Partnerships for Building Science and Technology Capacity in Africa: Canadian and UK Experience

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Paper prepared for the Africa–Canada–UK Exploration:

Building Science and Technology Capacity with African Partners

30 January – 1 February 2005

Canada House, London, UK

Executive Summary

In the last three years, a series of influential reports has highlighted both the importance of science and technology in achieving development goals, and the role of capacity building in that process. Africa is particularly needy — not only is it the poorest continent; it is also the one with the weakest science and technology institutions.

Recently, Britain and Canada have been considering significant increases in funding for capacity building in science and technology, and policymakers are now considering the best means of channelling those funds. There are huge opportunities to make a real difference, but the challenge is to find new and innovative approaches to capacity building.

The aim of this paper is to enhance Canadian and British efforts by looking at seven very different approaches in Africa, and offering suggestions for ways forward. There are three key issues that need to be addressed to develop successful and meaningful capacity-building programs: understand the local context; find the correct mix of short-, medium-, and long-term interventions; and encourage the development of systems of innovation.

Local context is everything, and yet it is often ignored and misunderstood. History is littered with examples of capacity-building projects that have failed because of this, and program designers must understand the needs of the people they seek to serve and the local knowledge available.

Even projects that must achieve a goal by the fastest method possible can benefit enormously from local engagement and at the same time build local capacity. The International AIDS Vaccine Initiative and the East Coast Fever vaccine project have both been highly effective in combining top-class international science with local expertise.

However capacity building is part of a continuous process and cannot be completed through project-funding alone. Although short-term funding may produce some long-term capacities, it may not necessarily be cost-effective or appropriate. Long-term support for research centres alone does not guarantee that immediate development goals will be met.

Different agencies have taken different approaches. Canadian support has been largely project-based and has funded some top African scientists. British support has been channelled through several agencies, all with different priorities. Both approaches are in transition. Some Scandinavian support has focused on building institutional capacity by allowing them to decide how to spend the money. The challenge for Canada and the UK is to combine both approaches.

The third issue is to encourage the development of systems of innovation. This involves long-term support to build both management capacity and linkages between practitioners through a series of knowledge-sharing networks. In the West, networks built between science parks, technology-transfer offices, consultants, and venture capitalists are an essential part of science and technology. The need for analogous institutions and networks is even greater in developing countries. Long-term relationships between institutions with different skill sets, even different aims, can help local scientists build on their strengths and identify strategic needs over time.

One pressing challenge for both governments is to construct funding mechanisms that effectively facilitate enhancing capacity. Both Canada and the UK are broadening their support from funding aid projects to developing partnerships, especially public–private partnerships, and supporting the development of new institutions. Policymakers in Canada are considering channelling their new funds through Canadian development agencies and other research councils. In Britain, a range of options is being considered to increase the development component of development-research funding. The danger is that developing countries may not be involved in setting research priorities, and that funds may not be used to build Southern research institutions. Both these concerns must be addressed to achieve more local control and local capacity building.

Across these different approaches it is clear there is no one definition of research excellence. Alternative versions of excellence need to be framed that better take account of both different

local contexts and differing development challenges, which do not respect academic disciplinary boundaries. Crucially, capacity building in science and technology enables innovation that can help countries meet development goals and improve people's lives. But innovation is not only something that happens in sophisticated research laboratories, it can also happen by developing new and more effective approaches and institutions.

Introduction

In recent years, a number of high-profile initiatives and reports have signalled a renewed interest in and concern about science and technology capacity-building in Africa. The World Summit for Sustainable Development, held in Johannesburg in 2002, centred on both the key role science and technology must play in driving more sustainable trajectories of development and the role of partnerships as a mechanism to link technology, capacity, and needs in fundamental new ways (WSSD 2002; Smith 2003).

The United Nations Millennium Project task force on science, technology, and innovation reiterates the need to harness science and technology sustainably to accelerate development. The report underscores the generation of enabling and innovative policy as crucial in this regard, further noting that:

> *[T]here cannot be a viable science and technology policy if it is not underpinned by well-designed measures for addressing issues such as learning, technology, technology diffusion and transfer, research and development (R&D).* (Millennium Project 2004, page 19)

The role of learning, and by extension capacity and capabilities, is fundamental to generate maximum benefits from enabling technologies, emerging knowledge bases, and concrete technologies. The October 2004 UK House of Commons Science and Technology Committee report on The Use of Science in UK International Development Policy draws on a wide range of expert knowledge to illustrate the importance of generating real capacity through development, partnerships, and science and technological innovation. Building capacity is seen as a lever to draw together the "yawning divide between north and south" (House of Commons 2004, page 44). The importance of capacity building is drawn through the Science and Technology Committee document, and the UK and Canadian Governments have made a series of commitments in this regard, including Canada's pledge to spend 5% of its national R&D budget on developing country initiatives.

The flurry of reports in 2004 highlights the importance of first, science and technology, and second capacity building. But the issue of how best to enable the sustainable development of capacity in developing countries with respect to new knowledge is not a brand new endeavour. Historically, much effort has gone into attempting to diagnose the problem of the weak science and technology base of the "South" (Garrett and Granqvist 1998). The seemingly increasingly intractable paradox of a globalizing, integrating world within which asymmetries of information, knowledge, and wealth continue to grow, signals the need for new and innovative approaches in this area. As the very need for a Commission for Africa (2004) demonstrates, in Africa these issues are further amplified, and new approaches must be firmly embedded within an understanding of the African context if suitable and sustainable progress is to be made.

The aim of the paper is to enhance Canadian and UK science and technology capacity building efforts by drawing out opportunities for joint Canada–UK efforts within Africa. Through the presentation of seven case studies, the key requisites of understanding local context, implementing the correct mix of temporal initiatives, and utilizing a system of innovation approach are highlighted. These case studies also underline the many elements that encompass capacity building: individuals, organizations, institutions, and systems of innovation. Furthermore, capacity building encompasses

support for many skills and activities, including elements of the ability to search for, select, and use scientific and technological knowledge and products; the ability to develop the means to improve existing scientific and technological knowledge; and the necessary management and governance experience to organize and manage R&D facilities.

Section 1 of this paper briefly traces Canadian and UK efforts in this area. Seven examples of capacity building are presented in Section 2 to explore different approaches and to examine how international capacity-building efforts have interacted with local environments. Section 3 relates the successes and weaknesses to a condensed set of guiding propositions about how capacity building should be constructed. Section 4 considers the implications for the UK and Canadian African partnerships. The final section contains conclusions and some questions for debate.

Trends in UK and Canadian Capacity Building

This section briefly summarizes the Canadian and UK approaches to capacity building in science and technology, focusing as much as possible on recent changes and possibilities for the future.

Canada

Canada has considerable experience in capacity building in science and technology and its system for achieving this is viewed by many as a highly successful model. Two institutions, the Canadian International Development Agency (CIDA) and the International Development Research Centre (IDRC) play a major role in administering funds and resources and developing policy to support capacity building in developing countries.

The International Development Research Centre (IDRC)

IDRC has provided a unique institutional model for research capacity building. Since it was started in 1970, IDRC's approach has been to mainstream "capacity development'" and "research for development." Its basic philosophy is to support developing country researchers working in developing country institutions, for the needs of those countries. Thus it focuses on locally defined problems, locally designed research. It does this by funding institutions and individuals in developing countries and supporting partnerships between developing country organizations and their Western counterparts.

IDRC is governed by an international board of 11 Canadians and 10 non-Canadians. Like the Canadian International Development Agency, the government's aid agency, it supports a range of bi-lateral and multi-lateral programs. Its budget is about CAD96 million annually. Approximately 80% of this goes to Southern research partners.

IDRC employs 350 staff: 200 at the Ottawa headquarters and 150 in regional offices in Uruguay, Senegal, Kenya, Egypt, India, and Singapore. Sixty of these are program officers, highly qualified front-line staff who work directly with researchers in the field to develop, monitor and follow up on projects. The relatively labour-intensive nature of this organizational structure allows for good support and a high degree of networking and knowledge sharing.

At present, IDRC is supporting more than 700 researchers in over 400 institutions located in 76 developing countries through 482 active projects with a total value of CAD128 million (GBP58 million). IDRC does not operate on a "tied aid'" basis, and

careful consideration is given to whether a Canadian partner would add significantly to the specific needs of a project.

IDRC has been influential in guiding efforts by Western donors to support S&T capacity building in developing countries. It represents a particular model of capacity building support, one that focuses on project work. In general, IDRC does not support institutions, distinguishing it from the Swedish International Development Agency Research Department (Sida/SAREC) initiatives that are discussed later in the paper.

However, IDRC recognizes that project support is limiting and it makes additional efforts to help institutions in the poorest countries with funding for equipment, software, staff costs, materials, maintenance, and management training.

IDRC's submission to the UK Parliamentary Select Committee's enquiry into the use of science in international development (House of Commons 2004) concludes with some lessons learned about strengthening and creating institutions:

- **Time** is of the essence: whether strengthening or creating, it is important to sustain support for long periods to have prospects of success;
- The greater the degree of core institutional support, the greater the potential for creating dependence on external funding. While recognizing the importance of a long-term relationship, attention should also be paid to ways of increasing **institutional autonomy**;
- Giving researchers an opportunity to **work in their own institutions** with adequate funding is an important way of supporting and strengthening those institutions;
- Institutional capacity can be considerably enhanced by repeated project funding, provided that support is sensitive to particular needs of the institution — in other words, project support should be **flexible** (IDRC 2004).

Although IDRC does not generally support institutions, it has given significant support to research networks that have built regional capacity, including in science and technology policy research. In part, the high ratio of staff to projects accounts for success in linking researchers and creating local and international networks. But additional effort is put into building networks, for example through the Research on Knowledge Systems (ROKS) program. Other examples include networks that have assisted developing countries to understand the implications of new issues in international trade, and the impact of industrialized-country agricultural subsidies on cotton production in West Africa.

IDRC clearly represents a powerful effort at capacity building in developing countries. However, the Canadian government has now made a "five per cent pledge" to spend 5% of its national R&D budget on developing country initiatives. Policy analysts are calling for an enhanced role for partnerships between Canada and developing countries. A recent paper by a senior Canadian S&T policy analyst calls for a more strategic approach to international partnerships, particularly partnerships with developing countries, and discusses the need for a new "paradigm" to guide Canada's leadership in this area (Dufour 2002).

The proposed new approach highlights the need for a re-evaluation of notions of "research excellence'" and "good practice." Although institutions in industrially developed countries put much effort into judging and reviewing research performance, and can therefore legitimately claim excellence, it is not clear that institutions in

developing countries benefit from using the same criteria. Maureen O'Neil, President of IDRC, has articulated it thus:

> *[H]edging and risk-averse approaches must not trap Canadian researchers within one definition of research excellence, blinding them to other less familiar approaches to knowledge creation and capacity building while blunting the potential to create new knowledge.* (O'Neil 2004)

IDRC's experience highlights the need for multidisciplinary and interdisciplinary approaches and a willingness to consider institutional and policy innovation. Canada will almost certainly have to pursue some institutional innovations to meet the challenge of the "five per cent pledge'" set by Prime Minister Paul Martin and newly appointed National Science Advisor, Arthur Carty. Two broad types of interventions will emerge from this new commitment. The first category will encompass research partnerships with "innovating" developing countries such as India, Brazil, and China. The second will involve partnerships based on technology transfer with less developed countries. But it is unclear as to whether new money will be channelled through the existing architecture of Canadian institutions and universities or whether each government body will create arrangements with CIDA and IDRC to pursue capacity-building efforts.

Canadian International Development Agency (CIDA)

At present, Canadian aid expenditure is 0.27% of GNP and the Canadian government has made commitments to increase this amount, although not as quickly as once hoped. The Canadian International Development Agency is Canada's principal aid agency. It has a broad remit covering both emergency aid and a range of development programs that are in line with the types of activities supported by other Western aid agencies. Within this set of activities, CIDA has given a high priority to capacity building or capacity development — it is one of CIDA's four pillars of development. A key Canadian foreign policy review *Canada in the World*, stated the following:

> *A sound development program must be people-centred, with a focus on human development — on building capacity, which means helping women, men and children in developing countries, their communities and institutions, to acquire the skills and resources needed to sustain their own social and economic progress.* (Foreign Affairs Canada 1995)

Capacity development in science and technology accounts for a relatively small amount of CIDA's capacity-development efforts but the agency is actively engaged on several fronts. It supports a range of bilateral and multilateral projects, including contributions to research institutes associated with the Consultative Group on International Agriculture Research (CGIAR) and more recent initiatives such as new health-research partnerships.

CIDA works closely with IDRC. For example, in Honduras the two agencies recently launched a 5-year project to expand the institutional capacity of Hondurans to plan and carry out development. Building Learning Systems for Honduran Development is working to forge connections between the Honduran research community and the country's public decision-making institutions.

The Peru Economic and Social Research Consortium, supported by both CIDA and IDRC, is an organization with over 30 institutional members among Peruvian university and research institutions. The Consortium seeks to strengthen the capacity

of Peru's research community to produce and disseminate useful knowledge for policymakers and decision-makers in government, civil society, and academia.

Apart from these two institutions, whose primary aim is to support international development, various other institutions support Canadian–Southern partnerships. These include the National Science Advisor's Office. The recent appointment of a National Science Advisor has added impetus to Canada's S&T developing country activity. One of Arthur Carty's new challenges is to implement the government's commitment to spend 5% of Canada's R&D on developing country initiatives.

Furthermore, three research councils (in addition to IDRC) provide funding for research. The Social Sciences and Humanities Research Council of Canada supports multi-disciplinary research that covers a variety of topics including globalization, immigration, and citizenship, each of which may pertain to science and technology capacity building. It has also recently involved international scholars in its programs (Dufour 2002). The Natural Sciences and Engineering Research Council is also hoping to expand its international activities partly in response to Canada's 5% pledge.

The Canadian Institutes of Health Research already has a Memorandum of Understanding with IDRC that enables it to create joint projects and programs with developing country partners. One option, which is regarded favourably by some senior managers and policymakers, is that this arrangement be extended to allow IDRC and other agencies to achieve the 5% target. Each agency would contribute to specific international partnership arrangements. Therefore, CIHR and IDRC might each contribute to a specific S&T capacity-building partnership with Malawi for example. Two and a half years ago, CIHR along with Health Canada, CIDA, and IDRC launched a Global Health Research Initiative designed to develop strategies for responding to the health priorities and agendas of poorer nations. This organization, the Canadian Coalition for Global Health Research, provides policy advice and acts as an advocacy group. The aim of the CCGHR is to develop a Canadian approach to North–South partnerships in health that builds capacity in the South and relevant skills in Canada.

In addition to the three research councils, a number of interdisciplinary initiatives that support research are worth noting:

- Genome Canada, a CAD300 million initiative launched in 2000 to promote genomics in five strategic growth areas, has encouraged linkages with partners in industrially developed countries and supported a large initiative at the Joint Bioethics Centre at the University of Toronto to address issues surrounding the "genomics divide" in the developing world.
- The Canada Foundation for Innovation has established two CAD100 million funds to strengthen international research cooperation and joint ventures with leading scientists, including support for a Canada–Kenya research laboratory to provide researchers in Canada and collaborators in Nairobi, Washington, and Oxford with a state-of-the-art facility for researching highly infectious diseases such as AIDS and hemorrhagic fever.
- The National Research Council of Canada has fostered research cooperation with agencies in Taiwan, Singapore, and Thailand.

CIDA supports a large university partnership program called the University Partnerships in Cooperation and Development. Large projects can be funded up to CAD3 million over 6 years. The most recent batch for 2004 totals eight projects with total funding of CAD23 million. There are also 75 smaller projects of up to CAD1

million over 6 years, managed by the Association of Universities and Colleges of Canada. These partnerships are designed to strengthen departments in Southern universities and to build institutional linkages, not just fund projects. The projects "are conducted as a means to an end, but not an end in itself."

The system that Canada has developed to support research and capacity building in developing countries has served it and its Southern partners well and is viewed by many as a model. However, the pledge to orient 5% of all research funding toward partnerships with developing countries means there is now a need to rethink the institutional basis of Canadian support for S&T capacity building in developing countries.

United Kingdom

The UK's science and technology system is one of the world's strongest. It has responded over the last decades to a number of political and economic pressures: measures to "close the gap" between the laboratory and commerce by making science more responsive; funding squeezes and research accountability pressures like the Research Assessment Exercise; and, more recently, funding increases often associated with new problem-oriented interdisciplinary research priorities, and pressure to make good previous funding shortfalls of infrastructure and people. At the same time, public disquiet about some technologies has led to increased regulation, both in the UK and the European Union.

UK science and technology has been recently receiving more government funding, although there is a sense that its world-class status will not be assured without significantly more effort and resources. However, the UK development budget declined as a proportion of gross national product (GNP) from around 0.4 per cent of GNP in 1980 to around 0.26 per cent of GNP in the late 1990s. This trend is now being significantly reversed. Most of the funding for development assistance is controlled by the Department for International Development (DFID 2000).

DFID and International Development

Funding for DFID has grown rapidly since 2000 with a focused mission to "help reduce world poverty." Each activity DFID funds has to be judged against that question — will it reduce poverty? UK Official Development Assistance will total GBP4.1 billion in 2004–2005 (GBP3.8 billion controlled by DFID) and is projected to rise to GBP6.5 billion by 2007–2008, with goal to reach 0.7% of GDP by 2013 (GBP9.7 billion). Hilary Benn, the Secretary of State for International Development, articulates this approach:

> *What matters to me is outcomes — lives saved, people better off, children surviving to celebrate their fifth birthdays.* (Benn 2004)

This tight focus has brought acclaim from across the world — from those mostly northern European countries that kept up their development assistance programs as the UK dropped its, and from those in the South who have noticed that their concerns and priorities are more attentively heard and that they are given more control over spending.

The UK's new reputation for its commitment to improving the situation of the poorest is not confined to DFID actions. The Treasury and Chancellor have been major players in the attempts to reach agreements both on debt relief for highly indebted countries and on granting increases in development assistance. The Prime Minister set up the

Commission for Africa in early 2004 to support and generate ideas and actions for a strong and prosperous Africa. Nine of its 17 commissioners are from Africa. It will report in early 2005. Its recent consultation document (2004) highlights the importance of supporting science and technology as part of an effort to reinvigorate African universities.

DFID recently published its new research strategy for 2005–2007 (DFID 2004). Some two-thirds of research funding will focus on four research themes:

- Sustainable agriculture, especially in Africa;
- Killer diseases;
- Where states do not work for the poor; and
- Climate change's impact on poverty.

DFID's 2002–2003 research budget was GBP80 million (GBP30 million spent on agriculture, GBP26 million on health, and GBP10 million on infrastructure) and this is due to rise to at least GBP100 million by 2006–2007. The increased funding will allow DFID to "give more effort to building developing country research capacity" and "further support to international initiative, public partnerships, and a funders forum that will allow us to work more closely with other UK research councils" (DFID 2004). DFID has also announced the appointment of a Chief Scientific Advisor (Professor Gordon Conway) to give strategic advice on how DFID can make better use of science.

The DFID research-funding framework pays attention to research capacity, emphasizing its weakness in much of Africa. It underlines its support to, and use of, developing country research institutes. For example, DFID's Renewable Natural Resources Research Programme commissioned 40% of its projects from developing country research institutes in 2001 and 2002. Weak research capacity does not only affect research — it affects entire public sectors. The document goes on to commit DFID to a review of overall support to science and technology following the appointment of DFID's Chief Scientific Advisor and in the light of the House of Commons Select Committee Report on Science and Technology in Development, The Use of Science in UK Development Policy (House of Commons 2004).

UK Science and Technology

The UK's involvement in science and technology in development is extensive, varied, and perhaps rather diffuse. Britain's research base in this field is substantial. A large number of research units concentrate on development issues, many providing postgraduate training for those fortunate enough to be able to come to the UK to study. At present, there are 35,000 international postgraduates doing research degrees and 77,000 doing taught courses, but very few are from Africa.

The UK has seven research councils and one research board. Four of these councils have extensive relevant research (RCUK 2004):

- The Medical Research Council spent GBP23 million in 2002–2003 on its portfolio of research relevant to developing countries, of which GBP4 million was provided by DFID. It runs the MRC Laboratories in The Gambia (since 1948), the MRC Programme on AIDS in Uganda (since 1987), and the MRC Laboratories in Jamaica (1974–1999), which are now based at the University of the West Indies and have been renamed the Sickle Cell Unit.

- The Biotechnology and Biological Sciences Research Council (BBSRC) emphasizes the following research as highly relevant for developing countries: developing salt-tolerant cereal crops; identifying what causes the swarming of locusts; developing nematode-worm resistant crops; and novel vaccines for rinderpest and caripox. BBSRC research institutes such as Rothamsted Research, the Institute of Animal Health, and the Institute of Grassland and Environmental Research are engaged on relevant research.
- The Economic and Social Research Council (ESRC) funds a range of research. There are ESRC research groups working on well-being in developing countries; global poverty; migration, policy, and society; and globalization and regionalization. It also runs a New Security Challenges Programme and the Genomics Network, which conducts significant research in partnership with developing countries.
- The Natural Environment Research Council (NERC) funds the British Geological Survey's work in building institutional capacity on issues related to groundwater, minerals, energy, and hazards. It supports research by the Centre for Ecology and Hydrology on water resources, global climate modelling, and tropical land use. It also funds important marine and oceanographic research.

UK universities have world-class research capacity in health, veterinary science, natural resources, social sciences, agriculture, agricultural engineering, forestry, water engineering, and biotechnology. Over 20 large units made submissions to the House of Commons Select Committee Report. These university units have taught a significant proportion of Africa's qualified scientists and technologists. There is a large amount of crosscutting funding and support across DFID, research councils, and other government departments.

Government departments other than DFID also sponsor relevant research. The Department for Environment Food and Rural Affairs (DEFRA) funds the Darwin initiative, which promotes biodiversity and sustainable use of resources, and also a Climate Prediction Centre with the Met Office Hadley Centre. The Office of Science and Technology, part of the Department of Trade and Industry, funds the research councils and houses the Chief Scientist, Sir David King, who is a keen advocate of increasing support for science and technology for international development.

The British Council manages the DFID Higher Education Links program, which has recently received a new round of funding of GBP3 million a year for the next 3 years for UK–developing country university links. It also manages a range of other educational programs and has a science budget of GBP8 million.

The Royal Society has also been active recently in its calls for better funding for UK science and technology for development and for developing country capacity building. In its response to the 2004 House of Commons Select Committee it stated:

> *It is essential that [DFID] builds sufficient in-house expertise so that science can play a central role in developing long-term, sustainable solutions, such as robust vaccination programmes and drought resistant crops… DFID must invest in building up the science and technology capabilities of developing countries.* (Royal Society 2004)

It went on to commend the creation of the Chief Scientific Advisor post, saying that the appointee "must develop the Research Funding Framework in consultation with both the [UK] science community and developing countries."

Science and Technology for Development

The UK's national science and technology system and British policies to support efforts to tackle global poverty have the potential to come together more closely. The House of Commons Select Committee report (House of Commons 2004) collated significant information on UK science, technology, and development activities. At the same time, it provoked many in the UK's science, technology, and development community to reactivate debates about its future direction.

The report welcomed the decision to appoint a Chief Scientific Advisor at DFID and also welcomed plans to increase support for science capability building in developing countries. Other recommendations of the report included:

- Britain should take an international lead (through its Commission for Africa and forthcoming presidencies of both the G8 and European Union) in calling for an international science and technology capacity building strategy. It appears that this is happening.
- A crosscutting Development Sciences Research Board should be created with the mandate to award grants to UK-based institutions with a budget additional to the aid budget (the committee proposed GBP100 million per annum). Currently most funds for new initiatives are distributed among research councils rather than through newly created boards.
- Technology-intensive areas (such as infrastructure, energy, water, and sanitation) should not be neglected due to their omission from the Millennium Development Goals.
- DFID should commit more resources to capacity building over and above its existing budget, and give country offices a larger role in capacity building.

The UK system is large and quite diffuse. There are numerous "interests" and "interest groups" in the UK and between the UK and its traditional research partners. One submission to the Select Committee, concerning research in Nepal, says:

> *There sometimes exist conflicts between the goals and rewards for UK researchers working in Nepal and the current needs for strengthening national and local level innovation systems in Nepal. For example, publishing an article in a UK/International respected journal at the end of research project may be a major goal for the UK (and Nepali) researchers. However, the process by which the research was carried out in Nepal may or may not have made much contribution to strengthening local capacities.* (Biggs, in House of Commons 2004, page Ev291)

Issues such as this are likely to increase as local capacity building in developing countries becomes increasingly prioritized. Issues over how research is measured and even why it is undertaken must be negotiated as UK funding re-orientates itself around partnerships and local priorities. The need for understanding the international and local context of research and design support in developing countries has clearly been acknowledged. The UK system has received increased funding and dramatically increased positive attention over the last few years, but especially in 2004. The system appears to be "in flux" and to present opportunities to make a real difference in capacity building if efforts can be focused and the key issues seriously addressed.

Different Approaches to Science and Technology Capacity Building

This section looks at seven examples of research capacity building in science and technology. The idea is not to be comprehensive but to introduce a series of different approaches. Our aim is to show that there may not be just one model for support but rather a diversity of approaches that can bring success. To what extent do embryonic approaches exist that could be learned from and drawn together if there was sufficient will? The examples below give an idea of what might be possible.

African Economics Research Consortium: Experience in African Leadership

The African Economics Research Consortium (AERC) is a large scale sub-Saharan Africa-wide network with headquarters in Nairobi and nodes in many sub-Saharan African countries. The donor consortium totals 16 and includes multilaterals, bilaterals, and the large US-based foundations. Its USD10 million a year budget funds over 100 researchers at any one time, plus 140 masters students and 71 doctoral students in its training program.

The AERC was established by senior African economists and a consortium of donors in 1988 for "the advancement of economic policy research and training." AERC's mission is to strengthen local capacity for conducting independent rigorous inquiry into the problems facing the management of economies in sub-Saharan Africa. This mission rests on the premises that: development is more likely to happen where there is sound management of the economy; and that such management is more likely to happen where there is an active, well-informed group of locally based professional economists to conduct policy-relevant research.

Capabilities in economics in Africa had begun to weaken and fragment in the 1980s, as donor interest and investment in African universities waned. The idea of AERC was to regain space for research that would strengthen national and regional ability to think about and practice better economic management, focused on macroeconomic management. AERC is generally seen by its main supporters (donors, economists, universities, private sector and governments) as having been incredibly successful. Senior economists have said that the capacity building organized and led over the years by the AERC through its project on poverty was the single most important reason why so many African countries had produced high-quality poverty reduction strategy papers required by the donor community.

Significantly, AERC's governance has three organs with very clear division of responsibilities, which separates donor interests from research and capacity-building priority setting. The Board of Directors is constituted by members of the donor consortium (made up of donors who commit non-earmarked finance of more than USD100,000 per year). The Board agrees on the annual budget and 5-year strategic plan. All donors accept a common reporting system, avoiding the normal fragmented constantly changing systems of each donor. The Programme Committee sets the research and training agenda and has no donor representatives. It is made up of four senior African economists, four senior African policy-makers, and four international resource persons. The committee is responsible for overseeing the research and training programs. The Executive Director and secretariat manages the consortium and the programs. There are four professional staff in Nairobi.

The AERC began by establishing a research-project funding system and developed explicit mechanisms for capacity building through research. It now has two types of research funding and formal postgraduate training programs.

The original concept of research training in AERC was that it should happen through doing research. Thematic areas are defined (there are four at present) and research-projects proposals invited. At any moment, there are about 100 small projects and a few larger networked projects. Over the last 7–8 years, about 760 projects have been funded with about 1000 researchers. Each proposal is judged, and the researchers who propose the promising proposals attend the bi-annual meetings to discuss and debate their proposals. At this stage, proposals are either agreed on or sent back for further work. Each promising proposal is given attention and feedback. Junior researchers are encouraged to apply, either in groups or with more senior colleagues. Every proposal accepted gets another work session as "work in progress" and is discussed at the final report stage. There is thus a collegial process of quality control. As well as this peer review system AERC provides methodology workshops and literature. At each biannual meeting there are Africa and international resource persons, all world-class economists. AERC says that the workshop process has been central to developing a sense of ownership of AERC activities on the part of researchers and their institutions.

More recently, formal training programs have been set up in partnership with 21 sub-Saharan African universities in 16 countries, all Anglophone. Nigeria and South Africa are not included because they have well-established Master's programs. All member universities can send students to the 18–24 month courses, but only the seven accredited universities can teach on the program. Accreditation is on the basis of capacity to mount a Master's degree in Economics. The program started with an intake of 58 students in 1993, and the latest intake was 140 in 2004. Most recently, a collaborative doctoral program has begun with eight teaching node universities and an aim to graduate 400 PhDs in 15 years. This has four sub-regions: Anglophone West Africa; Francophone Africa; Eastern Africa; and Southern Africa. Intake has risen from 19 in 2003, to 25 in 2004, to 27 in 2005, and all are still in the program.

AERC has several key characteristics that are important for capacity building:

- It is managed and coordinated from an African base, with strong African leadership and support at the highest levels. It has not turned inward but rather has excellent international relations and resource persons.
- It has a large set of node points around the continent, and good relations with most of the best universities, research institutes, and governments on the African continent. But it has managed to keep a very tight focus around its research capacity and training initiatives, which are strongly integrated.
- It has a disciplinary focus for capacity building in economics, but within a strong policy and practice framework on economic policy.

AERC seems to be able to grapple with the inevitable tensions around direction and focus. Donors, for example, are used to having a major say in the style and direction of the programs they fund and AERC is no exception. Similarly, international resource persons could become very powerful in shaping research agendas. Still, the leadership of AERC has worked hard to keep the leadership initiative, to avoid fragmentation of efforts, and to keep a single common reporting system. It is a high-profile institution with a reputation for international excellence around the world, and it has worked hard to maintain control of AERC's strategy and focus.

Swedish International Development Agency Research Department (Sida/SAREC): Building Capacity in Universities

Sweden's research-support agency for developing countries (SAREC, Sida's Research Division) and Canada's IDRC are two of the few bilateral institutions that support researchers in the South based on local research ideas.

SAREC has an unusual form of research support. At face value its mission statement is not that different from many other donors: "The contribution to strengthening research capacity involves assisting developing countries in their building up of research capacity in the form of functioning research environments, training of their own researchers, development of methods for planning and prioritising research, and allocation of resources for this." (Sida 2004). But the notion of "support for research environments," rather than the usual research production, outputs, or training, is suggestive.

What is more unusual is that SAREC focuses on supporting 12 of the world's poorest countries in rather unpropitious circumstances — not just the BRICs (Brazil, Russia, India, and China) or the South's research superstars. Another key difference from many research funders is that it does not just fund projects, it also supports institutions. The characteristics of its higher-education research support include:

- A focus on universities as centres in which research and training can take place together. The focus is on a few [the single best or a few good] "more research intensive" universities in each country with a strong attempt to avoid spreading resources for research support too thinly and away from key national universities. "Sida shall focus on support to research universities with a central position in the national system for research and education."
- A focus on support for systems of research (with future inspiration to systems of innovation). Thus, the support includes not only project support but program support, which includes library, Internet, and research management support "coupled with support for activities relevant to the institutional development of faculties or universities as a whole."
- There is an emphasis on local research design. "The formulation of realistic and constructive poverty reduction strategies relies on local assessment and analysis, underpinned by local research." Emphasis on local conditions includes support for local research training programs "in collaboration with universities abroad that allows university staff under training to continue activities at their home university," via development of local programs for research training, and the building of research environments, laboratories, libraries, Internet systems, and electronic journals. Projects are supported as a means of building university research environments: in Mozambique, for example, Sida research support has allowed the development of a research decision-making system to prioritize projects. The Mozambican Ministry of Higher Education Science and Technology has adopted a system based on this model for building research capacity in other universities.
- Support for Swedish development researchers is set up via a separate funding system to avoid Southern support being tied to Swedish research units. If a local university prefers to link to a non-Swedish partner that is accepted, though in practice most support involves Swedish partners.

- More recently, the idea of clustering institutions has emerged. “Clustering is more beneficial than scattering because it builds critical mass and it strikes a better balance between quantity and quality.”

It is important to understand why SAREC support has pinpointed universities as nodes for research-institution building. The decision to increase this type of support came from lessons learned over many years. First, support given to national science and technology commissions sometimes did not deliver grounded research environments for working scientists and technologists, but stayed at the national policy level. Second, the decision not to emphasize research institutes, individual scientists outside the national research institutes, and NGO research units was made in an attempt to build longer-term research structures. The thinking was also linked to the idea that research institutions should also be key national cultural centres not short-term ways of responding to particular development problems — although much of the research supported is quite applied and strategic. Finally, support to local universities for development of postgraduate and doctoral programs was important.

It would be fair to say that the Swedish agencies involved in this work feel frustrated that others do not back the idea of “support for research systems” but often cause fragmentation by focusing on research issues and inviting local researchers into their programs, with limited concern for the institutional impact of those actions. These fragmentary “parallel” programs were criticized by some submissions to the UK Select Committee.

Biosciences East and Central Africa (BECA): Concentrating Knowledge, Focusing Research, and Institutionalizing Innovation

There are debates around how capacity coalesces, or is encouraged to coalesce, within and around particular institutional structures. One model supported by the New Partnership for African Development (NEPAD), and funded with start-up money from the Canadian International Development Agency (CIDA), is the centre of excellence model.

Biosciences East and Central Africa (BECA) is a recently launched African centre of excellence focusing on the biological sciences. The vision for BECA is that it will enable African scientists and institutions to become significant technological innovators as well as users. It will become one of a network of similar facilities serving each region of Africa. The remit of these centres of excellence is to enable African scientists to undertake cutting-edge research targeted at priorities identified in the region by Africa’s broader research and development architecture. In the case of BECA, partners include the National Agricultural Research Systems (NARS) including its universities and research organizations, and other institutions such as the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), the East African Community (EAC), the Forum for Agricultural Research in Africa (FARA), and NEPAD. Moves are also being made to engage the private sector where appropriate.

Initially instigated by the NEPAD Science and Technology Secretariat, an initial investment of more than CAD30 million by CIDA’s Canada Fund for Africa has been earmarked to get BECA up and running. The facilities will be hosted by the International Livestock Research Institute (ILRI) in Nairobi, Kenya. The Canadian grant will be used initially to refurbish existing laboratory facilities, provide new facilities and equipment (including additional biosafety containment facilities) necessary for a centre of excellence in biosciences, and develop capacity in biosciences

among African scientists (through fellowships, educational and training activities that complement existing programs at national, regional, and international levels). An important additional aspect of BECA's development that sets it apart from the normal re-equipping of a research institution is a focus on developing BECA as a central node of a regional network of research institutions. Consequently, resources will also be channelled toward facilitating the generation of a knowledge network.

The idea of instituting a revitalized concept of centres of excellence within the African context are very much borne out of critiques of more traditional agricultural research and its institutional framing in developing countries (Hall et al. 2001; 2003):

- There are many examples of initiatives in Africa that have focused primarily on the supply-side, infrastructural aspects of institutional building. Technical and financial resources have been steered toward bricks and mortar and equipment, as opposed to perhaps providing the conditions needed for an institution to participate systemically within a given context.
- An understanding and acknowledgement of the array of constraints that face institutions in their pursuit of scientific knowledge and innovation has led to an increasing acknowledgement of the importance of building strategic partnerships and alliances to overcome these problems.
- Closely related to the issue of partnerships, is the realization that sound management of "knowledge flows" and "technological connections" define the strength and utility of relationships more so than the constituent institutions themselves.

"New model" centres of excellence, then, are a way of avoiding some of the problems that have characterized science and innovation, particularly in a developing country context. Centres of excellence take advantage of economies of scale, of strategic partnerships, of knowledge-sharing and informational networks, and of institutions becoming an integral part of an innovation system. Sound governance is at the heart of creating the conditions where a centre of excellence can flourish. Generating and managing inter-institutional relationships are fundamental to avoiding problems and using institutional structures and networks to integrate them with each other and within systems of innovation (Malkamaki et al. 2001).

BECA, despite being in its infancy, is potentially a blueprint for scientific centres of excellence in Africa. NEPAD has played a significant role in driving the BECA initiative, and has articulated a vision for a network of regional centres of excellence dotting the continent, very much in line with the Canadian model of networking centres of excellence. An important rationale for these centres of excellence is to build partnerships to ensure scholarship is translated into products that can aid Africa's negotiation through a rapidly globalising world. This is indeed a prevailing sentiment within NEPAD:

> *The imperative of development, therefore, not only poses a challenge to moral conscience; it is, in fact, fundamental to the sustainability of the globalisation process. We readily admit that globalisation is a product of scientific and technological advances, many of which have been market driven. Yet, governments — particularly those in the developed world — have, in partnership with the private sector, played an important role in shaping its form, content and course.* (NRF 2003, page 2)

BECA is very much a work in progress, but it does mark a shift away both from bilateral donors continuing to fund research and design at NARS in the face of a lack of results, and away from the idea that only the CGIAR centres can undertake cutting edge agricultural research in Africa. BECA is conceived as an institution that can work in partnership with NARS and the CG system to make better use of R&D comparative advantages in Africa. The extent to which BECA will become a *new* model for research and innovation in Africa is unclear, but significant resources have been earmarked to shape the initiative. A clear rationale for the way in which it should be organized, what its priorities should be, and how it builds capacity has been blueprinted from Canadian, Scandinavian, and Asian models of centres of excellence.

Two areas of concern remain. First, to what extent will existing institutional inertia, and the constraints that continually characterize agricultural research and development in Africa, constrain or promote new institutional arrangements in African agricultural research. Second, there are issues to be explored with regard to the centre of excellence model and capacity building in the African context. Experience with the CGIAR centres in East Africa shows that although some partnership activities occur with NARS, a certain amount of capacity is drawn from the periphery to the core and efforts must be made to support the building of sustainable R&D capacity within national research systems.

BECA will have to develop a reputation of excellence, and seek to centrifuge that reputation and allied mechanisms of capacity and capability building across 11 East African countries. This is a challenge that, if overcome, will truly create an institutional blueprint for research excellence in Africa.

The African Institute of Mathematical Sciences: Countering the Brain Drain

The African Institute of Mathematical Sciences (AIMS) is a new centre of excellence for education and research located in Cape Town, South Africa, that opened in September 2003. AIMS is a collaborative venture of the Universities of Cape Town, Stellenbosch, and the Western Cape and three international partner Universities: Oxford and Cambridge in the UK and the University of Paris-Sud in France.

AIMS was conceived in the spirit of NEPAD, which has strongly promoted the idea of regionally relevant centres of excellence. AIMS's prime focus is an interdisciplinary postgraduate residential course that brings students from all over Africa together for one year. The course aims to build a solid foundation in mathematics and computing while providing overviews on new developments in diverse areas such as bio-informatics, molecular biology, ecological mathematics, financial mathematics, astronomy, and wireless communication technology.

The course is taught by international and local lecturers in partnership. By educating students from all over Africa together, AIMS hopes in time to build a pan-African network of scientists and educators, itself well connected to the international scientific and teaching communities. Many of the AIMS students have continued to Masters and PhD programs. AIMS provides a stream of students feeding into local research efforts in a wide range of disciplines, from traffic management to financial mathematics to pure science areas such as mathematics and physics. AIMS is developing a special emphasis on topics of relevance to African development, such as telecommunication, epidemiology, and free computer software.

The need for mathematical skills both at school level and within industry, government, and science is chronic across Africa, including South Africa. Under the apartheid

education system, black South Africans had little opportunity to learn mathematics. Ten years after apartheid, there remains an acute shortage of trained mathematics and science teachers at all levels of education. South African teacher training colleges in the country are only graduating a handful of mathematics and science teachers each year.

To respond to this, AIMS is seeking funding to launch a Schools Enrichment Centre (AIMSSEC) based in Muizenberg. The goal is to support teachers by providing web-based and paper materials to assist mathematics and science learning. In-service teacher training courses are held during the months when the Diploma course is in recess (June–August).

AIMS is an explicit attempt to help counter the brain drain. The Institute's website states: "By being located in Africa, and by teaching excellent courses which feed into African educational and research initiatives, the institute seeks to build a culture of commitment to Africa. The brain drain from Africa is a major problem for the continent. By working to enhance the educational and research environment in Africa, AIMS is helping to counter this trend."

AIMS received over ZAR1 million (about GBP90,000) in funding from South Africa's Department of Science and Technology, as well as support from a range of public and private organizations — Gatsby Trust, Vodafone, Vodacom, the Mellon Foundation, the Ford Foundation, SUN Microsystems, PetroSA, and the International Council of Science.

International Aids Vaccine Initiative (IAVI): A Product-Based Approach

In some cases it seems that research "for" developing countries is clearly needed, although in capacity building terms this is not comparable to research "with" developing country partners. Developing a preventative vaccine for HIV/AIDS might be considered such a case. The need for a vaccine is overwhelmingly evident and the emphasis has to be on the fastest and most effective way of achieving that target. However, a closer look at the main public–private partnership working on a preventative vaccine, the International Aids Vaccine Initiative (IAVI), suggests that even here the distinction between "for" and "with" need not (nor perhaps should not) be so clear cut — IAVI has in fact had very positive impacts in terms capacity building. In this case, political and ethical sensitivities around vaccine development and clinical trails are powerful arguments in favour of local engagement at all levels.

Developing a vaccine for East Coast Fever is another example of an approach that requires top-class international science, but also benefits enormously from local engagement. Although a very different case, the combination of research "for" and research "with" is brought together in a product-focused initiative that addresses issues of local engagement in a way that adds to the overall outcome of the work.

IAVI was set up in 1996, initially within the Rockefeller Foundation and then as an independent entity. From the outset, IAVI's mission and mandate focused on the creation of an effective preventative AIDS vaccine and the distribution of that vaccine to those in the world who most need and can least afford medication. On the one hand, IAVI acts as a sort of venture capitalist, investing in promising vaccine candidates and offering support for the expensive clinical-trial stage of drug development. It works in a completely untied way, funding on the basis of excellent research. On the other hand, IAVI engages in high-profile and grass-roots advocacy work to promote the need for a vaccine and to provide insight into technological

possibilities. Political support, in the absence of economic demand, is considered crucial if a vaccine is to be distributed. Much of the grass-roots advocacy work takes the form of vaccine preparedness work, which is linked to preparation for clinical trials. In short, IAVI focuses on three things: awareness, access, and research.

A crucial part of IAVI's work is developing strong links with developing country institutions. Vaccine Development Partnerships (VDPs) have been established with institutions in a number of countries including India, Kenya, and Uganda. VDPs are responsible for running clinical trials and for the vaccine preparedness work. They also engage in planning for vaccine manufacturing and distribution. VDPs create extensive networks with community-based groups and local nongovernmental organizations (NGOs).

IAVI's role in capacity building is paradoxical but successful. Capacity building is not a core priority but it is strategically important, and IAVI has achieved significant capacity building through its VDPs. One senior IAVI manager explains the approach:

> *It's not part of IAVI's mission, nor a mandate but it is part of the reason we're funded. The IAVI mission and mandate is clear which is to develop a vaccine. That probably…can't be done without capacity building in the developing. In other words, as a strategy it's probably essential in the truer sense, in that without it we probably can't achieve what we want to, but it's not part of the mission nor mandate. (Interview with senior IAVI manager, 2004)*

Capacity building has been essential to IAVI for three principle reasons. First, for scientific reasons it is essential that clinical trials be conducted among those populations for whom the drug is intended and in many instances it is more convenient and in some cases acceptable to do those clinical trials locally. Second, and relatedly, building support for a vaccine requires local political support and this is built through active engagement. Third, the majority of IAVI's funding now comes from bilateral and multilateral funding agencies and these agencies clearly favour a capacity-building approach where possible. In this case, capacity building has been possible.

IAVI partners in Kenya, Uganda, and Rwanda have all received very significant investment in training and infrastructure, and have benefited in particular from close and constant communication via phone, Internet, and face-to-face meetings with leading scientists and managers. IAVI's African partners say it is the constant focused activity around a boundaried set of tasks associated with vaccine development that has been particularly valuable. For partner organizations in Uganda, Kenya, and Rwanda, new prospects have opened up as a result of this engagement. They are able to interact with IAVI on a broader basis, to assume increased control and responsibility, and to think of engaging with other vaccine development initiatives. They can now aim realistically to be centres of excellence for the development of vaccine clinical trials.

This product-based approach to capacity building seems to have important lessons for those thinking about S&T capacity building policy. Capacity building can result from initiatives that focus on product development rather than on broader and more diffuse initiatives aimed at formal training. The tacit knowledge exchange around the vaccine and vaccine preparedness that has taken place as part of the IAVI work is particularly important to try and build on in other S&T capacity-building initiatives.

The East Coast Fever Vaccine Project: Developing Product Networks

The East Coast Fever (ECF) vaccine project is an initiative funded by DFID to research, design, and disseminate a bio-engineered vaccine for a parasite that affects cattle across Eastern, Central, and Southern Africa. The regional economies lose about GBP300 million a year from the disease, which is caused by the parasite *Theileria parva*. The project was funded on the basis of the advanced state of research into *T. parva*, the identification of appropriate immune responses, and an assessment of the economic impacts of ECF on smallholder farmers and their livelihoods. This analysis led to the identification of several problems with the existing, traditional live attenuated vaccine currently in use. Issues related to poor efficacy, cost, transportation, and refrigeration led to efforts to design a new bio-engineered vaccine.

The project is based at the International Livestock Research Institute (ILRI) in Nairobi and is an important model of how to manage a product-focused R&D process in a developing country. DFID has provided GBP5.1 million as a needs-based public–private partnership, which has ensured that effective systems of vaccine delivery provided by the private sector will be in place when the vaccine comes on stream. In fact, a complex set of partnerships between the public and private sectors across several continents has played an important role in moving the science forward. Private-sector ventures are involved in producing the vaccine for trial and will be responsible for the delivery of the vaccine in a context where there is little demand (because of a lack of resources) and to create a "pull" where the vaccine is needed most.

There is a high degree of complementarity between the major partners. ILRI has conducted basic research on *T. parva*. The local national agricultural research system, the Kenyan Agricultural Research Institute (KARI), is responsible for conducting trials of the vaccine and for monitoring impacts of cattle. Merial, a French biotechnology company, produces the vaccine candidates and has been working on novel delivery systems with University of Oxford collaborators. This new delivery system has potential spin-offs for the effective delivery of other human and veterinary vaccines. Other potential spin-offs for the private sector include insights into the life cycle of the parasite itself.

The East Coast Fever parasite has properties of great interest to biomedical researchers. Like the organisms that cause malaria, TB, HIV/AIDS, and many other human diseases, the cattle parasite invades its host's cells. The East Coast Fever parasite invades the white blood cells of cattle and causes the cells to start dividing endlessly. In this way, the infected white blood cells are immortalized and behave very like cancer cells. The East Coast Fever researchers have gained valuable experience in identifying key molecular components of cell-invading pathogens. This work could allow medical researchers to more readily identify previously unknown antigens from the pathogens causing TB and malaria. This is important because no user-friendly, widely deployed, and universally efficacious vaccines are yet available for malaria or HIV/AIDS.

The project is interesting from the perspectives of innovation and capacity building for a number of reasons. The project is an example of funding and conceiving a project within the CGIAR in quite a different way. Furthermore, the way in which DFID prioritized and funded the project is very different from the more traditional, technology-led approach. DFID's more recent emphasis on the role of partnerships in delivering technological innovation, particularly public–private partnerships, and its focus on how best to achieve "maximum impact" have clearly shaped the rationale of

the project (DFID 2004). Aside from recognizing the need to support and generate mechanisms for the delivery of the vaccine once it exists (technological dissemination is generally a key constraint in such ventures), several interesting issues regarding capacity building can be underscored. Encouraging a tight focus on the development of the product, in particular the individual steps needed to develop the product, appears to have generated tangible capacity in several areas.

The product-focus itself seems to be more effective in this particular case than a broader, multi-sectoral approach. In particular, playing to the strengths of KARI in coordinating and assessing vaccine trials in cattle has resulted in much needed funding percolating into the national agricultural system at a time when KARI does not have the capacity to attract large amounts of international research funding. Interviews with senior researchers in KARI attest to the important role that attaining some project funding, even for quite low-level science, has played in stocking laboratories and training staff.

In this case, building an institutionally embedded R&D network focused on creating a very particular product appears to have built concrete capacity in a more effective and broadly based way than injecting broadly based funding in the way Kenya's NARS appears to have done. This has interesting implications for understand both how capacity can be built and the relationship between capacity building and innovating in an African institutional context.

Similar to the example of IAVI, product networks tie researchers and research entities together in quite different collaborative structures from the more traditional knowledge-based approaches to collaboration. Building collaborations around products involves understanding the broader system of innovation, and by extension, understanding what capabilities particular partners can bring to product development *outside* of purely cutting-edge academic knowledge. Product networks can incorporate, and gain strength from, academic centres and this broader perspective works to build capacity across the widest possible spread of partners. Support for the resulting networks can then be incorporated into longer-term institution building. Therefore, supporting product-focused initiatives and broader institution-building approaches need not be seen as contradictory but rather as complimentary. The ECF project appears to be a good model for the research and development of veterinary and medical products. It remains to be seen if the same approach of building product networks that cut across research institutions in new ways can be applied to the development of agricultural biotechnologies.

The Tanzanian Essential Health Interventions Project: Science and Technology Capacity Building in the Context of Health Systems

It is important to think about systems more generally. These systems may be innovation-based, where ensuring productive linkages between different actors and structures in innovation is the issue, or they may be broader, as found in health or agricultural systems. New approaches to S&T and innovation-based linkages are needed.

The Tanzanian Essential Health Interventions Project (TEHIP), a project that has been supported by both CIDA and IDRC, has attempted to link S&T and other forms of capacity building into broader health systems. Total spending on health in Tanzania amounts to USD10 per annum for each citizen. This has been increased by less than one dollar a day in two districts where TEHIP operates, Morogoro and Rufiji, but with

very impressive results: a 40% drop in childhood mortality since the late 1990s (Watts 2004).

The aim of the project has been to bring the priorities of local health-care systems more closely into line with the actual distribution of disease. One of the initial tasks was to develop a toolbox of methods for use by local health officials. These included "burden of disease profiles" to illustrate the health needs of a community and "district health accounting," which enabled local health budgets to be related to local disease. After information had been collected and analyzed, each district set its budget priorities. Previously only 5% of spending had gone to malaria, but the new analysis showed the disease to be responsible for almost a third of the years of life lost. The proportion of the budget allocated to prevention and treatment of malaria was raised to 25%. This innovative tool development and training in information gathering together constitute a focused and directly useful capacity-building effort.

Project manager, Dr. de Savigny is quoted in a recent British Medical Journal article as saying, "We've really become more and more convinced about the mortality reductions in the last year or two. At the beginning you think, well, it could just be a random fluctuation. But the only change we can document that could impact on under 5 mortality is what the health sector has been doing." (Watts 2004)

TEHIP demonstrates the importance of integrating research and capacity building and of working in an interdisciplinary fashion that brings together essential natural and social science skills together with management knowledge. It is being called an "evidence-based approach" to developing local health policy (Watts 2004).

Conclusion

UK and Canadian approaches need to take on board the need for local setting of priorities, and the support that might be needed for more than the research project, or the research collaboration. Support is needed for the broader system — research strategy, management, financial management, and technicians. If any one part of the system is "hijacked" by the Northern side it will weaken the development of the system. As these case studies demonstrate, this support can take several forms — support for institution building, generating stronger networks between existing institutions, or focusing on producing particular products. The key is to understand how these differing approaches may be welded together to support systemic development. Table 1 summarizes what each of the examples contributes to our learning about how to develop positive S&T capacity-building support.

Table 1: Summaries of lessons learned from case studies.

African Economics Research Consortium (AERC)	Research capacity building on a continental level, with node points in many countries. Research capacity building by "doing research" and creating supportive environments. Avoids danger of core being a magnet for skilled staff by strengthening a large number of centres. Separates funder accountability from decision-making on research priorities. Reaches out to international resource persons without losing local priority setting.
SAREC University Research Support	Support to set up some universities as national centres, with support not just for projects but for the whole university research environment. Local research design and management.
BECA	Research and training centre of excellence focused on building capacity for the continent. Aspires to strengthen other institutional basis rather than undermine.
AIMS	Research and training centre of excellence, attracting international scientists to work with local and regional scientists. Designed to support universities rather than undermine them and to provide incentives for scientists to stay in Africa and so working against brain drain.
IAVI	Product-focused approach to capacity building. Product is of extreme importance where it would be easy to do the research "for" the people of the continent. But in this case, research is also being done "with" the continent's researchers.
East Coast Fever	Product-based network with '"implicit" research capacity building based on understanding local needs and local capacities to conducting research.
Health Systems	Integrated S&T capacity building in context of health systems.

Lessons and Challenges for Capacity Building

The case studies illustrate some of the challenges faced in building R&D capacity in the African context. The examples draw both on concrete examples of capacity building in developing countries and on policies and institutional arrangements in the UK and Canada. Underlying this analysis, three key issues need to be addressed:

- Understanding the local context;
- Finding the correct mix of long-, medium-, and short-term interventions; and
- Encouraging the development of systems of innovation

It is important to understand different capacity-building approaches with two things in mind. First, the importance of building longer-term sustainable capacity while meeting shorter-term development needs. Second, to have a deeper understanding of what capacity is, and may be, and how it is articulated in real-world situations. Acknowledging and understanding these two issues is vital to develop an effective system of innovation.

Understanding the Local Context

It is essential to understand the local context, not only in terms of understanding local needs, but also how the local context shapes the ability of local scientists and researchers to find solutions. Failure to understand local needs often leads to inappropriate solutions. Furthermore, not understanding local capabilities can lead to

an erosion of local capacity as local scientists are bypassed by particular activities and funding, and effectively removed from systemic local innovation.

Problem-oriented projects are a good way to build initial capacity, and indeed may do more than this if the project is sufficiently embedded, uses local input in problem identification, and concludes by creating a concrete product that can be efficiently distributed. The key here is to understand how to embed project approaches within both broader systems of innovation networks and a deep understanding of local capacities, needs, and markets.

The East Coast Fever project is a good example of just such a 'joined-up' project; pulling together highly technical scientific knowledge with embedded tacit ideas about what ought to be done, and how it will be done once the technical core has been advanced to a sufficient level. The International Aids Vaccine Initiative (IAVI) is another example where technical knowledge is transferred and accumulated among African partners but is made useful and more lasting by intensive sharing of more tacit knowledge. The focus on both technical and tacit knowledge helps to relate projects to the real world.

Both initiatives illustrate ways in which inter-institutional capacity can be built almost as a by-product of the research and design process. By strategically understanding the local institutional architecture and sets of available capacities and competences, complementarities can be achieved and further capacity built. Both the East Coast Fever Project and IAVI draw on local competences where available and international competences where necessary. Therefore, understanding the local context enables research and design networks to be effectively extended and stretched over whatever distance and skill sets that are necessary to achieve the aim. From this perspective, understanding both local needs and local capacities allows a fuller, broader and more appropriate innovation system to be developed. Although the interaction of the CGIAR centres with the NARS has in numerous cases incorporated this approach, this is something that the CGIAR system as a whole has not managed in many instances.

Finding the Correct Mix of Long-, Medium-, and Short-Term Interventions

One of our key concerns is the necessity to identify and implement the appropriate mix of long-, medium-, and short-term interventions necessary to build research and design capacity that lasts. There is often a tension between finding suitable interventions for both shorter-term and longer-term capacity building. Although short-term approaches may play some role in shaping long-term capacities, they may not be systemic, cost-effective, or appropriate.

Loosely allied in many ways to differing shorter- and longer-term approaches to building capacity are the spectrum of activities such as projects, programs, networks, and institutions. Supporting the correct mix of activities is crucial to building effective capacity in Africa. Short-term initiatives and activities must be understood in the context of longer-term institutional support and innovation. Projects such as the East Coast Fever vaccine initiative and IAVI are two of the best examples of projects focused on meeting the relatively short-term goals of vaccine production, within the context of local capacities and institutional realities. Despite these apparent successes, the landscape of donor-supported R&D activity in Africa is still dominated by many discrete projects. This "projectization" limits the creation of true capacity in several ways: projects may be replicated, little learning is passed from one project to the next, it is very difficult to prioritize at the regional levels, and it remains difficult to embed individual projects within local realities.

Horstkotte-Wesseler and Byerlee (2000) identify four key things necessary to avoid the negative impacts of "projectization":

- Creating systemic learning from project to project;
- "Hierarchizing" project priorities;
- Avoiding replication by building projects on the back of one another; and
- Embedding projects within local realities.

However, focusing on long-term support for institutions such as BECA in no way guarantees that immediate development goals will be met. Networks that stretch beyond the traditional research centre are just one of the prerequisites necessary for that to occur.

The experience of Sida-SAREC in supporting African universities as hybrid research and learning institutions is illustrative. This approach, which focuses on supporting the single best institution within a particular resource-poor setting, places universities squarely within national systems of innovation. This approach provides short-term project support and also longer-term infrastructural program support, including library and ICTs, support for research management, laboratory development, and technician training. The Scandinavian model appears to be one way of supporting the short-term within the context of the longer-term — as an institutional approach and potentially as part of a systemic approach.

Positive changes have been taking place in African universities, but much remains to be done and huge resources are needed if they are to play there full role in developing innovation systems. It is a major challenge, but an essential one, to get a better mix and linkage between institutional support and clear goals for teaching and research.

By acknowledging that capacity building can be based on both short-term and long-term support, ideas of how to develop R&D capacity bound to African realities and contexts, not to project deadlines and institutional budgets, may be forthcoming.

Encouraging the Development of Systems of Innovation

The case studies, and the ideas and concepts drawn from them, despite their diversity, all point toward one thing: a systemic approach to building capacity and achieving development goals through science and technology.

Our understanding of such a systemic approach is a richly networked array of institutions of differing skill sets, and indeed aims, that can build on strengths to identify strategic needs, and collective weaknesses that may necessitate further networking. Increasingly, this systemic approach is considered important in science and technology capacity building. Systems of innovation differ from nation to nation. Some like Japan and Korea demonstrate strengths in industrial technologies (measured in new products rather than new science and citation). Others, like the Scandinavian countries or the UK, are strong in science. All have relatively strong educational systems, from nursery to university. A system of innovation approach highlights the importance of the interaction of different actors as catalysts of innovation. This interaction may be formal and "codified" (for example, regular high-quality industry reports from a Ministry of Industry) or more informal and "tacit" (for example, experiential and on-the-job forms of training). Both codified and tacit forms of interaction and knowledge sharing are crucial. Hall et al. (2003) describe systems of innovation in the following manner:

> *At its heart lies the contention that change — or innovation — results from and is shaped by the system of organisations and institutions (in the rules, norms and conventions sense) in particular locations and points in time. An innovation system includes organisations involved with research and the application and adaptation of research findings, as well as intermediary organisations that promote knowledge transfer.*

Networks that stretch beyond traditional research centres to include industry, health, and education sectors are just one of the prerequisites necessary for enabling centres of excellence to meet development goals. NEPAD's vision of a networked system of centres of excellence is very much in this vein, as is the approach taken by IAVI and AERC. Networks can be seen as the tacit glue that holds projects, and potentially institutions, together:

> *Even if single elements of such systems are strong, the system as a whole may be weak. The capability to learn and build new competencies will depend on how well the parts fit together and on the strength of these connections.* (UNCTAD 1996)

Networks and projects both take place within the context of institutions. Much money has been invested in creating supporting research institutions in Africa. The NARS are a very good example of this. It appears that more broadly defined projects and strong learning networks provide both the raw material and the glue to regenerate institutions as an important part of the research infrastructure in Africa.

But, to create competent research and to design networks it also important to support the correct mix of "mode 1" and "mode 2" institutions. Gibbons et al. (1994) argued that a shift was taking place in modes of knowledge creation from mostly mode 1 toward mode 2. Mode-1 knowledge, produced in institutions like universities and research institutes and companies, is disciplinary, usually peer reviewed and written down — codified. They did not suggest that mode-1 knowledge was not important, but suggested that mode-2 knowledge was growing in importance. Mode-2 knowledge is practice based, transdisciplinary, and involves groups joining together with different skills to solve problems. It tends to be more practice-based than theoretical, and has a greater ability to draw on local knowledge and expertise. Some have argued that the science base in many developing countries has not shifted as quickly as in other countries.

AERC is a good example of a mode 1 institution. It is a capacity-building initiative in one discipline, economics, that has had a major impact on continent-wide problem solving in economic policymaking. It is a "mode 1 plus" initiative in those respects. The implications for Africa are sound postgraduate support, including doctoral programs with sufficient technical resources (laboratories, technicians, and organizations) and good, experienced supervisors. Strong supervision need not be geographically close, but good formal and informal networks allow long-distance supervision.

Mode 2 institutions are also needed. Many of the case studies, including the East Coast Fever project and the International Aids Vaccine Initiative, might be labelled as mode 2 in that they seek answers to problems and focus on multidisciplinary methods of finding those solutions.

It is important for policymakers to further analyze case studies that begin to draw together these multi-sectoral approaches to building different kinds of capacity within different networked organizational and institutional structures. The TEHIP project is an extremely good example of a capacity-building initiative that has started from the

assumption of a complex environment and designed a specific range of scientific research, technological experience and management expertise that could have a variety of impacts over shorter and longer times.

There are tangible and intangible elements to such an approach and both must be supported in different ways. One particularly important intangible element is time. Capacity building often works best when relationships are built up over time, where knowledge is sticky and applied, and where knowledge flows freely to continuously lubricate those relationships. This calls for, above all, an acknowledgement that a range of long-term, sustainable interventions must be put in place. This has implications for the way in which northern development cooperation is both conceived and implemented.

Implications for Canadian and UK African Partnerships

This section focuses on the implications of our analysis, particularly for Canada and the UK. This is a key moment in policymaking for science and technology in development. Over the last couple of years a large number of studies of the situation for science and technology in development, and specifically in Africa, have been commissioned. There is now an opportunity to act — to invest in, and transform, the environment for capacity building.

Canada and the UK are both planning major changes and increases in their support to science and technology capacity building for, and with, Africa. The evolving policies promise tremendous potential in the near future. There are real possibilities for synergy as new policies emerge and are implemented. These changes are coming not a moment too soon given the needs and possibilities.

Canadian, UK, and African policymakers can together change the ways in which science and technology are created and used to improve people's lives and national economies in Africa. Canada's "five per cent" policy is a major change and will likely lead to institutional transformation in the ways S&T capacity building for development is organized, with major implications for partnerships with Africa. Similarly, in the UK, increases in development assistance funding, including for research, also promise a concerted effort leading to improvements in arrangements for capacity building in S&T. Better coordination and the development of like thinking will improve the chances of success.

Policy issues need to be addressed under into two areas:

- Governance, both in Canada and the UK and in their partnerships with African institutions; and
- The need to accept that there are different notions of excellence, especially how to build a sustainable research base while supporting centres of excellence.

Governance

One pressing challenge for the UK and Canadian governments is to construct domestic funding mechanisms that best facilitate partnerships for S&T capacity-building partnerships. In Canada, where a firm commitment has been made for increased funding, policymakers and managers are now considering how funding should be channelled. A favoured option is for a series of Memoranda of Understanding to be signed between IDRC and the Canadian research councils. This model already exists between the Canadian Institutes for Health Research and IDRC and has allowed for

productive partnerships to emerge. The Social Sciences and Humanities Research Council (SSHRC) has recently changed its rules to allow foreigners to receive funding, which has increased the scope for partnership with Southern researchers.

In the UK, there has been a Concordat between DFID and the Medical Research Council (MRC) where DFID influences the MRCs portfolio of research relevant to developing countries and funds a substantial share. They jointly monitor the portfolio. However, that type of condordat does not, so far, allow for developing country participation in research priority setting. Neither does it allow for funds to be given to non-UK institutions. DFID funding allows for both, and indeed DFID has had successes in untying its support and obtaining high quality and successful tender bids from developing countries. Clearly, changes to allow developing country researchers and institutions to apply would be needed to continue and increase local control over research priorities and local capacity building. Representation of developing country scientists, technologists, and users on funding panels is also important. Canada and the UK can learn from each other as they move forward on building new and solid governance structures.

Big changes in donor policies have implications not just for donors and donor country institutions. In the past, changes in donor policies have been more disruptive for weaker partners who are often called to adjust without even having their views canvassed on whether they think changes are in their best interests. Sometimes this hinders rather than helps capacity-building efforts and their abilities of partners to consolidate and improve their research output and quality. AERC is clear that it would not be able to operate without its donor consortium accepting its common reporting system. Such common reporting systems are growing, but they are not common, and well meaning attempts to set them up often become entangled in multi-agent committee systems. Nevertheless, if Canada and the UK were both to accept common reporting systems for research and research capacity-building support, that might be a big step in the direction of developing country institutions building their own decision-making systems.

The development of new institutional capacity and approaches in Canada and the UK must be paralleled by their development in Africa. In the past, there has been little funding for developing the policy and management skills needed to organize how science and technology can best be used. One crucial element in avoiding past patterns is to ensure that support is given to build local science-policy capacity and to fully address the range of constraints on S&T development in Africa.

African science and technology policy has not been explicitly discussed in this paper. Nonetheless, much of what is said relates to a need to increase capacity in local policy, management of initiatives, and planning. There are current initiatives sponsored by NEPAD and others, including attempts to create better indicators, which are key for science-policy capacity that could be built on with future Canadian and UK support. A recent paper commissioned by NEPAD considers the development of useful S&T and innovation indicators in the African context (UNU-INTECH 2004). It is possible that the NEPAD Science and Technology Secretariat could play a useful role in building partnerships and complementarities both between and with Canada and the UK with respect to African capacity building. The key role played by NEPAD in instigating BECA in Kenya is an example of how this can usefully work.

In the past, science-policy initiatives have tended to focus on the supply side of science rather than address the extraordinary weakness of industry, broadly defined. Poverty-alleviation and debt-cancellation progress has not focused strongly on the

need to support country capacities in production and productivity. Systems of innovation in Africa, at present, show extreme weakness in firms, academic-industrial links, and new technology-based companies. The use of a systems of innovation approach rather than a narrow "science policy" approach, which does not address how science can benefit the nation as a whole, has tremendous potential for improving policy environments in African countries. It also draws attention to the weakness of research and R&D management and the need for more training and support in its development.

Building a Sustainable Research Base and Supporting Centres of Excellence

An important issue that emerges in supporting capacity building is how to define excellence and how to define research focus and performance. The criteria for excellence on Western scientific and social science research boards are judged by peer review and publication in respected journals. There is increasingly another criterion — relevance to user needs — but this still tends to be secondary to the first. Maureen O'Neil has observed the dangers of applying these criteria to South-oriented research partnerships. She points to confusion about the criteria of excellence in research funding and notes that it potentially contradicts a call for more innovation:

> *Innovation seeks to do what has not been previously tried. Since "research excellence is measured against past performance, the two measures are incompatible and leave researchers wondering how best to proceed. (O'Neil 2004)*

O'Neil notes that development related research is often not considered wholly legitimate:

> *Too often IDRC hears stories — especially from younger faculty — that they get little or no credit towards career promotion and tenure for the research they do on IDRC and CIDA-funded projects. This is considered "research for development" or research that is worthy but not "excellent."*

In important respects the situation in the UK is analogous. In the last Research Assessment Exercise (RAE), the method by which university research is graded by department and institution in the UK, no development studies department judged within the development studies sub-panel received the top two highest grades. This was despite widespread acknowledgement of the UK's leading position in Europe in development studies.

But, at the same time as the complaints about rigidities in the RAE, the problem-oriented interdisciplinary programs that the UK research councils fund on top of basic disciplinary support are often seen as "in tension" with the need to fund the very best disciplinary researchers in each discipline.

Maureen O'Neil (2004) offers an alternative version of excellence that may be more appropriate for judging research carried out in partnership with developing countries:

> *By "excellence", we may mean "urgently needed and challenging research" — that which is problem oriented, multi-disciplinary (preferably comparative) and carried out by teams networking internationally across research sites and policy jurisdictions. By "innovative", we may value co-production of knowledge through innovations only made possible by bringing together the experience of experts in Canada and other countries and applying that knowledge to solve real problems.*

Such an approach allows for multiple notions of excellence that can be assessed in an open way, using similar, if broader, peer review and measures of excellence and

potential. Many partnerships and networks do combine research goals with training junior and less experienced researchers.

But support for capacity building requires further thought. If internationally based indictors of excellence were to be developed, even the broader ones proposed by O'Neil, weaker institutions would find it hard to obtain funding. There is also the danger that centres of excellence will be chosen in a very small number of countries.

One possible approach is to develop criteria that will allow the measurement of gradual capacity building. There are examples of support through small funds and funds for smaller and newer institutions to link to centre of excellence. AERC has them, and Sida-SAREC has several different categories of support precisely to make sure that countries with weaker research capacities get a chance to improve. It is possible to ring-fence a proportion of funding for specific types of capacity building against tight criteria.

Conclusion

There is no one model for successful science and technology capacity building in developing countries. But if there is one principle that could usefully guide capacity-building efforts it is this: pay attention to the local environment. Context is everything; local strengths must be built on and efforts must be tightly related to local problems and infrastructure. The apparent simplicity and triteness of the phrase "local context" should not detract from the fact that making such a link in any meaningful sense often does not occur. Development histories are littered with attempts to build capacity undone by a fundamental failure to exactly understand locality —local needs, local realities, and local sets of knowledge (Scoones and Thompson 1994). Of course the reality of trying to increase scientific and technological capacity is enormously complex, but this one vital principle is often both ignored and misunderstood. It is intimately related to a move within UK and Canadian development agencies away from implementing capacity-building initiatives as aid projects and toward viewing them as substantive partnerships that integrate global science, technology, and knowledge and local realities.

A second principle to be addressed is that capacity building is part of a continuous process and cannot be constituted by project funding and other short-term initiatives. Building on existing capabilities in local contexts involves negotiating and encouraging change in a range of time scales. The correct mix of short-, medium-, and long-term initiatives is needed to support the ability of research and design to respond to more immediate local needs, and to ensure that the necessary skills, capabilities, and institutional infrastructure is in place to develop long-term capacity at the national level. Enabling capacity building in a range of time scales requires the multi-sectoral and multi-pronged approach illustrated in the case studies.

The final principle is that systems of innovation must be encouraged and locally contextualized. Innovation is not something that only happens in high technology firms or in sophisticated research laboratories. New discoveries with economic and social significance are rare. More often what emerges are new combinations of existing scientific, technological, and organizational elements. Indeed, innovation need not even mean something that is totally new. It is better taken to mean something that is new to those who are innovating. Therefore, in the context of innovation by firms, Ernst et al. (1998, page 12) write that innovation should be defined broadly as "…the process by which firms master and implement the design and production of goods and

services that are new to them, irrespective of whether or not they are new to their competitors."

Increasingly, a systems approach is considered important in science and technology capacity building. Systems of innovation differ from nation to nation. Some like Japan and Korea demonstrate strengths in industrial technologies (measured in new products rather that new science and citation). Others, like the Scandinavian countries or the UK are strong in science. All have relatively strong educational systems, from nursery to university. A system of innovation approach highlights the importance of the interaction of different actors as catalysts of innovation. This interaction may be formal and "codified" (for example, regular high-quality industry reports from a Ministry of Industry) or more informal and "tacit" (for example, experiential and on-the-job forms of training). Both codified and tacit forms of interaction and knowledge sharing are crucial.

In addressing these three principles, two further policy issues must receive attention: governance and excellence. On governance, resources must be managed with more Southern representation in decision-making from the earliest stages of program design, but without adding extra research councils or boards. On excellence, there can be multiple notions of excellence, which can be assessed openly and transparently.

What is known from half a century of intensive research is that the translation of research knowledge into economic and social benefit (getting science out of the laboratories) is extremely complex. The factors that shape innovation, and its take up within what is both a social and economic value chain, will vary by sector and reflect distinct knowledge bases and networks, organizational structures, and institutional (including regulatory) contexts. The lessons and recommendations from this paper, as always, generate a set of challenging questions for policymakers and those driving the transformations of the next years.

There is a need for the, seemingly unproblematic, understanding of local context. The understanding of local needs and local context includes taking account of local abilities to find solutions. Key questions that arise are:

- How to take account of local needs and abilities without massively overstretching local capacity?
- How can a range of new, agreed as important, initiatives begin without going beyond local absorption capacities?

Long- and short-term interventions can better be integrated and have pinpointed possibilities for multi-partner product-development initiatives and for institution building.

- How can both be done effectively at the same time without diffusing and blunting goal oriented R&D?
- What types of product development partnership work best for institution building? Where might they not work so well?
- What are the institution-building priorities for product-based interventions?
- How can social development targets such as increased gender equality in science and technology be incorporated into different types of initiatives?

It is important to go beyond science policy to taking up an innovation systems approach.

- How concretely to move in this direction?
- Can big projects (e.g., BECA, IAVI, and AERC) be constructed with clearer regard to their capacity building goals? Is BECA, for example, a research capacity initiative? Is AERC a research and policy-building initiative?
- How can initiatives that are crossing boundaries be developed in useful ways without spreading out too thinly?
- If new innovation systems require public–private, how to get the private sector engaged?
- Do diasporic relations have a role to play in building those bridges?

On governance issues:

- Can donors construct ways of increasing support without each requiring its own governance clauses?
- Given that the biggest initiatives must be regionally based, how to design governance systems that take root and build on systems that are working in each region?
- Can regulatory systems be constructed [for policymaking (as in AERC) and for clinical trials (as in IAVI), and to implement the Cartagena protocol and genetics treaties] without each country needing to reinvent the wheel?
- Can African expertise be brought to bear, at the earliest stages, on new research initiatives affecting Africa?

This last question leads to questions about excellence. Notions of excellence do not need to be dividing and indeed can be uniting:

- Can the interdisciplinary expertise of the research councils in promoting excellent interdisciplinary problem-oriented research be built upon?
- In what ways can notions of excellence be used to integrate Southern partners into important programs of research?
- How can Southern partners be integrated in the planning of new initiatives?
- How can excellence in training and research best be used to mitigate against "brain drain"?

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Acknowledgements

The authors would like to thank all those who gave their time for face-to-face, telephone, and electronic interviews.

Desmond Bermingham, DFID, London

David Dickson, Scidev net, London

Paul Dufour, Office of National Science Advisor, Canada

Tim Dottridge, IDRC, Ottawa

Joann Fong, Royal Society, London

Janet Halliwell, Social Sciences and Humanities Research Council, Canada

Yvan Hardy, Natural Resources, Canada

William Lyakurwa, AERC, Nairobi

Caroline Martin, Canadian High Commission, London

Jim Mullin, Independent Consultant, Ottawa

Vic Neufeld, Canadian Coalition for Global Health Research, McMaster University, Canada

Berit Olsson, Sida, Stockholm

Ros Rouse, ESRC, UK

Peter Singer, University of Toronto, Canada

Paul Spray, DFID, London
Neil Turok, Cambridge University, UK
Marc Wuyts, Institute of Social Studies, Le Hague (and an evaluator of AERC)
We also wish to thank Alex Whiting for editing work done at very short notice.