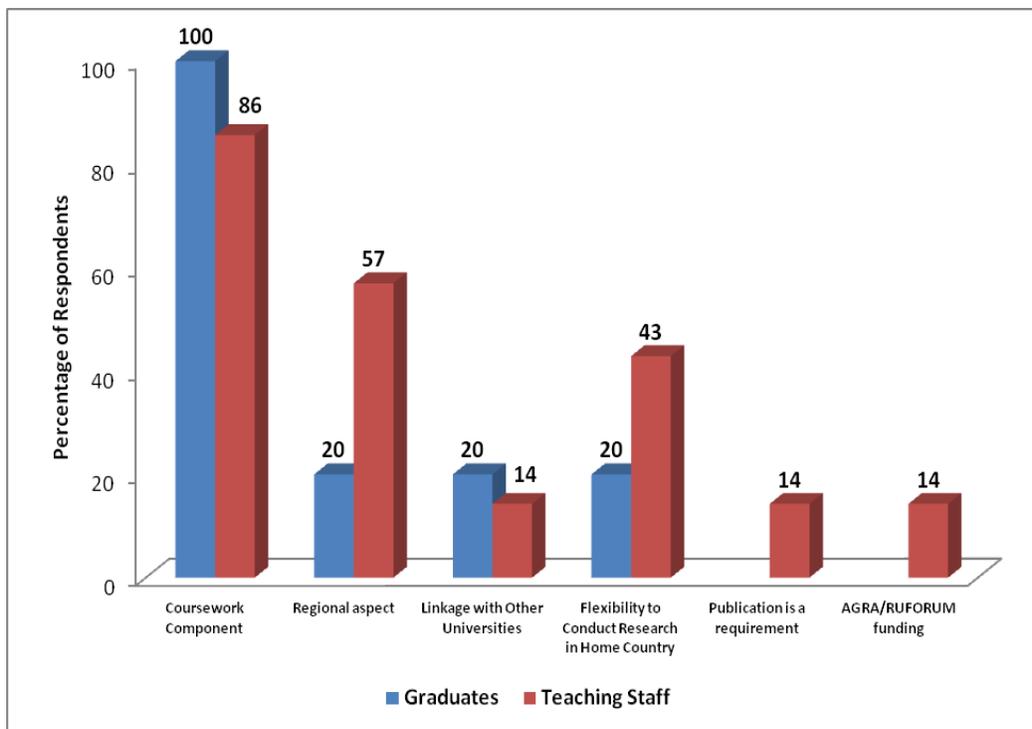
2.3 Factors that ensure success and sustainability of the regional program

2.3.1 Unique attributes of the program

Students and teaching staff were asked to identify the unique attributes of the program. All respondents noted that the program is unique and majority of teaching staff (87%) and all students singled out the coursework component as a key attribute. Coursework allows for deeper understanding of the discipline, more interaction between students and lecturers particularly during proposal development phase. Because the program is structured, completing study within 4 years was seen as relatively fast as opposed to PhD by research only. Research PhDs are open ended, students move at individual pace and take longer to complete. Regional attribute was also important as it serves to bring students from the region together, enhances sharing and peer learning in addition to creating a window for establishing networks for future

collaborations. Flexibility to conduct research in home countries was seen as relatively cheap, an opportunity to address local constraints and contribute to national and regional development. These attributes are summarized in figure 4. Therefore, the regional aspect, coursework and thesis approach, maintaining linkages with other universities and flexibility to conduct research in home countries have a bearing on the success and sustainability of the program.

Figure 4: Unique attributes of PhD Soil and Water Management program as identified by students and teaching staff



2.3.2 Curriculum and delivery

2.3. 2.1 Curriculum content

Both the students and teaching staff assessed the curriculum with regard to content, depth and delivery. All the teaching staff and 80% of students rated the curriculum as adequate in content. Only 10% of the students rated it as too broad and suggested that courses which are not related to soil and water management be omitted, the number of core courses be reduced from the current 6 and the areas of specialization which currently stand at three, be increased. In addition, students raised the issue of

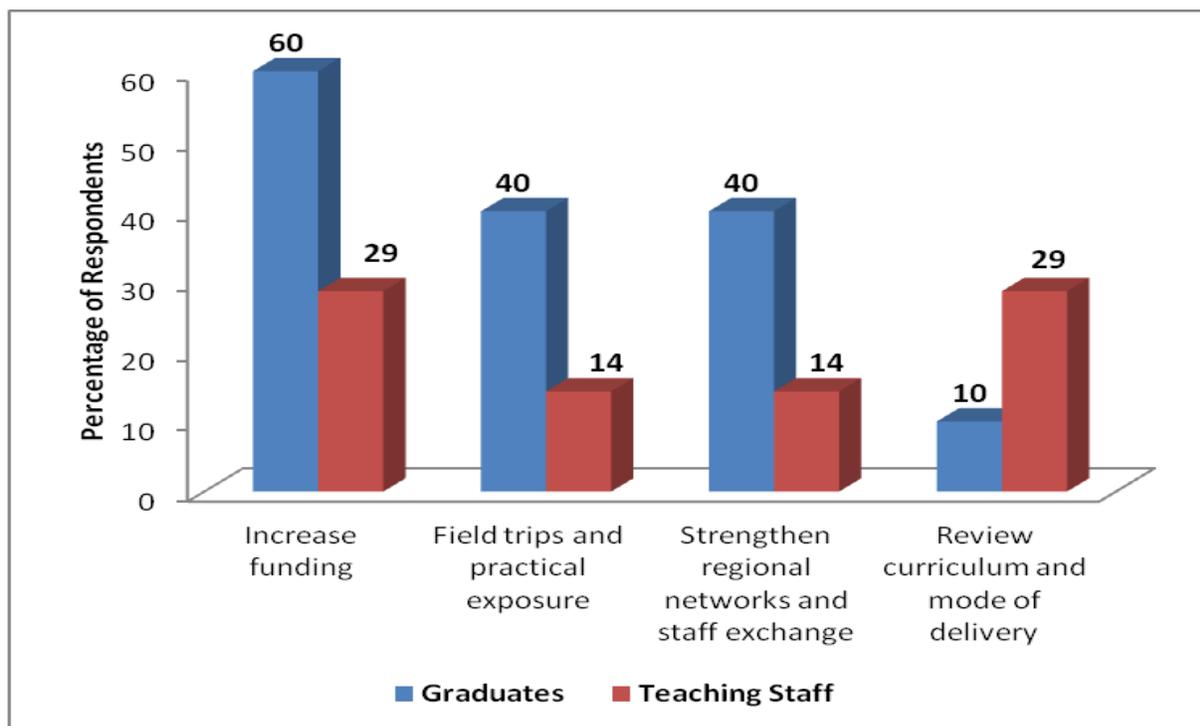
irrelevance of some case studies used during coursework and recommended the use of more appropriate ones. Noting that this is a new program, the concern should be resolved as more research in soil and water management is conducted in the region and could also be addressed through mobilizing human resource from the region and elsewhere to share experiences. Mobilizing more resources for faculty research could also address this gap. It is interesting to note that some teaching staff recommended the omission of scientific writing and presentation skills, communication and leadership development from the curriculum, an indication that they are oblivious of the need to impart these skills. This knowledge gap needs to be addressed.

With regards to depth, majority of the students (88%) and all teaching staff rated the curriculum as adequate. It is evident that the design of the program is meeting the expectations of the students with 75 and 13% rating it as relevant to their professions to a great extent and very great extent, respectively. To ensure success and sustainability of the program, there is need for periodic consultation with stakeholders and to review the curriculum to ensure continued quality and relevance.

2.3.2.2 Curriculum delivery

The teaching approaches used were lectures, laboratory 'hands on' and field based activities, interaction with guest lecturers, seminars, and presentations. Issue of imbalance between theoretical, practical and field based components of the program was raised by majority of the students (56%) and about 43% of teaching staff. Teaching staff reported that for certain courses, no time was scheduled for hands on activities and even where this was provided for, funding was limited. About 40% of the students recommended field visits to sites relevant to the theoretical aspects, field based and also more laboratory based hands on activities, practical data analysis, group discussions and partnering with farmer groups as means to improve practical skills and experiential learning as shown in figure 5. It was also recommended that the number of instructors handling a course (2 to 3 lecturers handle one course) be reduced and the frequency of oral presentation increased to weekly. The need to increase funding, strengthen regional networks and staff exchange was recommended as ways to improve delivery. About 40 and 50% of the students rated their lecturers' preparedness as very good and good respectively.

Figure 5: Ways to improve program delivery as identified by students and teaching staff



An assessment of whether students feel better prepared to play their roles in the market place was encouraging as 70% attested to being better equipped as a result of the training. Research and communication competences were singled out as the most important skills imparted. Discipline depth particularly soil fertility, problem identification and crop productivity improvement were also singled out by 40% of the students. Although there is a course on entrepreneurship and business management, no student singled out related skills. Details of the core skills imparted are provided in table 5. Overall, the students pointed out that the program is relevant, it is addressing critical gaps in the region and more people should be trained.

Table 5: Core skills imparted and considered critical for better performance as identified by students

Most important skills	Percentage of respondents
Communication: writing, presentation and reading	100
Research Data analysis and project management	60
Leadership	20

The program is imparting discipline depth and the desired skills as expressed by the students. But there is need to enhance learning further by adhering to the curriculum especially to maintain a balance between theoretical and practical components in the timetable, ensure that experiential learning is incorporated and supported with necessary financial allocation. In addition, learning materials need to be contextualized.

Overall, the Soil and Water Management curriculum is detailed and has incorporated courses in discipline depth. As well as providing courses deemed essential to the discipline, a major effort has been made to impart skills and competencies perceived as lacking in past agriculture graduates. There is a strong emphasis in developing research skills, including data and information management and application of statistical packages. In addition, communication is covered in details, ranging from scientific writing, inculcating a reading culture, and learning to critique published work. Important to note is inclusion of communication and leadership for development, with a focus on packaging and disseminating information - including to non-scientific audiences. There is emphasis on participatory approaches and development in pursuit of developing abilities to facilitate the development process. Areas of focus include mobilising and engaging communities in development initiatives, mainstreaming gender and analysing developmental frameworks. Entrepreneurship and business management is also covered. Also included are emerging issues and relatively recent reading materials. Generally, the curriculum is innovative and reflects the RUFORUM principles.

2.3.3 Availability of critical inputs for tertiary education training

The critical inputs for tertiary education training include infrastructure, qualified and motivated faculty and support staff, qualified and motivated students, competent administration and resources needed to facilitate learning. The condition of the core infrastructure at SUA was assessed by students and staff involved in teaching the program and also the profile of the teaching staff was obtained. The results are summarized in 2.3.3.1 and 2.3.3.2.

2.3.3.1 Staff teaching the program

All the seven teaching staff respondents are male and majority (5) were aged between 50 and 59 years. Within the age bracket of 40 to 49 and above 60 years was one person each. All the teaching staff have doctoral degrees and most (71%) have over 20 years teaching experience. The university is well endowed

with highly qualified and experienced teaching staff. But as most are close to retirement age, there is need to train a new generation of professionals.

2.3.3.2 Infrastructure capacity of the university as assessed by students and lecturers

Both the students and teaching staff assessed the infrastructure capacity of the university and details are provided in table 6. Majority of the students (80%) and all teaching staff rated the lecture theatres as generally good or fair. The soil science laboratory has received new equipment and the facilities were rated as good by majority of the students (70%) and 57% of the staff respondents. About 14% of the teaching staff rated laboratory facilities as poor. There may be a particular issue in the area of microbiology, pointing to the need to continue improving the laboratory facilities. Generally the computer facilities were rated as good or very good by most students (80%) mainly because these services have been enhanced in the building housing the students. However, 71% and 57% of the lecturers rated computer facilities and internet access (respectively) as either fair or poor. There is need to enhance these facilities further. There were mixed feelings regarding assessment of the accommodation facilities with 60% of the students rating them as good or very good but a total of 20% rated them as poor or very poor. Generally, accommodation is limited but whenever graduates report on time and particularly during the first year of study, SUA offers priority allocation to foreign students. Challenges arise during the thesis write up period because there is no structured schedule and as such university hostel accommodation cannot be guaranteed. The university has renovated a three bedroom house and made it available to graduate students. When shortages persist, students are accommodate in hotels in the nearby Morogoro town at subsidized rates.

Table 6: Infrastructure capacity of the university as assessed by students and teaching staff

Infrastructure	Assessment by students					Assessment by teaching staff				
	Very Good %	Good %	Fair %	Poor %	Very Poor %	Very Good %	Good %	Fair %	Poor %	Very Poor %
Lecture theatres	10	20	50	10		14	57	29	-	-
Laboratory	-	70	20	-	-		57	29	14	-
Computer facilities	40	40	-	10	-	14	14	57	14	-
Internet access	-	30	-	30	-	14	29	43	14	-
Library	20	40	-	-	-	14	57	29	-	-

Accommodation	30	30	-	10	10	14.3	14.3	71.4	-	-
Transport	-	-	-	-	-	-	57.1	28.6	14.3	-
Sports	-	30	-	20	20	-	-	-	-	-

- Means no score was awarded

SUA has good infrastructure and facilities required for quality tertiary education training but there is room for continued improvement especially with respect to some disciplinary areas and laboratories, library, internet access, transport services and sports facilities.

2.3.4 Support for the program

The teaching staff made an assessment of how effectively the key stakeholders play their role in support of the program. The role of SUA was seen as training and providing an enabling environment. The teaching staff noted that SUA played her role either effectively or only to some extent as reported by 43 and 14% of the respondents respectively. The university could enhance her role by ploughing back some of the income earned from tuition to support the program, including maintenance of laboratory equipments. The role of RUFORUM in funding students and also in helping the university to mobilize resources was appreciated. Nevertheless, RUFORUM could enhance effectiveness by timely disbursement of funds and offer further support through facilitating the establishment of a formal mechanism of engaging professionals from the region to teach and supervise students registered at SUA. SUA has devised an innovative partnership with professionals from the home countries of the students, and the latter are involved in students' proposal development and also guide the student during research. This partnership has been beneficial in the absence of a written MOU between the universities involved. Employers were seen as playing a key role in participating in the design of curriculum and support of students. This role could be enhanced by releasing students on time and where possible participate in field visits during supervision. Students could enhance their effectiveness by devoting more time to studies to ensure they complete within the stipulated 3-4 years.

2.3.5 Research being conducted by the students

The students are drawn from the region and some are conducting research in their home countries namely, Kenya, Malawi, Tanzania and Ethiopia. The research is addressing regional environmental challenges especially climate change and declining soil fertility. There is focus on drought tolerant indigenous crops such as sorghum, cowpea and pigeon pea. The promotion of these crops should increase farm productivity more so with the ranging climate change where rainfall regime is increasingly erratic and amounts continue to vary. The interventions involving promotion of drought tolerant crops coupled with emphasis on

enhancing soil fertility through promotion of nitrogen fixing leguminous crops, appropriate crop rotation, intercropping, optimized fertilizer rates and use of planting pits to enhance water efficiency are bound to boost sustainable productivity. The initiatives have the potential to reverse recurrent food insecurity common in the region.

2.4 Results of the regional training

Running the program has resulted in multiple benefits including trained professionals, publications, enhanced networks, improved infrastructure at the university and income generating activities initiated as detailed below.

1. The university in partnership with stakeholders developed the curriculum for PhD Soil and Water Management by coursework and research and this was approved by SUA senate. In addition, the program has registered 24 students from the region and they have successfully completed course work. Six students are expected to graduate with PhD in Soil and Water Management in 2014. All students are equipped with discipline depth, fundamental skills and they have also enhanced their networks.
2. Publications: Most students are in the final phase of the research component of their studies. Two students have published a total of 7 articles as detailed in appendix A1 and this is evidence of high quality research being conducted. Considering that the publication of at least one journal article is a requirement for graduation, 24 to 48 publications is an assured output from the program and should be realized in 2014 and 2015.
3. As a result of teaching the program, teaching staff (57%) have registered benefits in supervision and enhanced networks. About 14% have published at least one article in addition to supervising at least one student. Further, over 90% of the teaching staff enhanced their networks to a small, moderate and great extent as reported by 42, 29 and 19% of the respondents respectively.
4. The University has also benefited in multiple ways including monetary gains from tuition and enhanced partnerships. By virtue of registering students from the region SUA has registered enhanced linkages with the scientists and the networks are proving useful especially in responding to research calls with a regional outlook.
5. Enhanced infrastructure which resulted in the establishment of income generation unit and accreditation of the soil science laboratory: AGRA invested substantial funds (USD 320,000) for

purchase of equipments for the soil science laboratory. The equipments bought include: thermo scientific mineral detector (equipment is ISO accredited), spectrophotometer, fume chamber, electronic balance, centrifuge, oven and a generator. After being equipped with modern equipment, the soil science laboratory is playing a key role in sample analysis and generating income in addition to advancing research and national development. It is also a referral laboratory for fertilizer analysis to ensure quality product is distributed to the farmers. Because the laboratory is playing a critical role in providing fertilizer analysis among other services, the university is in the process of having the laboratory accredited by the Tanzania Bureau of Standards. Further, the SUA is in discussion with the Tanzanian Government looking at modalities for establishing a commercial laboratory which will generate income for the university.

2.5 Challenges encountered during implementation

Most students (60%) faced challenges while undertaking studies. These were related to finances, accommodation and language barriers. The lecturers reported heavy workload in teaching and supervision of students, and to ease the burden, they recommended active engagement of professionals from the region. Generally, the program registered limited external inputs from professionals in the region partly because of the short notice given in the advertisement. Further semester dates for different universities are not synchronized and this tended to limit availability of professionals to teach at SUA. Together with SUA staff, the professionals in the region are co-supervising the students. One international guest lecturer from the United States was involved in teaching the first cohort, mainly in the area of proposal development and also accompanied students for a field excursion. The challenge pertaining to limited funding and late disbursement of finances was mentioned and this tended to disrupt flow of studies and in particular the research component. It also interfered with timely arrival of students to the university.

2.6 Overall assessment, Issues and Conclusions

There is regional demand for the program and to date 24 professionals from 7 African countries have been trained. Most students (67%) were registered in the 1st cohort and so far only 6 have submitted their thesis and are likely to graduate in 2014. Therefore, most students (63%) in the first cohort will not complete studies within the stipulated 4 years. All students are on full scholarship and the program encourages students to undertake research in their home countries. However, during the research phase, SUA staff can only make a single supervisory visit due to financial constraints. This limited interaction could be contributing to delays in timely completion of studies. Students have supervisors from their home countries

who are not compensated for supervisory duties but benefit from publication of research findings. There are indications that the home country supervisors devote limited time for consultation with students. Further, students are expected to collect data at home and then return to SUA for analysis and write up. However, some students have opted to write from their home countries. The compounded effect of limited supervision during research and write up from home countries where students devote less time on studies and have less interaction with supervisors may be contributing to delays. Further, lecturers reported heavy workload in teaching and supervision and recommended engagement of professionals from the region in teaching. Formal engagement of home supervisor could help address the delays in completing studies.

The program is attracting young civil servants mainly within the 30-39 age bracket, are keen to enhance knowledge and skills needed in current positions and for upward career mobility. With the exception of university employees, other students hold senior positions in their respective institutions and are in a position to influence policy. Further, the program is relevant to students' profession, curriculum is adequate in content and depth and training is imparting discipline depth and fundamental skills. These factors are likely to enhance attractiveness of the program and contribute to its success and sustainability. The flexibility to conduct research at home, regional aspect and access to funding are also important factors and have a bearing on program success. In addition the research being conducted is relevant to the region and has a strong bearing on sustainable management of basic resources essential for agriculture production and potential to boost productivity.

The program has received support from key stakeholders. Sokoine University of Agriculture could plough back some of the income accrued from tuition in support of the program. In addition, majority of the staff teaching the program are close to retirement age and there is need to support training of a new generation of professionals. The training of high level laboratory managers also needs to be factored in because the old managers are retiring without appropriate replacements. Further, teaching staff reported heavy workload in teaching and supervision of students and promoting mobility of professionals from the region and beyond to teach and supervise students would be worthy support to the program. The program has mainly trained males with females making up 25% of the total chiefly because the later are few in the human resource pool. SUA has short term strategies in place and will tap graduates from the ongoing Masters Soil Science program. However, there is need to provide career guidance at secondary school level and also to spark interest in advancing studies in soil science. In addition, the program has been running for 4 years and could benefit from support to review the curriculum. The program encountered challenge of limited funding and late disbursement and the later tended to disrupt flow of studies and timely

release of funds would assist the program run smoothly. In addition, limited funding contributed to compromising delivery especially practical and field based activities. The program has registered substantial results in terms of capacity building, generating innovations and enhancing visibility of SUA. However, sustainability remains a challenge in the face of financial challenges. The program has registered a decline in enrollment and in 2013 and 2014 no students were enrolled partly due to lack of scholarships. The absence of registered students will translates to under utilization of resources. Therefore, substantial financial supported is necessary for success and sustainability of the program. The following conclusions can be drawn from the study:

1. The program curriculum is innovative and the training is imparting discipline depth and fundamental skills as expressed by the students but to enhance learning further, ***it is recommended that learning materials be contextualized and program maintain a balance between theoretical and practical components in the timetable, ensure that experiential learning perspectives are incorporated and supported with necessary financial allocation. Also the curriculum should be reviewed.***
2. The faculty is endowed with qualified and experienced teaching staff but most are close to retirement age while another is above 60 years. ***Therefore, it is recommended that a new generation of professionals be trained.***
3. Generally, SUA has good facilities as required for quality tertiary education but there is room for continued improvement and ***it is recommended that infrastructure should continue to be enhanced especially microbiology related laboratory equipments, internet access, library and transport services.***
4. ***In addition, SUA and RUFORUM secretariat need to mount an aggressive fund raising campaign to ensure sustained support for the program to cater for scholarships, support staff mobility and experiential learning***

3: PHD DRYLAND RESOURCE MANAGEMENT PROGRAM

3.1 Background and program design

The program is hosted by the University of Nairobi in Kenya and was initiated to develop capacity to contribute to improving the livelihoods of communities in drylands through sustainable resource management. In Africa, two thirds of the land is drylands and about 73% of the agricultural drylands are moderately to severely degraded. Further, due to the high rate of deforestation and the resulting effect on water resources, Africa is under the greatest desertification threat. Nevertheless, drylands make a significant contribution to the Gross Domestic Product (GDP) of many developing countries particularly in terms of livestock products, food grains, and from tourism. Example, in Kenya drylands constitute over 80% of the country and is source of livelihood to about 14 million people. These people own livestock valued at approximately 70 billion Kenya shillings. Livestock keeping employs about 90% of the workforce in these marginal lands (Kenya Vision, 2030). In Ethiopia, the livestock sector contributes 16% to GDP, one third of agricultural GDP and 8% of export earnings. Generally the drylands are fragile and must be developed in a sustainable manner. Further, ecological and social issues are interwoven and so are options for livelihood support and ecological management. Also critical is the important role of indigenous environmental knowledge in the management of drylands. This program aims to contribute to the goal of improving the livelihoods of communities in drylands through sustainable resource management supported by focused research, graduate training and community based interventions.

The program consists of coursework, examinations, and a research thesis. It takes a minimum of 3 years and a maximum of 5 years. The coursework is taken during the first year of study and students take a total of twelve courses consisting of seven core and at least five elective courses. A candidate may be exempted from some courses and credits transferred from an approved institution subject to approval by the University of Nairobi Academic Registrar. The transfer cannot exceed one third of the courses. A student must pass examinations of all the courses before embarking on the research component of the study. During the research phase, a student is required to present a minimum of two seminars. The research component leads to the development of a thesis which is examined by two internal examiners and one external examiner, followed by oral examination at the faculty. Candidates are expected to submit at least two publishable papers to peer reviewed journals before graduating. The program has three thematic areas

of specialization; namely human ecology, production systems, ecology and environment and the degree awarded is Doctor of Philosophy in Dryland Resource Management, in the thematic area of study.

3.2 Implementation progress and demand

The University of Nairobi used various avenues to advertise the program and in 2008, a total of 78 applicants were received from seven countries. Due to limited number of scholarships, only 18 applicants joined the program out of which 15 were sponsored by Rockefeller Foundation through RUFORUM. The program has attracted applicants annually and to date five cohorts consisting of 47 students from Eastern, Southern and West Africa have been trained (Table 7). Despite the high demand for the program, enrollment has declined due to financial constraints faced by the applicants. Fourteen of the students have graduated and a further 8 are likely to graduate in 2014. The other 25 students are at various stages as detailed in table 7. Most of the students who have been trained are males, with females making up 34% of the total. Due to family reasons, one female student in the second cohort discontinued studies after the first semester.

Table 7: Students registered in PhD Dryland Resource Management program as of April 2014

Year of admission	Total applicants	Admissible applicants	Students Registered	Students countries of origin	Gender		Students progress
					Male	Female	
2008/2009	78	-	18	Kenya, Uganda, Malawi, Ethiopia, Zambia, Zimbabwe, Sudan, Tanzania	13	5	9 graduated in 2011 3 graduated in 2012 1 graduated in 2013 3 doing research, 1 writing up & 1 developing research proposal
2010/2011	36	30	8	Kenya and Sudan,	4	4	1 graduated in 2013, 3 have submitted thesis & 4 are writing thesis
2011/2012	20	-	9	Kenya, Uganda and Ethiopia	6	3	All doing research
2012/2013	15	11	10	Kenya and Uganda,	7	3	4 on research, 3 on proposal development
2013/2014	10	-	2	Kenya and	1	1	1 finished

				Nigeria			coursework & 1 finished 1 st semester of coursework.
Totals	159		47		31	16	

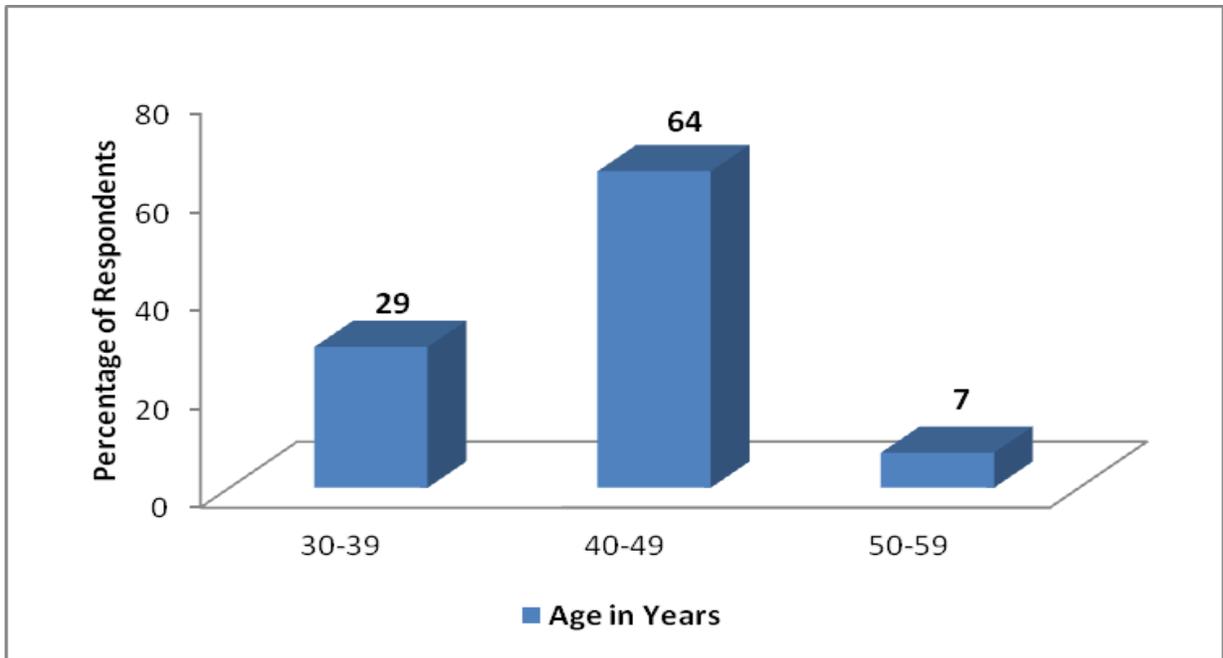
- Means information not available from the department

3.2.1 Characteristics of students enrolled for the program

Fourteen respondents (30% of all students and alumni) consisting of equal proportion of females and males responded to the questionnaire. Majority (64%) of the respondents were within the age bracket of 40 to 49 years and a further 29% within the 30 to 39 bracket. Only one student was within the age bracket of 50 to 59 years (Figure 6). This is a clear indication that the program is attracting people of diverse ages, and more so those who have been in employment for over 15 years. At undergraduate, most students had backgrounds in agriculture, range management, environment and natural resources and two specialized in mathematical statistics or veterinary medicine. In addition to attracting professionals with agriculture and natural resource backgrounds at Masters level, the program is also in demand by holders of Masters degree in Sociology and Community Development, Statistics and Business Administration. The Masters degrees were awarded by seven universities located in Ethiopia, Uganda, Kenya and Nigeria.

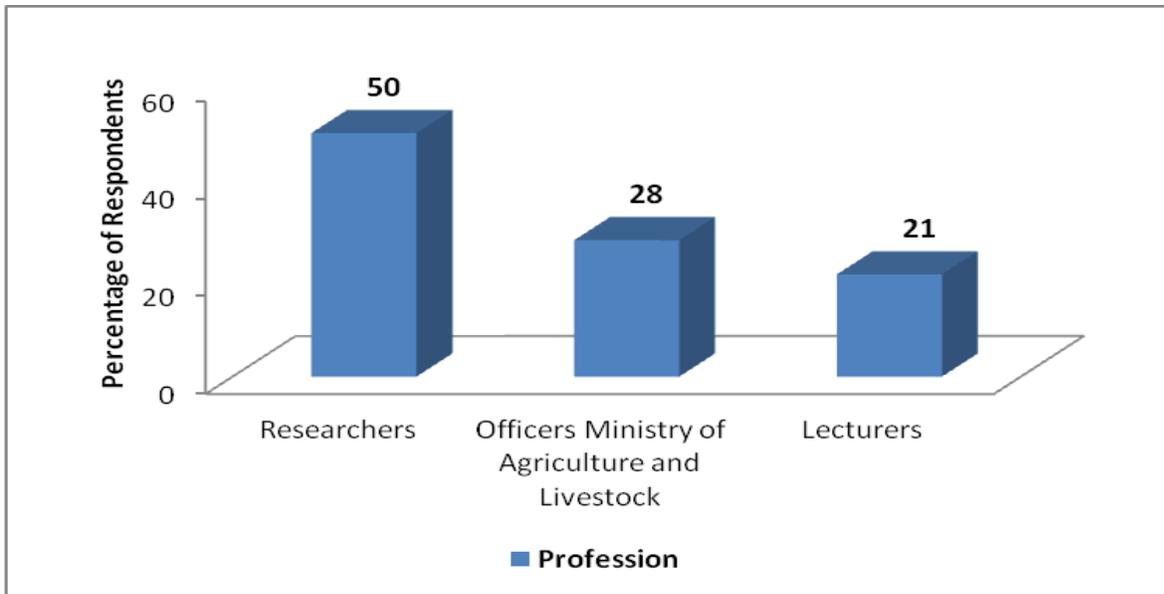
Prior to commencing PhD studies, all the students were in full time employment in the public sector. Researchers make up the bulk (50%) of people trained. A further 28% were officers in the Ministry of Agriculture and Livestock and 21% were university lecturers as shown in figure 7.

Figure 6: The age of students registered in PhD Dryland Resource Management program as of April 2014



Based on information gathered, the program is training teaching staff for universities based in Kenya, Uganda and Nigeria, researchers in National Research Institutes in Kenya and Uganda and officers in the Ministry of Agriculture and Livestock. To enable them pursue studies, 45% of the students were accorded study leave, 27% resigned while the rest made local arrangements with employers.

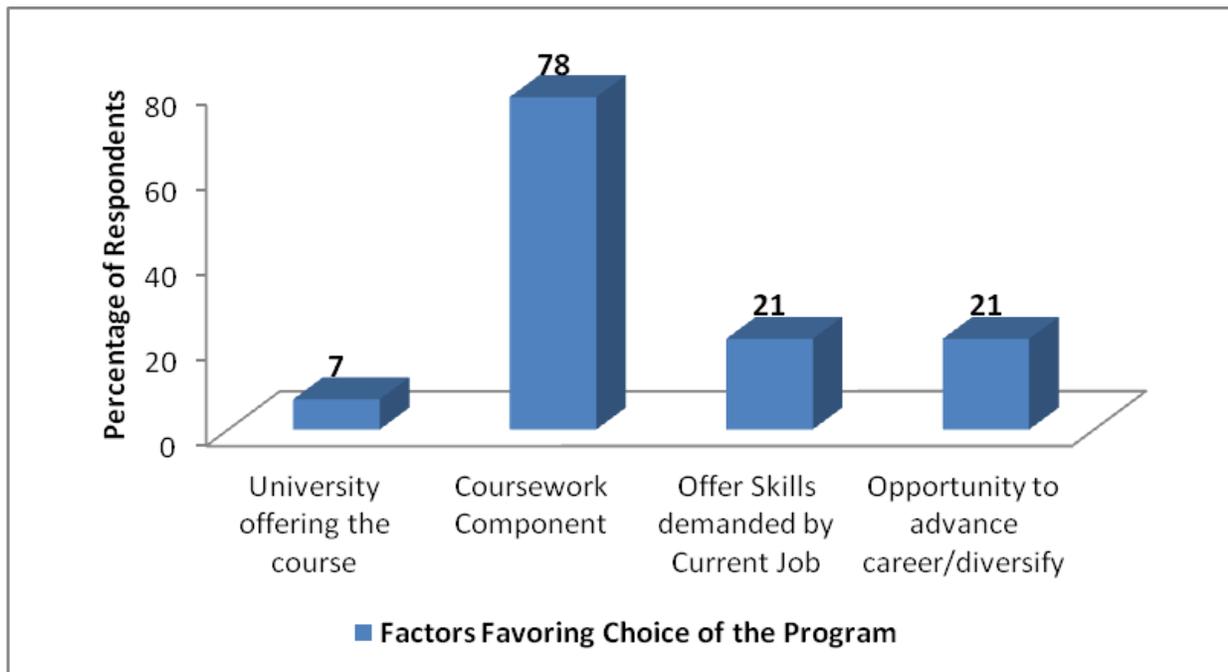
Figure 7: Professions of students registered in PhD Dryland Resource Management



3.2.2 Factors favoring enrollment in the Program

The study endeavored to identify the key factors which influenced students to enroll in the program. The coursework component of the program was the most important factor and is core for imparting fundamental skills and discipline depth to advance knowledge in dryland resource management as highlighted by 78% of the respondents. In addition to meeting the interest of the students, the program is seen to impart skills demanded in current positions, for upward career mobility and expanding career opportunities. Credibility of the university offering the program and structured short three year timeframe for completion of studies were also important. The relative importance of these attributes is illustrated in figure 8.

Figure 8: Factors favoring enrollment in PhD Dryland and Resource Management program



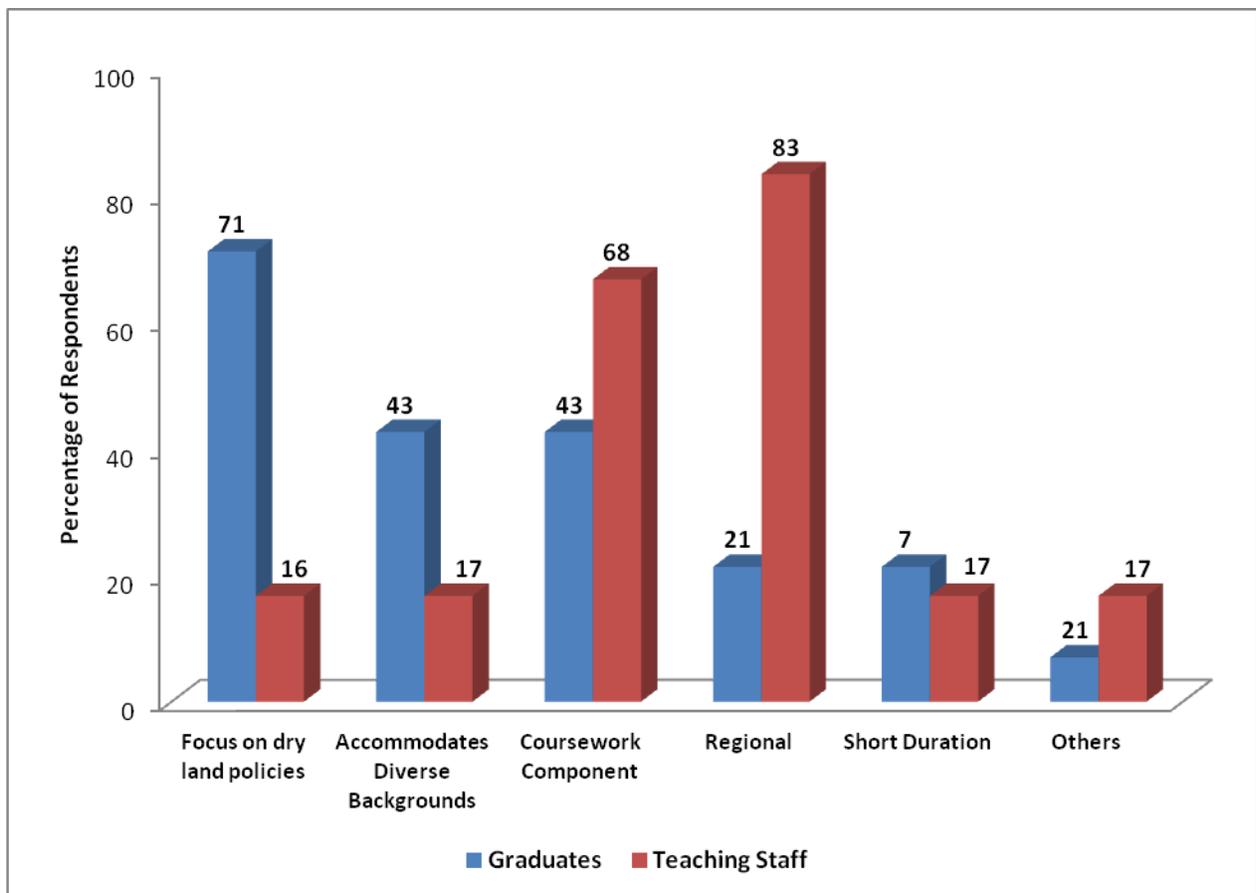
3.3 Factors ensuring success and sustainability of the regional program

3.3.1 Unique attributes of the program

Considering that the program is new, the study set out to document its unique attributes as perceived by students and teaching staff, university management and employers. Majority (71%) of the students singled out focus on dryland policies as an important attribute because it addresses challenges facing marginalized communities, affecting extensive areas of land and the economy of the region. On the other hand, teaching

staff (83%) identified the regional enrollment as the most important attribute because it fosters establishment of international networks, interactions and peer learning. As indicated by employers, 43% of students and 68% of teaching staff, the coursework element is a unique attribute for imparting discipline depth and fundamental skills. The university management also lauded coursework component for providing discipline depth and reported improved performance by students during the oral examination of thesis. Further, the short three year duration to complete studies was also singled out. In addition, the program accommodates students from diverse academic backgrounds as indicated by 43% and 17% of students and teaching staff, respectively. It is evident that the strength of the programs lies in its regional approach, focus on dryland, relevant coursework component and accommodating students with diverse backgrounds. Details of the responses from students and teaching staff are provided in figure 9.

Figure 9: Unique attributes of PhD Dryland Resource Management program as identified by students and teaching staff



Others attributes refer to flexibility of the program, the fact it has no age limit, quality control and marketability of graduates.

3.3.2 Curriculum and delivery

3.3.2.1 Curriculum content

Both the students and staff who teach the program assessed the curriculum with regard to content, depth and delivery. All teaching staff rated the curriculum as adequate in content and depth. However about 20% of teaching staff did not see the relevance of marketing of dry land products and applied economic theory and recommended these be excluded from the curriculum. A similar proportion of teaching staff recommended that climate change and risk and uncertainty management be incorporated in the curriculum. About 77% of the students rated curriculum content and 79% of the students rated depth of coverage as adequate. A further 23% rated content as too broad, did not see the relevance of the agriculture technology unit and suggested it be omitted from the curriculum. In addition, students proposed the inclusion of a course in agricultural communication. Some students indicated that some case studies used during coursework were not relevant, pointing to the need for further contextualization of learning materials. Generally, curriculum design met the students' expectations and majority (50%) rated it as relevant to their professions to a great extent and a further 29% noted it was to a very great extent relevant to their professions. Only 22% indicated that the program was to a moderate extent relevant to their professions.

3.3.2.2 Curriculum delivery

The program employs a range of teaching approaches including lectures, seminars and interaction with invited speakers, presentations and discussions. It also entails a two-week pre-requisite exposure to dryland regions in Kenya during which students interact with professionals in the field, identify researchable areas and make presentations on observations made. However, most students (79%) and lecturers (67%) reported insufficient emphasis on practical aspects, including field excursions. The limited field exposure was attributed to time constraint, shortage of funds and poor planning where only lecturers went for trips. About 20% of teaching staff recommended that more time be devoted to seminars. Similarly, students (43%) recommended an increase in oral presentations, field trips, laboratory based activities and the use of more updated software for data analysis especially for modeling in Agro-Meteorology.

An assessment of whether students feel better prepared to play their role in the market place was encouraging with all students attesting to being better equipped and that their enhanced understanding of issues surrounding dry lands and environment in general would strategically position them in the market place. Core skills acquired were singled out as holistic view of problems, communication (including

presentation and proposal writing) critical thinking, team building, ethical and leadership skills. About 93% of the students indicated that there was sufficient emphasis on developing communication skills. As expressed by the students, the training is imparting the desired knowledge and skills.

Overall, the Dryland and Resource Management curriculum is detailed and has incorporated courses in discipline depth, including emerging issues. Also included is dryland resource economics and marketing of dryland products, human rights and gender issues. It has placed emphasis on developing research skills including data analysis, project planning and analysis, monitoring and evaluation and application of a range of statistical packages. There is emphasis in developing communication skills but there is little mention of packaging and disseminating information to non-scientific audiences. Generally, the curriculum is innovative, has incorporated courses in discipline depth. Training is provided in areas deemed essential to impart skills and competencies perceived as lacking in past agriculture graduates. Nevertheless, based on the feedback received, it is important that learning materials are contextualized further; the program maintains a balance between theoretical and practical components in the timetable; and is supported with the necessary financial allocation.

3.3.4 Academic Quality Assurance

The University of Nairobi has a Directorate of Academic Quality Assurance (DAQA) which was established in 2012. The Director is a chartered quality professional. The directorate is charged with developing quality assurance plans, their implementation, and feeding the results to university top management. The directorate also provides support to implementing faculties. Generally, quality assurance at the university is the responsibility of the Deputy Vice-Chancellor Administration and Finance, Principals, Deans and Directors, Quality Assurance Board and Directorate of Quality Assurance. The University of Nairobi has so far bench marked 60 of the total 240 programs offered. Bench marking of the remaining 180 programs is ongoing and will be completed in 2014. The directorate has a quality assurance officer to ensure that the programs meet needs of stakeholders and also assesses the capacity prior to students' admission. The directorate ensures quality of inputs and is guided by the University policy. Further, the directorate monitors delivery and ensures that scheduled teaching sessions are delivered and assessments are accurately posted. In addition, the directorate monitors quality of outputs with a focus on graduation rate, pass rate and mean examination score. Students also evaluate lecturers' teaching effectiveness. The directorate has developed a framework for monitoring research outputs but implementation has not commenced. A schematic presentation of the current academic quality assurance plan for the University of Nairobi is

provided in figure 10. The University has Credit Accumulation and Transfer System in place and students can request for exception of courses and credit transfer for not more than one third of the total units through the University of Nairobi Academic Registrar. The exception is tabled before senate for approval and is granted for courses taken in a university recognized by the University of Nairobi senate. Basically, self evaluation and Credit Accumulation Transfer Systems are in place, but the proposed grading system, external evaluation system of teaching and the external evaluation system of graduate research (RUFORUM Secretariat, 2011) are not.

Day to day quality assurance measure of postgraduate activities is handled by the Board of Postgraduate Studies (BPS). Appropriate quality assurance measures are followed during program development. For admission, academic credentials of the applicant must be issued by an accredited university and copies certified. In addition, the BPS is in-charge of monitoring the progress of students to ensure that they are accorded all the support, including opportunities to consult with supervisors. The general welfare of the students especially in terms of conflict in supervision and processing of thesis is handled by BPS. As a quality control measure, each thesis is examined by two internal and one external examiner.

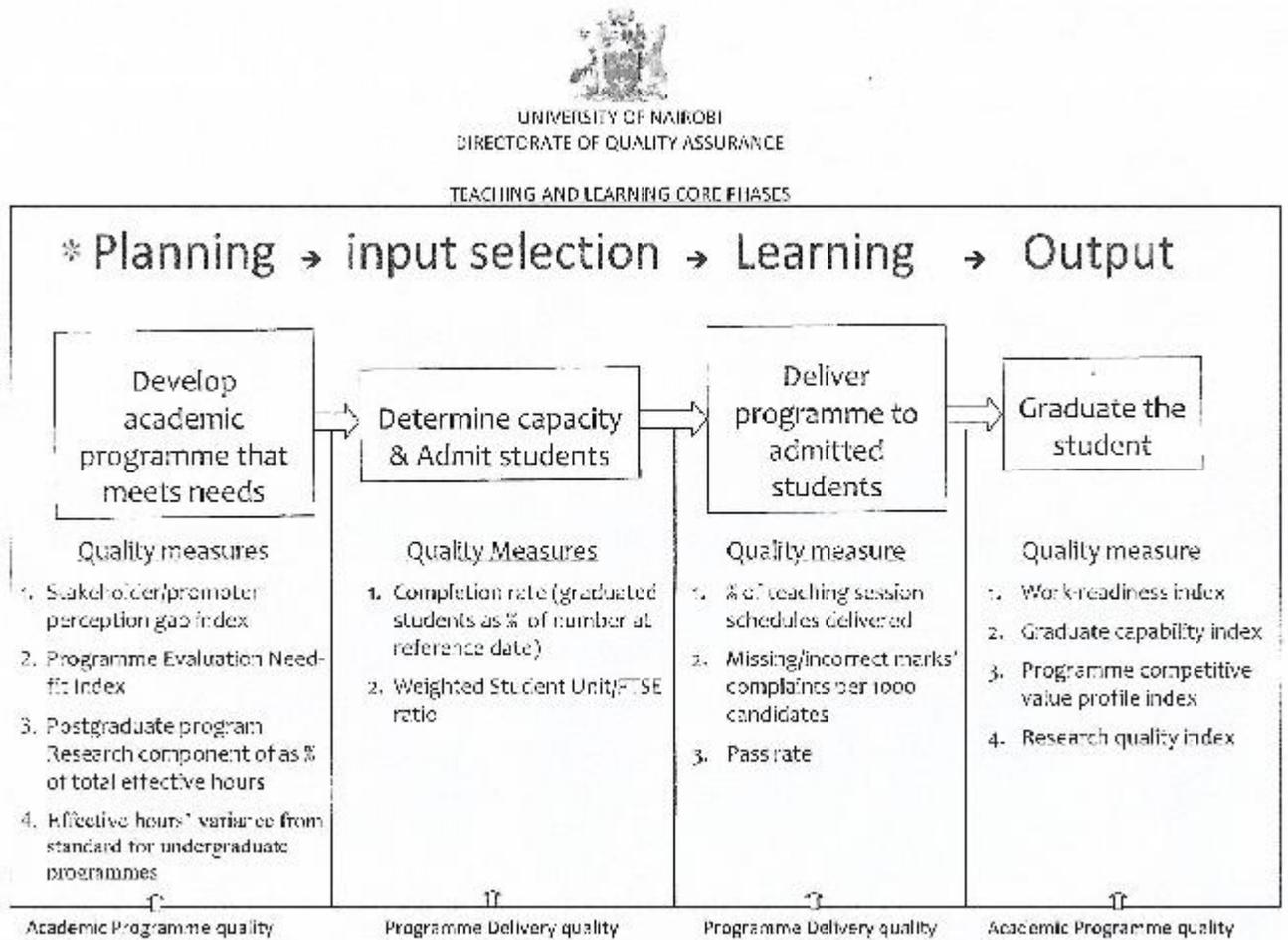
3.3.5 Availability of critical inputs essential for quality tertiary education training

The critical inputs for quality tertiary education training include infrastructure, qualified and motivated faculty and support staff, qualified and motivated students, competent administration and resources needed to facilitate learning. The profile of staff teaching the program was obtained and is provided in 3.3.5.1.

3.3.5.1 Staff teaching the program

All the five teaching staff respondents hold doctorate degrees and are male. Three staff members were between 40 and 49 years of age, one each was within the age bracket of 50 to 59 and above 60 years of age. The university is endowed with highly qualified and experienced teaching staff with 30% having 16 to 20 and 70% with over 20 years teaching experience. Considering the age distribution of the respondents, it is important to initiate training of a new generation of professionals and efforts made to ensure gender balance. Out of the 23 teaching staff in the host department, two are females and none is involved in teaching the program.

Figure 10: Schematic presentation of the current academic quality assurance plan for University of Nairobi



3.3.5.2 Infrastructure capacity of the university as assessed by students and lecturers

Both the students (43%) and teaching staff (83%) rated the lecture theatres as good (Table 8). In addition, half the teaching staff and students rated the laboratory facilities as fair, pointing to the need to improve the facilities further. There were mixed feelings regarding assessment of computer facilities with only 33% of staff and 14% of students rating them as good. 29% of the students rated the facilities as poor. The accommodation facilities remain a challenge with 28% of students and 17% of staff rating them as poor. To address the accommodation constraint, the local community is investing in real estate specifically targeting the students and to some extent, this is easing the problem.

Table 8: Infrastructure capacity of the university as assessed by students and lecturers

Infrastructure	Assessment by students					Assessment by teaching staff				
	Very Good %	Good %	Fair %	Poor %	Very Poor %	Very Good %	Good %	Fair %	Poor %	Very Poor %
Lecture Theatres	-	43	36	-	7	-	83	17	-	-
Laboratory	7	7	50	-	7	-	50	50	-	-
Computer Facilities	-	14	43	29	7	17	33	33	-	17
Internet Access	14	36	29	14	7	17	33	17	33	-
Library	14	57	21	-	-	14	57	29	-	-
Accommodation	7	14	21	21	7	-	33	50	17	-
Transport	-	-	-	-	-	-	50	33	17	-
Sports	-	14	29	14	7	-	57	29	14	-

-means no score awarded by respondents

Generally, the University of Nairobi has good facilities as required for quality tertiary education training but there is room for continued improvement especially the computer facilities, internet access, library and transport services.

3.3.6 Support for the program

The key stakeholders involved in supporting the program include universities, RUFORUM, students, outreach communities and employers. The teaching staff assessed whether stakeholders played their core

roles effectively and also made suggestions on how effectiveness could be enhanced. About 67% of the teaching staff indicated that all stakeholders played their role effectively while 33% indicated that some stakeholders did not play their roles effectively. The role of the host university was identified as coordination and training. Fifty percent of the teaching staff indicated that the university played her role effectively and can enhance effectiveness by improving the coordination committee and retooling lecturers. Considering that this is a new program and 80% of the staff encountered some challenges in the course of teaching, retooling of lecturers was considered important by 20% of the respondents.

The role of RUFORUM was seen as provision of funds, quality assurance and promoting networking. 17% of the teaching staff indicated that RUFORUM played her role effectively while 33% indicated that RUFORUM played her role only to some extent. The effectiveness of RUFORUM can be enhanced by timely release of funds as proposed by 40% of the respondents, being more proactive to improve networking, and supporting more short courses. Teaching staff identified the role of employers as to support students by granting them study leave and could enhance their effectiveness by partially funding students' research, following up their progress and releasing them on time to start studies. The assessment is summarized in table 9.

Table 9: Assessment by teaching staff of how effectively key stakeholders played their role

Partner	Key roles	Played role effectively		Ways to enhance effectiveness
		Yes (% respondent)	To some extent (% respondent)	
University	Coordination Training	50	-	Improve coordination committee Retooling lecturers
RUFORUM	Funding Ensuring quality and Promoting networking	17	33	Networking and support more short courses Timely disbursement of funds
Students	Learning Conduct research Timely completion of studies	17	33	Full time dedication to complete studies in three years
Outreach Communities	Facilitate learning	-	50	-

Employer	Provide study leave	17	17	Fund part of students research Follow up student progress Timely release of students
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3.3.7 Relevance of research being conducted

Research is being conducted in seven countries in the region namely, Kenya, Uganda, Sudan, Ethiopia, Zambia, Zimbabwe and Malawi. All the respondents are conducting research in the dryland ecosystems with a focus on major dryland tree species of medicinal value, those used as fodder and wild fruits. The findings should elucidate the important role of target plants and offer strategies for their enhanced sustainable production in support of dryland livelihoods. Further, research on medicinal plants used for pest control in animals will build on indigenous knowledge. This is of key importance considering that pastoralists occupy vast areas which are not efficiently served with veterinary services and have limited infrastructure support which is an impediment to access. Also bio-pesticides are environmentally friendly and may turn out to be more cost effective than the synthetic products. Further, drylands are home to pastoral communities and are also wildlife habitats. Because wildlife impinges on pastoral livestock production systems, wildlife-human conflicts are common. There is research being conducted with a focus on interactions with the pastoral communities and findings should provide deeper insights on wildlife-human conflicts, demystify issues and inform policy on strategies for sustainable dryland management for enhanced livelihoods. Other research activities being conducted are focusing on gender roles in the midst of changing land use. Generally, the applied research being conducted will contribute to sustainable resource management and enhanced livelihoods of communities living in the fragile and harsh dryland environments.

3.4 Results of running the regional training program

Running the program has borne multiple results including trained professionals, publications, enhanced networks and financial gains to the host university as detailed below.

1. A curriculum for PhD Dryland Resource Management by coursework and research was developed and the program has registered 47 students. As of April 2014, fourteen students had graduated with doctorate degrees and a further 8 are likely to graduate in 2014. The 47 students have gained discipline depth, acquired fundamental skills and enhanced their networks. The graduates have realized upward career mobility or moved to more lucrative jobs as detailed in appendix A2.

2. The study shows that 67% of the respondents who joined the program prior to 2013 have published some research findings. Six students have collectively published sixteen articles in peer reviewed journals which is evidence of the high quality research being conducted by the program. Details of the publications are provided in appendix A3. Considering that the requirement for graduation is publishing at least 2 articles, the number of publications will grow to about 100 and will enhance the profile of the university.
3. About 75% of the teaching staff registered direct benefits as a result of teaching the program, including publications in peer reviewed journals which ranged from 2 to 8 articles per staff. In addition, supervision of students featured as a benefit and the number of students supervised by each lecturer span from 2 to 4. Participation in international conferences was another benefit and it is important to note that members of staff had presented research findings in up to 5 conferences. Supervision of students and publication of research findings was reported by 33% and 67% of the teaching staff respectively and is bound to contribute to the upward career mobility of the staff. Another result was expanded networks as registered by 83% of the teaching staff.
4. Outcomes related to community-student interactions. As a result of the interactions between students and the communities, there is the potential of developing partnerships for innovation. The students appreciated the important role of indigenous knowledge of the pastoral communities including the ethno-veterinary practices of the communities especially use of traditional animal weight estimations and herbal concoctions made from local ingredients for treating various livestock diseases.
5. Running the program has also resulted in catalyzing desirable changes in the University where lecturers who taught the program are convinced that PhD by coursework and thesis is the best approach. The University of Nairobi is encouraging the move towards offering PhD by coursework and thesis because the students complete their studies faster and the program is more structured. The School of business is offering a PhD in Business by coursework and thesis, PhD in Climate Change has components of coursework, both the School of Journalism and School of Computing and Informatics are also introducing PhD by coursework and thesis.
6. The Dryland and Resource Management program attracted funding from USAID in support of Center for Sustainable Drylands Ecosystems and Societies (CSDDES). The grant supports students research, student exchange, seminars and short courses in addition to catering for faculty research. The grant also supports a student-led conference which is held annually and has been taking place for the last

two years. This is a forum where students from different universities and at Bachelors, Masters and PhD levels participate and it enhances sharing, learning and development of communication skills. Faculty also participates as observers and offer guidance. The grant was in partnership with Colorado State University, RUFORUM, Dares Salaam University, AU-IBAR and ILRI. The grant comes to an end in 2014 and the University of Nairobi is restructuring the CSDES to in build sustainability element in addition to seeking for a renewal.

3.5. Overall Assessment, Issues and Conclusions

There is demand for the program; to date 47 students from eight countries in Eastern, Central, West and Southern Africa have been trained. However, enrollment has declined from a high of 18 students from eight countries in the first cohort to the current two from Kenya and Nigeria in the 5th cohort. Not all admissible applicants have been trained and the decline is mainly attributed to unavailability of scholarships. Similarly, graduation rate has gone down. The three year duration to undertake PhD studies is ambitious but with the first cohort, the program graduated 50% of the students in exactly 36 months. With the 2nd cohort only one of the eight students graduated in the third year. To date, the program has graduated 14 students and a further 8 are likely to graduate in 2014. Five students from the 1st and 2nd cohorts are still conducting research and consequently the program has 5 cohorts in the pipeline. In the 1st cohort students had scholarships but in subsequent ones some students are self sponsored and working on part-time basis. There is an indication that self-sponsored students who are working on part-time basis are devoting less time to studies and this is delaying completion. Further, other students have completed research but are unable to raise funds to cater for publisher fees for articles submitted yet publication in peer-reviewed journal is a requirement for graduation. When students conduct research in home countries, there is less interaction with supervisors and this could mean limited guidance in some cases. Nevertheless, some students who are on full scholarship are lagging behind. Short completion time was identified as a unique attribute of the program and delays may compromise its attractiveness. The number of PhD students being supervised by individual staff was reported as 2-4 and considering that the department offers other postgraduate programs there could be an element of overload on part of the lecturers. The low graduation rate is alarming and there is need for closer monitoring to reverse the trend.

The program is attracting civil servants of diverse ages and majority are within 40-49 years of age and are principally training to acquire discipline depth and skills needed in current positions, for upward career mobility and for enhanced career opportunities. This is a clear indication that the program is addressing real

needs. Further, the curriculum was rated as adequate in content and depth and a range of teaching approaches are being employed in delivery of the program. Relevance, high quality of training and expanded career opportunities are key to attractiveness of training programs and this should contribute to the success and sustainability of the program. The most important attributes of the program were singled out as the coursework and thesis approach, short three years duration to complete studies, regional aspect, wide access base and credibility of the host institution. It is important that these aspects are maintained.

The program is contributing to building the human resource in the region and the graduates are equipped with discipline knowledge, fundamental skills and are in high demand by the industry. A sample of 10 graduates of the program reveal that the professionals have been promoted to positions of greater responsibility or moved to more promising careers and those who were unemployed have found employment. The graduates have been absorbed in the public service and details of their placement are provided in appendix A2. Further, reports from employers (Universities, Ministry of Agriculture and Livestock, Private sector and National Research Institutes) attest to the graduates being equipped with discipline depth and fundamental skills, exude confidence, and are able to articulate issues in a cohesive manner. Skills singled out by employers include communication, including report writing and presentation. The graduates also exhibit knowledge in relevant policies, have a holistic view of issues, leadership and team building skills. In addition, implementation of the program has had positive influence in the way the university does business and there is a push towards offering PhD by coursework and thesis. Further, wide use of modern approaches to facilitate learning, including Information Communication Technology is also evident. The study has observed progress in ensuring academic quality assurance measures are in place and a Directorate of Academic Quality Assurance has been established. Bench marking of programs is in progress and the university has developed a framework for monitoring research outputs and also has plans to undertake a tracer study.

The research being conducted is addressing challenges facing the region and is being done in the dryland ecosystems with a focus on major dryland tree species of medicinal value, those used as fodder, and wild fruits. Further research is targeting interactions with pastoral communities and the findings should provide deeper insights on the human-wildlife conflicts and inform policy on strategies for sustainable dryland management for enhance livelihoods. Generally, the applied research being conducted will contribute to enhance livelihoods of communities living in the fragile and harsh environments and sustainable management of resources.

The program has received support from key stakeholders but would benefit from further support. The lecturers encountered challenges in the course of teaching, including limited contextualization of learning materials. Re-orienting the teaching staff through short courses would be a means of according support to the program. Further, the program engages guest speakers without offering any payments or facilitation. Putting in place mechanisms to support staff mobility for joint-teaching would also boost the program. In addition, the program has been running for five years and is due for review. Support to review the curriculum to incorporate emerging issues and also scale down some details to create time for practical learning would add value to the program. The program is encountering financial challenges and this is partly contributing to reduced enrollment and also compromising delivery. Also, due to financial constraints students are working on part-time basis, devoting less time to studies and this is delaying completion.

The program has produced 14 theses, publications in peer-reviewed journals and scientists have participated in scientific forums. Whereas information has been shared with scientific community, there is no evidence that the same has been packaged and disseminated to policy makers and non-scientific users. Further, there are indications from stakeholders that the knowledge generated by the program and universities in general does not reach all end users especially policy makers and at times the journals in which the findings are published have a limited following. Noting that most students trained are in the Ministry of Agriculture and Livestock, inclusion of agriculture communication in the curriculum may contribute to packaging information for non-scientific audiences. The gap in information dissemination needs to be addressed. The following conclusions can be drawn from the study:

1. The program is imparting discipline depth and fundamental skills as expressed by the students but to enhance learning further, ***it is recommended that the program maintains a balance between theoretical and practical components in the timetable, ensures that experiential learning perspectives are incorporated and supported with necessary financial allocation.***
2. The program has been running for five years. ***It is recommended that the curriculum be reviewed and emerging issues such as risk and uncertainty management, agricultural communication especially to non-scientific audiences be included and depth of coverage scaled down to create more time for hands on activities as was also recommended by teaching staff.*** Further, the university has good facilities as required for quality tertiary education but there is room for continued improvement especially in computer facilities, internet access, library facilities and transport services. ***It is recommended that computer facilities, internet access, library and transport services be enhanced further.***

3. The university is well endowed with highly qualified and experienced teaching staff but considering the age distribution of the respondents, ***it is recommended that plans be put in place to train a new generation of professionals and also retool existing staff.***
4. There is demand for the program but enrollment has declined over the years partly due to financial constraints faced by students. ***To increase enrollment it is recommended that aggressive fund raising campaigns be mounted especially to cater for scholarships and to support mobility of staff from the region and elsewhere and also some courses be offered online.***

4: PHD FOOD SCIENCE AND NUTRITION PROGRAM

4.1 Background and Program design

The program is hosted by Jomo Kenyatta University of Agriculture and Technology (JKUAT) in the Department of Food Science and Technology. In Sub Saharan Africa, food security and nutrition are important areas of concern due to increased incidences of nutrition and food borne related diseases and prevalence of famine. The Food Science and Nutrition program aims to strengthen capacity to address nutritional and food science related challenges and it targets persons involved in planning and policy implementation of nutrition programs and scientists in research, teaching institutions and Non-Governmental Organizations. It is pegged on the premise that investment in nutrition is investment in human capital and thereby economic development.

This is a three year program by coursework and thesis but students can be registered for up to four years. The coursework is done in two semesters during the first year. It consists of ten units made up of five compulsory core units, two units from ones specific area of specialization and one unit from each of the three categories of elective units. Two of the elective units can be taken at any RUFORUM member university and cost borne by RUFORUM secretariat, provided the units will have been approved by JKUAT senate as equivalent to those offered at JKUAT. The student can opt to specialize in food science, nutrition or social science. Students sit for examinations at the end of each semester and they must pass all courses before proceeding to undertake research component of the study. The university engages external examiners as a quality assurance measure.

The research component of the study is done during the second and third year and leads to the development of a thesis. This second phase is examined through a written thesis and oral presentation. The thesis is examined by two internal and one external examiner. The curriculum for PhD Food Science and Nutrition was developed by key stakeholders and approved at both departmental and faculty levels. The JKUAT senate approved the program in 2007.

4.2 Implementation progress and demand

Although JKUAT senate approved the program in 2007, there was a lag in implementation due to lack of funds. In 2013 and through the Intervention of RUFORUM, the program received financial support from the German Academic Exchange Service (DAAD). Various channels were used to advertise the program and in 2013, a total of fourteen applicants from Kenya, Uganda, Northern Sudan, Malawi, Ethiopia and

Democratic Republic of Congo were received (Table 10). Twelve applicants met the admission requirements but, due to financial constraints, only seven registered for the program in 2013. Most of the applicants were females and are also the majority (83%) of registered students. The students are drawn from Kenya, Northern Sudan, Ethiopia and Uganda. The three non-Kenyan students have full sponsorship from DAAD. In addition, Karatina University and Masinde Muliro University in Kenya are sponsoring one student each and the rest are self sponsored. The female student from Northern Sudan encountered language barrier and after failing two units, she quietly discontinued studies, although she was eligible to take supplementary examinations. The students sat for 2nd semester examinations in April 2014 and they have embarked on proposal development.

Table 10: Applicants and students registered in PhD Food Science and Nutrition as of April 2014.

Countries of applicants	No. of applicants	Gender of applicants		Admitted applicants		Registered Students		
		Male	Female	Male	Female	Male	Female	Total
Kenya	7	2	5	2	4	0	4	4
Ethiopia	1	1	0	1	0	1	0	1
Malawi	1	0	1	0	1	0	0	0
Northern Sudan	3	1	2	1	1	0	1	1*
Uganda	1	0	1	0	1	0	1	1
Democratic Republic of Congo	1	0	1	0	1	0	0	0
Total	14	4	10	4	8	1	6	7
*Student absconded studies after 1 st semester								

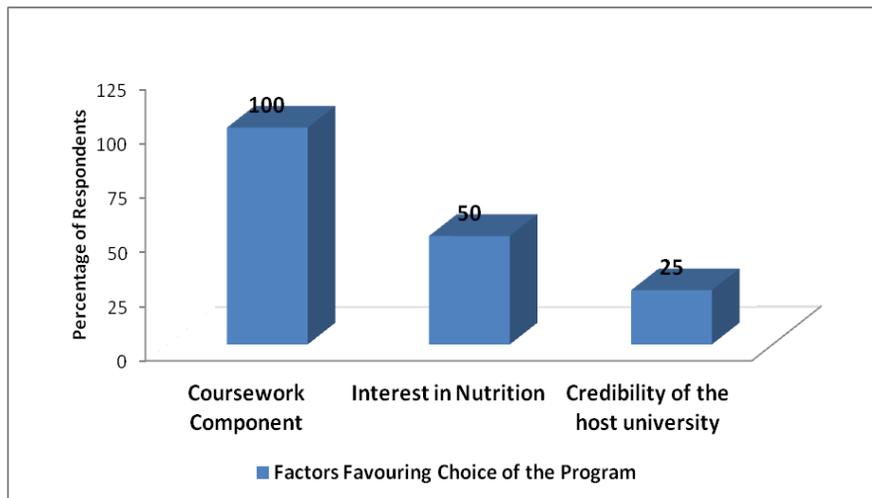
4.2.1 Characteristics of students enrolled in the program

The questionnaire was administered to all students registered for the program and of the four who responded, three are females. Respondents represent 83% of the total students registered. Two students are within the age bracket of 30 to 39 years and the others are between 40 and 49 years. The students have relevant education backgrounds at Bachelors degree level and at Masters' degree, they specialized in food science, food nutrition and dietetics or food engineering. The Masters degrees were obtained from four universities namely, Addis Ababa University, Karahne University, Kenyatta University and Makerere University. This reflects a wide regional aspect of educational background. Prior to enrolling for the program, all respondents were serving in the public sector. One student worked in the Ministry of Agriculture while the other three are university employees at tutorial, assistant lecturer or lecturer level. Three students were granted study leave to enable them pursue studies, an indication of strong support from employers. One student works on part-time basis to raise finances to cater for tuition.

4.2.2 Factors favoring enrollment in the Program

All the students singled out the coursework component as the most important factor which influenced their choice of the program. This reflects demand for discipline depth especially for students who are employees of tertiary training institutions because it will enhance their teaching as well as research quality. Students also identified the credibility of the host university as an important factor. Interest in nutrition was also cited by 50% of the respondents as shown in figure 11.

Figure 11: Factors favoring enrollment in Food Science and Nutrition program

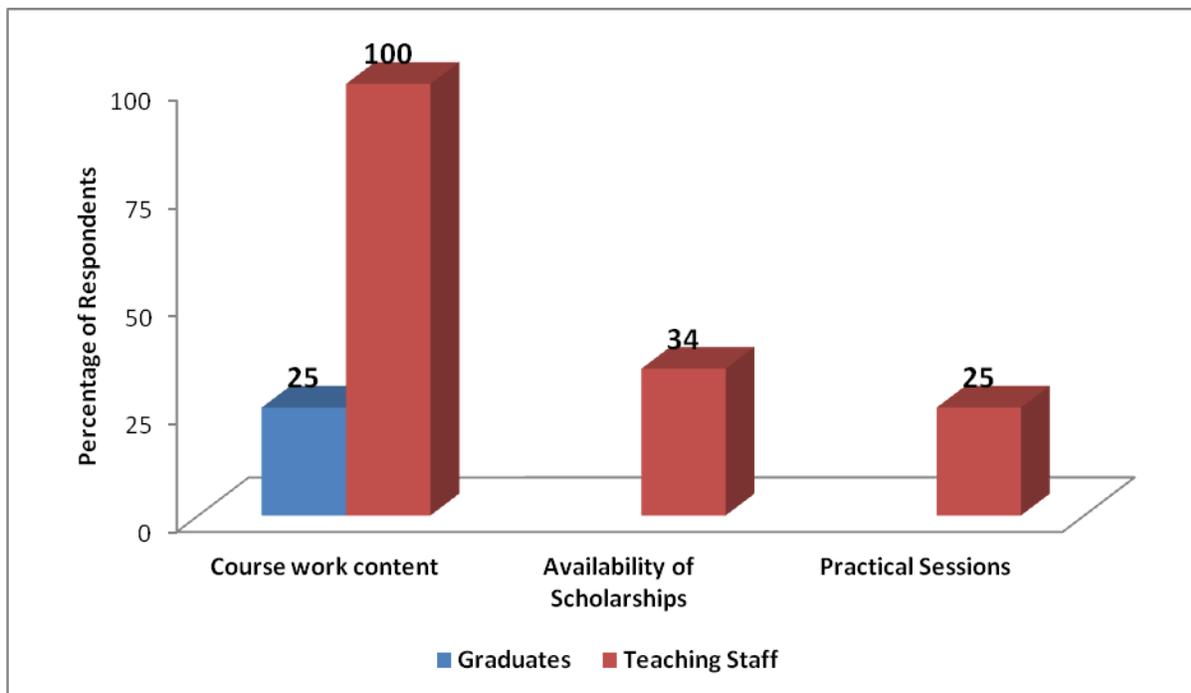


4.3 Factors ensuring success and sustainability of the regional program

4.3.1 Unique attributes of the program

The Food Science and Nutrition program is new and both students and the four teaching staff respondents identified its unique attributes. The student (only one responded to this question) and all the teaching staff singled out the coursework component as the most important and outstanding attribute which make the program stand out from other PhD programs in Food Science and Nutrition. In addition, availability of scholarships and practical component of the program were cited by teaching staff as shown in figure 12.

Figure 12: Unique attributes of the Food Science and Nutrition Program, as identified by student and teaching staff



4.3.2 Curriculum and delivery

4.3.2.1 Curriculum content

Both the students and teaching staff assessed the curriculum with regard to content and depth. All the students and majority (75%) of teaching staff rated the program as adequate in content. Although this is the first year of program implementation, teaching staff (25%) recommended incorporation of courses in nutritional assessment, nutritional epidemiology and nutritional research. In addition, all teaching staff and students rated the curriculum as adequate in depth. Overall, the curriculum design met the expectations of

the students and they rated it as relevant to their professions to a great extent or to a very great extent. The findings suggest that the design of the curriculum is aligned to the students' professions.

4.3.2.2 Curriculum delivery

The program was also assessed with regard to balance between theoretical, laboratory based hands on activities, field exposure and industrial attachment components. The program relied on lectures, seminars, individual assignments and practicals as the core teaching approaches. Most students (75%) reported sufficient emphasis on laboratory based aspects while 25% recommended more hands on exercises. The limited laboratory activities was also reported by teaching staff who confirmed that for some units, practical components are neither in the curriculum nor in the time-table. Further, 75% of the students indicated that there was insufficient field exposure to cater for links with the industry, a point also raised by a similar proportion of teaching staff. Insufficient field exposure was attributed to limited funding. Only 25% of the teaching staff assessed field exposure as sufficient. Further, the program does not require students to be attached to other institutions during coursework. Important to note is that this is the first year of program implementation and the students reported lack of sufficient emphasis in developing communication skills. Overall assessment shows that 25, 50 and 25% of the students rated the mode of delivery as fair, good and very good respectively.

The program has been running for two semesters and already the students feel better prepared to play their role in the market place. Discipline depth in food safety (especially toxic effects and food bio-safety), metabolism of nutrients and role of nutrients in immunity were singled out as the most important aspects which would contribute to better performance in the market place. No student singled out communication, managerial, research or entrepreneurial skills as having been imparted. Food Science and Nutrition curriculum is rich in discipline depth but has not incorporated courses deemed essential to impart skills and competencies perceived as lacking in past graduates in agriculture and related disciplines.

The curriculum scope needs to be expanded to incorporate courses essential for development of core skill sets especially; entrepreneurship and business management, leadership, participatory approaches and communication for scientific as well as non-scientific audience. Further, the curriculum needs to place more emphasis on hands on activities, currently only two courses (experimental design and statistics II and advanced chemical analysis) have explicit emphasis on practical components. The curriculum does mention seminars as a means to assess the students but there should be more emphasis on developing

communication skills. Delivery relied heavily on lectures and there is need to exploit more learning approaches including group work, hands on activities, interaction with guest speakers and field exposure.

4.3.3 Academic Quality Assurance

The University has a Directorate of Academic Quality Assurance which was established in 2008 and falls under the office of the Vice Chancellor. DAQA is fully staffed and has the mandate to monitor the quality of teaching administered to the students by lecturers and the university at large. The directorate is in the process of bench marking the programs offered by JKUAT. Postgraduate programs are developed by host departments with inputs from stakeholders. The programs are then approved at departmental and faculty levels and also by JKUAT senate. DAQA validates new programs to ensure they are in line with JKUAT academic quality assurance regulations. Further, DAQA takes audits to ensure appropriate inputs are in place. To join postgraduate programs, applicants must have relevant academic background and credentials issued by an accredited institution. The university has credit accumulation and transfer system in place and students can ask for exception of up to 25% of courses taken at a university approved by JKUAT senate. Admission is coordinated by BPS. Further, JKUAT has 33 programs offered at 15 university-approved centers, some at postgraduate level. DAQA undertakes annual audits in these institutions to ensure that appropriate inputs are in place. In addition, DAQA monitors quality of teaching at delivery points and also facilitates students' assessment of teaching effectiveness which is done by administering pre-formatted questionnaires to students on semester basis. DAQA is also involved in developing quality measure policies specifically targeting postgraduate training for BPS to implement. Example, the office is in the process of giving guidance on the number of students an individual lecturer can supervise. Currently, there is no limit and the directorate is consulting with different departments for bench marking. In addition, the office oversees students' welfare to ensure that students complete studies without unnecessary delays. The office is also involved in monitoring research done by university staff. Generally, Self evaluation systems are in place and are being applied. However, the harmonized grading systems and external evaluation systems proposed by RUFORUM are not in place.

4.3.4 Availability of critical inputs for tertiary education training

The critical inputs for tertiary education training include infrastructure, qualified and motivated faculty and support staff, qualified and motivated students, competent administration and resources needed to facilitate learning. The profiles of the staff involved in teaching the program were obtained and results are summarized in 4.3.4.1

4.3.4.1 Staff teaching the program

The four teaching staff respondents are holders of doctorate degrees coupled with long teaching experience which span from 6 to 20 years. All the respondents are males. One of the teaching staff was within the age bracket of 30 to 39 years, two were aged between 40 and 49 while another was within 50 to 59 age bracket. Thus, the university has qualified and experienced teaching staff.

4.3.4.2 Infrastructure capacity of the university

Both the students and teaching staff assessed the infrastructure facilities of the university and results are summarized in table 11. Only 25% of the students indicated that the lecture theatres are in good condition while a similar proportion rated them as being in very poor condition. Some teaching staff (25%) also rated lecture theatres as poor, pointing to the need to refurbish the facilities. Both the students and lecturers rated laboratory facilities as good. The computer facilities, internet access and library facilities were rated fair by most respondents. Some teaching staff (50%) indicated that transport facilities are poor. Generally, JKUAT has fairly good infrastructure and facilities required for quality tertiary education training but there is need for further enhancement, particularly the lecture theatres, internet access, computer facilities, transport and library services.

Table 11: Infrastructure capacity of the university as assessed by students and teaching staff

Infrastructure	Assessment by students					Assessment by teaching staff				
	Very Good %	Good %	Fair %	Poor %	Very Poor %	Very Good %	Good %	Fair %	Poor %	Very Poor %
Lecture theatres	-	25	-	-	25	-	-	75	25	-
Laboratory	25	25	-	-	-	-	75	25	-	-
Computer facilities	-	25	25	25	-	-	-	75	25	-
Internet access	-	25	25	-	-	-	50	50	-	-
Library	-	25	-	-	-	-	50	50	-	-
Accommodation	-	25	25	-	-	-	-	-	-	50
Transport	-	-	-	-	-	-	25	-	25	25
Sports	-	25	25	-	-	-	-	-	-	-

- means no score awarded

4.3.5 Support for the program

Several key actors support the running of the program. The teaching staff made an assessment of how effectively these actors play their core roles and also made suggestions on how effectiveness could be enhanced. About 75% of the teaching staff indicated that some stakeholders did not play their roles effectively while others did play their roles effectively. The core roles of the university were singled out as teaching and hosting the program and only half the teaching staff indicated that JKUAT played her role effectively. There is a misconception among teaching staff that RUFORUM is a donor as reported by 50% of the respondents. Consequently, half the teaching staff felt that RUFORUM did not play her role effectively while one indicated that RUFORUM played her role only to some extent. The overall assessment is summarized in table 12.

Table 12: Assessment of how effectively key stakeholders played their roles in support of the program

Stakeholder	Key roles	Effectiveness			Ways to enhance Effectiveness
		Played role effectively	Played role to some extent	Did not play role effectively	
University	Hosting program and teaching	50%	25%	-	Support infrastructure development
RUFORUM	Funding	-	25%	50%	Support infrastructure and staff development
Students	Attending training and conducting research	75 %	-	-	Devote more time to studies
Outreach	Setting training goals	-	25	25	-
Employer		-	-	-	-

- Means no score awarded

Overall, all teaching staff felt that the program has not been accorded the support it requires and recommended that more funds be availed to cater for scholarships especially for students from the host country, enhancing infrastructure (especially lecture theatres) and support purchase of delivery tools such as laptops and projectors. Only JKUAT lecturers are involved in teaching the program and students floated the option of inviting guest speakers from other universities to participate in the teaching.

4. 4 Challenges encountered during implementation

Majority of the students (75%) did not encounter major challenges while undertaking studies. A few had issues of language limitation which was a challenge to the teaching staff. Shortage of lecture theatres was

noted as a challenge and respondents suggested that specific lecture halls and working cubicles be allocated to PhD students. Financial constraints were encountered and this limited hands on and field exposure components of the program. In addition, 42% of the admitted applicants did not register for the program due to lack of finances.

4.5 Overall Assessment, Issues and Conclusions

The program is in initial stages of implementation and the students were taking 2nd semester examinations during the visit made in April 2014. Implementation is on course with six students from three countries registered in the first cohort of 2013/2014 academic year. Most of the students trained are females. Demand for the program exists but many applicants (42%) who met admission requirements did not register due to financial constraints. The curriculum is well detailed in discipline depth, including emerging issues, places some emphasis on developing technical laboratory skills but non with regard to linking with the industry or the communities. The training is providing discipline depth but not equipping students with soft skills perceived as lacking in past PhD graduates of agriculture and related fields, especially managerial capacity, entrepreneurial skills. Although there is a course on experimental design and statistical methods, the curriculum is silent in enhancing proposal development skills in general. The university has self evaluation system in place with emphasis on monitoring quality of program, inputs, some elements of outputs, has provision for credit accumulation and transfer but the harmonized grading and external evaluation system of teaching is not in place. Further, JKUAT has qualified and experience teaching staff and some good infrastructure with the need to further enhance lecture theatres, internet access, transport facilities and library services. The program needs support to review the curriculum and finances to cater for practical learning and support staff mobility from other institutions in the region and beyond. The following conclusions can be drawn from the study:

1. The PhD Food Science and Nutrition curriculum is well detailed in technical content but lacking in equipping the students with appropriate soft skills and competencies. ***It is recommended that the curriculum be reviewed to ensure that it also incorporates courses with a focus on communication, entrepreneurship, management, leadership, team work, field exposure and more hands on activities and also diversify learning approaches.***
2. The University has highly qualified and experienced staff and some good infrastructure which has continued to be enhanced. ***To enhance learning further, it is recommended that lecture theatres, transport and internet access be improved.***

3. This is the first cohort, it has good regional representation but the student population is relatively low. It is ***recommended that aggressive fund raising campaigns be mounted so as to offer financial support to qualified applicants and boost both enrollment and regional representation and also support mobility of teaching staff.***

5: PHD AGRICULTURAL AND RURAL INNOVATION

5.1 Background and Program design

Three universities in East Africa namely; Makerere University, Egerton University and Sokoine University of Agriculture in partnership with two European Universities (Wageningen University in the Netherlands and Montpellier SupAgro in France) are jointly implementing PhD in Agricultural and Rural Innovation (ARI) program. New knowledge and technologies are the key drivers of agricultural and rural development. To bring about social and economic benefits to the people involved, institutional arrangements are needed- that allows the utilization of knowledge and technologies from diverse sources in a coordinated and integrated way. The region is deficient of human resource capacity to appropriately design, implement and manage integrated interventions to address the complex problems of agricultural and rural development. The program aims to produce high level professionals with integrated thinking and skills required to provide guidance in innovative and integrated agricultural and rural development (ARD) at national and regional levels. The consortium of universities targets strengthening the capacity of the three East African Universities to develop this level of human resource in the Eastern, Central and Southern Africa. The ARI program is pursuing the model of distributed institutional capacity building among the three East African partner universities. The long-term goal is for the three universities to gain capacity to implement the program in a manner that responds to their respective national development needs as well as regional development agendas in the areas of agriculture and rural development.

The PhD is by coursework and research with cohorts of students admitted by the three universities. Each of the three universities is expected to admit up to ten students each year. A cohort (of up to 30 students) takes part of coursework in a central place in one of the three universities (so far this has been at Makerere University) for purposes of sharing capacity and quality assurance. The European partner universities are providing lead resource persons in some courses and are paired with African partners as a capacity development strategy. The program duration is 3-4 academic years with the first year being devoted to coursework and consists of a minimum of 18 credit units and also includes research proposal development. Students are required to take all the core courses plus at least two elective courses. Coursework is assessed on the basis of written university examination and continuous assessments. The program has provision for transfer of credit units from other recognized universities through the due process. Upon successful completion of coursework students embark on research in their home countries. Research leads to development of a dissertation which carries credit range of 8-10 units and is defended orally. During the

research period, students come together as a cohort for up to two weeks to share experiences and preliminary findings and also to participate in seminars. The process of developing the program was highly consultative and iterative and it involved key stakeholders relevant to national and regional needs. The European partners also contributed to the process. The program development was completed in 2010 and is hosted in the Department of Agricultural Extension/Education in Makerere University and the Departments of Agricultural Education and Extension in Egerton University and SUA.

6: PHD AGRICULTURAL AND RURAL INNOVATION PROGRAM HOSTED BY EGERTON UNIVERSITY

6.1 Implementation progress and demand

The program was approved by Egerton University senate in 2010 but implementation started two years later. In 2012, a total of 12 applications were received from Kenyan citizens. Nine students consisting of seven females and two males registered for the program in August 2012. The following year, nine applications were received and five applicants enrolled in September 2013. One student in the second cohort is Ugandan while the rest are Kenyans. Thus, currently a total of fourteen students consisting of eleven females and three males are registered for the program. The details of the enrolled students and their academic progress are provided in table 13. The university had hoped to secure funds to support students in the first cohort but this did not materialize and the students had to seek alternative sources of funding. It is encouraging to note that even in the absence of financial support, students are financing their studies. It is evident that there is demand for the program and the university plans to enhance publicity so as to attract more applicants. Past students learnt of the program through word of mouth, advertisements in the daily newspapers and proactive means by visiting the university to enquire about training opportunities with a focus on rural innovations. This shows that the students were seeking to enhance their knowledge and skills in the realm of Agricultural and Rural Innovation.

Table 13: Students Registered in PhD Agricultural and Rural Innovation, as of May 2014

Cohort /year of enrollment	Total applicants	Registered students	Gender of students		Students countries of origin	Students progress
			Male	Female		
1 st cohort/ August 2012	12	9	2	7	Kenya	2 doing research, 1 has submitted proposal, 6 developing proposals
2 nd cohort/ September 2013	9	5	1	4	Kenya, Uganda	Doing 2 nd semester of coursework
<i>Total</i>	<i>21</i>	<i>14</i>	<i>3</i>	<i>11</i>	-	-

6.1.2 Characteristics of students enrolled in the program

Although the questionnaire was sent to all 14 students registered, only 22% (one female and two males) responded. One student was within the age bracket of 30 to 39 years while two were aged between 40 and 49 years. At undergraduate level, the students' academic background was either in agricultural education and extension or horticulture. In addition, the students had specialized in agricultural education and extension or crop protection at Masters degree level. Prior to registering for the program, all the respondents were in full time employment with the Ministry of Education, Private sector (Kenya National Farmers Federation (KENAFF) or Sandra Rotman Centre of University of Toronto as a research consultant. One of the respondents resigned from employment to pursue studies while two made local arrangements with the employer and juggled both work and studies.

6.1.3 Factors favoring enrollment in the Program

The students identified key factors which influenced them to register for the program and these are summarized in table 14. All students indicated that the program is relevant to their careers and it addressed knowledge and skill gaps. Thus, it was seen to impart essential skills demanded by current positions and also to pave way for upward career mobility. The skills were also seen as a bridge to enhance effectiveness in agriculture information diffusion to the end users as stated in Box 1 below.

Box 1: Why did you join ARI program?

"We were implementing a 12 year World Bank supported project under Kenya Agriculture Productivity Agribusiness with a focus on multi-stakeholder processes and value chain development for the empowerment of farmers. We needed knowledge and skills in action research".

Response from a student working with Kenya National Farmers Federation, an umbrella organization of farmers in Kenya which represents the interest of about 2 million farm families. General Manager Resource Mobilization

In addition, coursework component is important as it equips the students with discipline depth, including existing knowledge in intellectual property rights. Also the fact that the program is offered within the region was core as it offered an opportunity to undertake studies at relatively lower cost when compared to training overseas, raise funds to cater for tuition as one continued with studies and being mature students, they could also attend to family responsibilities.

Table 14: Factors which influenced enrollment in PhD, Agricultural and Rural Innovation program

Factors	Frequency	Percent
Relevant curriculum and addressed core skill gaps in current job	3	100
Coursework component	2	66.7
Needed to move up the career ladder	1	33.3
Program offered in local universities	1	33.3

6.2 Factors ensuring success and sustainability of the regional program

6.2.1 Unique attributes of the program

All the teaching staff and students pointed out that the program is unique in the approach of PhD by coursework and research. The element of action research was also singled out by both students and teaching staff. Other unique attributes identified were the emphasis on proposal writing, seminars, practical aspect and the regional approach of the program as detailed in table 15.

Table 15: Unique attributes of PhD Agricultural and Rural Innovation program

Unique attribute	Assessment by students		Assessment by teaching staff	
	Frequency	Percent	Frequency	Percent
Coursework	3	100	2	100
Research component stands out	1	33.3	2	100
Seminars	1	33.3	-	-
Practical/experience in action research	2	67	1	50
Regional approach	1	33.3	1	50
Proposal writing	1	33.3	2	100

- means teaching staff did not identify the specific attribute

6.2.2 Curriculum and delivery

6.2.2.1 Curriculum content

Both the teaching staff and all students assessed the curriculum content and depth as adequate. It was recommended that intellectual property rights be incorporated in the curriculum. Overall, the curriculum was rated as relevant to students' professions either to a great extent or to a very great extent.

6.2.2.2 Delivery

The program relied on lectures, seminars, group discussions, independent reading, field activities and assignments as the core learning approaches. Due to financial constraint, only one guest lecturer from the Kenya Agriculture Research Institute was involved in teaching the first cohort and the rest of the training was handled by Egerton University staff. As attested by both the students and teaching staff, there was little emphasis on practical aspects and field activities which was attributed to lack of appropriate sites and relevant on-going activities during the coursework period and inadequate funds to facilitate travel. The first cohort did not have joint learning experience with students registered at Makerere University because the semester dates of the two universities were not synchronized. SUA did not have an intake in 2012. With the second cohort, joint learning took place at Makerere University and e-learning platform was also utilized for quantitative research unit. The overall assessment of the program in terms of mode of delivery was rated as good by all students. Nevertheless, the program needs to adhere to the curriculum to ensure that appropriate skills and competences are imparted to the students.

Suggestions put forward to improve delivery include having a structural break during the first year to enable students engage with agricultural communities and other stakeholders, to focus more on enhancing writing skills, more field work and also engage professionals who have firsthand experience in action research. As stated in the curriculum, it is recognized that the innovations systems thinking is relatively new and not universally understood. The need to retool resource persons was identified as part of the institutional capacity building. The areas singled out for retooling include innovation systems thinking, supervision, mentoring and managing effective student/staff relationship (including management of gender and multi-cultural diversity). Retooling was either not done or it was not given sufficient emphasis and the students recommended that teaching staff be trained in relevant areas. In addition, all the students recommended use of African examples in the modules, calling for the need to contextualize learning materials.

Nevertheless, the graduates feel better prepared to play their roles in the market place as discipline depth and critical skills were imparted. The most important skills imparted were singled out as communication and research skills especially value chain analysis, action research, innovation brokerage and processes of agricultural innovations. Details of the skills are provided in table 16. Knowledge in discipline depth especially innovation brokerage and processes of agricultural innovations was also acquired as reported by 67% of the students.

Table 16: Most important skills imparted as identified by PhD Agricultural and Rural Innovation students

Skills	Percentage of respondents
Communication Presentation Reflective reading	100
Research Use of PRA tools Value chain analysis Processes of agricultural innovations Action research	100

The approved ARI curriculum is rich in technical component and also places great emphasis on developing communication skills, ranging from inculcating reading culture, writing and oral presentations. Field excursions/practical components and opportunities to enhance team building skills, qualitative and quantitative research approaches are also included in the curriculum. In addition, general learning techniques are well outlined in the curriculum and they include: face-to-face interactions, group discussions, assignments, guest lecturers/seminars, field excursions, practicals, self-learning through independent reading and also through e-learning platform. The curriculum does emphasis that ARI is a field work based program.

6.2.3 Academic Quality Assurance

The university has a Directorate of Academic Quality Assurance and quality assurance policy is also in place. The quality officers were trained by Inter University Council for East Africa following which the

directorate developed a self assessment manual and a framework for external evaluation. The directorate is charged with monitoring the quality of teaching and research. Self assessment of programs is handled by a team involving key stakeholders. The directorate is also responsible for monitoring inputs, delivery and outputs. Bench marking of the programs offered by Egerton University is in progress and for the Regional PhD Agricultural and Rural Innovation program the harmonized grading system and credit accumulation transfer system proposed by RUFORUM are in place. Generally self evaluation systems exist. Day to day monitoring of the quality of postgraduate training is handled by BPS who coordinate admissions, look into students' welfare and handle the processing of theses - which are examined by two internal and one external examiner. The directorate has a challenge with staffing because quality officers are also involved in teaching.

6.2.4 Availability of critical inputs for tertiary education training

The critical inputs for tertiary education training include infrastructure, qualified and motivated faculty and support staff, qualified and motivated students, competent administration and resources needed to facilitate learning. The staff involved in teaching the course and students assessed the capacity of the university with regard to key infrastructure and facilities and results are summarized in 6.2.4.1.

6.2.4.1 Infrastructure capacity of the university

There were mixed feeling regarding assessment of lecture theatres with about 33% of the students rating them as very poor and a further 67% rating them as either good or fair. However, the teaching staff rated lecture theatres as generally good or very good. Perhaps the issue lies with those facilities allocated to the PhD students and needs to be looked into. Generally, the computer facilities and internet access were perceived as poor by all and 50% of teaching staff, respectively. Similarly, majority (67%) of the students rated internet access as very poor. Important to note is that not all wings of the Department of Agricultural Education and Extension block, including PhD students wings, lecture theatres and offices have internet access. Nevertheless the video conference centre has good connectivity and is fully utilized. The library facility has access to TEAL but generally has limited capacity even in terms of sitting space and was rated as fair or poor by the students while teaching staff rated them as either good or fair. Details of the assessment are provided in table 17.

Table 17: Infrastructure capacity of the university as assessed by students and teaching staff

Infrastructure	Assessment by students					Assessment by teaching staff				
	Very Good %	Good %	Fair %	Poor %	Very Poor %	Very Good %	Good %	Fair %	Poor %	Very Poor %
Lecture theatres	-	33.3	33.3	-	33.3	50	50	-	-	-
Laboratory	-	-	-	-	-	-	-	50	-	-
Computer facilities	-	-	33.3	-	-	-	-	-	100	-
Internet access	-	-	-	-	66.7	-	-	50	50	-
Library	-	-	33.3	33.3	-	-	50	50	-	-
Accommodation	-	-	-	66.7	-	-	-	50	50	-
Transport	-	-	-	-	-	-	50	50	-	-
Sports	-	-	-	33.3	-	-	-	-	-	-

- -Means no score was awarded

Overall, Egerton University has some good infrastructure and facilities as required for quality tertiary education training but there is room for continued improvement especially with respect to computer facilities, internet access, lecture theatres and laboratory facilities. Also the needs of the students in terms of access to lecture theatre and reading cubicles need to be looked into. The students recommended that the university should provide the necessary infrastructure to facilitate learning.

6.2.5 Support for the program

The teaching staff assessed the effectiveness of the key stakeholder in playing their core roles and indicated that generally, the program has not received the support it requires. Egerton University was instrumental in launching the program and ensuring that training went on smoothly. But as recommended by teaching staff, she could enhance her effectiveness by improving the internet access and library facilities in addition to contributing more funds to run the program. There is a misconception that the key role of RUFORUM is financing the program and as such, RUFORUM is seen to have played her role only to some extent. It is important that RUFORUM releases funds in a timely manner and also makes more effort to assist Egerton University mobilize more funds to support the program. The details of the assessment are shown in table 18.

Table 18: Assessment of how effectively key stakeholders played their role

Stakeholder	Key role (s)	Played role effectively		Measures to improve effectiveness
		Yes	To some extent	
University	Training	50%	50%	Provide more funds to support running of the program support review of curriculum Improve accommodation facilities, internet access and library services, increase access to computer room Avail more study rooms and resource centers
RUFORUM	Funding	-	100%	Timely release of funds Mobilize more funds for the program
Students	Learning	50%	50%	Devote more time to class work
Outreach communities	Collaboration	50%	50%	-
Employer	Provide information	100%	-	Maintain strong linkages More flexibility in releasing students to enable them pursue studies

- means no score was awarded

6.3 Challenges encountered during implementation

Funding was a key constraint and this compromised practical learning and mobility of staff. The university had hoped to secure funds to finance students in the first cohort but this did not materialize. As a result, students encountered financial challenges during their studies and local arrangements were made for students to juggle both work and studies. Because the students are engaged in part-time employment, they have limited time to undertake studies, especially the research component. Also, learning through the long distance mode was a challenge due to differences in connectivity configuration and learning materials were eventually sent online. The poor internet access as assessed by both students and lecturers may also have contributed to the challenge. In addition, teaching staff faced challenges in that when the program started, learning materials were in draft form and also they had limited previous exposure in some subject matter. This could have compromised delivery with students recommending use of local examples and retooling of

lecturers. To ensure sustainability of the program, there is need to source for more funding to support practical component of the program, collaborative teaching and learning and also cater for students research and tuition.

6.4 Overall Assessment, Issues and Conclusions

Program implementation is progressing well and currently 14 students from Kenya and Uganda are registered. It is important to note that females are well represented and they make up 79% of the total. Nevertheless, the number of professionals being trained is relatively low and there is need to mobilize funds to cater for scholarships and also support staff mobility. The program has attracted students from the public agriculture education and also from the private sector in pursuit of enhancing knowledge and skill gaps relevant to their professions. Further, two students are working on part time basis and do not give studies full attention and this could prolong their study beyond the stipulated 3-4 years. Most (67%) of the students in the 1st cohort are still developing research proposals about 8 months after completing coursework. It is unlikely that students in the 1st cohort will complete studies within the stipulated period.

The curriculum is detailed and has incorporated courses in discipline depth as well as those deemed essential to impart skills and competencies perceived as lacking in past agriculture graduates and reflects RUFORUM principles. However, reality on the ground is that practical and field components are given little emphasis partly due to financial constraints. In addition, the use of multiple learning approaches is recommended. However, existing services and infrastructure such as internet access may have limited the use of some tools such as e-learning. Nevertheless, as attested by the students, in addition to discipline depth and research skills, soft skills have been imparted and the students feel better prepared to play their role in the market place.

The program can be supported better by increasing funding to support practical learning and mobility of professionals from the region and beyond, support students to increase regional representation, to retool teaching staff as indicated in the curriculum and for enhancing infrastructure and services, especially internet access and library services. The various key actors are playing their role in support of the program. Egerton University could particularly enhance her effectiveness in support of the program by improving the internet access and library facilities while employers could offer students financial support. The following conclusions can be drawn from the study:

1. The training is imparting discipline depth and fundamental skills especially in communication and research but to enhance learning further, ***it is recommended that learning materials be contextualized and program maintain a balance between theoretical and practical components in the timetable, ensure that experiential learning perspectives are incorporated and supported with necessary financial allocation. Further, it is recommended that teaching staff be retooled in areas deemed important and as stipulated in the curriculum.***

2. Generally, Egerton University has good facilities as required for quality tertiary education training but there is room for continued improvement. ***Thus, it is recommended that infrastructure be enhanced especially computer facilities and internet access, library services and also to allocate lecture theatre and reading cubicles to PhD students as recommended by both the students and teaching staff.***

7: PHD AGRICULTURAL AND RURAL INNOVATION HOSTED BY SOKOINE UNIVERSITY OF AGRICULTURE

7.1 Implementation progress and demand

The program was approved by SUA senate and in 2013 a total of 10 applicants consisting of 9 males and 1 female were received from Tanzanian citizens. Due to financial constraints faced by applicants, most (70%) of the admitted candidates did not enroll and only three self sponsored male students registered for the program in December 2013. It is encouraging to note that even in the absence of external funding, students are willing to finance their studies. During the time the consultant visited SUA, students had travelled to Makerere University for joint learning. Consequently, the questionnaire was administered online to all 3 students. Only one student aged between 50 and 59 years responded. The student holds a Bachelors and Masters' degree in Agricultural Education and Extension from SUA. He is an employee of the Ministry of Agriculture, Food and Cooperatives in Tanzania working as production inspector. Most of the information on the program was received from the five teaching staff respondents.

7.2 Factors ensuring success and sustainability of the regional program

7.2.1 Unique attributes of the Program

All the teaching staff respondents are male and most (80%) indicated that the program is unique. The coursework component of the program and the interdisciplinary orientation were singled out as the most important attributes (Table 19). In addition, the student singled out emphasis on quantitative and qualitative research, knowledge management and opportunities for interactions with communities as unique.

Table 19: Unique attributes of PhD, Agricultural and Rural Innovation program as assessed by teaching staff

Attributes	Frequency	Percent
Coursework component	3	60
Interdisciplinary orientation	3	60
More than one instructor for each module	1	20
Organization and leadership skills	1	20
North South Collaboration	1	20

Develop mindset to influence utilization of knowledge and technology driven innovations for rural development	1	20
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7.2.2 Curriculum and delivery

All the teaching staff and one student respondent assessed the curriculum as adequate in content and depth. With regard to balance between theoretical, practical and field based components, only 20 percent of teaching staff indicated there is imbalance, especially in field excursions. The imbalance was attributed to too much emphasis on course details which made it difficult to schedule time for field activities. About 80% of the teaching staff felt there was balance between practical and theoretical components of the program. The student did not comment on course delivery in general but noted that the program can be improved by incorporating more outreach activities.

The ARI curriculum is detailed. It has placed emphasis in developing research skills including qualitative and quantitative research and application of statistical packages. Important to note is the inclusion of Knowledge Management and Communication, Agricultural Services Delivery, and Social and Program Development and Evaluation. Further, the curriculum has put a lot of emphasis on Participatory Methods and Action Research for Innovation in Livelihoods and Agricultural Systems. Personal Mastery and Soft Skills, Entrepreneurship and Research Mentorship are also covered. Generally, the curriculum is innovative, has incorporated courses in discipline depth, and also those deemed essential to impart skills and competencies. It is suited to develop high level professionals with integrated thinking and skills required to provide guidance in innovative and integrated agricultural and rural development and reflects RUFORUM brand

7.2.3 Availability of critical inputs for tertiary education training

The critical inputs to tertiary education training include infrastructure, qualified and motivated faculty and support staff, qualified and motivated students, competent administration and resources needed to facilitate learning. The profile of the staff teaching the program was obtained and is provided in 7.2.3.1.

7.2.3.1 Availability of teaching staff

The five teaching staff have doctoral level training coupled with over 20 years teaching experience. Majority (3) were above 60 years of age and the rest were within the 50 to 59 age bracket. The university has

qualified and experienced teaching staff but considering the advanced age distribution of the respondents, it is important to train a new generation of professionals.

7.2.3.2 Infrastructure capacity of the university as assessed by teaching staff and the student

Both the teaching staff and the student assessed the infrastructure of SUA and results are summarized in table 20. The lecture theatres were rated as poor and good by 40% and 20% of the teaching staff respectively. A further 20% rated the facilities as fair and the rest did not respond. Computer facilities were rated as good by 20% of the teaching staff while 40% rated them as poor. Forty percent of the teaching staff did not respond. Both the library facilities and transport services were rated poor by 40% of the teaching staff. The ratings for internet access, laboratory, accommodation and sports facilities are summarized in table 20.

Table 20: Infrastructure capacity of the university as assessed by student and teaching staff

Infrastructure	Assessment by student**					Assessment by teaching staff				
	Very Good %	Good %	Fair %	Poor %	Very Poor %	Very Good %	Good %	Fair %	Poor %	Very Poor %*
Lecture Theatres	-	100	-	-	-	-	20	20	40	-
Laboratory	-	-	-	-	100	-	-	40	20	-
Computer Facilities	-	-	-	100	-	-	20	-	40	-
Internet Access	-	100	-	-	-	-	60	20	-	-
Library	-	100	-	-	-	-	40	-	40	-
Accommodation	-	100	-	-	-	20	20	20	20	-
Transport	-	-	-	-	-	20	20	-	40	-
Sports	-	-	-	-	100	-	-	-	-	-

* Total Percentage is less than 100% because some did not respond to the facility in question, ** only one student respondent

Generally, SUA has good infrastructure and facilities required for quality tertiary education training but there is room for continued improvement especially with respect to lecture theatres, library, computer and sports facilities and transport services. With regard to evaluation of whether the partners played their role effectively, 80% of the teaching staff noted that the partners had played their core roles in supporting the

program but it was rather pre-mature to gauge the level of effectiveness. The program has been running for less than six months.

7.4 Overall Assessment and Conclusions

SUA senate approved the curriculum for PhD Agricultural and Rural Innovation with coursework and thesis and it has registered three self-sponsored Tanzanian students. The program is in initial stages of implementation and the first cohort is yet to complete coursework. The program is encountering challenges in funding and this is partly responsible for the low student population. In addition, teaching staff encountered challenges due to limited previous exposure in subject matter and as a result they had to invest significant amount of time in preparing learning materials. The assessment of the infrastructure by teaching staff (40%) shows that the lecture theatres, transport, library and computer facilities are generally poor. This may explain why lecturers cited poor infrastructure as a key challenge encountered while teaching the program. The following conclusions can be drawn from the study:

- 1. Generally, SUA has some good facilities as required for quality tertiary education but there is room for continued improvement. **Thus, it is recommended that infrastructure continue to be improved especially with respect to computer facilities, library services, sports, transport and lecture theatres.***
- 2. All the five teaching staff have doctoral level training coupled with over 20 years teaching experience but considering the advanced age distribution of the respondents, **it is recommended that a new generation of professionals be trained.***
- 3. In view of the fact that this is the first cohort and the student population is low and lacks regional representation **it is recommended that aggressive fund raising efforts be mounted so as to offer financial support to qualified applicants and boost enrollment and regional representation of the students.***

8: PHD AGRICULTURAL AND RURAL INNOVATION PROGRAM HOSTED BY MAKERERE UNIVERSITY

8.1 Implementation progress and demand

The program was approved by Makerere University senate and in 2012, the university advertised for the program and over 50 Ugandan citizens applied. Owing to financial constraints faced by applicants, only 28 registered. Five students had full scholarships and the rest are self-sponsored. In 2014, the second cohort of 13 was registered and 8 have full scholarships. Details of applicants, students' countries of origin and gender are provided in table 21. There is demand for the program but only 51% of the qualified applicants have been trained.

Table 21: Applicants and students registered in PhD Agricultural and Rural Innovation program

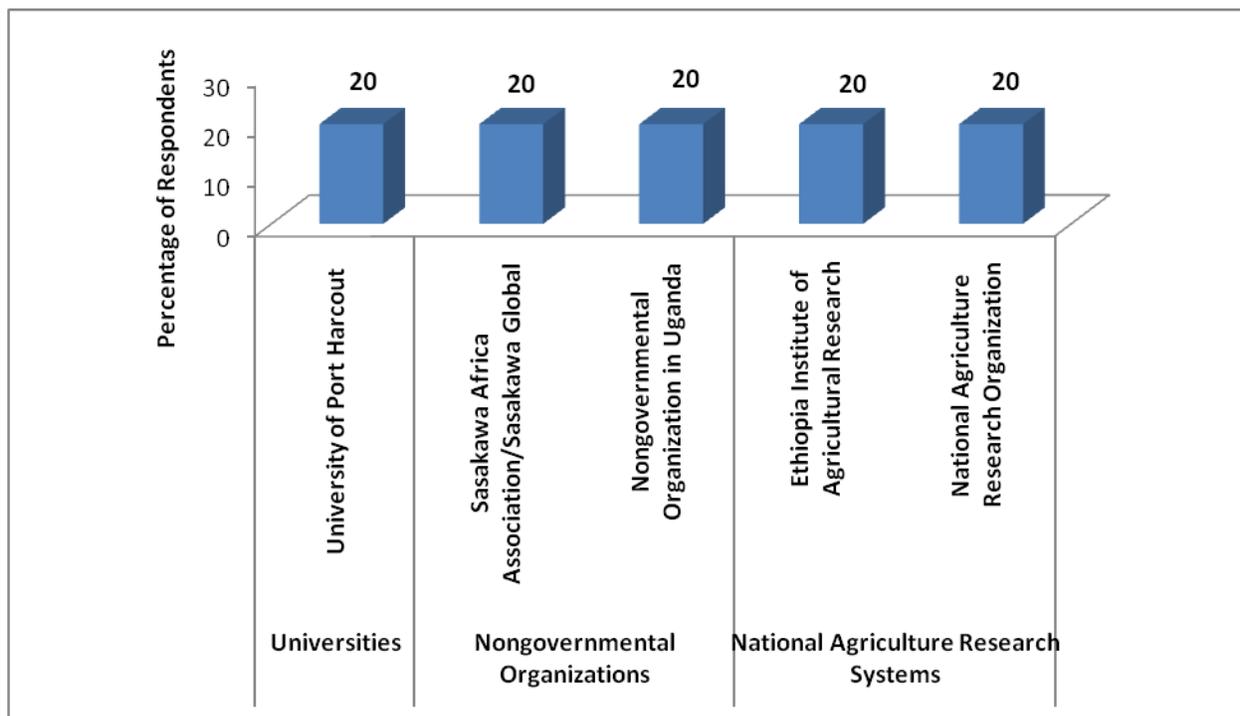
Cohort /year of admission	Total applicants	Registered Students	Gender of students		Countries of Origin	Students Progress
			Females	Males		
1 st / 2012	Over 50	28	14	14	Uganda	At research and proposal development stages
2 nd / 2014	Over 30	13	6	7	Uganda, Nigeria, Sudan, Zambia and Ethiopia	Doing 2 nd semester of coursework
<i>Total</i>	<i>Over 80</i>	<i>41</i>	<i>20</i>	<i>21</i>	-	-

8.1.2 Characteristics of students enrolled for the program

The questionnaire was administered online to 41 students and all teaching staff. Only twelve percent of the students (3 males and 2 females) responded. Most (60%) were within the 30 to 39 years age bracket while the rest were between 40 and 49 years. Except for one student who holds a Bachelors degree in electronic engineering, the other four have academic background in arts or social sciences. In addition four students specialized in sociology or agriculture extension at Masters degree level and one holds two Masters degrees, in Computer Engineering and Agriculture Information and Communication Management. The Masters degrees were awarded by universities located in Uganda, Kenya, Nigeria and Sudan. The program attracted students who were in full time employment in the public institutions, namely, the National

Agriculture Research Institutes in Sudan and Uganda, University in Nigeria and the Private Sector, and Non-Governmental Organizations. The details of the students' host institutions and employer are provided in figure 13. To enable students pursue studies, majority (60%) were accorded study leave, an indication of support by employers. Forty percent of the students made local arrangements with employers and continue to work as they study.

Figure 13: Employers of students enrolled in Agricultural and Rural Innovation program



8.1.3 Factors favoring enrollment in the Program

The study set out to identify the key factors which influenced students to enroll in the program. They include: relevance of the program, new systems and coursework and research approach. All students singled out the new Innovation systems approach and multidisciplinary focus as the key factors. In addition, the coursework and research approach, need to acquire discipline depth and skills for upward career mobility and to expand career opportunities are also important. Further, the short 3-4 year period to complete studies was cited. Relevance of the program to students' profession and potential to touch rural lives was highlighted by 60% of the students. The details of the key factors are provided in table 22.

Table 22: Factors which influenced enrollment in Agricultural and Rural Innovation program

Factors	Frequency	Percent
New approach Innovations system Multidisciplinary New in Africa and interesting program	5	100
Relevance Relevance work Touching rural lives	3	60
Coursework and research approach Enhance skills and knowledge needed to move up career ladder Acquire skills to expand career opportunities Short duration	4	80
Funding available	1	20
Program offered in local universities	1	20
Flexibility- background in agriculture not a requirement	1	20
Regional aspect	1	20

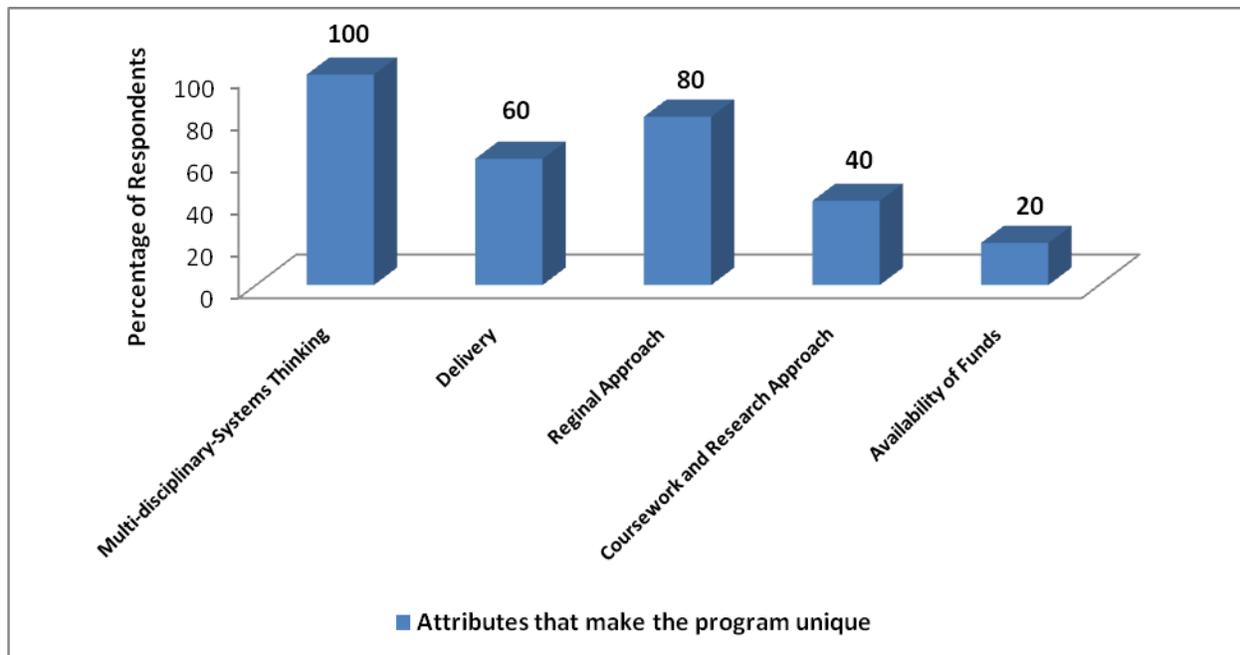
8.2 Factors ensuring success and sustainability of the regional program

8.2.1 Unique attributes of the program

All students singled out the multi-disciplinary approach which integrates technical and social skills and has potential to enhance rural livelihoods as a unique attribute. Further, the systems approach was seen as the solution to addressing the real issues surrounding communities and within context. In addition, 80% of the students identified the regional aspect as key as it brings together lecturers and students from the region and Europe and promotes sharing, learning and building networks for future collaborations. Learning approaches employed by the program were also identified as unique. Also highlighted by 60% of the students was the involvement of learners, interactive sessions and emphasis on hands on activities. This is a clear indication that the program has adopted appropriate approaches to facilitate learning. In addition, the short 3-4 years period for completing studies and the coursework and research approach also featured

with the later singled out as important for imparting discipline depth and fundamental skills needed to climb career ladder and to expand career opportunities. Details of these attributes are provided in Figure 14.

Figure 14: Unique attributes of Agricultural and Rural Innovation program



8.2.3 Curriculum and delivery

8.2.3.1 Curriculum content

The students made an assessment of the curriculum with regard to content, depth and delivery. Using a score of too narrow, narrow, adequate, broad and too broad, the curriculum content was rated adequate and broad by 40% and 60% of the students respectively. Students suggested that incorporation of philosophy of methods would add value to the program. Further, using a scale of too shallow, shallow, adequate, deep and too deep, the curriculum depth was rated adequate and deep by 40% and 60% of the respondents respectively. Overall, the curriculum was rated by 20% of the students as relevant to their professions to a moderate extent. A further 80% rated it as relevant to their professions to a great extent or a very great extent. These findings are evidence that program design is well aligned to the needs of the students.

8.2.3.2 Delivery

Most (60%) students indicated that the program has a good balance between theoretical and practical components while one student rated the practical component as inadequate. Field based activities were rated as insufficient by 60% of the students. To improve delivery they recommended engaging more guest speakers, incorporation of computer based practical sessions in the knowledge management and communication module, increase field activities in general and especially for participatory research module. Most students (80%) rated the lecturers' preparedness and the overall curriculum delivery as either good or very good. One student rated delivery as poor noting that the facilitators rushed through the course and barely paid attention to student's views.

Following the training, students attested to being better equipped to play their role in the market place. Majority of the students (80%) confirmed that discipline depth had been imparted and particularly in areas of multi-stakeholder processes, innovations and knowledge management. The most important skills imparted during the training were singled out as communication, research, managerial and social skills. Details of the skills are provided in table 23.

Table 23: Most important skills imparted by the training as identified by Agricultural and Rural Innovation students

Skills	Frequency	Percent
Research specifically Multi-stakeholder processes Analytical	4	80
Communication Writing Presentation and facilitation	2	40
Managerial	2	40
Social skills	2	40

The approved ARI curriculum is rich in technical component and has also placed great emphasis on developing communication skills, ranging from inculcating reading culture, writing and also oral presentations. Field excursions/practical components and opportunities to enhance team building are also included in the curriculum which also has components touching on both qualitative and quantitative

research. In addition, general learning techniques are well outlined in the curriculum and they include: face-to-face interactions, group discussions, assignments, guest lecturers/seminars and field excursions and practical, self-learning through independent reading and also through E-learning platform. The curriculum does emphasis that ARI is field work based program.

8.2.4 Infrastructure capacity of the university as assessed by students

The students assessed the infrastructure capacity of the university and the information is summarized in table 24. There were mixed feelings regarding the rating of lecture theatres with 40% of the students rating them as poor and an equal proportion rating them as being in good. Generally, the computer facilities were perceived as either fair or poor and internet access was rated as good or fair by 40% of the respondents each. Library services are good as rated by most (80%) of the students. Overall, Makerere University has some good infrastructure and facilities as required for quality tertiary education training but there is room for continued improvement especially with respect to computer facilities, lecture theatres and sports facilities.

Table 24: Infrastructure capacity of the university as assessed by students

Infrastructure	Assessment by students				
	Very Good %	Good %	Fair %	Poor %	Very Poor %
Lecture Theatres	-	40	20	40	-
Laboratory	-	40	-	40	-
Computer facilities	-	-	60	40	-
Internet access	-	40	40	20	-
Library	20	60	20	-	-
Accommodation	-	20	40	-	-
Sports	-	-	40	20	-

- Means no score awarded. Figures do not add to 100 because some respondents gave no response for certain facilities

8.3 Challenges encountered during implementation

Most (60%) students encountered challenges in delayed guidance from advisors and difficulties in conceptualizing and articulating research ideas. These were resolved through active engagement with advisors and consulting with colleagues. A few students did not own computers, had limited knowledge in

Information Communication Technology (ICT) and accessing learning materials online was a challenge. To facilitate learning, the students took training in ICT, borrowed computers from friends (and eventually purchased their own) for easy access of learning materials.

The Regional Program Coordinator also encountered challenges. The Agricultural and Rural Innovation program has a regional secretariat based in Makerere University which works closely with national ARI coordinators based in Egerton University and SUA. The regional coordinator has been proactive in resource mobilization and the challenge of heavy workload was cited. Also the need for more pro-active participation of the national coordinators in resource mobilization was recommended. Each module is handled by 4 resource persons and synchronizing their availability and sequential delivery of modules was no easy task. Funding constraints were also reported especially when students from Egerton University and SUA travel to Makerere University for joint learning. The students' travel costs are covered by ACP-EU EDULINK grant but each student is supposed to cater for their upkeep. However, students normally run short of funds and the regional secretariat is forced to finance their upkeep. Further, considering that ARI is a field based program transporting large number of students and staff was cited as a challenge and the need for a vehicle with a capacity of 30 persons was reported. ARI program is jointly implemented by three Africa Universities and two European partners and the latter would want their universities to benefit more from the partnership. The option of dual registration of students is being explored but it has a cost implication and the program is already encountering financial constraints.

8.4 Overall assessment, Issues and Conclusions

Program implementation is progressing well with 41 students drawn from 5 countries registered. It has enrolled equal proportions of female and male students. Further, the program has attracted students employed in the Private as well as Public Sectors and about 60% are self-sponsored. The students' progress is rather slow and eight months into the second year of study, most are at proposal development stage. It is unlikely that they will complete studies within the stipulated period. Further, most students are working and studying and the divided attention may be contributing to the slow progress. In addition, the program has 41 on-going students and there is a possibility of supervision challenges mainly because 60% of the students reported delayed guidance from supervisors. The program has adopted a wide range of learning approaches and students singled out delivery as a unique attribute. However, there is need to maintain a balance between theoretical and practical components of the study. Field aspects were rated as

inadequate and to improve delivery students recommended that measures be taken to increase practical sessions in knowledge management and communication and participatory research modules in addition to increasing the number of guest lecturers. Overall, the program is imparting discipline depth and fundamental skills.

9. PHD PLANT BREEDING AND BIOTECHNOLOGY

9.1 Implementation progress and demand

The Plant Breeding and Biotechnology program is hosted by Makerere University in Uganda. The program was developed by stakeholders and approved by Makerere University senate. Various avenues were used to create awareness about the program; word of mouth and RUFORUM publications were the most common means through which students learnt of the program. The University opened its doors to the first students in 2009 and a total of 22 students drawn from five countries and consisting of six females and 16 males registered for the program. In 2012 and 2013, a further 5 and 9 students respectively registered. To date, the program has trained 31 professionals from nine countries; females make up 29% of the total. Eleven students have graduated. The gender, countries of origin and progress of the students are provided in table 25.

Table 25: Students registered in PhD Plant Breeding and Biotechnology program as of April 2014

Cohort/ Year of admission	Students Registered	Gender		Students countries of origin	Students progress
		Male	Female		
1 st cohort/ 2009/2010	22	16	6	Kenya, Uganda, Malawi, Zambia, Zimbabwe,	11 graduated 3 submitted thesis 8 yet to submit thesis
2 nd Cohort /2012	5	3	2	Kenya, Sudan, Uganda	1 about to submit thesis 4 in research stage
3 rd Cohort /2013	4	3	1	Sudan, Nigeria, Ghana, Benin	Doing coursework
Totals	31	22	9	-	-

9.1.2 Characteristics of students enrolled in the program

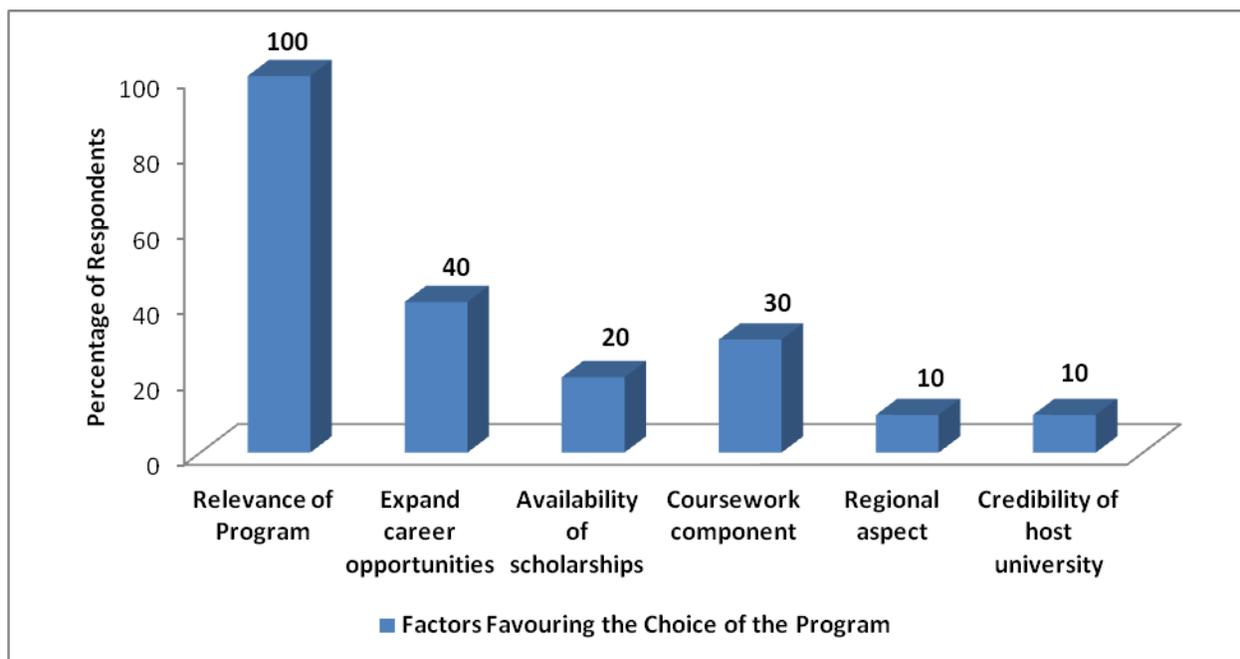
Ten respondents (32% of all students and alumni) consisting of three females and seven males responded to the questionnaire. Majority (80%) of the respondents were within the age bracket of 30 to 39 years while 10% were between 40 and 49 years. With the exception of one student who had a Bachelors degree in natural sciences, the others had specialized in agriculture or related fields. Similarly, at Masters degree level, most students had background in agriculture and related fields while 20% had Masters' degree in Natural Resource Management or Plant Biosystematics and Taxonomy. Further, the postgraduate degrees were obtained from 7 universities located in Belgium, Uganda, Sudan, Nigeria, Ghana and Kenya. Prior to

joining the program, nine of the students were employed in the public sector while one was unemployed. Half (50%) of the students are employees of universities located in Kenya, Sudan, Nigeria and South Africa and are at lecturer, assistant lecturer or graduate teaching assistant grades. Four students are officers in the Ministry of Agriculture and Livestock. To undertake studies, 30% of the students were accorded study leave, an indication of strong support from the employers. Three students resigned and the rest made local arrangements to continue working as they studied.

9.1.3 Factors which favored enrollment into the Program

The students identified several factors which influenced their choice of the program. The relevance of the program to their profession and its potential to impact lives was singled out as the most important factor by all students. The program was seen as instrumental to addressing the challenge of food insecurity and poverty in the region through development of elite varieties. In addition, the need to expand opportunities for career development coupled with the high demand for plant breeders in the region was important as indicated by 40% of the students. The coursework component of the program which is important for imparting discipline depth and fundamental skills was highlighted by 30% of the respondents. Credibility of the host institution, availability of scholarships and regional approach were also important. Details of the key factors are provided in figure 15.

Figure 15: Factors favoring enrollment in Plant Breeding and Biotechnology program



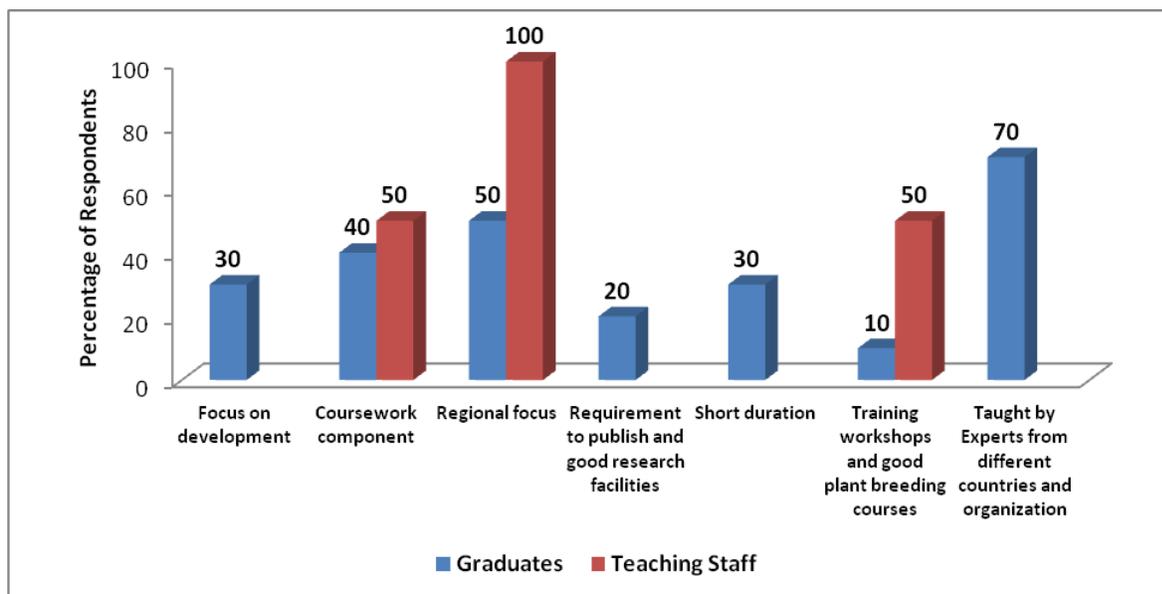
9.2 Factors ensuring success and sustainability of the regional program

9.2.1 Unique attributes of the program

The program is new and this study set out to document its unique attributes as perceived by students, teaching staff and university management. The most important attributes as singled out by students were its focus on development, coursework component and regional aspects, short duration to complete studies, strong collaboration between relevant institutions, and the engagement of professionals from the region and beyond. A majority (70%) of the students hailed the strong collaboration between universities and research institutions and also the engagement of experienced professionals from the region and beyond in teaching and supervision. Also unique is the regional aspect which brings together students from the region and promotes sharing and peer learning in addition to forging networks. The two teaching staff who responded to the questionnaire also singled out regional aspect as a unique attribute. Further, the university management hailed the regional approach and took pride in contributing to human resource development for nine African countries. The short three year duration to complete studies is another important factor. As reported by the Dean of the School of Agricultural Sciences, coursework is imparting discipline depth as evidenced by high performance by students during oral examination of thesis. The coursework element and the focus on science for development also featured. The emphasis on applied

research (especially for developing elite varieties characterized by short maturity period, better yield, improved nutrition and tolerance to biotic and environmental stresses) was singled out for its potential to impact lives through improved food security and reducing poverty. Further, the requirement to publish research findings was seen as important for developing skills in scholarly writing. The unique attributes are illustrated in figure 16.

Table 16: Unique attributes of Plant Breeding and Biotechnology program as identified by students and teaching staff



9.2.2 Curriculum and delivery

9.2.2.1 Curriculum content

The students and teaching staff made an assessment of the curriculum with regard to content, depth and delivery. Using a score of too narrow, narrow, adequate, broad and too broad, the curriculum content was rated as adequate and broad by 90% and 10% of the students respectively. Further, using a scale of too shallow, shallow, adequate, deep and too deep, the curriculum depth was rated as adequate by all students. The two teaching staff rated the curriculum as adequate in content and depth. Overall, 90% of the students rated the curriculum as relevant to their professions to a great extent and only 10% rated it as relevant to their profession to a moderate extent. The findings are evident that program design is well aligned to the needs of the students.

9.2.2.2 Curriculum delivery

The program was also assessed with regard to balance between theoretical components, laboratory based activities and field exposure. Teaching approaches employed included lectures, interaction with guest resource persons, laboratory and field based 'hands on' practicals, individual assignments and seminars. The program puts sufficient emphasis on laboratory based activities as attested by teaching staff and 80% of students. A small proportion of students (20%) indicated the need to increase hands on activities, especially in molecular biology. In addition, there was sufficient field based activities as reported by 90% of the students. Overall, the delivery was rated as good and very good by 80% and 20% of the students respectively. Further, all the students rated the lecturers preparedness as good or very good. Ways to improve delivery as suggested by 20% of students included condensing coursework so as to create more time for research, and increasing practicals in molecular biology as well as the frequency of presentations and discussions.

The training is imparting discipline depth and fundamental skills. The results of the assessment of whether students feel better prepared to play their role in the market place was encouraging with all attesting to being better equipped. As a result of the training, 70% of the students reported enhanced knowledge in traditional and modern breeding approaches, coupled with hands on experience in molecular as well as conventional breeding techniques. As attested by the students, the training is imparting relevant research skills and in particular proposal development, project management and data management. Communication skills, especially publication and presentation, were also singled out as important. 90% of the students indicated that the program has sufficient emphasis in developing communication skills. Details of the core skills imparted are provided in table 26.

Table 26: Core skills acquired during the training and considered critical for better performance by students

Skills	Frequency	Percentage respondents
Communication Scientific writing, Publication and Presentation	6	60
Practical Hands on experience in laboratory and field based activities	7	70
Research Proposal development, data management and project	4	40

management		
Soft skills in general Interpersonal, organizational	4	40

9.2.3 Availability of critical inputs for tertiary education training

The critical inputs for quality tertiary education training include infrastructure, qualified and motivated faculty and support staff, qualified and motivated students, competent administration and resources needed to facilitate learning. The condition of core infrastructure and facilities at the university was assessed by students and the two teaching staff respondents and results are detailed below.

9.2.3.1 Infrastructure capacity of the university as assessed by students and teaching staff

The students were allocated renovated facilities and most (75%) rated the lecture theatres as good. On the contrary, teaching staff rated the facilities as poor. It is possible that teaching staff based their assessment on multiple facilities used by several programs. Through the support of the program new equipment was procured for the laboratory used by PhD plant breeding and biotechnology students and this could explain why they rated the facilities as good while the teaching staff rated laboratory facilities as poor. The computer facilities were rated as fair by most students and teaching staff. Internet access and library facilities were also rated as good by most respondents. Details of the assessment are provided in table 27.

Table 27: Infrastructure capacity of the university as assessed by students and teaching staff

Infrastructure	Assessment by students					Assessment by teaching staff				
	Very Good %	Good %	Fair %	Poor %	Very Poor %	Very Good %	Good %	Fair %	Poor %	Very Poor %
Lecture Theatres	-	70	30	-	-	-	-	-	100	-
Laboratory	-	40	40	-	10	-	-	-	100	-
Computer Facilities	10	-	60	20	10	-	-	50	50	-
Internet Access	40	40	30	20	-	-	100	-	-	-
Library	-	50	30	10	-	-	50	50	-	-

Accommodation	20	40	30	10	-	-	50	-	50	-
Transport	-	-	-	-	-	-	-	-	-	50
Sports	10	-	70	10	10	-	-	-	-	-

- Means no score was awarded

9.2.4 Support for the program

Only one member of staff responded to the question on how effectively the key stakeholders are playing their core role in support of the program. The university was seen as playing her full role only to a limited extent. Effectiveness can be enhanced by reviewing the examination process. This is an important observation because students also recommended the process of thesis examination be fast tracked. RUFORUM was seen as having played her role only to some extent. The program has registered a decline in participation of professionals from the region and beyond and the respondents recommended that support for visiting professionals be revisited. The role of outreach communities in partnering with scientists was seen as important and the partnership could be enhanced by clarifying roles before commencing work. The employers were commended for supporting students but more support could be accorded by extending study leave on a case by case basis. The regional program has some similarities with a local program run by the host Department of Agricultural Production in the School of Agricultural Sciences and the two are running parallel. The teaching staff and University Management reported duplication of efforts and that the program is not fully owned by the host department. For the regional program to be better embedded in the host department, the common courses could be handled jointly or the possibility of merging the programs could be explored and the department takes lead in the academic component while the program coordinator attends to students welfare including logistics and identification of research sites. Overall, the program could be supported better by enhancing staff mobility and integrating the program with other activities so as to exploit synergies and avoid duplication of efforts.

9.2.5 Relevance of research conducted by students

The students are mainly conducting research in Uganda and with a focus on improving nutrition and yields through enhanced resistance to insect pests, other disease causing agents, and improving soil fertility through biological nitrogen fixation. Emphasis on indigenous early maturing and drought tolerant crops namely; tropical maize, sorghum, beans, soya beans, sesame and cassava is important for mitigating climate change and enhancing food security. In addition, malnutrition is being addressed through focus on diversity and inheritance of beta-carotene in cassava which is an important high yielding and drought

tolerant crop and a major staple for millions of people in the region and the African continent as a whole. Further, pests and disease are the main cause of low yields and postharvest losses in Africa. The research on major pests and diseases including Stem Borer, Larger Grain Borer, weevils and rust and the development of resistant materials will result in generation of public goods with immense potential to enhance food security in the region and beyond.

9.3 Results of the regional training program

The program has been running for over four years and has realized impressive results including trained professionals, developed elite varieties of important indigenous crops, publications, enhanced networks and infrastructure at Makerere University as outlined below.

1. A curriculum for PhD Plant Breeding and Biotechnology by coursework and research was developed by key stakeholders and the program has registered 31 students. As of April 2014, eleven students had graduated with doctorate degrees. A further 3 are likely to graduate in 2014. All students registered have gained discipline depth, acquired soft skills and enhanced their networks. Further, Makerere University is taking pride in having enhanced human resource for nine countries in Africa.
2. Publication of at least two articles in peer reviewed journals is a requirement for graduation and the five students who registered for the program in 2009 have published a total of 17 articles as detailed in appendix A3. This is evidence of high quality research being conducted and the total publications are bound to grow and enhance the profile of Makerere University.
3. Supervision related benefits and networking. One of the teaching staff reported enhanced networks, supervision of five students, publication of five articles in peer reviewed journals and participation in two international conferences. The achievement will contribute to upward career mobility of the staff.
4. Enhanced infrastructure and income: Makerere University has benefited from income accrued from tuition. In addition, as a result of hosting the program, modern equipments were acquired for the molecular biology laboratory, students' accommodation facilities were refurbished and the university received a project vehicle. In addition, one technical and one teaching staff are supported by the program.

9.4 Challenges encountered during implementation

Some students (50%) encountered challenges during the course of training. They include, delays in registration and issuing of university identification cards which resulted in the students being denied access to library facilities. Further, students (30%) reported challenges related to supervision during research and they recommended that monitoring of research activities be strengthened. Slow processing of these was also cited and this tended to delay completion of studies. Issue of frequent power disruption and isolated cases of water shortage in halls of residence were also mentioned. Language barrier was cited as a challenge which was resolved by registering for remedial English classes. In addition, the program has engaged a professional who offers tuition in English language to needy students. Transport from the University to Kabanyolo farm and limitation of teaching space were the two challenges cited by the teaching staff. It was recommended that a van to shuttle staff be availed and more buildings be renovated to increase teaching space.

9.5 Overall assessment, Issues and Conclusions

There is demand for the program and to date 31 students from 9 countries in Eastern, Central, West and Southern Africa have been trained. The program has registered a decline in enrollment but regional representation has remained relatively high with the three cohorts having registered students from different countries of origin. As shown in table 28, graduation rate is low. Fifty percent of students in the 1st cohort have graduated but 44% of students in the 1st and 2nd cohorts are yet to submit thesis.

28: Summary of enrollment and progress of students enrolled in Plant Breeding and Biotechnology program

Cohort	Students registered	Number of countries of origin	Students progress, number		
			Graduated	Submitted thesis	Not submitted/ Research phase
1 st / 2009	22	5	11	3	8
2 nd / 2012	5	3	0	1	4
3 rd / 2013	4	4	-	-	4

Consequently, the program has 3 cohorts in the pipeline. Students reported limited supervision during research and recommended that monitoring of research be strengthened. Further, there is an indication that self-sponsored students who are working on part-time basis (30% of respondents) are devoting less time to studies. In addition, both students and teaching staff have reported slow processing of thesis. The combined effect of limited interaction with supervisors, students devoting less time to studies and slow processing of thesis could be contributing to delays in completion. The low graduation rate is alarming and there is need for closer monitoring to reverse the trend. Completion of studies within a short period was singled out as a unique attribute of the program and delays in completion could make it less attractive. The low enrollment in the current cohort could translate into under-utilization of resources.

The program is mainly attracting young scientists (80%) with a passion for plant breeding, are within the 30-39 years age bracket and from the public service. The students enrolled in the program principally to gain discipline depth and fundamental skills needed to enhance career opportunities. Further the program was rated as relevant to students professions, has a focus on science for development and potential to alleviate food insecurity in the region. Training entails use of modern tools, diverse approaches and has a balance between theoretical and practical components. The relevance, high quality training and expanded career opportunities are likely to improve attractiveness of the program and contribute to its success and sustainability. Further the host institution has critical inputs for quality training and this too should contribute to success of the program.

The students are mainly conducting research in Uganda and with a focus on improving yields through enhanced resistance to insect pests, other disease causing agents and improving soil fertility through biological nitrogen fixation. Emphasis on breeding of indigenous early maturing and drought tolerant crops is important for mitigating climate change and enhancing food security. In addition, the research on major pests and diseases will result in the development of resistant materials, thus generation of public goods with immense potential to enhance food security in the region and beyond. In addition, the program is mostly building capacity for teaching institutions and the Ministry of Agriculture and Livestock who make up 50 and 40% of the respondents respectively. The program is providing training opportunities for faculty members in universities in Kenya, Sudan, Nigeria and South Africa. Officers in the Ministry of Agriculture and Livestock have been trained and they should play a leading role in influencing policy and also steering developmental initiatives.

Although the program has received support from key stakeholders, Makerere University could accord further support by fast tracking thesis examination and issuing of student identification cards. Further, the

students hailed the engagement of professionals from other institutions in teaching and supervision. However teaching staff reported decline in participation of visiting professionals and there is need to revisit their support. The program has mainly trained male students with females making up only 29% of the total. Efforts need to be made to promote gender balance in the selection of students and award of scholarships.

The Following conclusions can be drawn from the study:

1. The program has maintained a balance between theoretical and practical components and also employs multiple teaching approaches. It is also imparting the desired discipline depth and fundamental skills as expressed by the students. However, graduation rate is low and there is need to identify factors contributing to this and reverse the trend.
2. The program has been running for four years and is running parallel with a similar program in the host Department of Agricultural Sciences. ***It is recommended that the two programs be reviewed to remove duplication and identify areas where synergies could be exploited.***
3. The university has good facilities as required for quality tertiary education but there is room for continued improvement especially in computer facilities, internet access, library facilities and transport services.

10: OVERALL ASSESSMENT, ISSUES AND CONCLUSIONS

10.1 Overall assessment

There is demand for the programs and as of 2013 over 350 applications had been received from 13 countries in Eastern, Central, Southern and West Africa. Demand in the initial calls as reflected by number of applicants and wider regional representation has been higher than in subsequent ones, an element which may be attributed to unavailability of scholarships. To date the five programs have collectively enrolled 166 students from 12 countries but owing to financial constraints, over 184 qualified applicants have not been trained. Further, the region needs professionals to replace those close to retirement age, research activities have focused on a few staples, targeted limited agro-ecologies and yet the evolving environmental and biotic challenges need to be addressed on a continuous basis.

The programs are mostly attracting students within the 30-39 and 40-49 age brackets who make up 49% and 41% of the total trained, respectively. Further, employees of the public agriculture education, research and extension organizations make up 89% of the total and the rest are from the private sector. Details of the proportion of professionals trained for each category of employer are provided in table 29. Faculty members at graduate assistant, tutorial fellow, assistant lecturer and lecturer grades based in 14 universities and located in 9 African countries have been trained. Further, senior officers in the Ministry of Agriculture and Livestock and researchers make a significant proportion of those trained.

2: Employers of the students trained by the five RUFORUM regional PhD programs

Employer	Percentage of total trained	Home countries of the students
Universities	36.4	Tanzania, Uganda, Nigeria, South Africa, Kenya, Malawi, Zimbabwe, Sudan and Ethiopia
Agriculture Research Institutes (national and International)	15.9	Kenya, Uganda and Ethiopia
Ministry of Agriculture and Livestock	36.3	Kenya, Tanzania and Uganda
Private Sector	11.4	Sudan, Kenya and Uganda

With the exception of Agricultural and Rural Innovation, and Food Science and Nutrition programs where females are well represented, the five programs have mainly registered male students who constitute 59%

of the total trained. Thus the proportion of women trained in individual programs range from 29-83%, with an overall mean of 41%. Representation of females is low especially if the target to increase enrollment of women in postgraduate programs in SSA and also increase their participation in agriculture research within Eastern, Central and Southern Africa regions to 40% by 2015 as stipulated in RUFORUM strategic goal 5 (RUFORUM, 200) is to be realized. Ways to boost female enrollment in the programs are discussed in 10.2.1.

All RUFORUM regional programs were rated as relevant to the students' professions and they are training principally to acquire discipline depth and fundamental skills required in current positions, for upward career mobility and to expand career opportunities. In addition, students and teaching staff singled out the unique attributes of the programs as potential to impact lives. The coursework and research approach, short duration to complete studies and regional approach are also important elements in ensuring the success of RUFORUM regional programs. University management and employers also hailed the regional and coursework and research approach as unique. Further, the study observed the programs deliberate emphasis on both theoretical and practical components of the curriculum and use of a wide range of teaching approaches including modern tools although to some extent, financial challenges limited their use. The elements of students' attachment, option to specialise in ones area of interest, admitting students from a wide academic backgrounds, offering the programs on modular as well as semester basis are unique and the norm in RUFORUM regional programs. Overall, the students attested to the innovativeness of the curricula in terms of content, depth of coverage and delivery, an indication that the RUFORUM regional programs have improved the quality and relevance of agriculture education. This was reaffirmed by employers who commended the innovativeness of the curricula of the new RUFORUM regional programs and recommended that the other postgraduate programs be reviewed to include courses which will impart communication skills, particularly writing, extracting messages to inform policy and inculcating a reading culture. Managerial, entrepreneurial, and practical skills are also needed to enable graduates work better with farmers. The employers, especially the Ministry of Agriculture and Livestock recommended that the universities revise other agriculture programs (at under graduate and postgraduate levels) to include areas perceived as attractive to the youth. This should include units focusing on commodity exchange and warehouse structured grain marketing, urban and peri-urban agriculture and emerging livestock species such as rabbits and quails. This was seen as having twin benefits; the potential to attract youth to a career in agriculture and also engage in farming as a business. The last is important as it will help reduce the advanced average age of smallholder farmers in the region.

All universities hosting the regional programs have academic quality assurance units. Directorates of Academic Quality Assurance have been established in four universities and monitoring of quality of programs, inputs, delivery and outputs is ongoing though at different levels of sophistication. As a means of strengthening postgraduate training and research programs in Eastern, Central and Southern Africa (ECSA), RUFORUM recommended among others the need for credit accumulation and transfer and harmonized grade point average systems for ECSA region (RUFORUM Secretariat, 2011). The universities hosting RUFORUM regional programs have credit accumulation and transfer systems in place and the number of courses which can be transferred range from 25% to 60% of total graduation load for the program (but only for courses taken at specific universities). In some universities the process may also entail administering an examination. The existing credit accumulation and transfer systems in individual universities need to be harmonized if students across the regions are to fully benefit. Also, there is need to adopt the recommended harmonized grade point average system. Internal bench marking of the programs is ongoing. Basically, self evaluation systems are in place but external evaluation systems for teaching are not. Individual programs have admitted students from as many as 7 universities located in 6 countries and lack of harmonized grading system will continue to be a challenge. For instance, some faculties reported incidences where they were forced to refer to degree awarding institutions for interpretation of results to facilitate student admission.

The credibility of the universities hosting the programs was also singled out as an important factor by the students. In all programs, training is done by holders of doctorate degrees who have long teaching experience spanning from 6 to over 20 years. For three of the programs, majority of teaching staff are close to retirement age and there is need to train a new generation of professionals. Further, universities have good facilities and infrastructure but there is need to improve specific facilities as detailed under each program. The RUFORUM regional programs are providing high quality training and students attested to having acquired discipline depth and skills which will enhance their effectiveness in the market place. Running the programs is also catalyzing move towards offering PhD by coursework and research. The adoption of modern tools to facilitate learning and engaging stakeholders in both curricula development and review are also on the increase. For success and sustainability of the programs, it is important to maintain the unique attributes, high quality of training and also ensure harmonized grading and QAM are in place.

The five RUFORUM regional programs have made a significant contribution to enhancing human resource in the region and they have registered a total of 166 students, 25 have graduated with doctorate degrees

with a further 17 likely to graduate in 2014. Employers in universities, research institutions, Ministry of Agriculture and Livestock and the Private sector were interviewed. There was consensus that the graduates are well equipped with discipline depth and fundamental skills. The graduates exude confidence, articulate issues in a cohesive manner, exhibit knowledge in relevant policies, holistic view of issues, leadership and team building skills. As a show of confidence in the products, the University of Nairobi has recruited three graduates of Dryland Resource Management program. Pwani University, Embu University College and National Agriculture Research Institute in Kenya have recruited graduates of the Plant Breeding and Biotechnology program. Further, a sample of 10 graduates of the Dryland Resource Management program show that the professionals have been promoted to positions of greater responsibility or moved to more promising careers. Those who were previously unemployed have found employment as detailed in appendix A2. These results are a clear indication that the doctoral programs are responsive to stakeholders' needs and national and regional development agenda and in line with RUFORUM's 1st strategic goal (RUFORUM, 200). For the graduates absorbed into teaching positions at university level, employers noted the need for more mentoring in student supervision in addition to post doctorate exposure to establish further links for resource mobilization. Comment from Private sector, Kenya National Farmers Federation as detailed in Box 2 shows that the training is bearing fruits.

Box 2. How did Kenya National Farmers Federation (KENAFF) benefit from the training in ARI?

Our skills in developing policy briefs have been enhanced, we have developed more partnerships and increased our level of participation and because in the course of working with farmers we generate a lot of knowledge we have now moved into knowledge application. KENAFF is an umbrella organization of farmers in Kenya which represents the interest of about 2 million farm families. Response from General Manager Resource Mobilization, KENAFF

Further, the strength of the Agricultural and Rural Innovation Program in linking with farmers was seen as key to empowering rural communities and sparking development and is in line with RUFORUM's 4th goal as outlined in the 2005-2015 strategic plan. To produce a critical mass of professionals who are in close contact with rural communities, the Private Sector recommended that the program be cascaded to Masters and Bachelors degree levels. Based on the feedback, it appears that the relevance of the program, high quality of training and the expanded career opportunities are likely to continue to enhance attractiveness of the programs and promote their sustainability. Further, the initiative has fostered the development of

centers of excellence and increased the profiles of the host universities. For instance, SUA is attracting more attention from the international community, the Tanzanian Government, as well as stakeholders in agriculture and other sectors. SUA attracted significant funds from AGRA for purchase of equipment for the soil science laboratory. The laboratory is playing a key role in sample analysis for the public, fertilizer analysis for government bodies, generating income for SUA and the laboratory is in the process of being accredited by the Tanzania Bureau of Standards. Further, the university is in discussions with the Tanzanian Government to define the modalities for establishing a commercial laboratory. Similarly, the University of Nairobi is attracting more attention from the international community and as a result of hosting the Dryland and Resource Management program it attracted funding from USAID in support of Center for Sustainable Drylands Ecosystems and Societies. The grant supports students' research, student exchanges, seminars and short courses in addition to catering for faculty research. The grant also supports a student-led conference which is held annually. Overall, the centers have received support for infrastructure development and purchase of equipment. They have enrolled students from the African continent and show evidence of shared research and training facilities and capacities and in line mainly with the 2nd RUFORUM strategic goal (RUFORUM, 2005).

The programs are conducting research relevant to the region. Example, the interventions by Soil and Water Management program are putting emphasis on indigenous drought tolerant crops coupled with enhancing soil fertility through promoting use of nitrogen fixing leguminous crops, appropriate crop rotation, intercropping, optimized fertilizer rates and use of planting pits to improve water use efficiency. Thus, the initiatives are responding to emerging environmental challenges especially climate change and declining soil fertility and will result in technological innovations with immense potential to boost agricultural productivity and promote food security in the region. The Plant Breeding and Biotechnology program is focused on improving nutrition and yields of indigenous early maturing and drought tolerant crops through breeding for enhanced resistance to insect pests, other disease causing agents and improving soil fertility through biological nitrogen fixation. Development of elite materials will result in generation of public goods with immense potential to enhance food security in the region and beyond. Similarly, the students in Dryland and Resource Management program are conducting research in dryland ecosystems in multiple countries in the region and with a focus on important dryland tree species of medicinal value, those used as fodder and wild fruits. The findings will elucidate the important role of these plants and offer strategies for their enhanced sustainable production in support of dryland livelihoods. Other studies touching on wildlife-human conflicts and interactions with the pastoral communities will provide deeper insights on the conflicts

and ways to promote co-existence. The research findings will inform policy on matters pertaining to sustainable dryland management for enhanced livelihoods. Generally the programs are conducting research relevant for development of the region and are within the same work stipulated in RUFORUM's 2005-2015 strategic plan (RUFORUM, 2005). As evidence of high quality research the three older programs have so far generated 41 articles in peer-reviewed journals and will collectively produce 498 articles and 166 theses, an important contribution to the body of knowledge. The programs have mainly trained males with females making up 41% of the total, enrollment and graduation rates have declined and programs have encountered financial challenges. These issues are discussed in 10.2.

10.2 Issue of gender balance, enrollment, graduation rate and financial challenges

10.2.1 Gender concerns in the training

The programs are attuned to gender mainstreaming and females make up 41% of the total students trained. Agricultural and Rural Innovations and Food Science and Nutrition programs have trained 36 females, representing 59% of the total trained by the two programs. On the contrary, most persons trained by the other three programs are males and females make up 31%, mainly because the number of females among human resource pool is low. This is compounded by the fact that for family reasons, some registered females discontinued studies mid-stream. Considering that enrollment into agriculture programs in some tertiary institutions in SSA has been on the decline and because not enough females are enrolling through the conventional entrants into the programs, efforts need to be made to broaden access to agriculture education. Right from lower secondary level, females should be encouraged to study agriculture and other science subjects. In addition, there should be deliberate efforts to provide accurate information on the broad range of agriculture career opportunities so as to stimulate interest in the profession. This could be achieved by showcasing success stories through use of emerging technologies and approaches such as open education resources. Another avenue could be to tap into science and agriculture female professionals at certificate, diploma and bachelors degree levels by sparking their interest to advance qualifications. To achieve this, agriculture programs could be recast in modern and more appealing terms and aggressive marketing campaigns launched. Access can also be increased by offering certain courses on-line. For example, the Dryland Resource Management, Plant Breeding and Biotechnology and Soil and Water Management programs have already trained at least two cohorts. With the experience gained, certain courses could be offered online which could be attractive for women with families by shortening

residency in foreign countries, thus encouraging them to complete studies. Increasing the number of female faculty members to serve as role models could also spark interest in the programs. In some faculties females are under-represented, example the department hosting Dryland Resource Management program has 23 teaching staff and only 2 are females. The option of having family package to cater for accompanying family members may not be feasible owing to the financial constraints and the high demand for scholarships.

10.2.2 Low graduation rates

The programs were designed to graduate students in 3-4 years and this has been achieved to some extent. Dryland Resource Management, and Plant Breeding and Biotechnology have graduated 50% of students in the first cohorts in exactly 36 months. Similarly, Soil and Water Management program is likely to graduate 38% of the first cohort within the stipulated 48 months. However, graduation rate is low and about 42% of students who have been enrolled for 3-4 years have not complete studies within the stipulated period. Consequently, Dryland Resource Management and Plant Breeding and Biotechnology programs have 5 and 3 cohorts in the pipeline respectively. Details of the students' progress are provided in table 30.

Delays in completion can be attributed to multiple factors. There is an indication that self-sponsored students who are working on part-time basis are devoting less time to studies and this may be contributing to delays in completion. Further, when students conduct research in home countries, there is less interaction with supervisors and in some cases this could mean limited guidance. In addition, some students have reported delays in getting guidance from supervisors, requested that monitoring and supervision during research phase be streamlined, in addition to fast tracking the processing of theses. The last was also recommended by teaching staff. In a few cases students have completed research but are unable to raise funds to cater for publisher fees for articles submitted; yet publication in peer-reviewed journals is a requirement for graduation. Further, heavy workload was reported by some teaching staff and this could be contributing to the low graduation rate. The compounded effect of "inadequate supervision", students devoting less time to studies, delays in publishing research findings and slow processing of thesis could be contributing to delays in completing studies and there is need for closer monitoring of students' progress and extra efforts made to increase graduation rates.

30: Progress of students registered in PhD Dryland Resource Management, Plant Breeding and Biotechnology and Soil and Water Management programs between 2008 and 2010

PhD program	Total students registered	Students progress		
		Graduated	Submitted thesis	Not submitted thesis
Dryland Resource Management	26	14	3	9 (35 %)
Plant Breeding and Biotechnology	22	11	3	8 (36%)
Soil and Water Management	16	0	6	10 (63%)
Total	64	25	12	27(42%)

10.2.3 Decline in enrollment in the programs

As depicted in table 31, enrollment in the programs has been on the decline. Of all applicants, 53% did not register due to financial constraints. Completion of studies within a short time was singled out as a unique attribute of the programs and the low graduation rate could be discouraging potential students from registering. Further, a significant number of students in the programs are self-sponsored and some are working on part-time basis. This category of students has challenges in financing research activities. As word of mouth is the main avenue through which students learn of the programs, these students could be passing negative feedback to the would be students and contributing to decline in enrollment.

Table 31: Enrollment and countries of origin of students registered in the five PhD programs

PhD Program	Students registered in every cohort, total registered and applicants per program						
	1 st cohort	2 nd cohort	3 rd cohort	4 th cohort	5 th cohort	Total registered	Total applicants
Dryland Resource Management	18 (8)	8 (2)	9 (3)	10 (2)	2 (2)	47	159
Plant Breeding and Biotechnology	22 (5)	5 (3)	4 (4)	-	-	-	*

Soil and Water Management	16 (8)	10 ()	-	-	-	-	Over 50
Food Science and Nutrition	6 (4)	-	-	-	-	-	14
Agricultural and Rural Innovation at:							
Makerere University	28 (1)	13 (5)	-	-	-	-	Over 80
Egerton University	9 (1)	5 (2)	-	-	-	-	21
Sokoine University of Agriculture	3 (1)	-	-	-	-	-	10
() Denotes total number of students countries of origin, * information not available, - did not have an intake							

For programs which have trained at least two cohorts, some courses could be offered online as a strategy to boost enrollment. Important to note is that there has been a significant investment in Information and Communications Technology in the host universities and Virtual and Open Learning would cater for students who are unable to study at the universities through the traditional full-time on campus mode. This would encourage participation by students with limited funding who would have the flexibility to access the courses anywhere and anytime and at individual pace. Several studies have come to the conclusion that graduate training in SSA will have to be financed by African governments with support of local donors, businesses, international development partners and the students themselves. There is need to explore means to forge more mutually beneficial linkages between the universities and the private sector for the later to demand innovations which they can finance. In addition, political will must be generated to support training and avenues for lobbying need to be identified.

10.2.5 Sustainability and Centers of Excellence (CoE)

The established CoE have generated high caliber professionals who have been absorbed into the market and also shown high degree of generative capacity in terms of new knowledge. Research findings have been published in peer reviewed journals. This is a good indication of high quality research being done and that technologies developed such as elite crop varieties are new public goods. The CoE are also attracting international attention. In the initial years, the CoE were operating at a higher capacity but as funding constraints set in the human resource and facilities are currently under-utilized due to low numbers of

students enrolled. The centers should continue to be strengthened and this requires significant resourcing to support research, staff mobility and students from the region. The programs have mainly (89%) trained civil servants and this important contribution to human resource should be brought to the attention of the governments of the host institutions and avenues for their support in running the programs explored. Similarly, the high caliber scientists trained will feed into implementing the CAADP agenda. At regional and continental level there should be concerted fund raising efforts to support the programs.

Further, partnerships and support from development partners need to be explored. For example, the Board of International Food and Agriculture Development undertook a study to identify ways to address the needs of feed the future (FTF) countries to develop capacity for agriculture and economic development. The report (BIFAD, 2014) recommended that US universities be paired with flagship universities in each FTF countries to foster development of CoE. The study also recommended investment in infrastructure for ICT to foster linkages with global digital networks to expand forms of access to learning. Twenty two RUFORUM member universities are located in 9 FTF countries and they could exploit this window.

10.3 Conclusions on the on-going RUFORUM Regional training programs

1. The RUFORUM regional PhD training programs are innovative, relevant to stakeholder needs, are in demand and have trained 166 high caliber scientists. Faculty based in 14 universities and located in 9 African countries have been trained. In addition, the infrastructure and visibility of the host institutions have been enhanced. Also, senior officers in the Ministry of Agriculture and Livestock, Research Scientists and Private Sector employees have been trained. In essence, RUFORUM regional training programs have trained high caliber scientists for faculty to train more professionals to serve the African continent, trained research scientists for research and extension bodies and also provided a pool of highly trained technical experts to guide development process and policy frameworks.
2. Running the RUFORUM regional programs has also contributed to improved quality of training in host universities through deliberate balance of theoretical and practical components, attaching students to relevant institutions for mentoring and enhancing practical skills, offering promoting use of multiple and modern tools in delivery.
3. Being regional, the RUFORUM programs have also enhanced international networks amongst professionals and also improved linkages between universities and other actors in the agriculture sector, particularly communities.

4. As a result designing programs with inbuilt flexibility to specialize in ones area of interest, offer training on modular or semester basis and admit students from a wide academic background, the RUFORUM regional programs have contributed to attractiveness of agriculture programs. Running the RUFORUM regional training programs has also influenced the move towards offering PhD by coursework and thesis and in a sense fast tracked the establishment of Directorates of Academic Quality Assurance in host universities.
5. The training programs have engineered development of elite varieties of drought tolerant indigenous crops, contributed to approaches for sustainable use of natural resources for enhanced livelihoods, addressing challenges of climate change and food insecurity in the region.

10.5 GAPS

The existing programs are imparting core discipline depth and fundamental skills. In the future, it is important to initiate training programs in critical areas including 1) postharvest handling, value addition and agribusiness 2) environmental degradation and e-waste, 3) advanced design of irrigation infrastructure and 4) Design fabrication of production and food processing equipments appropriate for smallholder farmers and 5) Animal and Livestock production as outlined below.

Post harvest handling, value addition and agribusiness: Sub Saharan Africa loses significant amount of produce from postharvest related losses which result from use of inappropriate agronomic practices, poor handling during and after harvest. There is need to address skill gaps in the area of postharvest handling. Further, most smallholder farmers in SSA do not add value to their products and as a result do not derive full benefit from the produce. Agricultural value addition transforms primary products into products of greater worth, with a longer shelf-life and earn producers more income. It is important to initiate postgraduate programs with a focus on post harvest handling, value addition and agribusiness.

Environmental degradation, conflict resolution and e-waste: Exploration for minerals resources especially in the arid zones are on the increase in Eastern, Central and Southern Africa and mining activities are underway. These activities are likely to promote environmental degradation. Further there are concerns over piling amounts of e-waste which are threatening human and environmental health by releasing harmful substances. Inappropriate and unsafe management practices related to collection, handling, recycling and disposal of end-of-life of e-wastes is common. Studies conducted by Kenya Industrial Research and Development Institute in hotspot dumping sites in Nairobi revealed high levels of

toxic heavy metals in the soil and water. This has a bearing on sustainable resource management, human health and food security. The threat is real and a stakeholders' conference was convened in Nairobi in May 2014 to discuss issues of e-waste. In light of emerging environmental challenges, **it is important to initiate postgraduate training with a focus on environmental degradation, conflict resolution and e-waste.**

Advanced design of irrigation infrastructure: Agriculture in SSA is mostly rain-fed and with the challenges arising from climate change, many governments are putting emphasis on irrigated agriculture as entry points for integrated farming for crop, livestock and fish production. The move is aimed at addressing food insecurity, creating wealth and employment. Water is already a scarce resource and there is need to have irrigation systems and designs that are water efficient. It is therefore important to initiate postgraduate training program focusing on Irrigation engineering with emphasis on advanced design of irrigation infrastructure, including use of appropriate soft ware to complement the program currently offered at SUA.

Design fabrication of production and food processing equipments. Stakeholders raised concerns over the aging farming population and need to attract youth into agriculture. To some extent, this can be achieved by encouraging irrigated as opposed to rain-fed production, incorporating courses targeting the youth including putting emphasis on farming as a business, commodity exchange and warehouse structured grain marketing, emerging livestock species, Urban and Peri-Urban agriculture and designing appropriate machines for smallholder agriculture to ease drudgery in land preparation, planting, weeding, threshing, drying, grating, milling and other processes. This could spark interest in the youth to engage in farming. In the future, **it would be important to initiate training probably at diploma level with a focus on design fabrication of appropriate implements for production and food processing equipments.**

Postgraduate training in Animal and Veterinary Medicine: Livestock is an important source of protein, manure and draught for crop production and source of livelihood for millions of families. However, livestock productivity is low mainly due to seasonality and poor quality of feed and incidences of pests and diseases. Support in postgraduate training in animal and Veterinary Medicine would enhance the use of resources at the University of Nairobi Faculty of Veterinary Medicine in support of livestock production. It is important to inject modern digitalised laboratory equipments to enhance diagnostics, support postgraduate training especially in leather science, artificial insemination and fertility management, surveillance and control of zoonotic diseases and promote use of modern reproductive technologies especially ovum pickup and embryo transfer.

11: PHD ANIMAL AND VETERINARY MEDICINE AT UNIVERSITY OF NAIROBI

11.1 Background

The Regional Universities Forum for Capacity Building in Agriculture commissioned the study on PhD in Animal and Veterinary Medicine offered at the University of Nairobi so as to obtain evidence base for investing in livestock component of agriculture and also guide implementation. This information was obtained by visiting the Faculty of Veterinary Medicine at the University of Nairobi and holding discussions with the Dean, Chairpersons of the relevant departments and representatives of the teaching staff. The information sought focused on the capacity of the faculty, opportunities and challenges to advancing training in animal and veterinary Medicine at the University of Nairobi and the key findings are provided below.

11.2 Key findings of the study

The University of Nairobi has over 50 years training experience in Animal and Veterinary medicine. The postgraduate training in animal and veterinary medicine is offered by the Faculty of Veterinary Science situated in the College of Agriculture and Veterinary Sciences (CAVS) at Kabete campus. The faculty consists of five departments namely, clinical studies, veterinary pathology and microbiology, animal production and nutrition, public health, pharmacology and toxicology and animal anatomy and physiology. With the exception of the department of animal anatomy and physiology which is based at Chiromo campus, all the other departments are located in CAVS.

The faculty is endowed with over 50 highly qualified and experienced teaching staff at the levels of full professor, Associate professor, Senior lecturer, Lecturer and tutorial fellow and the staff are actively involved in research activities. In addition, the faculty has good infrastructure which supports quality tertiary training, including lecture theatres, seminar halls, laboratories, clinics for both small and large animals, surgical theatres and a fully fledged nutritional laboratory for livestock feed analysis. In addition, the faculty has a veterinary farm of about 360 acres which has over 200 cows in addition to a poultry unit and piggery, located close to CAVS. The laboratories are mainly used for training but also serve the livestock farmers and the nation at large. For instance, the toxicology laboratory in the public health, pharmacology and toxicology department is accredited and undertakes toxicology studies for the pesticide control board of

Kenya. This service is mainly offered to the pesticide companies which want to introduce new pesticide products into the Kenyan Market. The laboratory is also involved in monitoring of antibiotics and pesticide residuals in livestock food products (milk, honey, meat and even fish) especially for the export market. Because the food safety standards are ever changing, the laboratory needs to upgrade most of the existing equipments to modern digitalized equipments to be able to apply modern diagnostic techniques.

Similarly, the clinical chemistry laboratory used for disease diagnosis also needs injection of modern equipments as the faculty faces challenges in diagnosis, especially when there are outbreaks of such diseases as foot and mouth. The important role of disease diagnosis cannot be over emphasized especially with frequent outbreaks of [Zoonotic diseases](#) such as anthrax in the region. These are contagious diseases and are spread between animals and humans. The diseases are transmitted to humans in a variety of ways including consumption of diseased or contaminated animal products and although the “one health” concept requires collaboration between human and animal health personnel in control of zoonotic diseases, prevention of transmission between animals and from animals to humans is the responsibility of veterinarians. There has been a resurgence of zoonotic diseases, in the region. Capacity building through research is needed in order to formulate and implement effective disease surveillance and control programs.

In terms of human capacity, the faculty lost its best trained biometrician and currently relies on an epidemiologist who is not trained in biometry. For advanced skills especially for research work by both students and teaching staff, the faculty relies on the biometrician from the faculty of agriculture, whenever he can spare sometime. To enhance learning, the faculty needs a trained biometrician to support both students and faculty members.

In terms of postgraduate training, the faculty offers over 15 programs at Masters degree level and these are also offered at PhD level. The programs have an international outlook although the student population is low, mainly because of financial constraints faced by students. One of the most recent programs launched in 2013 is Masters in leather science and is also offered at diploma and bachelors degree levels. The program was initiated in response to demand by stakeholders, including the government of Kenya which was spending a lot of money in training staff overseas. The program is attracting students from Liberia, Kenya, South Sudan, Uganda and the Middle East. Support to leather program could increase the resilience of the communities in the drylands and also promote sustainable land use by establishing tanneries thus creating job opportunities, adding value to the livestock skin product and diversifying dryland

enterprises. Leather is an important source of income especially from export earnings. One key constraint is that the faculty relies wholly on part time lecturers to teach this course.

In addition, the faculty has a vision to promote the use of modern reproductive technologies such as ovum pickup and embryo transfer. The process involves ovum pick up from a cow followed by *in vitro* fertilization (fertilization outside the uterus of the female) and sex determination of the embryo. Hormones are administered to the cow to induce super ovulation so as to yield up to 50 ova per year, which translates into an equivalence of 50 calves (from one cow) annually. There is demand for sexed embryos especially by dairy farmers who are currently importing them from New Zeland at a prohibitive cost of Ksh 50,000/ (over USD 600) each. In addition, the conception rate of imported embryos is relatively low and there is need to optimize conditions to enhance conception rate. The technology could be instrumental in helping pastoralists restock herds especially following spells of drought and also contribute to increased milk production in the intensive systems which are under threat by the expansion of the real estate sector. The faculty has a laboratory within the department of clinical studies and trained staff (PhD level) but lacks the necessary equipments to promote use of modern reproductive technologies, specifically ovum pickup and embryo transfer.

As far back as 2001, the Faculty of Veterinary Medicine has been offering a certificate course (4-6 weeks duration) in artificial insemination and fertility management to secondary school leavers. The aim of the course is to build capacity to promote livestock reproduction and impact the livestock sector. In 2013, the veterinary surgeons and veterinary para-professionals act regulation stipulated that such courses could only be offered to animal health certificate holders. This was to ensure that trainees of the particular course possessed wider knowledge and competences to address the multiple challenges which face livestock farmers. The course has since been reviewed and admission criterion adjusted accordingly. Support of the program which focuses on livestock reproduction could significantly impact the livestock sector.

The involvement of RUFORUM could substantially increase the quality and focus of training opportunities available to graduate students and staff in the region and optimise use of resources at the faculty of Veterinary Medicine. It is important to inject modern digitalised laboratory equipments, support postgraduate training especially in leather science, artificial insemination and fertility management, surveillance and control of zoonotic diseases and promote use of modern reproductive technologies especially ovum pickup and embryo transfer.

12 RECOMMENDATIONS

Recommendations targeting on-going programs

1. The PhD Dryland Resource Management, Plant Breeding and Biotechnology and Soil and Water Management programs have been running for over 5 years. ***It is recommended that the curricula be reviewed and emerging issues incorporated and depth of coverage scaled down to create more time for hands on activities. Similarly, Food Science and Nutrition curriculum be reviewed to ensure that it incorporates courses with a focus on communication, entrepreneurship, management, leadership, team work, field exposure and more hands on activities and also diversify learning approaches.***
2. The programs are imparting discipline depth and fundamental skills but graduation rate is low, ***it is recommended that students' research be monitored more closely to address bottlenecks to fast track completion of studies and if necessary offer the programs on alternate years.***
3. Teaching staff in at least three programs encountered challenges during implementation. ***It is recommended that more support be accorded to teaching staff through short courses, more field exposure to facilitate further contextualization of learning materials and enhance staff mobility to reduce workload.***
4. All programs are taught by highly qualified and experienced faculty members but noting the advanced age distribution for staff teaching Soil and Water Management, Agricultural and Rural Innovation at SUA and Dryland Resource Management, ***it is recommended that a new generation of professionals be trained.***
5. ***Female enrollment is low and make up 41% of the total trained. It is recommended that the universities rebrand agriculture programs, review curricula and incorporate courses targeting the youth and also take lead in providing career guidance to secondary school students and marketing the programs to spark more interest in professions in agriculture.***
6. ***Most programs have encountered financial challenges and also registered decline in enrollment. For programs which have been running for at least 4 years it is recommended that some courses be offered online to increase access by more people. Further, there is need to mount an aggressive fund raising campaign to ensure sustained support for the program to cater for scholarships, support staff mobility and experiential learning***

Recommendations targeting future programs

7. Sub Saharan Africa loses significant amount of produce from postharvest related losses which result from use of inappropriate agronomic practices, poor handling during and after harvest. There is need to address skill gaps in the area of postharvest handling. Further, most smallholder farmers in SSA do not add value to their products and as a result do not derive full benefit from their produce. Agricultural value addition transforms primary products into products of greater worth, with a longer shelf-life and earn producers more income. It is recommended that **postgraduate program with a focus on post harvest handling, value addition and agribusiness be initiated.**
8. Exploration for minerals especially in the arid zones are on the increase in Eastern, Central and Southern Africa and mining activities are underway. These activities are likely to promote environmental degradation. Further there are concerns over piling amounts of e-waste which are threatening human and environmental health by releasing harmful substances. Inappropriate and unsafe management practices related to collection, handling, recycling and disposal of end-of-life of e-wastes is common. Studies conducted by Kenya Industrial Research and Development Institute in hotspot dumping sites in Nairobi revealed high levels of toxic heavy metals in the soil and water. This has a bearing on sustainable resource management, human health and food security. The threat is real and a stakeholders' conference was convened in Nairobi in May 2014 to discuss issues of e-waste. In light of emerging environmental challenges, **it is recommended that postgraduate training with a focus on environmental degradation, conflict resolution and e-waste be initiated.**
9. Agriculture in SSA is mostly rain-fed and with the challenges arising from climate change, many governments are putting emphasis on irrigated agriculture as entry points for integrated farming for crop, livestock and fish production. The move is aimed at addressing food insecurity, creating wealth and employment. Water is already a scarce resource and there is need to have irrigation systems and designs that are water efficient. **It is therefore recommended that the postgraduate training program offered at SUA be upgraded to PhD level with a focus on Irrigation engineering and with emphasis on advanced design of irrigation infrastructure, including use of appropriate soft ware.**

10. Stakeholders raised concerns over the aging farming population and need to attract youth into agriculture. To some extent, this can be achieved by encouraging irrigated as opposed to rain-fed production, incorporating courses targeting the youth including putting emphasis on farming as a business, commodity exchange and warehouse structured grain marketing, emerging livestock species, Urban and Peri-Urban agriculture and designing appropriate machines for smallholder agriculture to ease drudgery in land preparation, planting, weeding, threshing, drying, grating, milling and other processes. This could spark interest in the youth to engage in farming. In the future, **it is recommended that training probably at diploma level with a focus on design fabrication of appropriate implements for production and food processing equipments be initiated be initiated.**

11. Livestock is an important source of protein, manure and draught for crop production and source of livelihood for millions of families. However, livestock productivity is low mainly due to seasonality and poor quality of feed and incidences of pests and diseases. Support in postgraduate training in Animal and Veterinary Medicine would enhance the use of resources at the Faculty of Veterinary Medicine in support of livestock production. ***It is recommended that efforts be made to inject modern digitalised laboratory equipments to enhance diagnostics, support postgraduate training especially in leather science, artificial insemination and fertility management, surveillance and control of zoonotic diseases and promote use of modern reproductive technologies especially ovum pickup and embryo transfer***

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APPENDICES

Appendix A1: Publications by two students registered for PhD Soil and Water Management

Phiri, A. T., Msaky, J. J., Mrema, J., Kanyama-Phiri, G. Y., & Harawa, R. (2013). Assessment of Nutrient and Biomass Yield of Medium and Long Duration Pigeon Pea in a Pigeon-Pea-Groundnut Intercropping System in Malawi. *Journal of Sustainable Society*, 2(1), 36-48.

Phiri, A. T., Msaky, J. J., Mrema, J., Kanyama-Phiri, G. Y., & Msanya, B. M. (2014). Effect of Pigeon Pea-Groundnut Intercropping System on Selected Soil Properties. *International Journal of Plant & Soil Science*, 3(4), 397-407

Phiri, A. T., Weil, R. R., Kanyama-Phiri, G. Y., Msaky, J. J., Mrema, J., Grossman, J., & Harawa, R. (2014). In situ assessment of soil nitrate-nitrogen in the pigeon *pea-groundnut intercropping-maize rotation system*: Implications on Nitrogen management for increased maize productivity. *International Research Journal of Agricultural Science and Soil Science*, 4 (2), 13-29

Tolera, A., & Dhaba, F. (2004). Determination of the Optimum Proportion of Faba Bean and Field Pea in mixed cropping at Shambo, Western Oromiya, Ethiopia. In: *Crop Science Society of Ethiopia (CSSE). Sebil. Vol. 10. Proceeding of the Tenth Conference, 19 - 21 June 2001. Addis Ababa, Ethiopia*

Tolera, A., & Dhaba, F. (2005). The Influence of Seed rate and Weeding Control on Agronomic Performance of Faba Bean (*Vicia fabae*) In: *Arem. Ethiopian Weed Science Society*.

Tolera, A., & Dhaba, F. (2006). Effect of ploughing frequency, seed rate and weeding frequency on agronomic parameters of faba beans on farmers' field around Shambo, Western Oromiya. pp. 124- 134. In: *Sebil Vol. 11. Proceeding of the Eleventh Conference of Crop Science Society of Ethiopia*

Tolera, A., & Mathews, B. (2004). Agronomic and economic evaluation of break crops and management practices on the grain yield of wheat at Shambo, western Oromiya. In: *The Twelfth Regional Wheat Workshop for Eastern, Central and Southern Africa, Nakuru, Kenya. pp. 35- 40.*

Appendix A2: Placement of sample PhD *Dryland Resource Management* graduates

Name of Student	Placement after graduation	Position before PhD studies
Robert mulekebe	Head of Department <i>Kyambogo University, Uganda</i>	<i>Graduate Assistant</i>
<i>Emmanuel Zziwa</i>	<i>Lecturer, Makerere University, Uganda</i>	Assistant lecturer
Eunice Githae	Lecturer, Masai Mara University , Kenya	Assistant lecturer
Kibet Staline	Assistant Lecturer University of Nairobi, Kenya	Assistant Researcher National Museums, Kenya
Elizabeth Nduku Muthiani	Deputy Centre Director, Kiboko Kenya Agriculture Research Institute	Researcher
Nalule Sarah Agnes	Senior Lecturer Makerere University, Uganda	Lecturer
Oscar Koech	Assistant Lecturer, University of Nairobi, Kenya	Unemployed
Baaru Mary Wamuyu	Lecturer, Kenyatta University, Kenya	At Ministry of Agriculture and Livestock
Judith Mbau	Assistant Lecturer University of Nairobi , Kenya	Assistant Researcher National Museums of Kenya
Mugerwa Swidiq	Senior Researcher National Livestock Resources Research Institute, Uganda	Researcher

Appendix A3: Publications by 6 graduates of PhD Dryland Resource Management program

1. Debela Hunde Feyssa, Njoka, J.T., Zemedede Asfaw³ & Nyangito, M.M..Nutritional value of *Grewia flavescens*: Implications for household food security in north eastern Rift Valley of Ethiopia. Third RUFORUM Biennial Meeting 24 - 28 September 2012, Entebbe, Uganda.
2. Githae E.W., Gachene C.K.K., Njoka J.T and Omodi F.S (2013) Nitrogen fixation by natural populations of *Acacia senegal* in the drylands of Kenya using ¹⁵N natural abundance. *Arid Land Research and Management* 27:1 – 10 ISSN:1532-4982.
3. Nalule A.S., Mbaria J. M. and Kimenju J. W. 2013. In vitro anthelmintic potential and phytochemical composition of ethanolic and water crude extracts of *Euphorbia heterophylla* Linn. *Journal of medicinal plant Research*, Vol. 7(43), pp. 3202-3210, 17 November, 2013.
4. Muthiani, E N, J T Njoka, P I D Kinyua and G K Gitau² 2011 Conservation or Degradation: Application of remote sensing and GIS to determine effects of Community Wildlife Sanctuaries on land cover in pastoral areas .Paper presented at the AGRO conference held at the University of Nairobi, College of Agriculture and Veterinary Sciences on 26- September 2011
5. Zziwa, E., Kironchi, G., Gachene, C., Mugerwa, S and Mpairwe, D., 2012. Production systems, land cover change and soil factors affecting pasture production in semi-arid Nakasongola. *International Journal of Agronomy and Agricultural Research*, 2 (7): 6-17
6. Debela Hunde Feyssa, Jesse T. Njoka,Zemedede Asfaw and M.M. Nyangito.2012. Comparative analysis of indigenous knowledge on use and management of wild edible plants : The case of central East Shewa of Ethiopia. *Journal of Ethnobotany Research & Applications*. 287-304.
7. Githae E.W., Gachene C.K.K and Njoka J.T (2011) Soil physicochemical properties under *Acacia senegal* varieties in the dryland areas of Kenya. *Journal of Plant Science* 5: 475 – 482 ISSN:1996-0824
8. Nalule AS, Mbaria J M, Kimenju J W and Olila D. Ascaricidal activity of *Rhoicissus Tridentata* root-tuber ethanolic and water extracts. *Livestock Research for Rural Development* 24 (8) 2012
9. Muthiani, E.N, J T Njoka, P I D Kinyua and G K Gitau 2011. Paper presented at the End of KASAL Program Conference held at KARI Head quaters on 9th -12 August 2011, Nairobi, Kenya. – Submitted to *Journal of Human Dimension of Wildlife-* in Press.Zziwa, E., Kironchi, G., Gachene,

- C., Mugerwa, S and Mpairwe, D., 2012. The dynamics of land use and land cover change in Nakasongola district. *Journal of Biodiversity and Environmental Sciences*, 2 (5): 61-73
10. Debela Hunde Feyssa, Jesse .T. Njoka, Zemedede Asfaw and M.M.Nyangito. Uses and management of *Ximenia americana*, Olacaceae in semi-arid east Shewa, Ethiopia. *Pak. J. Bot*,44(4): 1177-1184
 11. Githae E.W., Gachene C.K.K., Njoka J.T., Odee D.W and Omondi S.F (2011) Genetic diversity of gum arabic-producing *Acacia senegal* varieties in Kenya using Inter-Simple Sequence Repeats (ISSR) and Chloroplast Simple Sequence Repeat (cpSSR) markers. In: CTA and FARA (Eds.). *Agricultural innovations for sustainable development*. Accra, Ghana. Vol 3 (2) pp 31 – 37 ISBN: 978-9988-8373-2- 4.
 12. Nalule AS, Mbaria JM and Kimenju JW. 2013. *In vitro* anthelmintic potential of *Vernonia Amygdalina* and *Secamone Africana* on gastrointestinal nematodes. *Agric. Biol. J. N. Am.*, 2013, 4(1): 54-66
 13. Zziwa, E., Mugerwa, S., Owoyesigire, B. and Mpairwe, D., 2012. Contribution of integrated catchment and surface water management to livestock water productivity in pastoral production systems. *International Journal of Biosciences*, 2 (5): 52-60
 14. Land use and land cover changes and their implications to human wildlife conflicts in southern Kenya ; *Journal of geography and regional planning*.
 15. Linking local and communities to land use and land cover changes using participatory geographic information systems.

Appendix A3: Publications by 5 graduates of PhD Plant Breeding and Biotechnology program

1. Muturi PW, Rubaihayo P, Mgonja M, Kyamanywa S, Sharma HC and Hash CT, 2012. Novel source of sorghum tolerance to the African stem borer, *Busseola fusca*. *African Journal of Plant Science* Vol. 6(11), pp. 295-302
2. Gasura E and Setimela P 2014 .variability and association of grain filling traits with grain yield in tropical maize breed lines
3. J.K. Mwololo, S. Mugo, T. Tadele and S.W. Munyiri 2013: Evaluation of traits of resistance to the maize weevil. *International Journal of Agriculture and Crop Sciences*, Vol. 6: 926-933
4. Maphosa M, Talawana .H and Tukamuhabwa P 2013: Assessment of comparative virulence and resistance in soybean using field isolates of soybean rust .
5. Munyiri S., Mugo S. N., Otim M., Tefera T., Beyene Y., Mwololo J. K and Okori P. 2013. Responses of tropical maize landraces to damage by *Chilo partellus* stem borer. 2013. *African Journal of Biotechnology* 12 (11):1229-1235
6. Njenga P, Edema R , Kamau J 2014. Combining ability for beta-carotene and important qualitative traits in a cassava F1 population. *Journal of plant breeding and crop science*. In press
7. Gasura E 2013. Exploiting grain filling duration to improve yield early maturing maize
8. Muturi P.W, Rubaihayo P, Mgonja M, Kyamanywa S, Kibuka J and Sharma HC, 2012. New sources of resistance to spotted stem borer, *Chilo partellus* in sorghum. *Int. J. Agr. & Agri. R.* Vol. 2, No. 8, p. 18-28.
9. J.K. Mwololo, S. Mugo, P. Okori., T. Tadele, M.Otim. and S.W. Munyiri 2012: Sources of Resistance to the Maize Weevil *Sitophilus zeamais*. *Journal of Agricultural Science*, Vol. 4: 206-215.
10. Maphosa M Talwana H Gibson P and Tukamuhabwa P 2012. Combining ability for resistance to soybean populations field crop research 130:1-7.
11. Munyiri S. W., Mugo S. N. Okori P., Otim M. and Mwololo J. K. 2013. Mechanisms of resistance in tropical maize inbred lines to *Chilo partellus* (Lepidoptera: Crambidae). *Journal of Agricultural Science* 5 (7): 51-60.
12. Njenga P , Edema R , Kamau J and Abong' G. Agronomic performance and carotenoid content of Kenyan yellow-fleshed cassava clones. Submitted to the journal of agricultural sciences
13. Genotype by environment interaction advanced soybean lines for grain yield in UG African Crop Science Journal 20

14. Gasura e Setimela Ps RT 2013. Simple sequence repeats markers for filling traits and yield components in tropical maize Journal of agriculture sciences (submitted)
15. J.K. Mwololo, S. Mugo, P. Okori., T. Tadele, Y. Beyene, M. Otim. and S.W. Munyiri 2012: Phenotypic and Genotypic Variation in Tropical Maize Inbred Lines for Resistance to the Maize Weevil and Larger Grain Borer. International Journal of Agricultural Science and Research, Vol. 2: 41-52
16. J.K. Mwololo, S. Mugo, P. Okori., S.W. Munyiri S. Kassa, T. Tadele, M. Otim. and Y. Beyene 2012: Resistance of Tropical Maize Genotypes to the Larger Grain Borer. Journal of Pest Science, Vol. 85: 267-275
17. Tukamuhabwa M 2011. State of knowledge in developing durable resistance to soybean Rust in the developing world Food & Agriculture Organization of the United Nations Rome Italy