Situation Analysis of ICT Capability and Infrastructure in RUFORUM Universities

Final Report

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1. Executive Summary: From Infrastructure to Education

Universities in Eastern, Central and Southern Africa, and particularly their schools of agriculture, are at a pivotal point in their use of information and communications technology (ICT) for research, teaching and extension. After years of effort, the crippling effect of limited data communications bandwidth, particularly Internet access, is about to be relieved in many areas. Also, the cumulative effect of dedication to improving ICT at many universities is being felt in new policies, stronger ICT departments and better equipment.

At the same time, this success is allowing universities to enter a new and in many ways tougher phase. The infrastructure may be in place, but in most cases the benefits of ICT to end users in research, learning and distance education continue to be limited. In particular, schools of agriculture at RUFORUM universities are not using ICT as a collective institutional tool, although many scholars are benefiting independently. Going the next distance, from infrastructure to effective education using ICT requires more changes in how *people* decide to teach, learn new methods and effectively implement them. Although the infrastructure is not ideal anywhere yet, this more complex task is the challenge being faced.

This report is the result of a study carried out in the summer of 2009 by RUFORUM, an initiative by a consortium of 25 member universities in Eastern, Central and Southern Africa to develop the capacity of universities engaged in agricultural and rural development. The purpose of the study was to benchmark the ICT capability at member universities, so that policies and plans for specific e-learning initiatives can be structured appropriately.

Respondents from 25 of RUFORUM's 25 universities (100%) participated in the study, which consisted of visits to several universities and data collection through questionnaires at all of them. The study examined the status of ICT policies and plans, ICT infrastructure, both technical and bureaucratic, the availability of key resources such as computers, bandwidth and online databases, how students and staff acquire computer skills, the current status of e-learning, and how academic staff in schools of agriculture use ICT.

The study adopted the approach that improving the use of ICT in agricultural education must combine knowledge from three ongoing investigations. First, approaches to improving agriculture in national development have gone through a major paradigm shift in the last decade. It is no longer a question of injecting new scientific knowledge into the farm, but rather a wider effort involving the surrounding physical and economic environment and post-harvest considerations and taking place in a cooperative fashion with much more multidirectional communication. Second, lessons have been learned from the global implementation of ICT over the last three decades that must be recognized if we are not to repeat mistakes made elsewhere. Third, the particular history and situation of African universities must be taken into account, as several recent studies of ICT capacities show.

What this means is that ICT has the potential to fit nicely into the needs of the new agriculture, particularly in how it facilitates communications and the necessary associated learning. But at the same time, we must not fling technology at the problem without adequate consideration of the subtleties of building effective communication systems in a resource-constrained environment.

In addition to benchmarking ICT capability, recommendations are made about how the situation can be improved.

1.1. Findings

The key findings are that RUFORUM member universities, like other African universities that have been studied recently, still have much to do to bring their level of ICT readiness up to where it can provide an adequate level of support to students, academic staff and other stakeholders. There are still not enough computers for students. Bandwidth is still below ideal levels and still costs too much. E-learning is in its infancy at most institutions. Academic staffs in faculties of agriculture mostly have computers, and they use them individually for email, Internet access, research, and data analysis. What they do not do is to use them much for instruction or collaboration.

At the same time that much remains to be done, considerable progress has been achieved. Ninety-two percent (92%) of member universities have ICT policies in place or under active consideration. Ninety percent (90%) have management information systems active in their finance departments and their libraries. Overall average bandwidth has increased to 6.84 megabits per second (mbps), where a similar study revealed an average bandwidth of 1.25 mbps only four years ago. National Research and Education Networks (NRENs), consortia of universities to purchase connectivity, have effectively delivered lower prices in several countries and promise to do so in more countries as their NRENs become operational.

Of particular concern is the state of e-learning, the actual application of ICT to real, ongoing educational activity. ICT is in highly limited use in most classrooms. Learning management systems have been implemented at only a minority of RUFORUM universities, and most of those have been implemented recently. With a couple of exceptions, they are just getting started. E-content, which actively uses computer-based techniques to guide learning, has been created effectively in occasional departments, but it is hardly ever more than one or two departments per university. In particular, only one faculty of agriculture reported including any e-content in its curriculum.

When these pluses and minuses are combined, a vision of uneven deployment emerges, both within universities and among them. One has hundreds of e-courses, another has no central ICT department, and its ICT managers complain of a lack of direction in what they should do beyond “putting out fires.”

There is evidence of commitment to ICT in the central administration, but not one that has propagated throughout the university. For example, 60% of universities have centralized ICT departments, often reporting high up in the administration, but only 38% have any incentives at all for staff to use ICT in teaching, learning or research. Only 18% give any credit towards tenure or promotion for e-content development, while we can be sure staff would get credit for developing a textbook.

1.2. Recommendations

As a result of this investigation, several recommendations emerge for increasing the impact of ICT in teaching, research and extension for agriculture. From an agriculture-centric perspective appropriate to RUFORUM, faculties of agriculture are viewed as the top of a pyramid, supported by the university infrastructure such as its policies, computer labs and bandwidth. RUFORUM is therefore a unique agency capable of coordinating activities among universities and assembling resources for joint projects. Thus, recommendations are made to three audiences: universities, faculties of agriculture, and the RUFORUM organization and Secretariat itself.

1.2.1. University-level Initiatives

- Implement an ICT strategic plan.
    - Meet to compare ICT policies.
    - Measure progress in ICT readiness and policy Implementation.
- Give ICT strategic importance in the university's organizational structure.
- Continue to increase Internet-access bandwidth until targets are reached.
    - Persuade national policymakers to facilitate access to ICT.
    - Support National Research and Education Networks.
    - Practice comprehensive bandwidth management.
- Expand access to computers.
    - Implement thin-client or desktop virtualization solutions in computer labs.
    - Enter into agreements with computer suppliers for price reductions for students, and arrange for financing.
    - Reduce software costs by balancing proprietary and open source software
    - Charge technology fees for maintaining computer labs.
    - Commit an annual amount in the budget for new computers.
    - Keep the computer labs open longer.
    - Work with organizations that supply refurbished computers.
- Support using ICT for research.
    - Expand the use of existing electronic resources.
    - Expand required computer literacy training to include research techniques.
- Realize the full potential of management information systems.
- Support initiatives in e-learning.
- Implement video conferencing.
- Increase incentives for academic staff's use of ICT.

1.2.2. Faculty-level Initiatives

- Develop a collaborative orientation.
- Support champions of using ICT for agricultural teaching, research and extension.
- Learn more about the potential of ICT for education.

- Begin a faculty-level discussion of what e-learning means for agricultural education and, once that is determined, seek financial support for a project.

1.3. RUFORUM Initiatives

As a consortium of universities with a focus on agricultural education for national development, RUFORUM is in a unique position to coordinate activities among universities and to assemble resources for joint projects. Because of this, these recommendations are addressed to the RUFORUM network which is coordinated through the Secretariat. It is true, however, that universities and faculties of agriculture could also undertake some of these initiatives themselves.

1.3.1. Drive Increased Research and Information Literacy at RUFORUM Universities

For agricultural education to move to a new paradigm a great deal of learning will be necessary. This will require research which will benefit from increased ICT support. In particular, the following four initiatives are recommended, which can be led, funded, or coordinated by RUFORUM.

1.3.1.1. Empower Academic Staff and Students in Faculties of Agriculture to Do Better Research

RUFORUM should organize advanced training seminars for scholars from its member universities. Teaching researchers from several universities simultaneously not only conserves resources but also allows for contacts to be made among the attendees that may lead to future collaborative work.

Another aspect of empowerment is providing strategic resources. A few universities still lack access to TEEAL, and RUFORUM is in a position to help them, for example.

A clear need that emerged in the RUFORUM study was for advanced software for data analysis. RUFORUM should survey faculties of agriculture to identify the specific needs for analytical software and coordinate its purchase with an eye to getting the most effective packages at the lowest collective cost.

1.3.1.2. Sponsor Collaborative Research Initiatives among Agricultural Scholars at RUFORUM Universities

Given RUFORUM's historical role in developing regional curricula and programs, it is a natural extension for the organization to coordinate collaborative research initiatives and to support the use of ICT in these initiatives.

1.3.1.3. Create Materials on How to Find Information that Can Be Integrated into Computer Literacy Courses

As noted above, while most RUFORUM members require students to take a course in basic computer skills, how to effectively use online resources is usually taught separately by the library outside of a formal course structure. While individual universities, departments and teachers are the ultimate arbiters of course content, a set of effective materials about how to find information on line that could be integrated into an introductory curriculum might find widespread use.

1.3.1.4. Coordinate Access to Digitized Materials among RUFORUM Universities

While many universities are working to digitize theses, dissertations and other local resources that might otherwise be impossible to access, these efforts are going on separately, using different applications and different taxonomies for classification, and it was not always clear how widely these materials would be available.

Ideally, all of this material would be available over the Internet, through a single interface that could be effectively searched. Such a task will require coordination and resources, and it is suggested that RUFORUM take on the task of supplying them.

1.3.2. Create and Test an Enabling Environment for Implementing ICT in Teaching, Learning and Research in Agriculture

ICT has great potential for teaching and learning, as well as research. Instead of waiting until universities have all the elements in place to allow these approaches to be tested, creating an enabling environment where the basics are present and then testing how they can be used can be an effective approach

What this means is setting up an environment where there are enough computers and enough bandwidth, and where instruction and resources about e-learning and the needs of agriculture can be combined. This could take advantage of the environment at a cutting-edge university, or it could be a combination of university resources and materials provided by RUFORUM or other donors.

1.3.3. Develop and Test at least One Communications System for Communicating with Stakeholders to Improve Agriculture

Finally, it is recommended that RUFORUM sponsor an effort to develop materials and communicate them with ICT to stakeholders beyond the university, including smallholder farmers. much more information is needed about how ICT can work to accelerate agricultural development in the many African contexts. An appealing candidate technology that emerged in the RUFORUM study and which is being explored in other fields is mobile telephony.

1.4. A Call to Action

As mentioned at the outset, the purpose of this report is to provide a baseline against which progress can be measured and in terms of which policies and strategies can be created. Clearly the potential of ICT to help revolutionize agricultural education is great, and hopefully this study furthers the efforts of universities and faculties to achieve it.

2. Introduction

The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) is an initiative by a consortium of 25 member universities in Eastern, Central and Southern Africa to develop and strengthen human resource capacity for inter-disciplinary problem-solving. RUFORUM's mission is to foster innovativeness and adaptive capacity of universities engaged in agricultural and rural development to develop and sustain high quality in training, innovative and impact-oriented research, and collaboration. In order for the RUFORUM institutions to develop and sustain high standards of training, innovative and impact-oriented research, Information and Communication Technology (ICT) has been identified as a critical tool. The RUFORUM consortium understands that ICT has the capacity to revolutionize the following:

- the way teaching and learning occurs, in terms of how content is delivered, the flexibility of learning, the changing roles of teachers and students and the vast information and knowledge that is currently available
- the effectiveness of the links between the RUFORUM institutions and other institutions , in terms of knowledge sharing
- the methods of communication within and among RUFORUM institutions
- collaborative initiatives, in terms of skills sharing and problem solving in the Agriculture Industry
- the management of university operations, i.e. student records, library information, financial information, human resources information among various others
- the management of research – i.e. collaborative research, sharing research results, carrying out surveys, etc.

2.1. Objectives of the Situation Analysis

Given this potential, it is necessary to learn what will be required to make it a reality. This is likely to be a process that will take several years, but the first step has to be to know where universities currently are, and then to measure progress over time. It is also necessary to build consensus among stakeholders, and particularly in government, to move initiatives forward. Therefore, this "Situation Analysis of ICT Capability and Infrastructure in RUFORUM Universities" is critical because it will:

- Benchmark the readiness and ICT capability of RUFORUM universities to engage in various ICT initiatives aiming at ensuring that RUFORUM universities produce high quality graduates that will solve Africa's development challenges.
- Inform all the stakeholders the true position of the RUFORUM institutions in terms of infrastructure readiness so that the implementation of such initiatives as e-learning can be structured appropriately – taking into account each individual institution's current situation.
- Inform the Policies and Strategic Plans of the RUFORUM institutions.

The specific areas of activity the report will examine include:

- the status of ICT Policies and ICT Strategic Plans in the RUFORUM institutions

- the ICT infrastructure status in the RUFORUM institutions
- the availability of key ICT resources, such as management information systems and other essential applications
- the e-literacy of staff and students, both in basic computer skills and in how to find and use information
- the usage of electronic resources – TEEAL, GenStat, AGORA, HINARI, etc
- the current status and positioning of e-learning in the university structures of the RUFORUM institutions
- how academic staff in schools or faculties of agriculture are using ICT and could use it more effectively in the future

This report will first present some relevant background, and discuss the study's methodology, then present the results for each of the categories of information listed above. Next, the results will be discussed, with the aim of providing the benchmarks mentioned above, in terms of absolute levels of capability and comparisons to similar results found in other studies. Finally an assessment of the potential of member universities to participate in future ICT-based RUFORUM programs will be made and a discussion of how those programs can be organized to take advantage of the situation as is currently exists.

3. Background

3.1. Three Contexts

The context of this study can be described as the intersection of three areas of research and advocacy:

- A reorientation of the goals and methods of agricultural education
- An analysis of the potential of information and communications technology (ICT)
- An examination of the strengths and weaknesses of ICT in African universities

3.1.1. Issues in Agricultural Education

The reorientation of agricultural education is perhaps epitomized in the World Bank's World Development Report 2008: Agriculture for Development:

> The new agriculture also requires more and better trained researchers and agricultural professionals. But the education and training structures are not always up to this task.
>
> Sub-Saharan Africa's human resource pool is severely depleted. Among the 27 African countries, half saw a decline in the number of agricultural researchers in the 1990s (chapter 7). Only one in four African researchers currently possesses a doctorate. The huge potential for women professionals to upgrade farming systems remains largely untapped, with women making up just 18 % of African agricultural scientists. The brain drain of senior staff and unfilled positions are widely reported in research agencies and universities. Too often, staff shortages are compounded by the loss of life from HIV/AIDS. For more than a decade, donors have turned their back on funding higher education and overseas training in agriculture. A new generation of agricultural professionals is needed to replenish this dwindling human resource pool and engage the shifting opportunities associated with the rise in market-driven production.
>
> Efforts to revitalize agricultural education should concentrate on updating curricula, transforming teaching practices, and increasing the number of graduates at all postsecondary levels. Most agricultural education institutions offer curricula focused narrowly on the production of predominant crops and livestock. Curriculum reform should introduce greater institutional flexibility in the face of rapid change and greater responsiveness to employers and stakeholders.[1]

Recognition of the situation has led to the presentation of various agendas for change, of which the following is typical:

[1] World Bank, World Development Report 2008: Agriculture for Development. Washington DC: The International Bank for Reconstruction and Development/The World Bank, 2007, p. 223.

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

3.1.2. Evaluating ICT in Higher Education

At the same time that this reorientation has been presented for agricultural education, particularly In Africa, another stream of research and discussion has been examining how ICT has improved higher education and its potential for further improvement.

Balasubramanian and his colleagues recently presented a good summary of this role and potential.[3] They mentioned the particular benefits of ICTs in research, including the ability to conduct complex calculations on large data sets, the availability of communication links to enable research teams to be spread across the world, and the combination of communications and digital libraries to equalize access to academic resources across geographical regions.

The role of ICT in community engagement is more problematic, however, because a precondition for effective use of ICT in this way is a functioning commitment to national development on the part of higher education institutions:

> Many HEIs do not have well-defined policies and action plans regarding their generative and developmental roles in the society. Most of their policies are inward looking, focusing activities within institutions and giving little emphasis to linkages with external stakeholders. Though HEIs in developed countries have policies on the generative role, there are controversies about balancing long-term academic research with short-term technology transfer projects. There is a need to strengthen HEIs in policy development strategies vis-à-vis generative and developmental role.
>
> In the absence of strong policy framework, ICT is seen more as an infrastructure and not as a tool for strengthening these generative and developmental roles. Hence, in

[2] Johnson, Richard, and William Saint, "Cultivating Knowledge and Skills to Grow African Agriculture: A Synthesis of Research Commissioned by the World Bank," World Bank, June 2007, p. xi.

[3] Balasubramanian, K., et al., "ICTs for Higher Education: Background paper from the Commonwealth of Learning, UNESCO World Conference on Higher Education." Paris: UNESCO, 2009.

addition to a general policy framework, specific policies and plans for integrating ICT for generative and developmental roles should be defined.[4]

Once these issues have been resolved, however, it is possible for success to occur in a variety of ways, from expanding multi-media centers, ICT kiosks and cyber cafes into rural areas, to taking advantage of existing media such as radio and mobile phones. As technology continues to progress and mobile phones become more and more intelligent, for example, a wide variety of information could be disseminated to areas that have previously been almost impossible to reach.

Considerable potential also exists for using ICT in teaching, but, again, it is important to learn from experience. In several countries, for example, a large number of virtual universities were established to capitalize on the potential of e-learning, but in most cases these virtual universities and eLearning experiences have failed to achieve the desired levels of sustainability and would not survive without massive government support.

> The OECD's 2001 Report contended that despite the investment of up to $16 billion made in eLearning by the OECD countries, there was no evidence that it lead to any significant improvement in teachers' performance or students' learning outcomes nor had it enhanced quality and access to education on the scale predicted initially. In its 2005 report, the OECD concluded that ICT in higher education had more impact on administrative services than on teaching. The reports attributed the failure of eLearning to its inability to be relevant to local needs and cultures.
>
> This does not imply a complete retreat from eLearning/online education but requires a re-conceptualization of eLearning so that it achieves a difficult balance. On the one hand it must recognize the importance of the effective interaction of students with content, fellow students and teachers/tutors during the learning process. On the other hand, if it is not to increase institutional costs there must be some substitution of capital for labor, as occurs in traditional open and distance learning (ODL). For this reason, HEIs that already operate through ODL (e.g. open universities) can more easily introduce eLearning cost-effectively than those that try to graft it onto classroom teaching.[5]
>
> In general, the use of ICT in teaching requires considerable training and planning:
>
> The four most common mistakes in introducing ICT into teaching are (i) installing learning technology without reviewing student needs and content availability; (ii) imposing technological systems from the top down without involving faculty and students; (iii) using inappropriate content from other regions of the world without customizing it appropriately; and (iv) producing low quality content that has poor instructional design and is not adapted to the technology in use.
>
> Technology is of little use if the pedagogical skills needed to effectively and optimally use it are lacking. It is important, therefore, that serious consideration be given to content preparation

[4] *Op. cit., p.18.*

[5] *Op.cit., p.22.*

> before deciding on the most appropriate way to deliver it to students. When this is accomplished, teaching is likely to improve in ways that foster more and better learning. Institutional policies and procedures for adopting and adapting technology must be in place and faculty and students involved in at least assessing content vis-à-vis the technological mode to deliver it.[6]

An area where success with ICT is more pronounced is in higher education administration. The implementation of management information systems not only improves activities such as better collecting accounts receivable, but it also can support decision-making and strategic planning. It can make information more easily available throughout the university, such as by establishing Web-based access to student records, and admissions procedures. Learning management systems can not only provide course-related information but also registration procedures and payment of fees.

3.1.3. E-Readiness in African Universities

In addition to the general global discussion about the role of ICT in higher education, a body of literature has emerged which addresses the particular challenges of using ICT in African higher education. It did not take long for African universities and development organizations to realize that ICT in Africa, particularly connectivity, was originally "too little, too expensive and poorly managed."[7] Beginning in about 2004, a series of studies have been carried out and have often been combined with an effort to improve Internet access from African universities, through various approaches to buying bandwidth, the formation of national research and education networks (NRENs), and by providing technical support to encourage best practices, ranging from the use of uninterruptable power supplies and anti-virus protection to effective use of bandwidth monitoring and management technology.[8] [9]

In an attempt to go beyond the narrow confines of studying connectivity, three studies have recently broadly evaluated African universities in terms of their e-readiness along many dimensions. Two of these studies have been published by the Kenya Education Network (KENET) and one by the Southern African Regional Universities Association (SARUA).[10] [11] [12]

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[6] *Op. cit., pp. 24-25.*

[7] Gakio, Karanja, "African Tertiary Institutions Connectivity Survey (ATICS) 2006 Report." Ottawa: International Development Research Centre, 2006. p. iii.

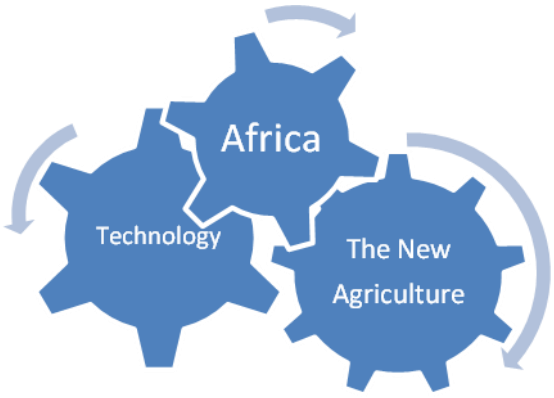
[8] Barry, Boubakar, "Research and Education Networking in Africa: Challenges, Achievements and Opportunities." Ottawa: PowerPoint presentation to the IDRC by the Research and Education Networking Unit of the Association of African Universities, 12 November 2008.

[9] Belcher, Martin, "Supporting training for the optimization of university bandwidth in Africa: Final technical report (including project extension period in 2007)." International Network for the Availability of Scientific Publications, 18 December 2007.

[10] Kashorda, Meoli, et al., "E-readiness survey of higher education institutions in Kenya," Nairobi: Kenya Education Network (KENET), May 2007.

These studies are in many ways similar to this one, so specific findings from them will be discussed in comparison to the RUFORUM study results, below. At this point, however, it is important to note the general tenor of these studies, which was to measure ICT at African universities either against theoretical targets or to create indices of e-readiness and to place each university on a scale for each indicator. The overall findings of these reports have been that in most areas achievement of ICT in African universities is well below optimal standards. The indicators are presented as a way that African universities can measure themselves in setting strategic priorities. Considerable emphasis has been put on recommendations about how to improve the situation, ranging from more comprehensive policy formation at all levels, to increased financial commitment to infrastructure such as increased bandwidth, to particular solutions to particular deficiencies.

3.2. Synthesizing the Three Contexts



As one reviews recommendations for improving the role of higher education in agricultural development, such as those cited above, it is not hard to see how many of them involve networking and communication, at least in the general sense. There are calls for increasing interaction with stakeholders, accessing more and better knowledge from online journals and global databases, establishing cooperative efforts with other institutions, and generally becoming more aware of the social processes surrounding the greater context of agricultural production beyond simply improving yield. Agricultural extension is asked to transform from a linear injection of information into the hinterland into a multi-directional exchange of insights and priorities.

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[11] Kashorda, Meoli, and Timothy Waema, "2008 e-readiness survey of East African universities." Nairobi: Kenya Education Network (KENET), August 2009.

[12] Twinomugisha, Alex, "ICT: A Status Review of ICT in Universities in the SADC Region." Wits, South Africa: Southern African Regional Universities Association (SARUA), Study Series 2007, 2008.

From here, it is only a small step to seeing a potential for ICT, because communications, collaboration and interaction have been some of its major appeals. Add to that the possibility of sharing resources such as expertise in a particular subject among universities, substituting electronic conferencing for travel and adopting electronic methods for distance education and the overlap between agricultural reform and ICT potential can be quite large, and, in fact, exciting.

This has to be balanced, however, against the knowledge that has been gained not only from ICT's successes but also from the disappointments. In other contexts, such as the use of ICT by corporations and government, there is a history of large amounts of money being spent without always achieving the desired goals. It is a cliché that five out of six in-house development projects do not come in on time and on budget. The watchword, in principle, is return on investment and the need for caution at the outset of projects. Technology can no longer be implemented for its own sake.

On the other hand, there is no doubt that ICT has transformed society where it has been widely adopted. Most of the general predictions for the "information society" made 30 years ago have come true.

Given the third context, the general lag in ICT in sub-Saharan Africa and the technological and institutional factors behind it, the question becomes how African universities can increase their e-readiness without repeating some of the mistakes that overly optimistic approaches have caused in other countries. A constant consideration in all of the contexts above is the need for policies and planning. The dilemma, however, is that policies and planning are labor-intensive and therefore expensive in and of themselves. Further, policies must be implemented, and commitments to match rhetoric are also expensive.

Thus, a study such as this one must not only explore the situation on the ground but also attempt to find solutions that simultaneously move HEIs forward and are cost effective. The recommendations are presented below.

4. Methodology

The primary methodology for the study was elite and specialized interviewing, based on visits to each RUFORUM member university, and the gathering of responses through the distribution of questionnaires via email. The study was a census of RUFORUM member universities, rather than a survey, in a sense that 100-percent coverage was sought. All of the 25 targeted universities (100%) have participated in the study, at least to some extent. The return rate for each university is shown in Table A:

Table A: Questionnaires Received from Member Universities

Country	Member University	Some Info Received	ICT Director Questions	Dean Questions	VC Questions
Kenya	Egerton University	1	1	1	1
	JKUAT	1	1	1	
	Kenyatta University	1	1	1	1
	University of Nairobi	1	1	1	
	Moi University, Kenya	1	1	1	1
Malawi	University of Malawi	1	1		
Mozambique	Eduardo Mondlane University	1	1	1	
Tanzania	Sokoine University of Agriculture	1	1		
Uganda	Makerere University	1	1	1	
	Kyambogo University	1	1		
	Gulu University	1	1		
	Uganda Martyrs University	1	1		
Zimbabwe	University of Zimbabwe	1	1	1	1
	Africa University	1	1	1	1
Zambia	University of Zambia	1	1	1	
Botswana	University of Botswana	1	1	1	
Burundi	National University of Burundi	1	1	1	
DRC	Université Catholique de Bukavu	1	1	1	
Ethiopia	Haramaya University	1	1	1	
	Mekelle University	1	1	1	
Lesotho	University of Lesotho	1	1		
Rwanda	National University of Rwanda	1	1	1	
Sudan	University of Gezira	1	1	1	1
	Kordofan University	1	1	1	1
Swaziland	University of Swaziland	1	1		
TOTAL		25	25	18	7
Percentage	25 replies out of 25 members	100%	100%	72%	28%

Standard sets of questions were developed for the three targeted interviewees at each university: the ICT Director, the Dean of the School or Faculty of Agriculture, and the Vice Chancellor of the university. The questionnaires are presented in the appendix. The questionnaires are a mixture of open- and closed-ended questions, with an emphasis on open-ended questions because, as a first study, this project was exploratory in nature.

The questionnaires were administered in four ways: In some cases, RUFORUM staff or consultants visited universities and conducted interviews with as many of the designated interviewees as it was possible to meet. In other cases, questionnaires were sent to the targeted interviewees via email. Third, some individuals in the cities where universities were located were enlisted to visit those universities and interview the appropriate people. Finally, questionnaires were given to the deans of agriculture schools at member universities who attended RUFORUM's annual general meeting in September 2009.

The data was analyzed with relatively simple methods, summarizing numbers, percentages, and categories of open-ended responses. While some other studies have attempted to code results into standard indicators of e-readiness, the authors of this study believe that keeping as close as possible to the raw data will allow both better comparability to future efforts and also provide concrete facts which universities can use to estimate their future progress.

5. ICT Capability in RUFORUM Universities

This section provides a basic presentation of the results of the study, with interpretation limited to what is necessary to make the results clear. Discussion of the results will follow in subsequent sections.

5.1. Policy, Strategies and Structure

5.1.1. Status of University ICT Policies

Table 1: What is the status of the University's ICT Policy?			
	ICT Policy in Place	Policy Under Consideration	No Policy
TOTAL	14	8	2
Percentage	58%	33%	8%

The establishment of ICT policies appears to be a priority among member universities. In all cases, the vice chancellors interviewed stressed the importance of ICT. In more concrete terms, as Table 1 shows, ICT policies were either in place or under consideration at 91% of respondents. In many cases, these were revisions of previous ICT policy documents.

5.1.2. University ICT Structure

Table 2: What structures are being used to initiate, manage and monitor ICT projects and initiatives?				
Universities	Central ICT Department	Oversight Committee	Multiple Committees	Other
Number	15	10	10	8
Percentage	60%	40%	40%	32%

*** Note percentages do not total because of multiple responses**

Most universities sampled also had a central ICT department. These departments appeared to be well established, but the question to whom the ICT director reported was not always asked. Thus, the RUFORUM results are not comparable with other studies.

In almost all cases, there were committees established to overlook ICT development and to review proposals from the ICT department. Other departments with responsibility at various institutions

included the library, academic departments or IT groups within those departments, consultants and a university foundation.

5.1.3. Financial Support for ICT

When asked about the percentage of the university budget, several respondents were reluctant to give answers. When answers were forthcoming, the percentage actually devoted to ICT was approximately 3 percent of the university budget, but only six universities responded to this question.

Table 3: What other strategies have been put in place for the funding of the ICT Budget?

Universities	Support/Projects from Donors	Student Tech Fee	Cost Sharing	Commercial Business	No Specific Strategies	Targeted Gov't. Funding
Number	**16**	**8**	**2**	**4**	**2**	**3**
Percentage	**64%**	**33%**	**8%**	**16%**	**8%**	**12%**

The primary strategy among member universities for augmenting ICT funding was to attract support from donors. Sixteen out of twenty-five respondents mentioned this. Student technology fees were a distant second solution with a 32% response. Interestingly, a few universities are making money by providing IT services to their communities.

Eight universities reported charging specific student fees to support ICT. Sixteen (67%) reported that they did not. It is possible that this solution could help several universities who do not have such a fee now.

It was difficult to determine precisely how members' network infrastructure was funded. Answers to the question, "To what extent, if any, is your infrastructure dependent on external funding?" often received answers such as "Partly." Nevertheless, the coding of the responses into categories revealed a highly mixed situation, as Table 4 below shows:

Table 4: Degree of External Funding for Infrastructure

None	1% - 9%	10%- 49%	50% - 90%	90%-99%	100%
4	**4**	**5**	**4**	**2**	**0**

While most of the 19 universities responding said that a majority of funding was from internal sources, i.e. the university budget, 32% reported that a majority of funding was external. The concept of "external" funding has become somewhat ambiguous, however, some respondents counted targeted government funding, such as for infrastructure, as external funding, while others defined external funding as money from donors.

The issue underlying the question is that in the past some universities have built up infrastructure with donor funding and then have not been able to maintain it or extend its scope once the funding period passed. Thus, regular funding from the university budget may be preferable in general. On the other

hand, a major infrastructure project such as fiber connectivity to a new offshore cable may be best financed by the national government, which may be more able to absorb large one-time costs.

5.1.4. Policies Supporting ICT Development by Academic Staff

Table 5: Incentives for Academic Staff Using ICT			
	Yes	No	% Yes
Any incentives for ICT in teaching, learning or research	6	10	38%
Credit towards promotion or tenure for e-content development.	3	14	18%

Very few incentives were in place to motivate staff to undertake ICT-based activities, outside of the requirements of individual donor-funded projects. In 82% of cases, no particular credit towards promotion or tenure was given to academic staff for ICT-related work, in and of itself. Given the fairly heavy course load for many lecturers, particularly in a period of rapidly rising enrollments, it may therefore be difficult to motivate academic staff to undertake ICT-related projects.

5.1.5. E-Learning Policy

Table 6: What is the status of the University's e-learning strategy?				
Universities	E-learning Strategy in Place	Under Consideration	No Strategy	Steps, but No Formal Strategy
TOTAL	6	7	5	7
Percentage	26%	30%	22%	30%

*** Note: percentages do not add to 100% because of multiple responses.**

E-learning policy is less established than overall ICT policy at RUFORUM universities. Only 26% had an e-learning policy in place, although an additional 30% said that e-learning strategies were under consideration. Twelve universities did have a department responsible for e-learning. In general, as discussed below, e-learning is in its early stages at most universities.

5.1.6. Storing and Sharing Research

The main mechanism put in place so far to store and share research outputs from the universities were efforts at the university libraries to digitize the "gray literature," such as theses and examination papers which were stored at the university. This appeared to be going on in about half of the universities replying to this question, as shown in Table 7, below. It is hard to generalize when less than half of the universities responded, however.

Table 7: What efforts are being made to store and share research?

Universities	None	Some	Put on Internet	Univ. Journals	Virtual Library	Conferences and Seminars	Digitizing Theses
TOTAL	1	10	1	3	0	2	5
Percentage	9%	91%	9%	27%	0%	18%	45%

5.1.7. University and National ICT Policies

ICT policy and practice at the universities was clearly affected by national policies and practices. One example is Kenya, where national subsidies to KENET, Kenya's NREN, had resulted in lower bandwidth prices to their member universities and cheaper construction of optical fiber links. Another example is Zimbabwe, where the recent national turmoil has resulted in significant non-operation at Zimbabwe University and difficulties in retaining ICT staff there. In general, national policies tended to be more supportive than not. In several cases, infrastructure had been provided by targeted government funding or subsidies of national research and education networks.

In other cases, however, national government policies have had adverse consequences. For example, one university implemented a campus-wide anti-virus application, but when it came time to renew it, the university was not allowed to pay for it until it had completed a lengthy purchasing process involving competitive bids. By the time the process was complete, viruses had destroyed a significant amount of the university's electronic assets, and the price of the software had risen to more than double what the initial renewal would have cost.

In general, the issue cited most often was the effect of government policies on the availability of infrastructure and the cost of bandwidth. In addition, government tax policies, such as whether computer equipment was subject to VAT, were mentioned more than once.

Although this data can't allow a strict mathematical comparison, the responses were sorted according to the effect of national policies on university ICT, based on four categories: supportive, mixed, no policy, and negative. The average amount of bandwidth was then examined per university and the average cost of a megabit of bandwidth for a month, in terms of those categories. The results are shown in Table 8

Table 8: Average Bandwidth and Cost per Mbps/month by Category of Government Policy			
Category	**Avg. amount of bandwidth (mbps)**	**Cost per mbps per month.**	**No. of cases**
Supportive Government Policy	**15.75**	**1848.5**	**7**
Mixed Government Policy	**7.25**	**3615.3**	**5**
No Government Policy	**4.2**	**3682**	**4**
Negative Government Policy	**1.65**	**2526.4**	**5**

The data indicate that the more supportive the government policy, the more bandwidth a university will have, on the average. In terms of price, the results are less clear. Thus, a rough indicator shows that supportive government policies lead to more, but not necessarily cheaper, bandwidth.

5.2. Infrastructure

5.2.1. Connectivity and Bandwidth

Infrastructure here is defined particularly as the university's campus-wide local area network and its components, its wide-area network, linking campuses, and its access to the Internet. The discussion of the other aspects of the universities' overall ICT infrastructure, such as computers, servers and multimedia equipment, will be made in different sections below.

Table 9: Characteristics of University Infrastructure								
Universities	**Fiber Backbone**	**% Bldgs connected to LAN**	**Total Internet Bandwidth (mbps)**	**Cost of Bandwidth $/mbps/mo**	**Bandwidth Monitoring**	**Bandwidth Management**	**Percentage Wireless**	**NREN Member**
Number	**19**				**16**	**14**		**20**
Percentage	**83%**				**67%**	**67%**		**80%**
Average		**69%**	**6.84**	**2,592**			**25% (est.)**	

In all but four cases, universities had some kind of campus-wide local area network, with a backbone and sub-networks in university buildings. The usual, but not universal, configuration for this network was a one-gigabyte fiber backbone, connected to 10/100 megabit per second (mbps) LANs running on Category 5 or 6 unshielded twisted pair cable. In 10 out of 25 cases, the wired network did cover all "appropriate" buildings on campus. Only three universities reported coverage in all classrooms, however. In many cases, the wired network was supplemented by a wireless network to reach the other buildings, but the wireless networks were generally seen as less dependable than the wired ones. Difficulties were noted with wireless configuration, sometimes due to the thickness with which walls were constructed.

In about half the cases, the ICT directors of the universities surveyed reported that the quality and type of switches used in the local area network were uniform. In the rest, some variability existed, although it was not seen as a critical problem.

Reasons for lack of coverage varied from delays in bringing the network to newly constructed buildings to losing connectivity because the network could not be properly maintained. For example, the University of Zimbabwe reported that rodents had destroyed the cabling in some buildings and that resources had not been available to replace them.

Coverage also varied among campuses of the same university. For example, at Moi University, a five-mbps point-to-point wireless link was in place between the Chepkoilel campus, where the School of Agriculture was located, and the main campus. But until only a few weeks before the visit, the link had not functioned for some time. At other universities, sub-campuses were only linked to the main campus through the Internet.

In addition to asking ICT managers specific questions about Internet connectivity, the deans of schools or faculties of agriculture were asked whether they thought their on-campus Internet access was adequate. Seventeen deans answered the question; Twelve said access was not adequate. Of the five who said it was good, four qualified their answers to allow for delays due to congestion at times.

Internet access varied greatly among the universities studied, from a minimum of 512 kbps to a maximum of 40 mbps with a median capacity of three mbps. Prices of bandwidth remained high by international standards as this census was completed, however. The prices reported ranged from USD 208 per mbps per month to USD 10,878 per mbps per month, with a mean price of about USD 2,592 per mbps per month. In general, as might be expected, the more bandwidth purchased, the cheaper the per-mbps price.

In the countries that are beginning to get access to new submarine fiber cable connections, the amount of bandwidth is expected to increase significantly in the next year, as universities will reinvest their bandwidth payments in increased bandwidth at lower per-megabit prices. Some universities, however, are still unable to take advantage of new submarine cables because of their location. Some of these are attempting to link with additional capacity available in neighboring countries, but the cost of the necessary optical fiber connection is an impediment. At this writing, there is also uncertainty about the prices to end-users in countries subject to various monopolies of supply, such as control of a single connection to the undersea cables from a landlocked country. Thus, the overall outlook remains uncertain, but hopeful. In some areas, such as Nairobi, however, prices for one mbps of Internet access are already dropping to USD $600/mo., which represents about 25% of the current average rate. One vice chancellor in Kenya expected prices to drop to 25% of their current Kenyan levels in the next year.

Some countries, such as Kenya and Uganda, have committed to national fiber networks, and significant progress has been made in Kenya, although last-mile connections to campuses are often still needed. This has resulted in lower connectivity prices to several Kenyan universities, with further price drops expected soon.

As Table 9 shows, 80% of those responding said that their universities were members of a National Research and Education Network (NREN). Only 54% of RUFORUM universities are currently connected to an active NREN, however, with the other NREN members involved with efforts to move to active status.

At this point, most Internet access is still slow, from the end user's point of view. Even at Makerere University, which has 20 mbps of Internet connectivity, end users can experience significant delays in downloading from the Internet. A more proper measure of Internet connectivity may be bandwidth per 1000 students, as KENET has suggested in its report. The discussions follwo further below.

Seventy-six (76%) of the universities responding employed some kind of system for bandwidth monitoring, and 67% practiced some form of bandwidth management. The particular applications ranged from the open-source MRTG monitoring and Squid management applications to hardware solutions such as Packeteer traffic shapers. Universities differed considerably in how they managed their bandwidth, ranging from QoS approaches to banning Internet-based email. Even with bandwidth management, however, bandwidth saturation remained an issue at most locations.

Table 10: Comment on the reliability of other related infrastructure – e.g. electricity

Universities	Electricity a Significant Issue	Electricity Not an Issue	Have Generator	Have UPSs
Number	**18**	**6**	**13**	**7**
Percentage	**75%**	**25%**	**54%**	**29%**

As Table 10 shows, electrical power outages are significant issues at most of the universities. Interestingly, generators and uninterruptable power supplies (UPSs) are not always available, despite the seriousness of the problem. In some cases, respondents reported damage to equipment as the result of related power surges.

Table 11: Most Important Infrastructure Issues

Issue	Mentions	% Respondents
Insufficient bandwidth	**9**	**43%**
Electrical outages	**7**	**29%**
Not enough computers (mostly for students)	**8**	**29%**
Inadequate wireless	**4**	**19%**
Shortage of routers and switches	**3**	**14%**
High cost of bandwidth	**3**	**14%**
Cost of repair or replacement	**3**	**14%**
Shortage of servers	**2**	**10%**
No fiber backbone	**2**	**10%**

No campus-wide LAN	**5**	**10%**
Lack of skilled staff	**2**	**10%**
No disaster recovery plan	**1**	**5%**
No network monitoring	**1**	**5%**
No fiber connection to Internet	**1**	**5%**
Obsolete equipment	**2**	**10%**
Too few air-conditioned rooms	**1**	**5%**
Security issues	**4**	**19%**
Cut fiber cables	**1**	**5%**

When asked to identify the top three infrastructure issues at their university, 24 ICT managers mentioned the problems in Table 10. As the table shows, the most important issues were insufficient bandwidth, electrical outages and too few computers. Beyond those, a wide range of issues was reported.

Anti-virus protection is still an issue at some universities, although most have taken steps to address the problem. Thirteen of the twenty-three universities responding reported that they had centrally purchased university-wide anti-virus software, but a few of these mentioned that it had not been thoroughly implemented. Ten universities had no central virus protection.

5.3. Access to Computers

Table 12: User-to-Computer Ratios

	1to 1	2-5 to 1	6-9 to 1	10 to 1	11-19 to 1	20-49 to1	50 to 1 or more
Students: Number	**0**	**2**	**2**	**4**	**6**	**8**	**3**
Students: Percent	**0.0%**	**8.7%**	**8.7%**	**17.4%**	**26.1%**	**30.4%**	**8.7%**
Academic Staff: Number	**11**	**5**	**2**	**1**	**0**	**2**	**4**
Academic Staff: Percent	**50.0%**	**22.7%**	**4.5%**	**4.5%**	**0.0%**	**4.5%**	**18.2%**
Administrative Staff: Number	**14**	**6**	**1**	**1**	**0**	**0**	**0**
Administrative Staff: Percent	**63.2%**	**26.3%**	**5.3%**	**5.3%**	**0.0%**	**0.0%**	**0.0%**

The student-to-computer ratio at RUFORUM universities, in terms of the number of university-supplied computers available in computer labs, ranges from approximately 4 to 1 up to 100 to 1, with a median ratio of about 1 to 20 and an average of 1 to 26.3. Only two universities out of the 25 reporting said that its student-to-computer was at or below the recommended level of 5 to 1. A majority of universities had student-to-computer ratios greater than 10 to 1.

The emphasis on university-supplied computers as a measure is based on the belief that few students have the means to purchase computers on their own. This study supports that notion. The median estimated percentage of students reported to have their own computers was five percent, with answers ranging from a low of one hundredth of one percent to 40 percent.

It is also important to note that certain departments were more likely to have a better computer-to-student ratio than others. Computer science and engineering schools, for example, usually had more computers per student. Schools of agriculture seemed to fall at or below the mean ratios. Three universities reported significantly lower student-to-computer ratios in their schools of agriculture.

Lack of student access to computers was described as a barrier to participating in e-learning at one university that had developed a significant number of e-courses.

The situation was much better for academic staff. Forty-three percent of the 23 universities reporting had 1 to 1 ratios, meaning all academic staff had university-supplied computers. Six universities, however, reported that the university did not purchase computers for academic staff at all, while nine universities had ratios ranging from two to one to 20 to one. In several cases, however, respondents said that many academic staff that did not have university-supplied computers had computers which they had either purchased themselves or had gotten as a result of sponsored projects.

Administrative staff was the most computerized user group - 12 of the 20 universities reporting said all their administrative staff had university-supplied computers.

In most all cases, computers supplied by the university had internet connectivity in the labs or offices where they were located. In the cases where computers were not supplied to the faculty, however, connectivity was lower. For example at Moi University's School of Agriculture, the dean estimated that only 50 percent of his faculty had on-campus Internet access.

5.3.1. Measures to Improve User-to-Computer Ratios

Table 13: Plans to Increase the Number of Computers	
Type of Plan	**Number**
Get more from the University budget	**14**
Encourage students to buy their own computers	**5**
Seek more from donors	**3**
Ask for discounts or assistance from vendors	**3**
Work with banks to finance computer purchases	**3**
Seek refurbished computers	**2**

The universities surveyed realized the importance of lowering the user-to-computer ratio, and they mentioned a variety of approaches to the problem. In most cases, raising the priority of computer purchases in the university budget was the main hope. In addition to this, several mentioned encouraging students to buy their own computers. This was sometimes accompanied by plans to get special financing from banks or special prices from computer vendors for students or for staff. Continuing to get computers from donors was also mentioned, including acquiring refurbished computers. In particular, two universities mentioned the Belgian NGO Close the Gap, which has donated tens of thousands of refurbished computers to African schools (www.close-the-gap.org).

5.3.2. Student Computer Labs

Table 14: Hours of Operation of Student Computer Labs

Number of Hours Open	Universities
9	9
10	3
12	2
13	2
14	4
16	2
18	1
24	2

An interesting finding was the variation in the number of hours that student computer labs were open. At 36 percent of the universities surveyed, labs were open only nine hours, usually from 8 am to 5 pm. At the other end of the scale, 20 percent of the universities had labs open 16 hours a day or more, with two reporting labs open 24 hours a day. Several universities seem to be able to operate with fairly long hours.

Given the widespread concern with insufficient student access to computers, it seems that an obvious step would be for those universities whose labs are open for fewer hours to extend those hours. If a university extended its labs' hours from 9 to 18 hours, for example, it would effectively double the computers available for student use. The main objection to this approach was concerns about security in the labs, which implies that more staffing would be needed, which would involve increased funding. Given the critical lack of computers, however, this might be a good investment, and it is possible that the staff could be given other productive duties, as well.

5.4. Management information systems

Table 15: Information Management Systems implemented					
Universities	**Financial Management**	**Student Records**	**Library**	**Human Resources**	**Inventory**
Number	**21**	**16**	**18**	**13**	**10**
Percentage	**84%**	**70%**	**78%**	**57%**	**43%**

Note: Percentages vary because of different numbers of responses per item

In general, universities have implemented management information systems more completely than computers for students in labs or e-learning applications. Eighty-four percent have a computerized financial information system. Less have university-wide student record systems, but most libraries had computerized catalogs. These catalogs were available over the Internet outside the universities that had them in about half the cases. Only slightly more than half the universities had inventory management or human resource management systems, although among those without them about half the universities had them under development.

5.5. Applications

The average number of servers in the universities studied was around just above 12, although this varied with the size of the university, from two servers up to more than 50. The usual applications on these servers, in additions to the management information systems mentioned above, were email, help desk applications, admissions, domain controllers, Web hosting, directory services, proxy, DHCP, bandwidth and network management, file and print services and learning management systems.

In every case, Linux or another version of UNIX was used on university servers, while 62 percent of respondents also reported using Windows Server. This contrasted with the situation on the desktops of university computers, where 100% of the universities used one version or another of Windows, while only 33% used Linux on the desktop.

Servers were located in a central facility administered by the ICT department in about 80% of all cases. Servers in individual departments were usually for the purpose of file and print services; although in a few cases major applications were housed away from the ICT department, such as in the offices dealing with university finances. In virtually all cases, the central ICT server room was air conditioned and had generator backup for electrical power.

All but four of the universities surveyed (84%) had an institutional email system, and all but five of those was Web enabled. Students had access to the email systems in 72 percent of the cases, but in about one-third of those cases, only a few students used it.

Less than one-third of interviewees reported use of collaborative applications such as SharePoint, Yahoo Groups or Google Groups, and it was generally the case that these technologies were only used by scattered individuals, and not as part of an organized university initiative.

Only 42% of universities were said to have video conferencing facilities. In the cases where room-based video conferencing was available, it was available in only one room at the university in half the cases. The idea of video conferencing was very popular, however. One hundred percent of respondents who said their universities did not have video conferencing said they were very interested in acquiring it. Videoconferencing was seen as a way to implement ICT support of distance learning without having to have a lot of course development of distance-specific materials.

Web conferencing, either desktop video conferencing such as with Skype or live desktop plus audio conferencing was reported to be used at only 25% of the universities, and, again this did not commonly appear to be within programs supported or sponsored by the university.

When asked how their universities limited the costs of software licenses, the overwhelming answer was that they sought to use open source applications wherever possible. This may explain why the use of open source applications averaged about 35% of all applications, even though most desktop computers ran a Windows operating system. Other responses mentioned purchasing proprietary applications through academic licensing programs and purchasing computers in bulk.

The leading open-source applications in use included several learning management systems (Moodle, Claroline, CHISIMBA), Linux, mySQL and Apache (often used in Websites, OpenOffice) and individual mentions of several other applications.

5.6. User Training

All but three of the institutions surveyed (87%) said that at least one course in basic computer skills was available. At 75% of the universities responding, the course was required. In most of these cases, the course was required to be taken during the student's first year. The courses were usually taught by the information science or computer science departments, although in some cases each department offered its own course, and in three cases the courses were offered by the university computer centre. Specific instruction in how to find information online was the responsibility of the university library in 75% of the cases, either as a short extracurricular course or through help at computer labs.

Most academic staff were either required to show a basic level of computer proficiency or required to be trained.

5.7. E-Library Resources

Table 16: Access to Relevant International Databases				
Universities	**AGORA**	**TEEAL**	**HINARI**	**GENSTAT**
Number	**11**	**12**	**9**	**13**
Percentage	**73%**	**80%**	**60%**	**93%**

Note: Percentages not comparable because of different numbers of responses for each item.

About 80% of the universities surveyed said that access to TEEAL was available, usually through the library. Five so far have said that they do not have TEEAL. Fewer said they had access to AGORA and HINARI. Many other online databases were also being used, particularly OARE, as well as subscriptions to collections of journals online.

The fact that the universities provided access to these databases did not necessarily guarantee that the schools of agriculture used them effectively. 53% of the deans of agricultural schools or faculties interviewed said that their units did not have adequate access to online databases. In some cases, this was because online access at the agricultural facilities was not as good as elsewhere on the campus.

As described in Table 7, above, he main e-library initiatives currently taking place are the implementation or upgrading of electronic catalog systems or the digitizing of university-specific materials such as theses. Almost all of the newer electronic catalogs were accessible over the Web. Some, including the older ones, were not.

5.8. E-Learning

5.8.1. The State of E-Learning

Simply put, e-learning at RUFORUM member universities, taken as a whole, is in a state of great change. A good example of this is whether universities have implemented a learning management system (LMS), which can be said to be the foundation upon which a system of e-courses can be built. This is the Web-based software where students can access syllabi, notes, reading materials and other instructional material necessary for participating in learning at a distance or for supplementing classroom work.

The survey found that eight universities (40%) have established, functioning learning management systems, six currently have them under development, or in the pilot stage, and nine have no learning management system at all. Thus, the system as a whole is in transition from only a minority of

universities having the necessary software to a majority who will have it operating in a year or two, if all goes to plan. The most popular LMS was Moodle.

Another way of approaching the question of e-learning's state was to ask two open-ended questions, one requesting examples of e-learning successes and the other asking the respondent to evaluate the university's success implementing e-learning. The results are summarized in Table 16.

Table 17: The State of E-Learning	
a. What e-learning projects have been successful?	
Success	**Number**
Good examples in one or two schools	**6**
An LMS has been implemented	**8**
None	**7**
Planning has taken place	**2**
In Distance Learning only	**2**
Training has taken place	**3**
Scattered Implementations	**1**
Widespread success	**1**
b. How successful has your university been at implementing e-learning?	
Success	**Number**
Not successful	**10**
Plans in formulation stage	**6**
Successful on a small scale	**3**
E-learning department established	**1**
Traing has taken place	**2**
Widespread success	**1**

As the table shows, only one university claimed widespread e-learning success. This was Africa University, where 286 courses have been put up on the Moodle LMS and 20 courses have been recognized for their excellence. In more cases, at six universities, success has been limited to work in one or two schools. This is not to minimize those successes. For example, Moi University has created several e-learning modules in Health Sciences which are being used all over Africa. The result does speak to the scope of e-learning, however, in that most of the schools at these universities are not yet implementing e-courses.

Most of the other reports of success can also be seen as indications of how much e-learning is still in its infancy. While training and planning are important, the fact that they are chosen as successes, as opposed to actual e-learning courses, indicates that work has begun relatively recently.

The same kind of picture can be drawn from the responses to the question about how successful the university has been in implementing e-learning. The most common answers, accounting for almost two-thirds of the replies, are that it hasn't been successful or that plans for e-learning are still in the formulation stage. The rest of the responses indicate success on a small scale at three universities with widespread success at one, plus some training and the establishment of an e-learning department.

In fact, 12 universities, 63% of those responding, said that a specific entity has responsibility for university-wide e-learning. Several of these are currently training lecturers on e-learning techniques. As mentioned above when discussing policies (See Table 6), about half of all the universities surveyed either have e-learning policies or have them under consideration. About half of those that have not developed a policy have nevertheless taken steps to advance e-learning without one.

In general, steps are being taken, but they are not consistently widespread or coherent. In most cases, commitments are fairly recent, usually within the last three years. E-learning can thus be said to be just beginning at most RUFORUM universities. This is particularly true in terms of agricultural content, where only one school of agriculture reported any e-learning materials.

5.8.2. Achievements and Hindrances

The most successful aspect of the LMSs in place was that they provided student access to course materials and university information. A few respondents reported implementing e-courses without using a LMS, while one other said it was delaying implementing courses until a LMS became available.

As Table 18 below shows, the main impediments, or hindrances, to e-learning were insufficient connectivity and a lack of computers. After that, many things were mentioned once, many having to do with the softer issues of getting staff time, training, finance and support.

E-learning was seen at some universities as being the primary concern of the distance learning department, although even there the reports received indicated that the use of e-content was only beginning. Future surveys of this sort ought to explicitly include respondents from the distance learning department, as well as the university library, which is usually responsible for online database access.

Table 18: Hindrances to E-Learning

Hindrance	Number
Insufficient network connectivity	**7**
Too few computers	**6**
Lack of support	**1**
Too many distractions	**1**

No learning management system	**1**
Low student knowledge	**1**
Lack of publicity	**1**
Finance	**2**
Lack of knowledge about content creation	**5**
Low use	**1**
Getting staff time for development	**1**
Administrative Issues	**1**

5.9. Academic Staff's Use of ICT

The responses in this section come largely from questions asked of the deans of schools or faculties of agriculture and should be seen as reports of the activities in those units, rather than in universities on the whole.

5.9.1. ICT in the Classroom

Table 19: ICT in the Classroom				
Technology	**Units Available**			
	None	**Few**	**Many**	**All**
Network access points	**3**	**5**	**3**	**2**
LCD Projectors	**2**	**16**	**2**	**0**
Whiteboards	**1**	**6**	**1**	**2**
Instructor Workstations	**3**	**4**	**0**	**0**
Classroom ICT Adequate?	**Nonexistent**	**Inadequate**	**Excellent**	
	1	**13**	**1**	

As the responses in Table 19 show, questions about some technologies were answered more often than others. Twenty questionnaires reported about the availability of LCD projectors, while seven, less than half that number, reported on the availability of instructor workstations in the classroom. It is possible to imagine, then, that leaving a question blank might have meant "No."

Even the data collected, however, point to the conclusion that use of ICT in the classroom does occur, but is still relatively rare. For all of the technologies, more respondents reported "none" or "little" than "many" or "all," usually by a wide margin.

The most frequent use of in-class ICT was projecting PowerPoint presentations. In many cases, according to open-ended responses, this was the only use of ICT in the classroom. Reasons given for little use included a lack of connectivity to enough classrooms, a shortage of ICT-enabled classrooms, and a shortage of computers in those classrooms. Often, lecturers used their own laptops as the source of the PowerPoints. A few universities mentioned videoconferencing, as noted above, and a couple mentioned video projections.

When asked to give an overall assessment of whether ICT was adequate in classrooms, respondents overwhelmingly said it was not, with more than 90% saying it was inadequate or non-existent.

5.9.2. General Use of ICT by Academic Staff

Table 20: Academic Staff Use of ICT

Use	Number
Email	9
Research	5
Internet Access	4
Course Preparation	4
PowerPoint	6
Data Analysis	2
Develop Proposals	2
Notes Online	1
E-learning	1
Word Processing	1
Notes Online	1

As this was RUFORUM's first study, there was a reliance on open-ended questions more than choices among specific alternatives because of the need to avoid biasing the question. In some instances, however, this injected its own bias. For example, in Table 20 above, only one respondent mentioned the use of ICT for word processing. It is suspected that the use is higher, but that most respondents took it for granted.

From the responses received, a wide range of activities are seen, with the most frequent - email and Internet access - depending on connectivity. In general, the pattern of use reflects other results of the

study, with most of the activities being directed at traditional methods of teaching and research, with occasional advanced use of ICT.

This is not to say that agriculture staffs are not anxious to adopt ICT. When asked, 100% of the respondents said they could use more ICT. The uses to which they envisioned ICT being put are summarized in Table 21:

Table 21: How ICT Can Help Faculties of Agriculture

Activity	Number
Data analysis	6
Access to academic publications	4
Video conferencing	3
E-learning	2
E-library	3
Notes online	1
Classroom use	2
Database access	1
More computers	1
Better connectivity	1
ICT maintenance	1
New equipment	1
Website	2
Link better with farmers	2
Grade submission	1
Communication / Collaboration	3
Information Sharing & Storage	2
Document management	1

The most often heard request was for better tools for data analysis. While most faculties have access to GenStat, a general data analysis package which RUFORUM makes available online in the basic free version, the need is often for more advanced or specialized packages addressing particular tasks, such as genetic analysis.

The next most popular responses point out issues that have appeared elsewhere in this study, video conferencing, access to online literature and databases, e-learning and e-libraries. This is a credible list of priorities. Beyond that, a number of uses are mentioned only once, but they are useful to indicate the range of issues with which faculties must deal.

5.9.3. Teaching Farmers and Distance Education

When discussing faculties of agriculture, it is important to distinguish between teaching farmers and distance education. Distance education is largely seen as using media, and perhaps through collaboration with a distance education department. Teaching farmers is seen as a normal part of the faculty's activity. This was evident in the difference in responses to questions about distance education and teaching farmers. Only thirty-one percent (31%) of respondents reported that their faculty or school was active in distance education, while 16 out of the 18 responding said they were active in teaching farmers, and the one coded as "no," really said "we do very little." Thus, agriculture faculties are teaching farmers, but they use traditional media more than ICT. This was reflected as well in a specific question asking which media were used to teach farmers. The results are summarized in Table 22.

Table 22: How Agriculture Faculties Provide Information to Farmers

Medium	Number
Face-to-face meetings	15
Print media	5
Distance Education	4
Radio/Television	4
Web portal	2
Student attachments	2
Internships	1
Mobile phone	1
Research sites	2

The extent to which ICT has not become part of agricultural faculties' interactions with farmers is clear. Face-to-face meetings including activities such as short courses on campus, field days, and general face-to-face contacts, were the most popular mode of contact. Several of the other categories are also really face to face, although perhaps over a more extended time, including student attachments and research sites. The second most popular medium was also traditional, namely print media. On the other hand, as many as nine cases could be said to be using distance education and ICT, if distance education, radio, the Web portal and mobile phones are included.

It should also be made clear that the relatively low use ICT in communicating with farmers is not simply a question of a failure to adopt the most effective methods. There are good reasons why traditional methods may be more appropriate. Very often, for example, no electronic media and often no electrical power exist in villages where farms are located. Also, farmers often do not speak English, and the number of different languages in different places is quite large. These are huge obstacles, even before reaching questions of computer literacy or the availability of ICT to farmers. It is possible that the use of

ICT in providing information to farmers may be part of a multi-step flow, where it is used to teach the people who will then teach the farmers.

On the other hand, there may be instances where the use of some electronic media, such as mobile phones or radio, may be appropriate to reach at least some farmers, and differences can be expected from place to place.

5.9.4. ICT and Research

Beyond capturing the mentions of research in the sections above, the question of ICT and research in faculties of agriculture was approached in two ways, by asking about recent projects and initiatives to use ICT in research, and by asking what policies support using ICT for research.

Recent projects and initiatives captured a range of activities, without a large degree of commonality among them. Among the projects mentioned were finding requests for proposals online and submitting proposals, building a database of local research projects, expanding access to online databases, holding training workshops on basic computer skills, planning to use the Web to disseminate research results, and a collaborative project with Belgian universities in GIS.

The status of specific policies support the use of ICT in research is summarized in Table 23:

Table 23: Specific Policies Supporting ICT in Research

Status	Number
Part of a strategic plan	5
Specific steps being taken	5
None	3
Policy in formulation	1

For about a third of those responding, some encouragement for research using ICT, at least as rhetoric, was part of the university's strategic plan, or in one case, Rwanda, part of the national ICT plan. In a significant number of cases, however, there were no supporting policies. In five cases, initiatives were under way, even though no broad policy was mentioned. These included the establishment of online databases, digitizing the library, training on recent software, and general encouragement of the use of ICT.

5.9.5. ICT and Collaboration

Respondents at some institutions reported collaborating online, through using online groups, e-conferences and debating groups, but this use was not widespread. Two universities reported sharing information with other specific institutions online, while one mentioned collaborating to respond to proposals, and one mentioned collaborating on a farm management application.

Faculties made several suggestions for how ICT could be used to improve collaboration, particularly video conferencing, more bandwidth and newer hardware. One interesting comment was that general improvement in ICT would enable the faculty to be more effective in competing in international requests for proposals, where now it seems difficult to get everything done as quickly and effectively as the competition.

6. Discussion

6.1. Benchmarks and Previous Studies

A primary aim of this report is to benchmark the ICT capability of RUFORUM universities to engage in initiatives to ensure that RUFORUM universities produce high quality graduates to solve Africa's development challenges. A benchmark measures the current situation, to allow comparison with future measurements. Often, it also compares what is with what should be. In the case of ICT readiness at universities in sub-Sahara Africa, a number of recent studies have been performed, and some of these have compared their results to standards against which their institutions' progress can be measured.

In 2008, the Southern African Regional Universities Association compared the results of its ICT status review for universities in the SADC region to targets it established from a literature review.[13] A comparison of those targets and results with some of the results in the RUFORUM study is in the table below.

Table 24: RUFORUM and SARUA Benchmarks Compared

Factor/Indicator	Target	SARUA: % meeting target as of Nov 2007	RUFORUM: % meeting target as of Sept 2009
Availability of adequate access to ICT infrastructure			
Student:PC Ratio	5 to 1	17%	8%
Teaching Staff:PC Ratio	1 to 1	8%	42%
Fibre campus backbone	Gigabit capacity	42%	86%
Adequate Bandwidth	10 mbps minimum	33%	27%
Existence of IMS	At least student management, financial, library, HR systems installed	50%	45%
Existence of e-learning applications	E-learning application installed	67%	59%
Existence of collaborative research infrastructure	University connected to NREN	43%	57%
Existence of supporting organizational structure and policies			
Existence of centralized ICT unit	Independent unit with Head reporting to VC or Deputy VC level	92%	68%
Existence of dedicated e-learning unit	Functionally separate from and independent from ICT unit.	50%	63%
Existence of ICT policy	Policy enacted and strategic plan developed	75%	59%
Existence of E-learning policy	Policy enacted	42%	26%
Existence of BWM policy and tools	Campus network and Internet connection monitored and bandwidth managed	42%	63%
Capacity of users			
Provision of e-learning training for teaching staff	All teaching staff	50%	Not asked
Provision of ICT training for teaching staff	All teaching staff	75%	Not asked
Provision of ICT training for students	All students	50%	87%

[13], Twinomugisha, Alex, "ICT: A Status Review of ICT in Universities in the SADC Region (Studies Series 2007). Southern African Regional Universities Association, February 2008, p.25.

In general, many RUFORUM universities have not reached the SARUA targets. Achievement is sometimes very low, such as the lack of student computers and connectivity. RUFORUM members also lag others in setting e-learning policies, although they have set up at least as many i e-learning units.

In several areas, RUFORUM universities appear to be doing better than the average of those measured by SARUA in 2007, including teaching-staff-to-PC ratios, use of optical fiber in the campus LAN backbone, NREN connectivity, and provision of basic ICT training for all students. Averages can be deceptive, however, in that the excellent performance of some universities in the survey can mask under-performance at others. Thus, the interpretation of the findings could be that 68% of RUFORUM universities have established centralized ICT departments and 32% still have not.

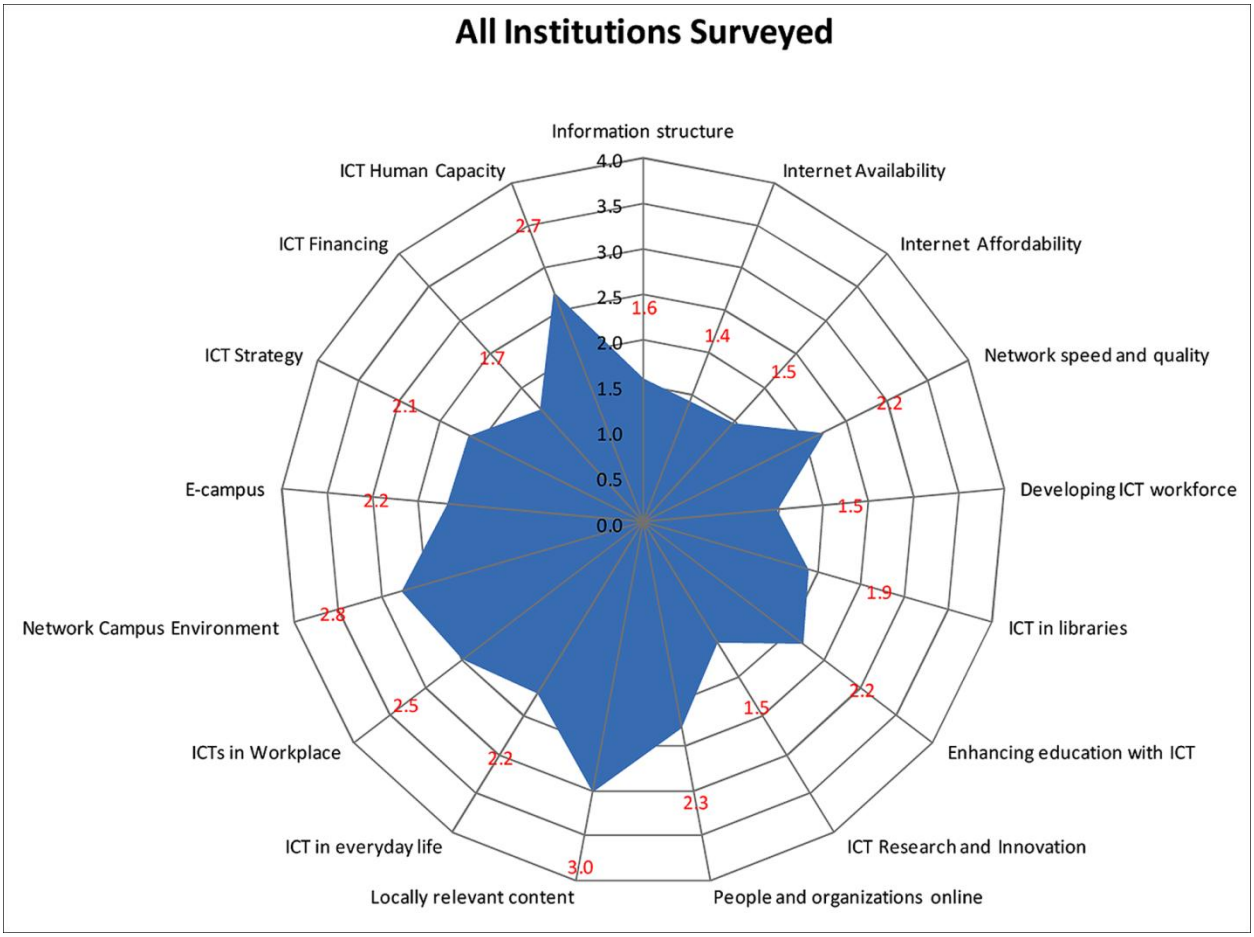

Figure 1: Average staging for 17 indicators for East African Universities[14]

In 2006 and 2008, the Kenya Education Network (KENET) undertook studies of e-readiness at East African universities.[15] [16] The studies assessed e-readiness at the institutions surveyed by rating each

[14] Kashorda and Waema, *op.cit., p.iii.*

university in terms of 17 indicators, each on a scale from 1 to 4. The overall results of the survey, for the 53 institutions surveyed in the KENET 2009 study are shown in Figure 1, above. The way the indicators were created was to select concrete measures in each indicator's category and them to combine them to generate the indicator. The scale of the indicator ranged from 1 to 4, with 1 meaning unprepared and 4 representing the highest stage of preparedness for the particular indicator. For example,

> The *Internet availability* indicator was measured using three sub-indicators, namely the uplink bandwidth per 1000 students, the download bandwidth per 1000 students, and the networked PCs per 100 students. Data for calculating the values of the sub-indicators was obtained from the hard facts questionnaires. The research study determined the range of values for each subindicator based on researchers' experience with Kenyan institutions but took into account internationally comparable values.[17]

Because the KENET indicators are ultimately based on subjective decisions about how various measurable values fall on the preparedness scale, they are impossible to duplicate simply from reading the KENET reports. Since the KENET reports do not provide enough information to allow us to replicate their indicators with the information from the RUFORUM study, the best comparison that can be made with the 2008 KENET report is to examine some of the raw data reported that were later aggregated into indicators.

An earlier series of studies were conducted as the African Tertiary Institutions Connectivity Survey (ATICS). The data from their last study [18] is included in the tables below. These tables present comparisons with other reports when comparable statistics were available. As with the SARUA indicators presented separately above, these results will be discussed in the recommendations below.

Table 25: Overall Bandwidth Availability to Institutions

Bandwidth Availability (kbps)	ATICS 2006	SARUA 2007	KENET 2008	RUFORUM 2009
Overall Average	706/1254	3500/4650	3158	6839
Minimum	7/20	32/64		512
Maximum	8000/8000	16000/16000		40000
kbps per 1000 students			430	675

KENET figures are based on averages per country, not per institution

[15] Meoli Kashorda and Timothy Waema, "2008 E-Readiness Survey of East African Universities: A Study Funded by the Rockefeller Foundation." Kenya Eduction Network (KENET), 2009.

[16] Kashorda, Meoli, et al., "E-readiness survey of higher education institutions in Kenya," Nairobi: Kenya Education Network (KENET), May 2007.

[17] Kashorda and Waema, *op.cit.,* p.14.

[18] Karanja Gakio, "African Tertiary Institutions Connectivity Survey (ATICS): 2006 Report." Ottawa: International Development Research Centre, 2006.

A general observation that can be made about bandwidth availability is that it has increased significantly compared to recent studies. These studies differ both in when and where they were conducted, so comparisons can be rough at best, but it appears that the main difference is the large amounts of bandwidth recently implemented in Kenya, perhaps in anticipation of connectivity to the new undersea cables. It is worth noting, however, that, even with these increases, there is still a distance to go. The 2008 KENET study set its target for adequate bandwidth at one megabit per second per 1000 students. As the table above shows, neither the 53 universities in the KENET study nor the 25 in RUFORUM reach that level yet, on the average.

Table 26: Average Overall Cost of Internet Access Bandwidth				
Bandwidth Cost ($/mo./kbps)	**ATICS 2006**	**SARUA 2007**	**KENET 2008***	**RUFORUM 2009**
Average	4.58	2.43	2.11	2.59
Maximum	28.61	5.20	2.85	10.87
Minimum	0.05	0.10	1.00	0.21
*KENET maximum and minimum are by country, not institution.				

According to this rough comparison, the average cost of Internet access has been roughly stable for the last couple of years and similar among areas studied, although it appears to have dropped significantly since 2006. As with previous studies, the RUFORUM census was taken before any influence on rates of new undersea cables in East Africa was realized.

Table 27: Characteristics of Campus LAN Backbones			
Percentage of campuses with:	**ATICS 2006**	**SARUA 2007**	**RUFORUM 2009**
Campus Backbone	94%	92%	86%
Fiber in Backbone	33%	92%	95%
Copper in Backbone	46%	42%	
Wireless in Backbone	21%	58%	
All Buildings and offices connected		67%	45%

While not all universities in the RUFORUM census reported having campus backbones, those that did said there were comprised of one-gigabit-per-second optical fiber.

Table 28: Extent of Bandwidth Management			
Bandwidth Management	**ATICS 2006**	**SARUA 2007**	**RUFORUM 2009**
Percentage of institutions who:			
Monitor Internet Bandwidth	42%	83%	76%
Have Bandwidth Management Solutions	41%	50%	67%

It appears from this comparison that RUFORUM universities are performing roughly as well as the institutions surveyed recently by SARUA in terms of bandwidth monitoring and management. It is important to note, however, that the question addressed only the existence of bandwidth monitoring

and management, not the specific technologies employed or their effect on network performance. Anecdotal evidence from staff visits to several universities indicates that bandwidth management, while present, may be limited and not be delivering the promised improvements of comprehensive bandwidth management for Internet access performance.

Table 29: Average User-to-PC Ratios				
User/PC Ratios	**ATICS 2006***	**SARUA 2007**	**KENET 2008**	**RUFORUM 2009**
Students per PC	53.00	20.40	18.72	26.32
Maximum	388.00	565.25		100
Minimum	1.53	1.69		4
Teaching Staff per PC		1.69	4.35	3.58
Maximum		23.63		20
Minimum		0.30		1
Administrative Staff per PC		2.21	1.89	2.75
Maximum		9.80		10
Minimum		0.70		1

*ATICS figures are for students plus all staff

As mentioned with reference to the SARUA targets above, the student-to-PC ratios at RUFORUM universities, on the average, represent a significant concern. The situation is somewhat better in terms of computers supplied by universities to academic staff, although it is important to mention that at six universities, PCs were not supplied to academic staff at all.

Table 30: Percentage of Universities with Management Information Systems		
Management Information Systems	**SARUA 2007**	**RUFORUM 2009**
Financial Management	83%	84%
Student Records Management	75%	70%
Library Information Management	83%	78%
Human Resources Management	67%	57%
Inventory Management		43%
Other	17%	23%
1 or more systems in place	92%	96%

Table 30 presents another view of the status of management information systems, comparing the SARUA and RUFORUM results. The results here show rough equivalence, with relative strengths in some areas and weaknesses in others.

Table 31: E-learning Indicators				
E-Learning	**ATICS 2006**	**SARUA 2007**	**KENET 2008**	**RUFORUM 2009**
Percentage with E-Learning Strategy	39%	42%		24%

Percentage with E-Learning Apps	47%*	100%*	28%	59%
Percentages with LMSs				37%
Percentage with e-learning offices		50%		63%

*Includes Learning Management Systems

As mentioned in Section 3, e-learning activities at RUFORUM universities are mixed, with some significant achievements but a general state of uneven accomplishment, with many institutions only at the beginning of activity. This can be seen in the table above, where RUFORUM universities tended to report lower indicators than in the other studies, with the exception of the number of offices of e-learning that have been established.

A general conclusion that can be drawn from the comparisons with targets and other studies above is that, in general, none of the studies show many universities at the levels that could be described as adequate ICT capability, with a few good exceptions. At the same time, it should be said that RUFORUM universities generally perform at about the level seen in studies of other groups of institutions, given the time difference among the studies.

The crucial question, then, is where do the RUFORUM universities go from here? Now that a baseline has been established, what does it say about efforts in the future?

7. Recommendations

The recommendations will be addressed to three distinct but overlapping audiences:

- The leadership of RUFORUM universities
- The schools and faculties of agriculture in RUFORUM universities
- RUFORUM as an organization, or its Secretariat

All of the recommendations will be of interest to those wishing to improve ICT at RUFORUM universities, however, particularly with respect to improving the use of ICT in agricultural education for development. The results of this study will be presented to the vice chancellors, deans and ICT directors of RUFORUM's member universities.

7.1. University-level Initiatives

7.1.1. Implement an ICT Strategic Plan

With 91% of RUFORUM's members either having an ICT policy in place or going through the approval process, the question of whether to have one has been resolved. The issue now turns to two further questions: What is in the plan, and how is it being implemented?

SARUA's 2008 report listed several specific policies that should be included:

- An ICT Strategic Plan
- An Acceptable Use Policy (AUP) for all users
- A Privacy Policy
- An ICT Security Policy
- A Bandwidth Management Policy
- An Open Source Policy[19]

These recommendations are in tandem with the findings of RUFORUM's study. Of particular importance is going beyond a policy to a strategic plan. Effective implementation of the policy will depend on how funding, behavior and accountability are attached to it. During the visits, more than one historical case was encountered where an ICT policy had been enacted some years back, only to gather dust. ICT is a vital resource for any university and that the results of this study and the others noted here show that much remains to be done. Thus, it is time to accelerate the pace with concrete steps.

[19] Twinomugisha, Alex, *op.cit.,* p. 15.

The aspect of policy dissemination is also very critical because the study found that faculty staff did not know much about ICT related policies.

7.1.1.1. Meet to Compare ICT Policies

The RUFORUM study found that more than one-third of RUFORUM's members currently have an ICT policy under consideration. Thus, this is a "teachable moment," when universities can benefit from the experience of those who have already enacted policies, so that the best practices of the group can be reflected in the emerging policies. Thus, a meeting of member university ICT directors is recommended for purposes of comparing policies and experiences, in addition to the general review of this study's findings mentioned above.

7.1.1.2. Measure Progress in ICT Readiness and Policy Implementation

Implementation must be measured by results; therefore it is recommended that follow-up studies of RUFORUM members' ICT readiness be performed periodically, starting two years from now.

7.1.2. Give ICT Strategic Importance in the University's Organizational Structure

It is encouraging that 60% of RUFORUM members have established central ICT departments. The universities that have not established central ICT departments should do so, because implementing effective university-wide policies and technology is much easier with such an organization.

It is also important that the head of the ICT department report high enough in the university's administrative hierarchy. Reporting to the vice chancellor, or at least a deputy vice chancellor, is recommended. Studies of how technology is implemented in organizations almost always discover that leadership from the absolute top of the organization is the best way to achieve and manage change. If we recognize that ICT is a strategic resource that must be used fully, then building in top-level attention and encouragement is essential.

7.1.3. Continue to Increase Internet-Access Bandwidth until Targets Are Reached

Throughout this study, whenever it was asked why some ICT-related goal had not been achieved or what could improve ICT at the university, the first or second answer invariably was the need for more bandwidth. Internet-access bandwidth has been increasing at RUFORUM universities, on the average, but this statistic masks two things. First, while some universities have acquired lots of bandwidth, 40 megabits per second in one case, others have a great deal less, as little as half a megabit per second. Thus, universities with little bandwidth today should make special efforts to increase it.

Second, measuring total bandwidth is not the best way to measure its benefits to users. Performance at a given bandwidth depends on the number of users. Thus, KENET's indicator of bandwidth in terms of kilobits per second per 1000 students is a better gauge. KENET has proposed a target of 1000 kilobits per

1000 students, which RUFORUM considers reasonable.[20] At present, RUFORUM universities, on the average, provide about two-thirds of that, 675 kbps per 1000 students, although the average is skewed by a few universities with very good ratios. It is recommended that the KENET target be reached as soon as possible.

7.1.3.1. Persuade National Policymakers to Facilitate Access to ICT

The arrival of the undersea fiber cables promises to decrease the cost of international Internet access, particularly for some regions, but getting the bandwidth from the ocean to the campus can involve many steps, such as the creation of a national fiber network and implementing local connections to such a network. For many countries, connection will have to be indirect, through some other country's network.

Achieving all this connectivity requires attention beyond the university. The fact that 80% of RUFORUM members have joined a National Research and Education Network indicates that the dimensions of the issue are well known. The collective efforts of an NREN well may not be enough, however, unless the national government takes a hand. In the most successful cases, such as in Kenya and Rwanda, the government has subsidized bandwidth prices and construction of critical backbones and links. This is the scale of effort that is required, and governments must be persuaded to provide this support.

Beyond subsidy, there are questions of taxation, regulation and, in some cases, competition. As participants in this study noted, the prices of ICT equipment and Internet access often depend on how they are regulated and taxed. Further, if the government supports monopoly carriers, or is one itself, the expected drop in prices from international bandwidth becoming available may not be realized. Universities have to become a voice in the debates around these issues.

7.1.3.2. Support National Research and Education Networks

As discussed immediately above, National Research and Education Networks are proving to be an excellent vehicle for providing bandwidth to universities, in the countries where they have been developed and supported. RUFORUM considers continuing this undertaking and expanding NRENs' benefits to countries where they are not fully realized to be important enough to warrant a separate recommendation.

7.1.3.3. Practice Comprehensive Bandwidth Management

Seventy-six percent (76%) of the universities in this study monitored their institution's Internet bandwidth, and 67% managed it. The most popular technology for bandwidth management was the Squid caching proxy server, which allows access to the Internet to be controlled by user or group of users, time of day, amount downloaded, and other factors. Squid is effective against some causes of bandwidth congestion, such as overwhelming use from student hostels or for downloading music and video. Using the software effectively, however, demands that policies be established about who gets to use the bandwidth for what purpose at what time. These policies then have to be reviewed, both in terms of their effect on congestion, measured through monitoring, and in terms of whether certain

[20] Kashorda, Meoli, et al., *op. cit.,* p. 75.

policies have unintended consequences, such as blocking acceptable traffic along with unacceptable traffic. This practice requires considerable attention and effort to be truly effective.

Effective bandwidth management also requires that the campus network be organized in a way that can be managed, usually by Internet protocol (IP) address. Network topologies using a combination of routers and switches often are difficult to segment effectively for bandwidth management. In this study, it emerged that most campus LANs had uniform architectures, but that several did not.

Other devices for managing bandwidth address other questions. For example, it is possible to conserve bandwidth by compressing data sent to some destinations. It is possible to define classes of service, so that regular Internet traffic is not carried in the same bandwidth as video conferencing or voice. As bandwidth increases and new uses are found for it, bandwidth management will have to expand beyond Squid, so it is recommended that a continuing review of bandwidth management and its technology be carried out by each ICT department.

7.1.4. Expand Access to Computers

On the average, only five percent of students bring their own computers to RUFORUM universities. It is true that students access the Internet from Internet cafes and other locations, as the 2008 KENET study effectively illustrated.[21] Even so, the aggregate amount of Internet access available is not yet sufficient. Targets for the ratio of students to university-supplied computers range from 5 to 1 up to 10 to 1 as a short-term goal. The current average in RUFORUM universities is more than 26 to 1. In only two cases, among all RUFORUM members, was the student-to-computer ratio 5 to 1 or lower.

It is encouraging to note that the academic staff and administrative staff computer ratios are far much better than those of students, and that this represents an improvement from earlier studies. Six universities still provide no computers to lecturers, however.

RUFORUM universities are urged to address this issue using a number of strategies:

7.1.4.1. Implement Thin-client or Desktop-virtualization Solutions in Computer Labs.

Thin clients are end users' computers which use a Web browser to access applications. This allows a user's computer to be less powerful and often older than if it is required to process applications itself. The limitation of the thin-client approach is that the application must be able to be accessed from a Web browser. This is less of an issue than it used to be, because of applications "in the cloud," such as Google Apps, which allows, among other things, creating and editing documents, spreadsheets and presentations in a Web browser. Cloud-based applications may depend on adequate bandwidth, however.

A new variation of offloading desktop processing is desktop virtualization, which puts only a small application on the desktop. The application accesses a virtual desktop based on a server, which can be

[21] Kashorda, Meoli, and Timothy Waema, *op. cit.,* p. 33.

as complete as any local computer and which looks just like it is local to the user. A large number of virtual desktops can be implemented on one server.

The benefits of these technologies are both that the lifespan of the desktop computer can be extended and that the software and maintenance required on the desktop is much less. Desktop computers in these configurations can run the open source Linux operating system, for example. All in all, costs can be reduced, allowing more computers to be provided for the same amount of money.

7.1.4.2. Enter into Agreements with Computer Vendors for Price Reductions for Students, and Arrange for Financing.

Several universities were experimenting with these options, according to conversations during the visits. They have some potential, and RUFORUM urges member universities to share the results of successful programs.

7.1.4.3. Reduce Software Costs by Striking an Effective Balance between Proprietary and Open Source Software

During the visits, it was regularly mentioned that a key strategy for reducing software costs, and thus being able to make software available on more computers, was to use open source software. What was found in practice, however, was that 100% of the universities surveyed used Microsoft Windows on their desktop machines, and that in most cases, Windows was used almost exclusively on the desktop. Since each computer requires an operating system, and, to be legal, a license for the system, the sheer number of desktop computers in labs and offices means that a lot of Windows and probably other proprietary software will continue to be used.

If this is really the case, then the question is how to pay for it. Avoiding payment by using unlicensed copies is not only illegal but has recently become more dangerous, because software vendors like Microsoft have discovered how to deny updates to unlicensed copies in use. Since many updates improve the security and anti-virus protection of computers, not licensing a computer's operating system puts it increasingly at risk of penetration or infection and of becoming a source of trouble for other computers on the university network.

Microsoft and other vendors have established programs and discounts for educational users, which are significantly cheaper than the prices charged to businesses or consumers. Universities should explore these arrangements and take advantage of them, as long as their widespread use of the products continues.

Further, it should be mentioned that the idea that open software is "free," is more in the sense of "free speech" than "free beer." As a recent UNESCO report summarized,

> A total cost of ownership calculation, including the cost of servers, programming and IT support staff time, needs (to be) done when comparing the suitability of software. The ability to integrate data usage between multiple computer programmes without having to re-write the programming is important. Sometimes, proprietary packages that have integration in their design might be most appropriate. The stability of having a

programme that works reliably may be paramount while the ability to have programmers rewrite the core program code might be most appropriate in other situations.[22]

7.1.4.4. Charge Technology Fees for Maintaining Computer Laboratories.

As mentioned above, the RUFORUM study found that 33% of the universities surveyed charged student technology fees, sometimes earmarked for Internet access. This percentage indicates that the practice is feasible, but that most universities have not adopted it. It bears consideration as a regular, sustainable source of ICT funding. The member universities are urged to share the results of their fee programs, particularly in terms of what is the best price level for such fees.

7.1.4.5. Commit an Annual Amount in the University Budget for the Purchase of New Computers.

Part of an ICT strategic plan should be a funding strategy for reaching targets in an orderly fashion, over the several years that will be necessary.

7.1.4.6. Keep the Computer Labs Open Longer.

Nine universities in the RUFORUM census operated their computer labs for nine hours daily, while nine operated them for 14 hours or more, with two open 24 hours a day. This variation shows that there is great potential for increasing the time the labs are open at some universities. Particularly if necessary supervisory personnel can be given other work to do while in the labs, this could be an economical way to expand access to computers without increasing their number.

7.1.4.7. Work with Organizations that Supply Refurbished Computers (e.g. Computer Aid International and Close the Gap).

Close-the-Gap, the Belgian NGO, has donated tens of thousands of refurbished computers to African schools. Particularly if combined with a thin-client or virtual-desktop solution, this can be an effective way to acquire effective computers for labs.

7.1.5. Support Using ICT for Research

Transforming African tertiary education, and education in agriculture in particular, involves having access and using the wealth of knowledge available globally. It also involves using the research produced in Africa to its fullest and giving that research the global recognition it deserves.

A key to improving the flow of research, into, within and out of Africa, is the adoption of ICT. Increasingly, the home for research is in a global database or virtual library. Getting access to those databases and libraries, both in the sense of acquiring research from them and adding research to them is crucial. In order to achieve this, some specific steps are required.

[22] Balasubramanian, K., et al., *op. cit.,* p. 5.

7.1.5.1. Expand the Use of Existing Electronic Resources

Before this study was begun, information had been received about universities where key databases in agricultural research such as TEEAL (The Essential Electronic Agricultural Library) were not being used. Thus, each responding institution was asked whether TEEAL and other similar collections of published research were available. Surprisingly, it emerged that TEEAL is available at 80% of RUFORUM universities, and other databases, such as AGORA and HINARI are equally or more available. What was discovered, however, was that in several cases, the deans of agriculture faculties reported that the data was not used as much as it should be.

RUFORUM plans to help make TEEAL available to the 20% of members who still do not have it, but in most cases, the issue is not availability but use. Several steps can be taken to improve use, including simple measures such as publicizing the databases' availability better and making their use part of appropriate class assignments.

Of particular importance is making sure that the databases can be reached conveniently. At one RUFORUM university visited, the librarian was quite proud of the access to several databases like TEEAL at the main library. Meanwhile, the faculty of agriculture said they could not get access to it. The problem, it turned out, was that the databases were only available through the university's local area network, and the wireless connection from the agriculture faculty's remote campus to the main campus had been down for most of the previous year.

Establishing adequate connectivity to the databases, then, is paramount. This not only means maintaining the university network but also allowing the databases to be accessed over the Internet, not just on the university LAN.

This applies not only to access to international resources, but also to the unique resources of the university library itself, such as its catalog and any digitized collections of local scholarship.

7.1.5.2. Expand Required Computer Literacy Training to Include Research Techniques

A very direct way to increase students' and lecturers' research activity is to train them specifically on how to do it and then to require it. It was exciting to find that 87% of RUFORUM members offer courses in basic computer skills to students, and that such a course is required at 75% of the universities. At the same time, however, when RUFORUM universities were asked who was responsible for teaching students how to find information on line, 75% of respondents said that the library was responsible and that the usual way it was done was through short courses or *ad hoc* training when a student requested help, not that the information was supposed to be part of the basic computer skills course.

There is a wealth of information that can be included in an introductory computer literacy course, but it is evident that how to find information on line must be a major component. In terms of what students, and particularly academic staff, will need in the future, how to find information on line has got to be a key component. It almost goes without saying that this must be even truer for lecturers, who should, at

a minimum, be required to demonstrate online research proficiency during their first year or required to receive instruction.

7.1.6. Realize the Full Potential of Management Information Systems

Management Information Systems are a reality at nearly all RUFORUM campuses, and they are generally successful. In some cases, the return on investment has been enormous. At Kenyatta University, for example, use of the financial management system to improve the University's accounts payable reduced the fees not paid from 35% to 10% contributing significantly to a year-to-year increase in fees of US $4 million.

The operation of Management Information Systems can be improved through the following:

- strengthening the information system units in the ICT Departments so that the in-house software development projects are sustained and documented
- sharing lessons learned among members of the RUFORUM network
- moving towards the integration of the various university MIS to improve the way that information is stored, managed and accessed
- researching the possibilities offered by the various free open source software applications

Although all management information systems have their special virtues and needs, library information systems call for special attention in this report. Electronic library catalogs not only simplify library operations but also have the potential to make the library's resources available to off-campus users and other institutions. Circulation systems not only keep better track of resources but also make activities like collecting and paying fines more convenient. Integration of the circulation system with the registration system, for example, can put a hold on registration until library fees are paid.

In particular, RUFORUM supports the efforts of universities to digitize and catalog their theses, dissertations and other "grey literature." In agriculture as in many other areas, Africa is unique and diverse and knowledge of local conditions is vital to appropriate approaches to development. Thus, this literature must be preserved and further efforts must be made to capture more of it, such as presentations at conferences and unpublished work of quality. RUFORUM supports the recommendations in the recent SARUA study on access to knowledge, in this regard.[23]

7.1.7. Support Initiatives in E-Learning

RUFORUM universities do not yet have a great deal of experience in implementing e-learning as defined in the developed world. Based on what was seen at the universities visited, RUFORUM members are in a

[23] Abrahams, Luci, et al., "Opening Access to Knowledge in Southern African Universities." Wits, South Africa: Southern African Regional Universities Association (SARUA), Study Series 2008, 2008.

position to start some kinds of e-learning initiatives. What is important to note is that e-learning means different things to different people. There is therefore a need to define e-learning within the context of RUFORUM's membership. For now, e-learning initiatives could mean any of the following: the use of PowerPoint presentations in the classroom; the use of email as a formal means of communication between lecturer and students; the creation of CDROM-based content for use by students; the use of mobile-phone SMS technology for communicating with students; referring students to specific online content that they access as part of their research activities, or many more examples.

RUFORUM universities are urged to begin to formalize their electronic content development initiatives, in order to get ready to take advantage of the improved bandwidth that is coming. Developing quality electronic content requires an enabling environment which must be put in place and this includes the following: time for staff to develop the materials; incentives and recognition for the staff that develop the content; policies that create an enabling environment; and facilities and equipment for developing the content.

7.1.8. Implement Video Conferencing

In the examination of collaboration technology, one results stands out. One hundred percent (100%) of respondents who said their universities did not have video conferencing facilities said they were very interested in acquiring them.

Video conferencing technology has been around for some time, and for many years the consensus was that it was expensive, bandwidth-intensive, difficult to manage, and so unreliable that it did not often perform effectively. In the last few years, however, the situation has significantly improved. The implementation of new standards, particularly the H.264 standard, have reduced the amount of bandwidth needed and facilitated the transmission of video conferencing over the Internet, instead of using IDSN lines. New terminal equipment, displays and bridges have also made the system more stable. The arrival of digital video technologies as major global consumer electronic appliances has also reduced the cost of video conferencing equipment because of economies of scale.

At the same time, many regions of Africa are beginning to see the promise of much greater bandwidth at lower prices, so that the allocation of 384 kilobits per second exclusively for video conferencing during some part of the day no longer seems impossible. Finally, the advances in Internet video generally, from YouTube to Flip video cameras, means that the general use of video, including reuse of recorded video conferences, is becoming radically cheaper and easier to manage.

With respect to e-learning in Africa, video conferencing promises to mitigate some of the barriers to producing effective e-learning content. One of the main barriers to effective use of technology to reach farmers is that farmers in Africa speak many, many different languages, so that translating materials into computer-based modules is very labor-intensive. Further, many lecturers do not have the skills, or the time, to create e-learning materials, but they are able to deliver a lecture in front of a camera and answer questions from a remote audience. Thus, video conferencing may have particular application in an African setting.

Implementing a technology for its own sake is hardly ever a good idea, however, so it is recommended that the implementation of video conferencing be considered in the context of at least a few specific potential projects. For example, a course including a series of video-conference guest lectures, where international experts in their agricultural specialty speak to students at other universities might be an effective use of the technology.

7.1.9. Increase Incentives for Faculty to Use ICT

During the visits, it was repeatedly mentioned that one of the most significant barriers to e-content development was the difficulty of fitting the task into the schedules of already over-scheduled lecturers who are coping with challenges such as rapidly increasing student populations. To get academic staff, particularly junior academic staff that may be more familiar with ICT, to devote time to developing e-content, is going to require a change. As noted above, only 38% of member universities provide any special incentives for using ICT for teaching, learning or research, and only 18% provide any credit towards promotion or tenure for e-content development.

RUFORUM believes that either funding will have to be made available to provide release time from usual academic duties or that ICT-related work will have to be allowed to substitute for traditional achievements supporting promotion or tenure. Otherwise, rational economic career decisions will keep junior staff assigning priorities to the existing system, rather than to developing new technologies.

RUFORUM has a role to play in providing incentives, as discussed below, but these will only be effective in an environment that is supportive of them.

7.2. Faculty-level Initiatives

The School or Faculty of Agriculture is where all the elements of this study must come together. While more computers and more bandwidth are necessary, those are infrastructure which ultimately must support research and education, and the use of agricultural knowledge for national development. Several ingredients must combine at the faculty level, including motivation to supply knowledge to the agricultural innovation system, relevant knowledge, a program combining research, extension and training appropriately, ICT, and the knowledge of how to use ICT effectively.

7.2.1. Develop a Collaborative Orientation

The RUFORUM study found that most uses of ICT in faculties of agriculture were centered on individuals' uses of computers and the Internet for email, online research and course preparation. Moving from here to using ICT to improve agricultural development will require learning new ways to do things and collective agreement that they are worth doing. The best first step in this process is adopting a collaborative orientation towards those who hold the different parts to the puzzle: the ICT department, the distance education department, academic with similar interests at other universities, and groups like RUFORUM who have the potential to support and coordinate efforts in this arena. As these various people and groups are identified, efforts should be made to maintain continuing communication with them through email and the Internet, and to involve members of this network in activities such as preparing proposals.

Those on campus with expertise on how to apply ICT to education should be invited to meet with faculty and students to describe the possibilities and present any concrete initiatives in which they may be involved. Departments of Open and Distance Learning at some universities, for example, are committed to training academic staff about how to develop e-content. If a learning management system such as Moodle is implemented, the ICT department will be concerned with training academic staff on how to use it.

During the visits, two cases were mentioned where agricultural scholars from other countries had approached faculties, suggesting the establishment of e-learning initiatives where experts at each school would provide content to the other. When such an opportunity arises, a first step could be to call together the experts at the university to explore how such a program could be supported and what additional help would be necessary. A university-wide coordinated effort around the project could provide measures of progress in many departments.

7.2.2. Support Champions of Using ICT for Agricultural Research, Teaching and Extension

Ever since two or three years since the personal computer was invented, studies have shown that organizations who are successful in adopting new practices using computers most often do so with the help of an internal "champion" who provides knowledge, an example of motivation, and results. Once a good example is established, a model is available to follow and to improve upon. The problem is how to find somebody who is both "in the mood" and "in the money." Good intentions and ambition will not go far if the potential champion is completely overwhelmed with other tasks. Thus, in exchange for real commitment to leading an e-learning initiative, some form of support is appropriate. One approach may be to support research into how ICT has been used in agricultural education around the world and how that can be improved upon in the African context.

7.2.3. Learn More about the Potential of ICT for Education

It is important for academic staff in RUFORUM universities to recognize the power of ICT tools if they are properly used in the classroom to improve the learning experience of the students. ICT has great potential to help the lecturer become more efficient in the way that she delivers her content. RUFORUM universities have a great deal to learn from those organizations that have experimented with the use of mobile phones in disseminating information to farmers. Radio technology is also a tried and tested tool for disseminating information. However, very few initiatives that recognize the potential of these ICT tools were found. The study reveals that the interaction with farmers was very low, meaning that the RUFORUM faculties of Agriculture are still not actively engaging with the farmers in order to learn from them and also influence some of the practices.

A number of collaborative initiatives using ICT are not formalized and happen at the level of various projects or at individual levels. This is probably due to the fact that sustaining online communities requires strong leadership and incentives for the members of the community. The issue of unreliable internet also contributes to this. The time is however ripe for RUFORUM universities to formalize some

collaborations that use ICT tools – so that RUFORUM universities begin to learn what works and what they need to do to make such collaborations sustainable.

7.2.4. Begin a Faculty-level Discussion of What E-learning Means in the Context of Agricultural Education and Once That Is Determined, Seek Financial Support for a Project

It must never be forgotten that information and communications technology is a means, not an end. For technology to be used effectively, its characteristics must constantly be measured against achieving a substantive goal, such as achieving successful growth within an agricultural innovation system by the use of the most appropriate techniques. Thus, knowledge of ICT's potential in specific forms, such as providing insect migration information via mobile phones, must be balanced with knowledge of what farmers can do with that information and what can motivate them to use mobile phones to receive it. In other words, it's necessary to get the innovation process started by visualizing an outcome and defining the steps toward its achievement.

RUFORUM is committed to helping faculties expand their knowledge of how to use ICT to support agricultural education in the service of national development. The specific initiatives suggested for RUFORUM below, then, are not just isolated activities for the RUFORUM secretariat to undertake, but rather a set of collaborative initiatives involving universities and faculties to which RUFORUM can provide coordination and resources. Thus, RUFORUM's initiatives are for universities and faculties, too.

7.3. RUFORUM Initiatives

As a consortium of universities with a focus on agricultural education for national development, RUFORUM is in a unique position to coordinate activities among universities and to assemble resources for joint projects. Because of this, these recommendations are being addressed to the RUFORUM network which is coordinated through the Secretariat. It is true, however, that universities and faculties of agriculture could also undertake some of these initiatives themselves.

7.3.1. Drive Increased Research and Information Literacy at RUFORUM Universities

If agricultural education is to move to a new paradigm, based on recent views of what is needed and how it is best supplied, a great deal of learning will be necessary. This learning will require research. Thus, research will have to move from a "business as usual" approach to an accelerated search for new approaches, and this, in turn, will benefit from increased ICT support. In particular, the following five initiatives are recommended, which can be led, funded, or coordinated by RUFORUM.

7.3.1.1. Empower Academic Staff and Students in Faculties of Agriculture to Do Better Research

Empowerment has two aspects. One is training in advanced methods of online research in agriculture, so that research by agricultural researchers can be more productive. RUFORUM should organize advanced training seminars for scholars from its member universities. Teaching researchers from several

universities simultaneously not only conserves resources but also allows for contacts to be made among the attendees that may lead to future collaborative work.

The other aspect of empowerment is providing strategic resources. A few universities still lack access to TEEAL, and RUFORUM is in a position to help them, for example.

A clear need that emerged in the RUFORUM study was for advanced software for data analysis. Agricultural research is sophisticated and specialized, and unique software has been developed to address the needs of various analytical tasks, such as genetic research. RUFORUM should survey faculties of agriculture to identify the specific needs for analytical software and coordinate its purchase with an eye to getting the most effective packages at the lowest collective cost.

7.3.1.2. Sponsor Collaborative Research Initiatives among Agricultural Scholars at RUFORUM Universities

Given RUFORUM's historical role in developing regional curricula and programs, it is a natural extension for the organization to coordinate collaborative research initiatives and to support the use of ICT in these initiatives. For example, RUFORUM could solicit proposals for research initiatives and then publicize them. It could collect responses and aid in the formation of inter-institutional research teams, and it could support the projects financially. It could supply essential ICT, such as collaborative sites for joint work. Finally, RUFORUM could monitor and evaluate the initiatives and their use of ICT and develop a set of best practices.

7.3.1.3. Create Materials on How to Find Information that Can Be Integrated into Computer Literacy Courses

As noted above, while most RUFORUM members require students to take a course in basic computer skills, how to effectively use online resources is usually taught separately by the library outside of a formal course structure. While individual universities, departments and teachers are the ultimate arbiters of course content, a set of effective materials about how to find information on line that could be integrated into an introductory curriculum might find widespread use.

Creating such a set of materials would provide benefits from the process alone. It should involve collaboration among ICT professionals, librarians and other information scientists, academic staff. It should use e-learning approaches and develop e-content. It should require input from students. All of these activities will have welcome side effects in terms of generating collaboration, e-content experience and awareness of student needs.

7.3.1.4. Coordinate Access to Digitized Materials Among RUFORUM Universities

It was exciting to see how many universities are working to digitize theses, dissertations, original research, examination papers and other local resources that might otherwise be lost or be impossible to access. It was noticed, however, that these efforts are going on separately, using different applications and different taxonomies for classification. Further, it was not always clear how widely these materials would be available.

Ideally, all of this material would be available over the Internet, through a single interface that could be effectively searched. This would not only facilitate access but would also create a unique collective body of knowledge where it would be easier to see the current state of research across the region. Getting to this ideal state requires combining the silos of information at each university into an integrated whole, real or virtual. This requires common information structures and quite likely a structure for access such as Web services, to make material from servers across the region available to a single search. Such a process would require a collaboration of ICT professionals, information scientists, and librarians from participating universities. Such a task will require coordination and resources, and it is suggested that RUFORUM take on the task of supplying them.

7.3.2. Create and Test an Enabling Environment for Implementing ICT in Teaching, Learning and Research in Agriculture

Beyond informational literacy and research, ICT has great potential for teaching and learning, from how ICT is used in the classroom, to how it can augment traditional teaching by the use of learning management systems, to how it can be used to communicate with farmers and other stakeholders. Instead of waiting until universities have all the elements in place to allow these approaches to be tested, creating an enabling environment where the basics are present and then testing how they can be used can be an effective approach

What this means is setting up an environment where there are enough computers and enough bandwidth and where instruction and resources about e-learning and the needs of agriculture can be combined. This could take advantage of the environment at a cutting-edge university, or it could be a combination of university resources and materials provided by RUFORUM or other donors.

Such an environment could demonstrate the potential of ICT in agricultural education as well as creating concrete materials that can be used throughout the membership. It could train practitioners in several ways, from seminars to longer sabbaticals dedicated to producing e-content.

Such an environment would allow the development of a model of what can happen when technology, incentives, skills, policy and vision are all in place. It could generate model programs for adoption in more real-world settings. It could move ICT in agricultural education forward.

7.3.3. Develop and Test at least One Communications System for Communicating with Stakeholders to Improve Agriculture

Finally, it is recommended that RUFORUM sponsor an effort to develop materials and communicate them with ICT to stakeholders beyond the university, including smallholder farmers. Much more information is needed about how ICT can work to accelerate agricultural development in the many African contexts.

An appealing candidate technology that emerged in the RUFORUM study and which is being explored in other fields is mobile telephony. It is evident how widely mobile phones have been adopted in Africa,

vastly exceeding other media and reaching all the way to the village, even beyond electricity in many cases. How exciting it would be to sponsor an experiment to assess the information needs in villages, assess how they could be addressed with mobile-telephony and create the materials to allow a fair evaluation of the system's effectiveness. RUFORUM could sponsor, monitor and evaluate such an effort.

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