

**Investing in STI in Sub-Saharan Africa:
Lessons from Collaborative Initiatives in Research and
Higher Education**

Global Forum

**Building Science, Technology and Innovation Capacity
For Sustainable Growth and Poverty Reduction**

Washington, DC February 13 to 15, 2007

Jeffrey C. Fine

jcfine@telepraxis.com

February 1, 2007

Ottawa, Canada

1. Investing in STI: National Systems of Higher Education¹

Accelerated economic growth is a necessary condition for human betterment and poverty alleviation in Sub-Saharan Africa. Success in achieving faster rates rests on the ability of its economies to compete effectively in global markets. Improvements in competitiveness will depend increasingly on the capacity to utilise knowledge and information in the design, production and marketing of traditional commodity exports and as well as new products and services, virtual as well as real.² This awareness is confirmed in official African pronouncements and documents, in particular those issued under the aegis of NEPAD by the African Ministerial Council on Science and Technology (AMCOST).³ The Millennium Science Initiative⁴ has prompted various activities, including World Bank loans directed toward strengthening STI capacities in some countries in Sub-Saharan Africa.⁵ The Bank is also contemplating large loans for post-secondary education in the region. Also indicative of its strategic importance to accelerated growth are activities of other donors⁶, such as the Partnership for Higher Education in Africa⁷, which has targeted investments in ICT including bandwidth, connectivity, and electronically mediated library services.

Strategies for revamping and expanding higher education, a key component of systems of science, technology and innovation (STI), must address inherent structural weaknesses as well as the legacy of past efforts.

With few exceptions⁸, national systems of higher education are not only small, in terms of overall enrolment and number of institutions, but also “undifferentiated”. Typically, a few publicly funded universities are expected to discharge a wide range of functions.⁹ Growth has been reflected principally in rapid expansion of undergraduate education, rather than in a deepening of the overall system through greater institutional specialisation.¹⁰ In terms of strengthening

¹ The author wishes to express appreciation to Al Watkins for comments on an earlier version of the paper.

² The Government of Uganda has included e-commerce among its short list of strategic exports. Senegal currently exports such services as the editing of law reports for the Province of Quebec (Canada). Ghanaians currently provide services via the internet for some American life insurance companies. A Kenyan call centre offers back office support to some major American travel firms.

³ See www.nepadst.org including the recent (Nov 2006) Cairo Declaration of the Extraordinary Conference of the African Ministerial Council on Science and Technology (AMCOST)

⁴ See <http://www.msi-sig.org/>

⁵ World Bank (2005) Millennium Science Initiative: Uganda

⁶ We note the continuing engagement of Scandinavian and Canadian bilateral donors in post-secondary education.

⁷ The Partnership is a coalition of six major American foundations. See <http://www.foundation-partnership.org/index.php>.

⁸ The principal exception is South Africa, with a range of post-secondary institutions and research bodies linked to government, academia, and the private sector. Both Nigeria and Kenya are beginning to move toward systems of higher education marked by greater differentiation, although not necessarily because of any formal policy in this regard.

⁹ It is not uncommon to find a leading public university responsible for mass undergraduate education, professional education (in law, business, medicine, and education), post graduate programs, research, distance education, and community outreach.

¹⁰ Designating a few publicly financed universities as “apex” institutions is clearly a very sensitive issue politically. Nonetheless, it is beginning to occur in some countries, either as the product of formally articulated measures, e.g. the financing of research and post-graduate education in South Africa, or an informal nudging of some institutions in this direction, as appears to be the case of Nigeria’s National Universities Commission with respect to “first” and “second” generation federal universities.

science, technology and innovation (STI) in these countries, more attention should clearly be given to this aspect of higher education. Of particular importance in this regard, but outside the immediate purview of this paper is the huge gap in post-secondary professional and vocational training, as exemplified not only by weak, underfinanced institutions, but also their lack of links to those institutions specialising in academic education as well as firms in the private sector.

In rapidly growing economies, the private sector comprises an important source of applied training and experiential knowledge. Within most Sub-Saharan African economies, the organised private sector is small and generates very little direct demand for research. Larger firms typically look elsewhere for the knowledge and skills needed to solve their problems.¹¹ Links to publicly financed research bodies, e.g. agricultural institutes and universities, remain weak. References by governments to “public private partnerships” are often interpreted, not without cause, as demands for private sector support, without any real prospect of direct benefit to the companies in question.

Even with significant “horizontal” growth, in terms of undergraduate education, and “vertical” deepening, with respect to functional specialisation among institutions, current global trends indicate that *national* systems of higher education in Sub-Saharan will remain sub-optimal in size. Cutting edge research is typically undertaken in highly specialised fields, often requiring expensive equipment and facilities and perhaps more significantly, experts within these areas. These requirements infer that quality graduate education, especially at the doctoral level, will necessitate collaboration across institutional and political boundaries. Another benefit is the avoidance of “inbreeding”, otherwise inevitable in much smaller and thinner systems. Whilst becoming increasingly commonplace in more mature systems, notably in Europe, institutionalised collaboration is still new to Sub-Saharan Africa.

Another major problem, also structural in origin, is the financing of higher education. Because of the very low ratio of public revenue to GDP, governments confront severe constraints to public expenditure. Improvements in revenue collection and progressively faster inclusion of the informal sector in the formal economy will allow governments to increase their investment in higher education and research. This process will take time. At present, governments have responded by transferring an increasingly greater share of the financing burden to students and parents through two forms of privatisation. The first is the establishment of private universities, which tend to concentrate on undergraduate education. The second is the establishment of “parallel streams” of fee paying students within public universities¹². Unfortunately this form of “income generation”, for both the teaching staff and institution, bears a high opportunity cost in terms of the quality time left for research.

Investment in higher education and research, key elements of STI, must also cope with two significant legacies from the past.

One is the consequences of prolonged underinvestment stemming in many instances from economic stagnation. Gross enrolment ratios are still low by international standards, particularly

¹¹ One such example, based on the author’s own experience, is applied research in the production and marketing of horticultural exports from East Africa. The leading firms invariably import the necessary expertise and knowledge.

¹² Another response, whose success has varied among countries, is the establishment of student loan schemes, essential for students from middle class as well as poorer families. However, even those efforts which achieve a high loan repayment ratio will require a major net cash outflow in the short and medium term.

in those fields requiring a sound foundation in mathematics and sciences. Addressing this shortfall will require investment in secondary education, especially in qualified teachers, who must first be trained or retrained at the university level. Governments are exploring various possibilities, including the use of distance education (open universities) and purpose built institutions. However, this turnaround, will take time. Perhaps even more compelling is the shortage of qualified staff. Whilst attention has often focused on the ravages of HIV/AIDS and the brain drain, an equally cogent cause is an emerging generational gap; because of the cutback in doctoral education over the past two decades, in conjunction with an aging generation of academics, set to retire over the coming decade. New scholars will often lack experienced mentors, and must also confront increased demands for undergraduate teaching, cutting into the time available for research.

A second legacy is the very spotty record, stretching back almost five decades, of designing appropriate modalities for investing in both research and higher education.

The recent call for major investment in physical centres of excellence, namely the African Institutes of Science and Technology, is not new¹³. Typically, the case for collaboration is advanced in terms of projected scale economies in staffing and facilities. Another unstated reason is the hope that a “green field” effort can circumvent the difficulties entailed in seeking agreement, nationally and regionally, among many existing players, usually with very diverse capacities and interests. Past experience, however, dictates that the lack of a genuine buy-in by national institutions, in particular leading universities, will prove fatal. Once external funding disappears, local support also evaporates. Unless these collaborative efforts complement rather than substitute for investment in national systems of higher education and research, they will also fail.

Collaboration has also extended to shared efforts among investors. Unfortunately, as in the case of the ACBF/PACT, they have been limited to groups of bilateral and multilateral donors, since they have not succeeded in “drawing in” investment from African governments. Nor have such efforts been able to generate a steady stream of sound projects for investors, possibly because of weak institutional capacities and high transactions costs.

Because of institutional under financing and rigidities, there was increased recourse to “networks”, in many instances simply to sustain research and quality teaching in exceedingly difficult circumstances. One initiative in particular, the African Economic Research Consortium (AERC) has proven highly successful, not only in sustaining core capacities, but expanding them through quality research, along with a collaborative masters and more recently, doctoral education programs. In spite of frequent citations as a highly successful African example of “capacity building”, the AERC has not been replicated in other fields. Is the modality unique to economics – as both a discipline and profession, or are there other factors which need to be understood in order for this approach to be applied to other fields?

Greater reliance on networks, spanning institutional and political boundaries, is inevitable because of the opportunities for learning and research arising from advances in technology as well as cheaper and more accessible connectivity. One possible model cited by the NEPAD S and T Secretariat is *networks* of centres of excellence, with electronically linked scholars coalescing around shared problems and dispersing once the research in question has been

¹³ African Institute Of Science And Technology (2005) Program Outline; African Institute of Science and Technology (2006) Abuja: Campus: Business and Implementation Plan; Gulf of Guinea Institute: Business and Implementation Plan

completed¹⁴. However, these networks – at least in principle – presume that the participating researchers already possess cutting edge skills and knowledge in their respective disciplines. In the Canadian case, for example, the network provides the opportunity to apply skills from different disciplines toward the solution of specific problems. In contrast, many African based researchers still need to acquire a high level of competence in their respective disciplines. Consequently, the aims and activities of such networks need to be adapted to African needs and circumstances.

2. Investing in STI: The Need for Sound Projects

The continuing search for effective modalities is directly germane to the broader issue of mobilising investment in STI.

The Cairo Declaration emanating from November 2006 meeting of African Ministers of Science and Technology calls for the establishment of an African Science and Innovation Fund as “an intergovernmental mechanism to mobilize technical and financial resources for implementation of the Consolidated Plan of Action”. The intention is to use resources donated to this Fund to identify and finance projects.

Africa’s chequered record argues in favour of the opposite sequence: **first** set up mechanisms that can generate a steady stream of sound projects. These in turn will draw in the investment, initially from the international donor community, needed to strengthen STI in the region. The operative terms are “*mechanisms*” and “*streams of sound projects*”. Certainly there have been solid individual initiatives such as the African Economic Research Consortium. However, such one off efforts have failed to create momentum sufficient to foster similar collaboration in other fields. There is simply no assurance that yet another fund, such as ASIF, will actually generate a stream of sound projects, which comprise the vehicles for actual investment.

This situation is not dissimilar to the one confronting funds wishing to invest in Africa.¹⁵ Capital is available. However, the transactions costs and indeterminate process entailed in bringing projects to market significantly lower the likely returns to investment.¹⁶ In essence, the problem is not a lack of funds per se. Rather it is the absence of an effective mechanism, namely one with low transactions costs, which can generate projects attractive to prospective investors.

¹⁴ NEPAD S and T sources cite the Canadian Network of Centres of Excellence, which is well documented and has produced some very useful studies on such key concerns as network financing and governance. See: Mugabe, J. (2004) Centres of Excellence in Science and Technology for Africa’s Sustainable Development.

Networks of Centres of Excellence of Canada (2002) Results Based Management and Accountability Framework; (2003) NCE Handbook 2003: A Resource Manual for New Networks of Centres of Excellence

¹⁵ Some of these funds receive funds from donors. However, they operate in accordance with private sector criteria.

¹⁶ This observation also applies to publicly supported venture capital investors such as the African Development Foundation. See Christy, R. D. and Fine, J. C. (August 2004) Overview of Business Management Assistance and Linkage Strategies: East African Experiences

3. Investing in STI: Lessons from Collaborative Initiatives in Higher Education

To validate this contention, we draw on the results of a study recently completed for the Partnership for Higher Education in Africa¹⁷. It focuses on those networks engaged in research and/or post-graduate education. The work was conducted in two phases: an initial “landscaping” of functioning networks, including their potential contribution toward strengthening higher education, followed by an inquiry into possible interventions for scaling up the most promising ones. The Partnership’s own interest, undoubtedly informed by its members’ support for the AERC, was further sparked by an awareness that some of these networks could play a major role in creating new fields of knowledge, pioneering new modes of instruction and learning; enriching and updating curricula, and promoting innovations in organisation and management of higher education.

Over 120 “networks” were examined over the course of the study. Of these, eighteen collaborative efforts, listed in table 1, appeared to satisfy “first order” conditions, namely they were operational; were centred on a (sub) discipline or body of knowledge and practice, e.g. management; were engaged in research and/or post-graduate education¹⁸; and appeared well positioned, with appropriate support and guidance, to make a significant contribution to higher education in the region. Geographical coverage was confined to those countries in which individual Partnership members were actively engaged in supporting higher education; consequently no francophone countries were included.

The study’s main findings and recommendations are reported elsewhere¹⁹. Highlighted here are those most germane to the financing of networks engaged in post-graduate education and research and, by extension, other cross institutional and cross border initiatives aimed at promoting technological innovation.

The number of such collaborative initiatives in Africa is likely to increase in future in line with what is occurring in higher education elsewhere. Among the salient factors is the growth of knowledge, particularly in specialised fields, as well as the increased ease and lower cost of communicating data and information in various electronic formats. Another factor, specific to Africa, is increased receptivity by universities to collaboration across institutional boundaries along with greater institutional autonomy to forge such ties.

The current trend contrasts dramatically to the situation prevailing in the 1980s and 1990s, when “networks” were often formed as a way around institutional rigidities, and in some instances, deep-rooted corruption. The explosive growth in highly specialised knowledge means that no single institution will have the staff or facilities necessary to cover the gamut of an entire discipline at the graduate level. Some African universities – and governments – are also aware of trends in Europe, where the EU is actively fostering formal inter-university links in doctoral education as well as research. Another indicator of a greatly changed stance toward collaboration

¹⁷ The Partnership currently comprises the Carnegie Corporation, the Ford Foundation, the Hewlett Foundation, the Macarthur Foundation, the Mellon Foundation and the Rockefeller Foundation. See <http://www.foundation-partnership.org/>

¹⁸ This stipulation excluded sound networks engaged in other activities, e.g. advocacy.

¹⁹ Fine, J. C. (October 2006) Partnership Support for Collaboration in Research and Post-Graduate Education: Findings and Recommendations and Fine, J. C. (June 2006) Collaborative Initiatives in African Higher Education: Some Observations

can be found in the policy statements of the AU, which in its declaration on post-secondary education strongly endorses collaborative partnerships²⁰.

Another finding of the Partnership sponsored study that senior university officials are becoming increasingly aware of other reasons for fostering collaboration. These include, in some instances, the nature of the subject area, where a broader geographical purview is important²¹. The benefits – in terms of quality and of bringing good students and staff together (most notably in the AERC’s joint facility for teaching electives) – are attracting increased attention. Not stated, but clearly important in some cases, is expanded scope for upgrading standards, updating syllabuses, and revising curricula under the rubric of a collaborative regional effort. In contrast, curriculum reform efforts are often problematic and invariably protracted when they are initiated within a single institution. Greater latitude for introducing major changes emerges where these become a condition for participating in a collaborative initiative involving two or more institutions. Finally, as noted earlier, some leading national universities are now openly acknowledging, at least at the faculty level, that increased collaboration will be essential in dealing with the rapid growth of specialised knowledge, especially at the research frontier.

Findings confirm that the “glue” holding a collaborative initiative together – in terms of the motivation and commitment of individual participants – is incentives that are professional and intellectual rather than financial. Although the latter cannot be ignored, good academics respond to opportunities for intellectual discovery; for career advancement through research and publications in accredited journals; for interaction with leading scholars during sabbatical leaves and conferences; and for formal recognition by their professional peers. Successful collaborative initiatives systematically cultivate such incentives: chances for young scholars to work with and be mentored by leading lights in their respective fields; for senior scholars to develop a network of former doctoral students; and for all to share in the intellectual excitement and professional kudos of their joint research. For this reason, persisting intellectual asymmetry will ultimately undermine a collaborative effort. Leading scholars in a well-endowed university may “do their bit” – a few times. Their continuing engagement rests on the intellectual stimulus provided by the shared effort.

²⁰ The AU draft statement on higher education, presented to African Ministers of Education in September 2006 in Maputo strongly endorses collaboration through networks as exemplified by the following statements: “Facilitate knowledge production networks and linkages at all levels, to advance African higher education's contribution to meeting the knowledge needs of Africa and other societies”; and “Encourage cooperation and networking to optimise utilisation of infrastructure across higher education Institutions”.

²¹ An abbreviated list of examples includes transmission of diseases from animals to humans (with added urgency arising from the recent outbreak of avian flu in the Southern Sudan); management of HIV/AIDS and associated opportunistic infections; trans-border management of wildlife; security and conflict resolution; population movements; the environmental and economic consequences of global warming; human rights law; mapping the earth’s mantle over the sub-continent and watershed management.

Table 1: African Based Networks Engaged in Research and/or Post Graduate Education

Title	Discipline	Location	Driver	Features/Comments
Africa Array	Geosciences	Wits U. J'burg	Wits	<ul style="list-style-type: none"> ▪ Unique blend of public and private financing ▪ Research agenda require Africa wide coverage ▪ Use of facilities, staff, equipment at Wits
Africa Earth Observatory Network (AEON)	Earth Sciences	UCT, Cape Town	UCT, SA NSF	<ul style="list-style-type: none"> ▪ Establishing networks for various earth science disciplines in E/S Africa ▪ Use of equipment, facilities at UCT ▪ Potential for doctoral level education
African Centre for Crop Improvement (ACCI)	Plant Breeding	UKZN	RF	<ul style="list-style-type: none"> ▪ Principal ties currently with government research personnel ▪ Possible ramping up to provide doctorates & research for university departments
African Economic Research Network	Economics	Nairobi	Donor Consortium	<ul style="list-style-type: none"> ▪ Transferability of model for collaborative doctoral and masters programs to other fields? ▪ Adaptation to accommodate growth in specialisations?
African Mathematics Millennium Science Initiative (AMMSI)	Mathematics	Five regional nodes. Lead node in Nairobi	Millennium Science Initiative (Princeton U)	<ul style="list-style-type: none"> ▪ 5 regional networks ▪ Buy-ins by local universities in order to ramp up post-graduate education and associated research? ▪ Links to other initiatives in this field?
Biosciences Eastern and Southern Africa (BECA)	Biotechnology	ILRI, Nairobi	ILRI	<ul style="list-style-type: none"> ▪ Use of advanced facilities and equipment by universities in EA ▪ Requires major up-front investment in staffing, programs in ILRI and universities ▪ Potential for p-g education
Centre for Environmental Studies	Environmental Sciences	University of Pretoria	Univ of Pretoria	<ul style="list-style-type: none"> ▪ Use of facilities and staff at UP ▪ Regional coverage for research and education
Centre for High Performance Computing (CHPC)	Computer science	UCT	UCT, SA government	<ul style="list-style-type: none"> ▪ Potential utilisation of unique facility by various networks for p-g education and research ▪ Innovative approach to financing from gov't and private sector
Centre for Human Rights	Human rights law	University of Pretoria	University	<ul style="list-style-type: none"> ▪ Ramp up existing region wide network for doctoral training and associated research ▪ Specialisation requires region wide coverage

In-Depth Network	Demography, statistics (in health)	Accra Ghana US registered NGO	Various foundations	<ul style="list-style-type: none"> ▪ Includes surveillance sites in Lat Am, Asia ▪ Move from data collection/analysis to investment in research, post-graduate education in universities ▪ Formal MSc link with Wits (SA)
International Programme in the Physical Sciences (IPPS)	Physics Chemistry Mathematics	At University of Uppsala Sweden	SIDA	<ul style="list-style-type: none"> ▪ Established 1961 ▪ Long term support for research and p-g education in SSA and other LDC's via various networks ▪ Documentation of key "lessons learned" ▪ Potential for ramping up some of existing networks for doctoral training on larger scale
LINK Centre	ICT (regulation and applications)	Wits U. J'burg	Wits, IDRC	<ul style="list-style-type: none"> ▪ Potential regional centre for p-g training in ICT policy and regulation
Regional Universities Forum for Capacity Building in Agriculture (RURAFORM)	Agriculture	Kampala (Makerere University)	RF	<ul style="list-style-type: none"> ▪ Grant making body with broad regional/national links ▪ Ramping up to provide more MSc's doctorates ▪ Need to strengthen management capacity, reduce transactions costs
School of Nursing, UKZN	Nursing	Designated WHO regional centre at UKZN, Durban SA	WHO, UKZN	<ul style="list-style-type: none"> ▪ Potential centre for doctoral training + research on regional basis ▪ Would others in the region buy in?
South African Structural Biology Initiative	Structural Biology	UCT	UCT	<ul style="list-style-type: none"> ▪ Use of UCT facilities and staff (scale economies) ▪ Innovative use of bandwidth for data transmittal and analysis
Southern and Eastern Africa Network of Analytical Chemists (SEANAC)	Analytical Chemistry	Univ of Botswana	SIDA	<ul style="list-style-type: none"> ▪ Possible ramping up of existing network for p-g training ▪ Requires formal buy-in by local universities and long term, expanded support
University Science Humanities and Engineering Partnerships in Africa (USHEPiA)	Humanities Engineering Sciences	UCT, Cape Town	UCT	<ul style="list-style-type: none"> ▪ Use of facilities, staff at UCT with follow-on small grants ▪ Challenges of doctoral course work, UCT staff capacities, network evolution from hub and spoke ▪ Question of expansion or replication of effort
Veterinary Wildlife Programme	Veterinary Sciences	University of Pretoria	Univ of Pretoria, SA Government	<ul style="list-style-type: none"> ▪ Potential and interest to become regional centre of excellence ▪ Field implies sub-regional coverage for research

The inquiry revealed a strong South African presence, which may well become more prominent in future. To some extent, this contention is supported by the fact that the “drivers” of 11 of the 18 collaborative initiatives in table 1 are based in South African universities. However, this strong South African presence is confined to just five or six of the more than thirty degree-granting tertiary institutions in that country. Furthermore, the underlying factors are instructive in terms of investing in other types of collaborative STI initiatives:

- This group of universities is relatively well-endowed in terms of staff and facilities. More importantly, however, their senior management has strongly encouraged collaborative links – within South Africa, within Africa, and with non-African partners. This policy has been matched by concrete management and budget support for offices devoted to international links and partnerships. Their services range from assistance to foreign students to the design, negotiation and management of major collaborative undertakings.
- There is a strong drive, among some senior staff in these universities, to develop research and training ties, institutional and individual, with other parts of Sub-Saharan Africa. In certain instances, the subject area (e.g. human rights law, mapping of the earth’s mantle above Africa, or wildlife management across national boundaries) dictates expanded geographical coverage. In others, it is motivated by a desire to increase utilisation of major fixed investments (e.g. a high speed computing centre, or an electronic microscope facility). Finally, there is the prospect of serving as a link between regional knowledge networks in various parts of the sub-continent and global knowledge platforms. Properly handled, such efforts could offer a “win-win” outcome – moving South African institutions to the global frontier in specific fields while greatly facilitating access by African academics to scholarship in other places.
- The South African government has developed and underwritten instruments aimed at encouraging and rewarding advanced research. These grants finance capital investment and research projects. They are awarded on a competitive basis. In addition, universities receive funding for post-graduate education, with higher amounts being given for successful doctoral candidates. Such support is unique within Sub-Saharan Africa.

Although not formally articulated, a strong South African presence, in driving collaborative initiatives, does pose a problem for some international donors who automatically assume that the lion’s share of the benefits will accrue to South African institutions and participants. The study does not reveal a similar sensitivity among other Africans. Indeed, meetings with the NEPAD Secretariat suggested a desire to increase South African engagement in higher education. Nonetheless the issue needs to be addressed honestly, but in ways that can accommodate the motivations and aims, institutional and individual, of both South African and other Africans.

The Partnership sponsored study also revealed that many of these networks, with appropriate scaling and longer term support, offer a cost effective way of addressing the pending shortage of qualified academic staff in virtually all fields of learning. One approach, used in many fields by Scandinavian donors is “sandwich doctorates” implemented through bilateral partnerships between African and (usually) Scandinavian universities. An African variant is the USHEPiA program, centred at the UCT, featuring collaboration of doctoral thesis research with 7 other Eastern and Southern African. A very recently completed survey of doctoral education in

agriculture has also identified some promising approaches. The most advanced African model is the collaborative doctoral programme in economics of the AERC. It is the outgrowth of a collaborative masters degree operating since 1991. It is worth noting that launching of the collaborative doctoral program in 2004 followed more than 5 years of detailed planning, institutional consultations, and resource mobilisation.

4. Investing in STI: Barriers to Collaborative Efforts

The creativity waiting to be unleashed by the right set of modalities is conveyed by the description, in Appendix I, of some of the more promising initiatives. Unfortunately, the same inquiry has detected enormous frustration among participants, institutional and individual. Potentially promising networks invariably operate at a sub-optimal level. They do generate outputs, e.g. improvements in teaching, but their scale of operation is simply too small, in terms of activities, time frame, coverage, and financing to realise their potential for creativity and innovation.

The principal constraints listed below, although derived from a study of collaborative efforts in *higher education*, appear equally valid to STI.

Lack of Vetted Information

Considerable effort is required to obtain *vetted* information, namely information validated by trusted sources. The high transactions costs, in terms of time and money, needed to obtain it, significantly inhibit investment.

This gap does great disservice to African higher education by seriously understating the capacity for creativity and innovation in universities. It adversely affects individual scholars as well as university departments. Unless specific individuals, groups of researchers, or collaborative programs can be “googled” within 20 seconds, they do not exist – for potential collaborators within and outside Africa. African scholars and universities, in particular the creative and innovative ones, are probably missing out on some promising opportunities, especially in terms of collaborative research.

Another negative consequence is that public policy toward higher education, as articulated nationally and by regional bodies, notably NEPAD and the AU is often not based on accurate information about research and learning activities in the region. Consequently, policies regarding collaboration, as well as the endorsement of specific initiatives, are often made in ignorance of existing and potential capacities. Donors, comprising the key group of likely investors, would clearly benefit from more accurate information. Aside from avoiding replications of effort, they would be able to collaborate more effectively with each other.

Inadequate Resourcing

Some networks begin as by-products of other activities. Those falling into this bracket tend to be modest, geographically delineated initiatives set up in order to provide small research grants for newly minted doctoral students returning to their home countries. Such efforts undoubtedly help retain them in situ. However, the scale at which they operate seldom provides a platform for cutting edge research, typically undertaken by teams collaborating on a longer-term basis. Also falling into this category are networks, formed in the enthusiasm of an international meeting.

Subsequently, they have been unable to secure more than a fraction of the resources needed to undertake a serious program of research or post-graduate education.

Lack of Government Support

Another problem, which unfortunately is all too often taken for granted, is the longstanding failure of virtually all African governments to provide serious and sustained financing for research and graduate education. The absence of even a modest amount of core financing has had a particularly deleterious impact on African based networks. Without it, they are forced to limp from one “project” to the next, in order to generate the money, usually from “overhead charges”, that is needed to finance their core operating costs. Rarely do they secure sufficient resources to pursue their own strategic objectives in a sustained fashion. The strong South African “presence” among promising collaborative initiatives listed in table 1 is at least partially attributable to a government policy of financing research through competitive grants awarded to universities as well as networks of researchers.

Clearly donors cannot be expected to fill this gap indefinitely. However by tapping the creativity of some promising networks, they can underscore, not only the need for African governments to begin supporting research and higher, especially post-graduate education, but also pioneer effective mechanisms for collaborating across institutional and political boundaries – an aim African governments have endorsed in principle, but have been unable to pursue in practice.

The Need for Strong Administrative and Managerial Skills

Dependency on donor financing does raise some serious issues, especially for networks in their formative stages of development, including the need to accommodate the varying priorities, time frames, and administrative procedures of different funders, whilst attempting simultaneously to respond to the divergent interests and capacities of the network’s participants. These demands, on top of those associated with administering the network’s activities, place a heavy burden on its manager(s). This burden is often not fully appreciated. In fact, supporting donors often see “collaboration” as a device for reducing administrative overheads.

The managerially demanding feature of “networks” can be addressed in two ways. First, it should be recognised as a legitimate cost, which must be accommodated within an agreed business plan and budget. Indeed, in programs providing long-term support, such as the Canadian Networks of Centres of Excellence, there is explicit provision for a Network Administrator alongside a Network Director who is responsible for content, quality and outcomes. This practice recognises that the administrative tasks entailed in running a serious, large-scale network are not only highly demanding, but also require a skill set rarely found among those qualified to provide intellectual leadership. The two roles are therefore split at the outset and financed accordingly. A second response is to provide time – and sufficient resources, at the design or planning stage for the would be participants, in particularly the collaborating institutions, to reach a genuine consensus regarding their respective roles, responsibilities and contributions. This buy-in should also be reflected in formal agreements among the participating institutions regarding arrangements for network governance, including the selection of qualified professionals to lead its scientific work and to administer its activities.

Risk Sharing and Exit Strategy

Networks operating at a sub-optimal level are typically supported by one or several donors. Scaling them up, in terms of scale and duration of financing, poses major risks, which individual donors find difficult to accommodate. Clearly the answer is burden sharing among a larger group, a strategy which has proven essential, for example, for mounting the AERC's collaborative doctoral program in economics. Assembling such support takes time. Likewise, concerns about risk can be alleviated where an activity has been "field tested" for some time, in terms of its administrative and financial systems; leadership; governance; activities; and initial outcomes.

More problematical is the question of an "exit strategy". One option is to adopt a firm policy – at the outset – concerning long-term support. This practice is followed, for example, by the Canadian National Centres of Excellence Program, which limits support to a maximum of two seven year grants. Participating institutions wishing to sustain their collaborative activities must either "reinvent" themselves in order to compete for a new grant and/or secure financing from other sources.

5. Investing in STI: Generating Sound Projects

Significant investment in STI will hinge on a steady stream of "sound" projects, namely those likely to attract investors because of their aims, outputs, design, financing, commitment and capacities. Furthermore, the study of networks engaged in research and post-graduate education suggests that such projects will increasingly take the form of collaborative initiatives transcending institutional boundaries and national frontiers. A third observation is that the creativity and innovation bound up in many of these efforts is thwarted by key constraints, in particular the lack of vetted information, inadequate resourcing, the absence of support by national governments, the need for strong administrative and managerial skills, difficulties in sharing various risks, and concerns about an eventual exit.

These findings are equally relevant to investment in STI. First, strengthened academic research and the production of highly trained professionals comprise key features of the larger STI picture. Secondly, a significant proportion of future investment in STI will feature networks operating across institutional and political boundaries.

The modality for generating such projects has two principal components. The first addresses the need for vetted information concerning potential initiatives, as well as emerging institutional and individual capacities in various fields of research and learning. The second involves a structured approach for *incubating* projects to the point where they can secure longer term financing from either individual investors or investment funds²².

The first component would involve four activities.

The first would be maintenance of a data base on collaborative activities. A logical starting point would be the data base, compiled by the Partnership supported study on networks focusing on

²² The AERC is a successful example of project incubation. It began as the Macroeconomic Network for Eastern and Southern Africa, which was solely financed by the International Development Research Centre of Canada. The Network's early success drew in other donors who then proceeded, along with the IDRC, to establish the AERC.

research and post-graduate education. Currently, it is “housed” by the Partnership Secretariat. Tasks associated with the database, viz. vetting and updating, progressive expansion of coverage, and utilisation of the information could be transferred to an appropriate body within SSA. One promising prospect is the Centre for Research into Science and Technology (CREST) of the University of Stellenbosch. CREST has been undertaking parallel documentation on S and T networks; it began with those in South Africa and is now expanding coverage to at least 20 other African countries.

A second activity would centre on the documentation by leading African universities of staff activities in research and post-graduate education spanning institutional and political boundaries. A body such as CREST could coordinate this activity, to ensure uniformity in coverage and accuracy and assist the participating universities in mounting information concerning their respective activities, in suitable formats, on their own websites.

A third activity would centre on further development of the database. At present, there are three possibilities, although others will undoubtedly emerge in future. The first is to make it more “user friendly” e.g. through easier manipulation of the data, and its presentation in graphical form. The second is to integrate information on networks in higher education more directly with others in science, technology and innovation. Not least, such work would highlight potential linkages among different stakeholders, i.e. government and business in addition to academia, and help identify promising areas for research and investment. The third is information on outcomes from collaborative initiatives, in particular innovations in research and its utilisation, as well as more immediate “outputs” including scientific publications, and numbers of successful post-graduates in various fields of learning.

A fourth activity would promote utilisation of the database for various purposes, including strategic planning by universities, governments, and regional authorities, as well as the formation and financing of collaborative activities across Sub-Saharan Africa.

The second component would incubate collaborative projects, namely those transcending institutional and political boundaries, to the point where the most promising ones secure longer term financing. Its principal dimensions are set out in Diagram 1.

Diagram 1: Project Incubator Mechanism

Year	Modality	
1	Planning Grant	Funds from
2	Incubator Grant	Project
3		Incubator
4		Initiative
5	Operating Grant I	Long term
6		funding by
7		interested
8		funders
9	Operating Grant II	
10		
11		
12		

Prepare incubator proposal
Operationalise project
Develop long term program
Local buy-in by institutions
Cutting edge collaborative research
training, outreach by local and international professionals.
Wind-up or “reinvention” after second grant.

The incubating activity would involve “planning grants” and “incubator grants” over a four year period. Projects that successfully “graduate” from this process would then attract longer term financing in the form of sizeable multi-year operating grants.

The planning grants, tenable for a period of one year and awarded on a competitive basis, would be used to prepare a detailed proposal for a multi-year incubator grant. The funds could be used to finance such activities as workshops, reviews of current research in a particular field, and innovations in teaching practices, e.g. use of distance education and electronically accessible learning materials.

Multi-year incubator grants would also be awarded competitively. The grants should be sufficiently large to initiate serious collaborative research and learning activities. The Partnership sponsored study has recommended that they be tenable for up to three years, a period that African respondents felt was the minimum necessary to sort out issues of governance and management, and also secure a genuine “buy-in” by the collaborating institutions. Three years also appears a realistic time frame for mobilising longer term financing in the form of operating grants.

Based on Canadian experience with Networks of Centres of Excellence, downstream financing should be time bounded. This practice directly addresses donors’ concern about an exit strategy. This approach should also work well in Sub-Saharan Africa, although the length of each grant may need to be shorter, say up to five years, with provision for one renewal, viz. a maximum of ten years in all. This period would suffice to invest in such critical activities as doctoral level training and to undertake in-depth research.

An initial estimate suggests that the total cost of incubating up to five collaborative *higher education* projects annually over a four year period would be around \$12.5 million, together with another \$ 1.3 million for sustaining and improving the data base.

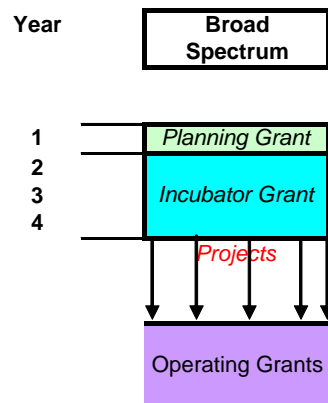
6. Investing in STI: The Next Steps

How this “incubator mechanism” is operationalised hinges on strategic decisions concerning its coverage. Whilst the ensuing comments, derived from the author’s immediate experience and knowledge, refer to Sub-Saharan Africa, they are equally valid in the case of other small developing economies seeking effective ways of investing in strengthening their capacities in STI.

One approach is to finance planning and incubator grants across a broad gamut of sectors. As depicted below, the aim of this shared effort is to incubate a steady stream of sound projects across many fields. These projects would then attract downstream investment, in the form of operating grants, from various sources.

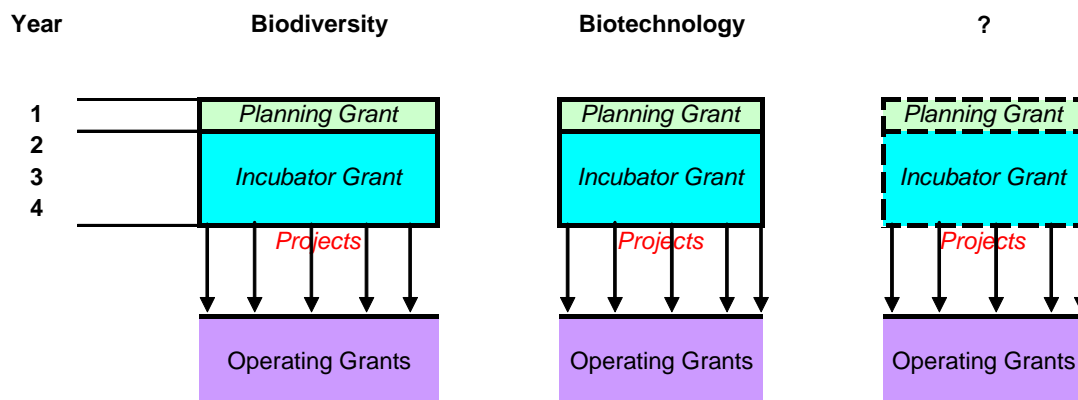
Left totally unbounded, however, the resulting projects would probably suffer from a lack of synergy. They would also fail to create a critical mass, in terms of skills and facility, within any given field, in spite of collaboration across institutional and political boundaries.

Diagram 2: Approach A



A second strategic approach is to focus each incubating mechanism on particular scientific field, perhaps delineated in accordance with the “platforms” proposed by NEPAD’s Science and Technology Secretariat. Over time, as depicted in diagram 3, there would emerge a series of incubating efforts running in parallel with each other.

Diagram 3: Approach B



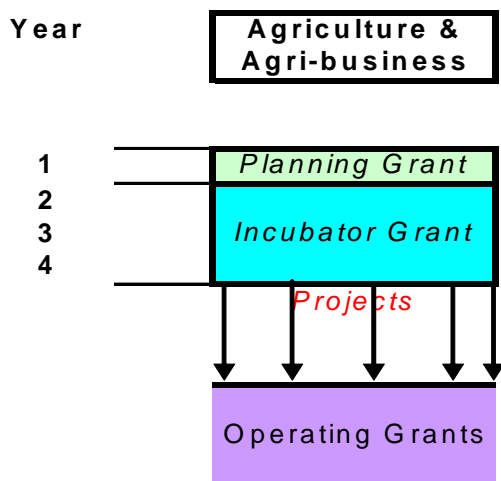
A third strategy is to *initiate* the incubator mechanism modestly by focusing either on a problem area or on a particular economic sector. This approach corresponds to the approach of the Canadian Network of Centres of Excellence. However, it assumes that the capacities already

exist in the respective disciplines being brought together to solve major social and economic issues. As noted earlier, this assumption cannot be made in the case of Sub-Saharan Africa. Hence, the challenge is to combine a focus on major issues and, at the same time, help develop the necessary capacities within the relevant disciplines.

A possible solution, which also would address the goal of creating a stream of sound projects, which attract investment in STI, in the form of operating grants, is to focus on an economic sector central to longer term growth. This strategy reflects the desire to link investment in STI to actual outcomes in economic performance, e.g. the introduction of new products and services, and improved competitiveness in domestic and international markets.

The sector presented in Diagram 4 is “agriculture and agribusiness”.

Diagram 4: Approach C



There are cogent reasons for selecting this sector as a starting point for pioneering the incubator process.

- Most SSA countries depend on agriculture and agri-business for a significant share of employment as well as export earnings. The introduction of new technologies and processes is required, e.g. in various stages of product supply chains, to remain competitive in domestic as well as international markets.²³ Effective application of science and technology, e.g. in bio-technology and in exploiting the region’s biodiversity, will help promote the production and successful export of differentiated and “boutique” products.

²³ One example is the need for countries exporting fresh fruit and vegetables to the EU to comply with EUREGAP, which are industry imposed standards regulating such matters as herbicide, fertiliser and pesticide usage.

- There has and will continue to be substantial investment in this sector. Unfortunately, its impact has been dampened by lack of solid ties among the leading players, namely governments, business, academia, local research agencies, international research centres, and perhaps most intriguingly, some highly professional international NGO's²⁴. A mechanism *incubating* trans-institutional collaboration through soundly designed projects should yield significant return from past as well as upcoming investments in the sector.
- Likewise, trans-border collaboration is desirable, indeed essential. No single economy can support the full range of the highly specialised skills and knowledge characteristic of cutting edge of research in various fields. Incubating regional and international ties will help release the creativity and innovation demonstrated by the Partnership supported study²⁵ (see Appendix I).
- Although focused on agriculture and agri-business, this initial “incubator mechanism” will also contribute to strengthening STI capacities more broadly, e.g. through improvements in the teaching of science, maths, and management, the revision of university curricula, and effective utilisation of ICT.

Based on findings from the Partnership supported study, an investment of \$15 to \$20 million – over four years – would yield a stream of four to seven projects annually (beginning in the second year and extending to the fifth one and beyond), which have competed successfully for incubator grants. The majority of these incubated projects, featuring collaborative activities across institutional and/or national boundaries, should then be able to attract investors willing to finance sizeable multi-year operating grants.

In the case of agriculture and agribusiness, the incubator “mechanism” would probably best be housed – at least during in its initial phase – in an international research centre, with a mandate, and corporate interest, extending to capacity strengthening as well as development of the agri-business sector.

²⁴ Increasingly NGO's have been enlisted to supply critical “public goods” including technical support in production, processing and marketing, typically to smaller scale producers. Their involvement in collaborative projects generated by an incubator mechanism would be inevitable.

²⁵One such case is veterinary sciences. The Faculty of Veterinary Sciences at Makerere University in Kampala is keen to support research and offer programs relating to such issues as disease transmission from animals to humans – an issue whose importance was poignantly underscored by the recent outbreak of avian flu in districts of the Southern Sudan, bordering on Northern Uganda, the capacity of livestock populations, living at a marginal level of subsistence, to cope with the impact of global warming, and the impact of grazing practices on the environment. Similar cross border issues motivate researchers at the University of Pretoria. In addition, its faculty members are keen to develop networks for the cross border management of wildlife as well as domestic animals.

References

- African Institute Of Science And Technology (2005)
- African Institute Of Science And Technology (2005)
- African Institute of Science and Technology (2006)
- African Mathematics Institutes Network (AMI-Net) (2006)
- African Union (AU) and New Partnership for Africa's Development (2006)
- Aluka (2006)
- Biosciences eastern and central Africa (BecA) (2005)
- Bloom, D., Canning, D. and Chan, K. (2006)
- Crawford, M. F. et al. (2006)
- Devol, R. and Bedroussian A. (2006)
- Economist (2005)
- Eicher, Karl K. (2006)
- Fine, Jeffrey C. (June 2006)
- Fine, Jeffrey C. (October 2006)
- ICSU Regional Office for Africa (2006)
- International Network for Higher Education in Africa
- Juma, C. (2006)
- Juma, C. (2006)
- Lyons, Elizabeth E. (2005)
- Makerere University (2006)
- Mugabe, J. (2003)
- Mugabe, J. (2004)
- National Academies (2005)
- National Center for Post-Secondary Improvement (2002)
- NEPAD Office of Science and Technology (2005)
- Program Outline
- Profile of Proposed Abuja Campus
- Abuja: Campus: Business and Implementation Plan
- Gulf of Guinea Institute: Business and Implementation Plan
- African Mathematical Institutes Network AMI-Net and Expanded AIMS
- Biotechnology in Africa's Development: Draft Report
- Digital Library of Scholarly Resources from the Developing World
- Business Plan 2005-2009
- Higher Education and Economic Development in Africa. World Bank
- Review of World Bank Lending for Science and Technology 1980-2004. World Bank
- Mind to Market: A Global Analysis of University Biotechnology Transfer and Commercialisation. Milken Institute
- The Brains Business: A Survey of Higher Education (Sept. 10 2005)
- The Evolution of Agricultural Education and Training: Global Insights of Relevance for Africa. MSU Staff Paper 2006-26
- Collaborative Initiatives in African Higher Education: Some Observations
- Partnership Support for Collaboration in Research and Post-Graduate Education: Findings and Recommendations
- Draft Workplans for Sustainable Energy, Health and Human Well-Being, Hazards and Disasters, Global Change http://www.bc.edu/bc_org/avp/soe/cihe/inhea/welcome.htm
- The Role of the Engineering Sciences in International Development: Redesigning African Economies: The Royal Academy of Engineering. The 2006 Hinton Lecture
- Reinventing African Economies: Technological Innovation and the Sustainability Transition Iowa State University
- NSF-funded Research Collaborations with Sub-Saharan Africa (power point) Presented at a Workshop on "Enhancing Research and Education Network Connectivity to and within Africa"
- Faculty of Computing and Information Technology: Proposed Building
- Biotechnology and Sustainable Development: Toward Regional Consensus and Common Strategy
- Centres of Excellence in Science and Technology for Africa's Sustainable Development. NEPAD AMCOST Meeting
- Enabling African Scientific Communities to Provide Policy Advice in the Public Interest: Grant Report to Gates Foundation
- Beyond Dead Reckoning: Research Priorities for Redirecting American Higher Education
- Africa's Science and Technology: Consolidated Plan of Action

Networks of Centres of Excellence of Canada (2002)	Results Based Management and Accountability Framework
Networks of Centres of Excellence of Canada (2003)	NCE Handbook 2003: A Resource Manual for New Networks of Centres of Excellence
Networks of Centres of Excellence of Canada (2006)	Program Outline (power point presentation)
Research Africa	Newsletter
Saint, W. (2006)	Innovation Funds for Higher Education: A Users' Guide for World Bank Funded Projects. World Bank
Southern African Regional Universities Association (2006)	Three Year Programme Proposal
Southern African Research and Innovation Management Association (SARIMA) (2006)	SARIMA Spectrum. http://www.sarima.co.za/
University of Dar Es Salaam (2006)	College of Engineering and Technology: Technology Development and Transfer Centre
University of Kwazulu-Natal (2005)	Research Report 2004-2005
University of KwaZulu-Natal (2006)	Research and Graduate Education Networks in Africa
University of Pretoria (2005)	Research Report
University of Pretoria (2005)	Department of Veterinary Tropical Diseases: Certificated Online Modules: MSc Programme (CD-ROM)
University of Stellenbosch and Universiteit Leiden (2005)	The African Science Map Project
University of the Witwatersrand (2006)	Africa-Focused Projects Of The Health & Population Division, School Of Public Health, And University Population Programme
University of the Witwatersrand (2006)	Africa Array: A Public-Private Partnership Supporting Capacity Building for Africa's Natural Resource Sector
University of the Witwatersrand (2006)	Development Oriented Training and Research
Uppsala Universitet (2006)	International Science Programme: Annual Report for 2005
Watson, R., Crawford, M. and Farley, S. (2003)	Strategic Approaches to Science and Technology in Development. World Bank Policy Research Working Paper 3026
Wild, K. (2005)	A Survey of Investment in Education and Research Networking in Africa by Development Agencies and Other Organisations. IDRC
World Bank (2002)	Constructing Knowledge Societies: New Challenges for Tertiary Education
World Bank (2005)	Millennium Science Initiative: Uganda

Appendix I Creativity in Research and Post-Graduate Education

At Makerere University, a large new building for the ICT Faculty, soon to become a semi-autonomous college is being erected alongside an existing smaller structure funded by Norwegian aid. A new building is necessary, we were informed, to ensure that ALL students are “ICT grounded”. In addition, the Faculty can run now a range of courses for non-university clients. What is intriguing is that the new structure is being financed from the earnings of the ICT Faculty’s consulting bureau. Operated on a commercial basis, it offers CISCO and Microsoft certification, generates extra income, and exposes staff as well as students to real business world needs. A similar process, less far advanced, has been observed in other East African universities e.g. University of Dar Es Salaam. Makerere University is quickly becoming a regional centre of “excellence” and the ICT Director would like to work collaboratively with other leading research universities elsewhere, including those in South Africa. Of particular interest is the development of stronger linkages with the private sector – outside as well as within Uganda and the acquisition of expertise in rapidly growing fields such as e-government.

The In depth Network, supported by several Partnership members, centres on the collection and analysis of longer term demographic data from sites, not only in Africa but other developing regions. The network, headquartered in Accra, has recently received a major longer-term grant from the Gates Foundation, which aside from buttressing existing activities will allow it to reinforce capacities in demography and statistics, especially as they relate to health sciences, within universities in the region. The process by which this particular network has been “incubated” to the point where it can be scaled up into an initiative, which could significantly strengthen higher education, is one reflected in our findings and recommendations. Elsewhere, there is equally strong interest in the collection, collation, and analysis of primary data. The University of Cape Town (UCT) has backed a university wide initiative, which it is hoping to share with others in South Africa and the region. Its Data First initiative centres on training graduate students in the collection and analysis of primary data, and on applying the results to policy analysis and program design. There is clearly synergy between this effort and the University’s support of a High Speed Computer Facility, which it hopes will be used by other institutions in the region.

A possible harbinger of future cybernetic links among researchers is the UCT Molecular Biology network, which would draw on the high-speed computer and, with appropriate investments in connectivity, could also analyse data sent in by researchers at other institutions in the region. The High Speed computer is also designed to position the UCT to undertake research for South African industry, a linkage that could be extended, through various research networks, to other universities in the region.

The study also uncovered efforts involving a similar innovative combination of “remote” or distance data analysis, using high speed computing facilities. Of particular note, in this regard, are at least three, which would allow academics, based at their home universities, to use advanced facilities and equipment in South Africa. One is the Africa Laser project, centred at the CSIR, a priority for the NEPAD S and T group, because of its broader downstream benefits for African economies. A second is the Africa Earth Observatory Network (AEON) at the University of Cape Town, whose principal aim is to develop a common platform for research and post-graduate studies, centred on Earth System evolution, resource economics and the resilience of the environment, and to develop robust Earth Stewardship models, with particular reference to the sub-continent. A third is the South African government’s bid to win the competition for the world’s most powerful radio telescope, the Square Kilometre Array (SKA). The signals received

by all its antennas will be combined using advanced electronic and computing systems to form a deep image of the cosmic radio sky. South Africa is bidding to host the SKA against competitors Australia, China and Argentina. Because the stations of the SKA telescope will be spread over a vast distance, seven other African countries are joining the SKA South Africa bid. Some SKA stations will be in countries neighbouring South Africa, while some of the stations will be as far away as Ghana, Kenya, Madagascar and even Mauritius. The bid underscores the fact that Southern Africa has the potential to become a major hub in the field of astronomy and related technologies. If successful, the new facility would be added to the Southern African Large Telescope (SALT) in South Africa, and the HESS gamma ray telescope in Namibia. Universities within all these countries could benefit enormously from the resulting network.

Considerable excitement within the Faculty of Veterinary Sciences at Makerere University has been generated by the proposed revamping of curricula, as part of an effort to reposition the field more broadly within what a relatively young, but well trained core of senior staff term the “biomedical sciences”. This effort is prompted in part by the fact that a large proportion of the student population comes from surrounding countries. Consequently, the Faculty is keen to support research and offer programs relating to such issues as disease transmission from animals to humans – an issue whose importance was poignantly underscored by the recent outbreak of avian flu in districts of the Southern Sudan, bordering on Northern Uganda, the capacity of livestock populations, living at a marginal level of subsistence, to cope with the impact of global warming, and the impact of grazing practices on the environment. Similar cross border issues motivate researchers at the University of Pretoria. In addition, its faculty members are keen to develop networks for the cross border management of wildlife as well as domestic animals. The stakes in terms of rural livelihoods are high – gains from tourism, especially to local communities must be set against the risk of animal diseases which close access to international markets. Exploratory links have been established between Makerere and Pretoria, on issues relating to research, curricula and post-graduate education. These could clearly be further developed, with benefits to veterinary schools in their respective circles of collaborating universities.

The International Science Program at the University of Uppsala supports programs in the Physical Sciences (1961), Chemical Sciences (1970) and Mathematical Sciences (2002) as well as one major bilateral project financed by Sida/SAREC – “Integrating Information and Communication Technology” at Makerere University.

In 2006 the physics program supported two networks: ESARSWG - Eastern and Southern African Regional Seismological Working Group, Network (Eritrea, Ethiopia, Kenya, Uganda, Tanzania, Malawi, Zambia, Zimbabwe and South Africa) and the Applied Atomic and Molecular Physic, Network (Senegal, Ghana, Kenya, Sudan and Zimbabwe).

The Chemistry program supports both networks and regional laboratories: ALNAP - African Laboratory for Natural Products (Addis Ababa University); ANCAP – African Network for the Chemical Analysis of Pesticides; FOSNNA - Food Science and Nutrition Network for Africa; NABSA - Network for Analytical and Bioassay Services in Africa (Univ. of Botswana); NAPRECA - Natural Products Research Network for Eastern and Central Africa; SARBIO - Southern African Regional Co-operation in Biochemistry, Molecular Biology and Biotechnology; and SEANAC - Southern and Eastern Africa Network for Analytical Chemists.

The networks supported through the Mathematics Program are Analysis, Geometry and Applications (Cameroon universities); the Eastern African Universities Mathematics Programme (EAUMP); and PDE, Modelling and Control (Burkina Faso, Senegal, and Mauritania).

African ministers have assigned priority to developing capacities and supporting research in the bio-sciences. Their decision has been guided by a study sponsored by the NEPAD S and T Secretariat²⁶ and other studies.²⁷ A possible entry point, especially pertinent to biotechnology, is BECA, a largely CIDA financed initiative aimed at placing upgraded facilities at ILRI, the International Livestock Research Institute in Nairobi, at the disposal of universities and national research institutes in Eastern Africa. With appropriate guidance and support, BECA could serve as the focal point for one or more larger scale, collaborative efforts by leading universities and research centres in Eastern Africa.

The Africa Array project, centred at the University of the Witwatersrand, incorporates some striking innovations that have potentially broader ramifications for African higher education. The first is the underlying motivations for collaboration. One is the justification usually offered for institutional collaboration, namely scale economies, in this case the use of excellent facilities and world-class staff at Wits. However, another is the nature of the research to be undertaken by the group, namely the mapping of the earth's mantle over the sub-continent. This activity necessarily involves the establishment of cross border collaboration. In fact, the network is proposing to set up a series of seismic research stations across Sub-Saharan Africa for data collection. Funding for many is being sought from a variety of sources: multinational oil companies – for self-evident reasons, but also the US National Science Foundation because of the potential contribution by many stations to a tsunami early warning system for Africa. Fashioning these various components into a broader program of partnering universities, mounting collaborative post-graduate education programs as well as longer term, cutting edge research, will take time and money.

Also spanning the continent, but more modest in scope is the digital mapping of African historical sites by the Geomatics Department of the University of Cape Town. This activity is gaining global recognition for two important reasons. One is the novel use of laser technology for historical research, since the resulting digital images can be manipulated and analysed in ways not available earlier to archaeologists and historians. The other is the preservation – digitally – of fragile sites, which are eroding, literally in the case of mud structures, because of pollution, ravages of war, and long term neglect. The results of this research can also be diffused quickly and widely via the internet. The Department wishes to develop similar capacities within leading universities in the region, and to apply the technology both to a larger number of historical sites and to other fields. A first step toward developing a collaborative effort along these lines would be to assess capacities among potential partnering universities. Once established, it would undoubtedly begin to external interest and support for both its research and post-graduate training activities.

The advantages of conducting research spanning national boundaries are also evident in other fields, including environment and law. Among the former is the Centre for Environmental Studies at the University of Pretoria and VICRES, a Lake Victoria centred initiative financed by Sweden (SIDA) and managed by the Inter-University Council for Eastern Africa (IUCE) on

²⁶ African Union (AU) and New Partnership for Africa's Development (2006) Biotechnology in Africa's Development: Draft Report

²⁷ Juma, C. (2006) The Role of the Engineering Sciences in International Development: Redesigning African Economies: The Royal Academy of Engineering. The 2006 Hinton Lecture

Juma, C. (2006) Reinventing African Economies: Technological Innovation and the Sustainability Transition Iowa State University

Mugabe, J. (2003) Biotechnology and Sustainable Development: Toward Regional Consensus and Common Strategy

behalf of the participating institutions. The University of Pretoria has also spearheaded a continent wide initiative in Human Rights Law. Its LL.M program is run from Pretoria and three other universities in West, North and East Africa. Although quite new, the program's graduates have begun playing important roles in legal reform and advocacy, as well as teaching and research in their own countries. The logical next step, for the program's leaders, is to introduce a collaborative doctoral program in order to ground programs in human rights law in universities and law schools across the continent, and to sustain a high quality research program, similar to efforts in Eastern Europe and Latin America.

The human rights law initiative also highlights another motivation for collaboration across institutional and national boundaries, namely the advent of an increasing number of highly specialised fields, a natural consequence of the growth in knowledge. One such case is economics. The African Economic Research Consortium operates a highly successful collaborative masters program. It has been joined by a collaborative masters in agricultural and applied economics mounted by 16 departments of agricultural economics in 12 eastern and southern African countries. Aside from its narrower focus, this latest program is targeted more directly toward individuals seeking a masters degree in order to enter the job market rather than as a stepping stone toward a doctorate followed by a career in teaching and research. Even so, both programs have been the source of major innovation in the collaborating departments – in using ICT for communication, access to learning materials, and dissemination of research findings; in the effective deployment of subject specialists; in creating a critical mass, for peer review and teaching, not available in any single university; and in introducing new areas of knowledge. Similar pressure is evident in other specialisations, e.g. in health and regulatory economics (telecommunications, transport, competition and so on). Universities will benefit to the extent that the ensuing collaborative initiatives promote three important innovations. The first, as we have noted earlier, is effective utilisation of scarce subject specialists, and improvement in quality resulting from the assembly of a critical mass of students and faculty. The second is advances in knowledge, especially as they relate to African conditions. The third is a strengthened link between academia and the economy. Prospective employers will expect graduates in these more specialised fields to emerge equipped with specific competencies. Consequently, there will be continuing pressure to ensure that the syllabus and course curricula respond to the working world graduates will be entering.

Not surprisingly business education, which tries to link competencies and knowledge directly to subsequent employment, is the fastest growing segment of tertiary education in Sub-Saharan Africa. Most of this growth is taking place in the private sector, either through the establishment of new institutions, as has been the case in Senegal, or the provision of courses by external providers, directly through the internet and usually in collaboration with locally recruited staff. Virtually all public universities have responded to this demand by establishing business schools and/or revamping their faculties of commerce. Needless to say, the quality, relevance – and cost – of these offerings vary enormously across the sub-region. Until recently, the principal attempt to network some of these business schools, in order to improve quality and relevance, was the IFC Global Business School Network, which will be winding up its activities in 2007. However, the IFC effort has left behind a potentially significant outcome. It is the newly founded Association of African Business Schools, which has set high requirements for institutional membership, in terms of applicants' program offerings, the number and quality of their staff, and their research activities. In developing standards for accreditation, the AABS does not simply want to replicate a North American or European model. Beyond the needs of the larger scale private sector, it recognises the importance of responding to at least three other groups: the smaller scale and informal private sector, the public sector, e.g. in delivering essential public goods, and the voluntary, not for profit sector, which often fulfils quasi-public roles, e.g. in

providing public health and agricultural extension services. Also indicative of innovative, “outside the box” thinking, is the attention being paid by some of the better business schools, e.g. at the University of Ibadan, to education in entrepreneurship, not only for their own students, but for graduates from other faculties who in many cases will not be able to secure employment in a small formal sector. Undoubtedly the AABS schools will be keen on developing collaborative links in teaching and research. These could have a more substantive impact on their home institutions, by linking them more directly to the world of work, as well as national systems of science, technology and innovation.

In summary, there is a new wave of collaboration in research and post-graduate education, transcending institutional and national boundaries. Some of those documented by the study for the Partnership for Higher Education in Africa display promise and creativity, in generating new knowledge, in repositioning their home institutions within regional and international systems of research and innovation, and in pioneering new modes of learning. Undoubtedly the study overlooked others – because they are still in nascent form, or because they have yet to be documented. And the underlying trends, global and Africa specific, suggest that there will be more in future. Effectively collaborative efforts are becoming an integral feature of both research and learning, especially at the post-graduate level.