Global Forum Action Plan

Science, Technology and Innovation Capacity Building Partnerships for Sustainable Development

September 1, 2010

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I. STI Action Plan: Introduction

Background

The World Bank, in collaboration with UNCTAD, the IDB, the Royal Society, the American Association for the Advancement of Science (AAAS), the Science Initiative Group (SIG), the Global Research Alliance (GRA) and other development partners, convened a Global Forum on Science, Technology and Innovation (STI) Capacity Building Partnerships for Sustainable Development in Washington, D.C. on December 10-11, 2009.

The objectives of the Forum were to (i) explore how well designed partnerships could promote inclusive globalization by helping developing countries build the STI capacity they need to address their social and economic objectives; and (ii) develop an Action Plan outlining how the World Bank, in collaboration with other stakeholders and development partners, could design, finance, and implement the new game-changing partnership ideas emerging from the Forum.

This Action Plan explains how the Bank and its development partners can help developing countries build the STI capacity they need to:

- Foster "inclusive innovations" focused on the needs of the three or four billion people at the Bottom of the Pyramid (BOP)
- Convert STI capacity into business opportunities and move ideas from the lab to the market via the establishment of Innovation and Technology Entrepreneurship Centers
- Train the next generation of knowledge workers and teachers for the global and local knowledge economy

Why STI Capacity Building Partnerships?

The Forum was predicated on three fundamental assumptions:

A. <u>STI Is An Indispensible Tool for Addressing High Priority Development Challenges</u>

The first assumption is that there can be neither inclusive globalization nor sustainable solutions to any of the critical development challenges facing the Bank and its clients -- food security, clean energy, effective health care delivery systems, competitiveness and job creation, etc. -- if developing countries do not build capacity to find and invent appropriate technologies, adapt them to local circumstances, and deploy them to solve local problems.

Experience suggests that building appropriate science and engineering capacity tailored to achieving each country's priority social and economic development objectives is the best and surest way to generate sustainable progress. Seen from this perspective, STI capacity building is not an end in itself but an indispensible tool or instrument for achieving these other priority objectives. Hence the need for a renewed emphasis on STI capacity building and for restoring STI capacity building to the top of the development agenda.

But what kind of STI capacity should developing countries build if their goal is to find practical solutions to such social and economic development problems as generating more value added from their natural resources, providing low cost internet and mobile phone services to remote rural areas that do not have connections to the central electricity grid, combating water borne infectious diseases by increasing access to affordable, clean (pure) drinking water, improving productivity and competitiveness of local industry, generating higher paying jobs, and reducing absolute poverty?

Experience suggests that capacity building programs should focus on developing a suite of skills and technical capabilities including (i) training scientists, engineers, technicians, and policy makers; (ii) promoting grass-roots, "inclusive innovation; (iii) developing local institutions that can scale-up locally generated grass roots innovations and also identify, evaluate, and import technology that is in widespread use around the world but which is not being used domestically to address local development objectives; (iv) strengthening the capacity of local scientific and engineering institutions to conduct the R&D needed to adapt these technologies for local use and to generate socially and economically relevant new technologies; (v) developing the technology transfer know-how as well as the management of intellectual property rights, that will be required to move inventions from the laboratory to the market; (vi) helping local enterprises become more innovative; and (vii) improving the governance and financial sustainability of the national STI system.

Ignoring even one link in the chain depicted in Figure 1 below, or failing to strengthen the interactions between individual links, will reduce the development impact of these capacity building efforts. This Action Plan, therefore, attempts to discuss how well-designed partnerships can help to strengthen each of these STI dimensions as well as the linkages between them.

Figure 1: STI Capacity Chain

B. Partnerships Are An Indispensible Tool for Building STI Capacity

The second premise is that building STI capacity will be slow and difficult when countries do not possess the critical mass[1] of indigenous STI capacity they need to launch and sustain the STI capacity building programs they want. This leads to the main question posed in this Action Plan: **How can countries build STI capacity when they do not currently have the indigenous resources needed for capacity building?**

To cut this Gordian Knot, STI capacity building partnerships will need to be forged between developing countries with specific STI capacity building needs and global partners in both developed and developing countries who possess the necessary technical expertise needed to build capacity. Partnerships can accelerate the capacity building process by providing the human capital needed to support vigorous, ambitious, and realistic national STI capacity building programs.

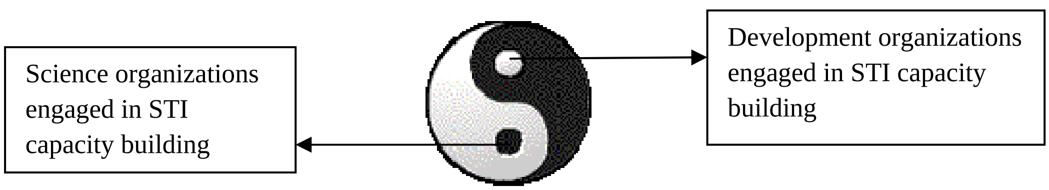
C. The World Bank Can Add Value to STI Capacity Building Partnerships

[1] Steve Hillier, DFID, suggests that a critical mass should a critical mass in this context can be defined as a sufficient number to meet essential needs, to sustain itself intellectually, and to be able to replace itself in absolute numbers. For the scientific community this will clearly mean counting not only the scientists needed to work at the practical level in the public and private sectors but those driving forward the intellectual agenda (and undertaking basic research) and those bringing through future cohorts.

But is there a role for the World Bank in this capacity building process? The World Bank is not a science organization and it does not have a large cadre of trained engineers and scientists that can be mobilized to help countries build their own capacity. What value can the World Bank add to capacity building partnerships led by world-class research institutions, universities, foundations, and corporations in both developing and developed countries?

The third premise is that the Bank does have a critical, and perhaps indispensible, role to play in the STI capacity building process. Simply stated, the Bank and its external STI capacity building partners can generate a larger development impact by working together (Figure 2) than if they each work separately, as is all-too-often currently the case.

Figure 2: Natural Synergy from Working Together



For example, scientific organizations and universities have the requisite technical capacity and knowledge needed to build STI capacity. But they generally cannot finance investments in modern scientific infrastructure in developing countries, nor is it typically their mission to do so. Nor can they engage the government in discussions about the detailed policy reforms that will make local capacity building efforts more sustainable.

Moreover, there seems to be a growing recognition on the part of numerous partners that their individual initiatives, although well-intentioned and well designed from an individual perspective, may not be achieving all that they set out to accomplish. This is because, in many cases, these individual initiatives are:

- **Ad hoc** in the sense that there are few formal efforts at coordination, consultation, or linkage between one set of partnership programs and another. As a result, each partnership proposal emphasizes a slightly different, albeit important, facet of STI capacity building. Only rarely, however, do individual efforts add up to a coherent, integrated STI capacity building program that focuses on all the essential links of the STI capacity chain.
- **Limited in their capacity to promote broad, systemic improvement**. Each partnership strives to do the best that it can within its own orbit. Thus, for example, many higher education and R&D partnerships strive to improve graduate training programs and research capacity in an individual university, department, or laboratory. These are all worthwhile endeavors. But reforming the governance and operation of the national R&D system is simply beyond the scope of these individual initiatives. As a result, these essential items often fall by the wayside.

- **Not always sustainable following the cessation of external funding.** Because many individual partnership programs do not have the capacity to generate systemic improvements or to mobilize follow-on donor support, they do not always generate a durable capacity building legacy.
- **Not always well integrated with the country's Poverty Reduction Strategy Paper (PRSP).** Under prevailing donor support procedures, this disconnect between the PRSP and STI capacity building partnership programs means that it will be difficult to mobilize complementary or follow-on donor support for individual partnership endeavors. As a result, many well-meaning and potentially important partnership programs operate in isolation from related donor activities taking place simultaneously in the same country.
- **Not always linked to the priority needs of developing countries.**

ROLE OF THE WORLD BANK GROUP: STI CAPACITY BUILDING AND THE WORLD BANK'S KNOWLEDGE AGENDA

The Bank Group, however, may be well-qualified to address these issues. It has a number of assets that could enhance the development impact of these individual STI capacity building endeavors. These include:

- **Knowledge** of many different countries and many sectors within each country. This will be especially important since STI capacity building cannot be confined solely to ministries of science and education. If science is to serve as an instrument of national economic development, ministries of agriculture, health, trade, energy, environment, industry and commerce, and infrastructure, among others must be part of the discussion. The Bank can help to mobilize these diverse stakeholders.
- **Financing** for essential systemic policy reforms and complementary investments -- labs, classrooms, incubators, etc. -- that other partner organizations may not be able to finance on the same scale as the Bank.
- **Convening power** to coordinate activities among independent partnership programs and donors and to mobilize co-financing from development partners
- **Long-standing business relationships and access** to national policy-makers in both developed and developing countries which can help put STI capacity building on the national development agenda and in PRSPs. Moreover, the Bank's permanent representation in the client countries enables a continuous policy dialogue on a wide range of STI issues.

In broad general terms, the Bank can use these assets to magnify the development impact of individual STI capacity building programs by helping to:

- Finance innovative capacity building activities and complementary investments that will be needed for effective capacity building programs but that exceed the financial capacity and mandate of external partners.
- Convene meetings to coordinate ad hoc, independent capacity building programs and to help developing country governments harmonize these capacity building programs with their own priority development objectives.
- Mobilize partnerships with groups that do not currently have large scale STI capacity building programs but that have essential scientific and technical expertise which the Bank lacks and which developing countries need
- Strengthen the enabling environment for higher education, R&D, and innovation, etc.
- Strengthen STI capacity in the key areas of research management, finance, administration, S&T infrastructure including R&D labs and MSTQ facilities, etc.
- Work with partner organizations to help move innovations from the lab to the market and mobilizing private finance for these ventures
- Align the program with current World Bank and regional development bank STI/higher education capacity building initiatives
- Establish a working group of donors, foundations, and other relevant stakeholders to establish a financing and governance mechanism, agree on appropriate selection criteria and calls for proposals, and define operating procedures for the specific initiatives outlined in more detail below
- Organize consultations, in collaboration with other development partners, with relevant stakeholders in each region wishing to participate in these programs
- Work with national governments and local stakeholders to embed these initiatives into broader university strategic development plans and holistic national STI capacity building programs. This work may include Incorporating STI capacity building partnership initiatives into individual PRSPs (in the case of IDA countries).
- Publish and disseminate information related to STI capacity building activities initiated by the World Bank and other development partners.

Work with country governments to prioritize their research and STI capacity building programs on the basis of high-priority country/regional social and economic development objectives. The Bank's range of contacts with member countries and different ministries within each country is especially relevant since STI capacity building is a cross cutting issue and cannot be left only to ministries of science and/or education.

The remainder of this Action Plan explains in more detail how the Bank, working in collaboration with various STI capacity building partners, can deploy these assets to help developing countries (i) foster inclusive innovation; (ii) transform scientific capacity into business opportunities, especially for SMEs and for women entrepreneurs; and (iii) train the next generation of knowledge workers.

II. Inclusive Innovation: Practical Solutions for the Bottom of the Pyramid

CHALLENGE:
DEVELOPING COUNTRIES NEED TO BUILD INDIGENOUS RESEARCH AND ENGINEERING CAPACITY FOCUSED ON MEETING THE NEEDS OF THE PEOPLE IN THEIR COUNTRY AND REGION WHO ARE LIVING AT THE BOTTOM OF THE PYRAMID. THEY MUST ALSO ESTABLISH INSTITUTIONS THAT CAN SCALE UP, MARKET, AND DEPLOY NEW, PROMISING INCLUSIVE INNOVATIONS.

Inclusive innovation programs are designed to help countries build the STI capacity they need to meet the daily needs of the four billion people with an income of less than two dollars a day who live at the so called "Bottom of the Pyramid" (BOP).[2] Living in poverty, they lack access to such necessities as water and sanitation services, housing, quality education, basic health care, electricity, telephones, internet, roads, and modern financial services. Addressing the needs of the BOP is an essential component of inclusive globalization and, therefore, must be a priority objective of STI capacity building partnerships.

The objective of inclusive innovation is to harness sophisticated science and technology know-how to invent, design, produce, and distribute, primarily via private sector SMEs, high performance technologies at prices that can be afforded by the billions of people at the BOP.

[2] For more information about these issues, see the special report in the April 17 edition of The Economist entitled, "The World Turned Upside Down: Innovation in Emerging Markets," available at: http://www.economist.com/members/survey_paybarrier.cfm?issue=20100417&surveyCode=NA

Also see: C.K. Prahalad, The Fortune at the Bottom of the Pyramid, Wharton School Publishing, 2006, Mobilizing Science-Based Enterprises for Energy, Water and Medicines in Nigeria, US National Academies, 2008, available for download at http://www.nap.edu/catalog.php?record_id=11997

and the following articles:
Reverse Innovation a Popular Trend
http://www.business-strategy-innovation.com/2010/02/reverse-innovation-popular-trend.html
What is Reverse Innovation?
http://www.vijaygovindarajan.com/2009/10/what_is_reverse_innovation.htm
Is Reverse Innovation Like Disruptive Innovation?
http://blogs.hbr.org/hbr/hbr-now/2009/09/is-reverse-innovation-like-dis.html
Emerging Markets As a Source of Disruptive Innovation
http://www.core77.com/blog/business/emerging_markets_as_a_source_of_disruptive_innovation_5_case_studies_15843.asp

As Dr. R.A. Mashelkar declared during the December 2009 Global Forum[3]:

> "The challenge [of inclusive innovation] is to deliver *high performance* products, processes and services at an ultra low price for resource poor people, from housing to transport and from medicines to computers. Such innovations should not just be *affordable* but *extremely affordable*. For achieving this, one cannot rely on just *incremental* innovation but *extreme* innovation or *disruptive* innovation. Then only can they be truly inclusive."

Inclusive innovation programs must also develop mechanisms that will encourage those at the BOP, who are typically excluded from the innovation process, to co-create and co-innovate inclusive solutions. To be inclusive, the BOP must be included in the innovation process. It is not sufficient for OECD institutions simply to parachute "inclusive" technologies into developing countries. Inclusive solutions will be much more sustainable in the long run if developing countries build the capacity to generate their own inclusive innovation solutions. Partnerships can play an important role in this capacity building process.

Inclusive Innovation Challenges

Inclusive innovation programs must address two major challenges. The first is helping developing countries build indigenous research and engineering capacity so that they can handle these inclusive innovation tasks without relying entirely on outside assistance. Unfortunately, science and engineering institutions in many developing countries are currently not geared to producing inclusive innovations and addressing problems at the BOP. Indeed, many of these institutions are trapped in a vicious circle, as depicted in Figure 3. Funding for science and technology is relatively low and generally not sufficient to support high quality, socially and economically relevant research. Yet requests by scientists for additional resources are often rejected on the grounds that they have not generated relevant research results with previous funding. As a result, the system remains stuck. High level political commitment will be required to establish new arrangements for STI – where more funding is provided for inclusive innovation capacity building programs to enhance the relevance and quality of the existing STI system.

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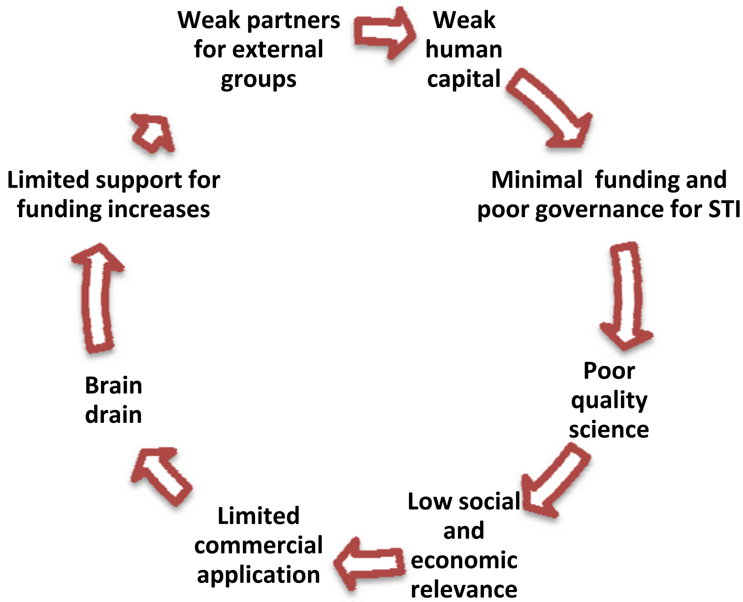
[3] Available at:
http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTSTIGLOFOR/0,,contentMDK:21128967~menuPK:6318815~pagePK:64168445~piPK:64168309~theSitePK:3156699,00.html

Also see, R. A. Mashelkar and Sushil Borde, "Value for Money and for Many," Technology Review, India Edition, February 2010, available at: www.technologyreview.in .

Figure 3: STI Vicious Circle



The second challenge relates to scaling up, marketing, and deploying new, promising inclusive innovations. These potentially valuable innovations tend to be isolated -- from each other, from potentially helpful technology commercialization and diffusion efforts, from local entrepreneurship development and support programs, and from public and private funding sources that could help take ideas from concept to prototype. For example, many inclusive innovations showcased at the World Bank's Development Marketplace (DM), catalogued by India's Honeybee Network, or developed by scientists and engineers working at the Global Research Alliance, CGIAR, MIT's D-Lab, SMU, Purdue, or Arizona State University, among others remain stuck in the lab or at the prototype stage. They are not transferred to SMEs for production and distribution. Needless to say, this blunts their potential development impact. Similarly, a successful inclusive innovation that was developed for and marketed in a rural village in Africa, for example, may also be relevant for rural villages in South Asia or Central America. Unfortunately, regional cross pollination is a rare occurrence.

A number of factors account for this isolation. For example, individual scientists, engineers, and inventors – irrespective of whether they are working in developing countries or at MIT's D-Lab -- do not have the capacity to scale-up, market, and deploy their inventions and yet, at the same time, the institutions needed to handle these tasks do not exist in many developing countries. Similarly, the know-how needed to enable these institutions to operate efficiently needs to be transferred from developed to developing countries. And finally, many institutions such as MIT, Arizona State, etc. that are actively promoting inclusive innovation programs[4] do not have the financial and technical capacity to address these institutional and training needs.

The World Bank does not have laboratories to generate inclusive innovations. But in collaboration with various partners and in a series of strategic interventions targeted at various critical links in the inclusive innovation chain – R&D, product design, IP management, financing, entrepreneurship support, marketing, and distribution -- the Bank can help to overcome these obstacles.

To meet these challenges, the Inclusive Innovation section of the Action Plan proposes the following initiatives:

Inclusive Innovation Grants Program (IIGP)

To break out of the vicious circle described above, a Center of Excellence/Millennium Science Initiative pilot program[5] would provide incremental funding for applied scientific and engineering R&D focused on BOP issues. The IIGP could be rolled out on a national basis in countries with a critical mass of science and engineering R&D capacity or on a multi-country/regional basis. The latter would allow countries to pool scientific resources, generate economies of scale in the use of scarce scientific capacity, and cover a wider range of topics than most individual countries could cover by themselves.

Under the auspices of the IIGP, scientists and engineers would be encouraged to form virtual, multi-disciplinary teams to address a problem related to a country's economic or social development priorities. Winning proposals would receive long-term research grants – perhaps five years or longer subject to periodic performance reviews. The precise size and duration of the grants would vary from country to country and proposal to proposal based on local costs and salaries and the proposed budget. Eligibility criteria would include (i) relevance of the proposed

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[4] For additional information about some of these programs see:

http://www.theinstitute.ieee.org/portal/site/tionline/menuitem.130a3558587d56e8fb2275875bac26c8/index.jsp?&pName=institute_level1_article&TheCat=1016&article=tionline/legacy/inst2009/jun09/profile.xml&
http://link.net.zm/?q=node/264
http://www.research-alliance.net/docs/mindspace_october2007.pdf
http://www.prism-magazine.org/mar06/feature_incredibles.cfm
http://www.eurekalert.org/pub_releases/2009-12/smu-nei121009.php
http://www.prism-magazine.org/nov09/upclose.cfm
http://bits.blogs.nytimes.com/2010/02/12/using-lasers-to-zap-mosquitoes/?emc=eta1
http://www.universityworldnews.com/article.php?story=20100226131159591
http://globalresolve.asu.edu

[5] The Bank designed and implemented related programs in Chile, Brazil, and Uganda. These programs, however, focused on general scientific research rather than science and engineering geared to BOP issues.

research program; (ii) quality of the proposed scientific and engineering research program; (iii) plans for diffusing the findings to local businesses; and (iv) plans to link research and teaching. The IIGP would be guided by an international scientific advisory board. Research proposals would be evaluated by international peer review panels.

Inclusive Innovation Fund

An Inclusive Innovation Fund (IIF) would help innovators develop their ideas to the point where they can raise private finance to support the production and marketing phase of the innovation process. The IIF would accomplish this objective by providing grants to help researchers and inventors demonstrate the technical feasibility of their innovations, conduct additional R&D to perfect their inventions, produce prototypes, and develop a business plan for production and marketing. Grants would be awarded on a competitive basis to partnerships between inventors, small business entrepreneurs, and research entities and/or universities. Grants would be awarded in two phases:

Phase 1: A smaller, shorter-term grant to demonstrate technical feasibility and proof of concept.

Phase 2: A larger, longer term grant to support additional R&D, prototype development, preparation of production and marketing plans, etc. The Phase 2 grant would be provided only to teams whose Phase 1 work program demonstrates the potential technical and commercial feasibility of the invention. Phase 2 grant applications would most likely be subject to the same international peer review as Phase 1 applications.

The amount and duration of individual grants should be geared to local cost conditions and the state of the overall innovation ecosystem in each country. The IIF would help to address the early stage angel or seed capital funding shortage that discourages start-ups in many countries. Recipients would be encouraged to affiliate in some fashion with infoDev's incubator network. This would automatically plug local inventors and innovators into a global network of like-minded individuals as well as into networks of potential marketing and financing resources. It would link inventors in one rural village with the global economy and allow them to share ideas with mentors and with other, formerly-isolated local inventors on the other side of the globe. The IIF would be especially useful for participants in the Development Marketplace, the Honey Bee network, and other local inclusive innovation programs who are looking for additional financing to move their innovations from lab to market.

Inclusive Innovation Centers (IIC)[6]

Entrepreneurs and inventors in developing countries need help embedding their innovations into viable businesses. This is not merely a matter of perfecting the technical dimensions of the innovation, although that is certainly an essential step in the process. Just as important is the task of creating a bridge between the inventor, on the one hand, and potential suppliers, manufacturers, financiers, and customers, on the other hand. It also involves mentoring potential financiers, innovators, and entrepreneurs so that they learn how to operate in a dynamic, global culture of innovation. This is not a simple, mechanical, linear process. It involves learning how to cope with such factors as the serendipity and unpredictability of how ideas are created, and how people with ideas decide convert them into businesses, and how to establish trust-based funding packages.

Inclusive Innovation Centers (IIC) would be designed to help institutions and individuals convert inclusive innovations into viable products and start-up businesses. They would accomplish this objective by providing such assistance as technology evaluation, demand assessment, market analyses, scouting for related technologies, finding partners, mobilizing financing, and developing linkages with relevant upstream and downstream private sector organizations and institutions. These IICs could be embedded in infoDev incubators and linked to the Innovation and Technology Entrepreneurship program described in more detail below. To provide the necessary hands-on coaching and mentoring services to local entrepreneurs/inventors, participants in an Entrepreneur-In-Residence/Venture Corps program would be attached to these IICs.[7] This would link local entrepreneurs with global expertise and the broader global "innovation eco-system." It would break the isolation that all-to-frequently plagues developing country entrepreneurs/innovators engaged in inclusive innovation.

Inclusive Innovation Project

As noted above, world renowned science and engineering programs at the Global Research Alliance, MIT, Purdue, Arizona State and elsewhere are making a concerted effort to harness world class science and engineering capacity to solving the problems of the BOP. To facilitate their work, and to help developing countries build the indigenous science and engineering capacity needed to produce and disseminate their own inclusive solutions, a series of Inclusive Innovation Projects could be designed and rolled out on a pilot basis. These projects which could be developed at a national or regional level could include **some or all** of the following components depending upon a country or region's needs, capabilities, and absorptive capacity:

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[6] Potential prototypes of IICs are already under development by various partners. For example, see the McLaughlin-Rotman Centre's work on Life Science Innovation Centres, available at: http://www.mrcglobal.org/LSCC . Also see infoDev's work on climate innovation centers available at: http://www.infodev.org/en/Topic.19.html

[7] This program would be analogous to the Global Science Corps proposal described in the section on Training the Next Generation of Knowledge Workers.

- Quick assessments of inclusive innovation constraints and capabilities in a particular country and for technical assistance in the design and implementation of public policy and institutional frameworks.
- Support to the formal public science and engineering R&D systems for creating and adopting technologies that address the needs of the BOP population.
- Support for twinning arrangements between local science and engineering institutions in developing countries and such counterpart institutions as the GRA, MIT, etc.
- Incentives to the business community for converting pilot technologies coming out of these efforts into commercially viable and affordable quality products and services, and into mass production.
- Support to the grass-roots innovators for pursuing the development, commercialization and marketing of grass-roots innovations that are conceived by the people in villages and towns and small informal enterprises.
- Training and technical assistance to informal enterprises to enhance their skills and capabilities to use and adopt technologies in order to improve their productivity and quality of products and services.

Wherever feasible, such projects should pilot some possible early wins where some pilot technologies are being developed in the country already. This approach will help demonstrate the concept, increase likelihood of success and reduce risks as well as provide experience to scale up other initiatives.

Role of the World Bank Group

The World Bank Group can take a leading role to promote inclusive innovation programs in several client countries. This would be done in close consultation and collaboration with key stakeholders— the donor community, governments, academia and R&D sector, business sector, NGOs, etc.

Specifically, the Bank would:

1. Form partnerships with relevant global, regional and national organizations
2. Carry out Inclusive Innovation Assessments for selected countries/regions.
3. Design and implement several pilot Inclusive Innovation Projects
4. Organize workshops and forum for promotion and dissemination, including possibly convening a Global Summit on the Inclusive Innovation Agenda with appropriately high level officials.
5. Provide policy advice and capacity building assistance to client countries.
6. Provide information on what other STI actors are doing.

To develop these ideas further, the Bank would:

- Form working groups with relevant stakeholders to design the MSI and Inclusive Innovation Grant programs and the Entrepreneur-In-Residence/Venture Corps program.
- Some of these programs may need to be administered on a regional or multi-country basis. Therefore, regional financing mechanisms may need to be devised.

Role of Partners

A wide and diverse group of organizations are currently involved in various facets of Inclusive Innovation. In the US alone, these include MIT, Stanford University, Purdue University, Arizona State University, Southern Methodist University, together with organizations such as the National Collegiate Inventors and Innovators Alliance (NCIIA), the American Society of Mechanical Engineers (ASME), the Institute of Electrical and Electronics Engineers (IEEE), and individual entrepreneurs.

Other key Partners would be the Global Research Alliance (GRA), a network of nine of the world's most prestigious knowledge-intensive technology and innovation organizations,[8] with a goal of creating "*A Global Knowledge Pool for Global Good.*" It has a capacity to undertake projects with a magnitude and complexity that exceed the capabilities of any single organization. The GRA includes organizations of the Northern and Southern hemisphere, with more than 50,000 scientists and engineers.

The inclusive innovations developed by these organizations could be scaled-up using the mechanisms described above. The membership of these organizations could also be mobilized to help developing country science and engineering institutions build the capacity they will need to support inclusive innovation programs. For example, students from the MIT D-Lab and other engineering programs may be ideal candidates for the Global Science Corps initiative described in greater detail below. These partnerships would give students and professors from developed countries a window into the problems of developing countries and they would give students and professors from developing countries entrée to labs, equipment and teaching resources in developed countries.

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[8] GRA members include Battelle Memorial Institute (USA), Commonwealth Scientific and Industrial Research Organisation (CSIRO Australia),Council of Scientific and Industrial Research (CSIR, India), Council for Scientific and Industrial Research (CSIR, South Africa), Danish Technological Institute, Fraunhofer-Gesellschaft (Germany), Netherlands Organization for Applied Scientific Research (TNO), SIRIM Berhard (Malaysia), and Technical Research Centre (VTT Finland).

III. Innovation and Technology Entrepreneurship[9]

CHALLENGE:
TO BENEFIT FROM THE GLOBAL POOL OF TECHNOLOGY, DEVELOPING COUNTRIES NEED TO BUILD THE CAPACITY TO FIND, ABSORB AND USE IT. THIS WILL ENTAIL BUILDING THE CAPACITY TO PLUG INTO GLOBAL TECHNOLOGY NETWORKS AND INSTITUTIONS THAT WILL FACILITATE THIS CONNECTIVITY.[10] PARTNERSHIPS HAVE A VITAL ROLE TO PLAY IN HELPING DEVELOPING COUNTRIES BUILD THIS CAPACITY.

"The capacity to absorb and diffuse existing knowledge is at least as important as the capacity to produce new knowledge….Innovation more frequently entails building the capacity to use technologies that are in widespread use elsewhere but that are new to the country, new to the firm, or used in new ways. To facilitate this type of innovation, countries must build the capacity to find, absorb and use these technologies."[11] This was reiterated in the 2010 World Development Report (p. 287) which observes, "Diffusing climate smart technologies requires much more than shipping ready-to-use equipment to developing countries; it requires building absorptive capacity and enhancing the ability of the public and private sectors to identify, adopt, adapt, innovate and employ the most appropriate technologies."

To meet this challenge, developing countries need to build STI institutions that, in collaboration with each other as well as with the private sector, government ministries and agencies, universities, research institutes, educational institutions, private foundations, and NGOs, can (as illustrated in Figure 1, below) (i) identify, evaluate, and locate relevant technology that exists outside the home country; (ii) license it or find other ways to acquire it and bring it into the

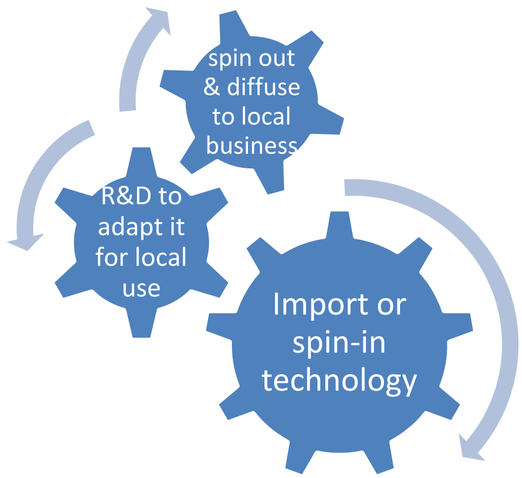
[9] This section of the Action Plan is based on the findings and recommendations of the 2009 IFC-sponsored Convocation on Technology Transfer, available at: http://www.slideshare.net/infoDevSlides/ifc-tech-transfer-facility

[10] As Tom Nastas and Victor Hwang have each pointed out independently, the next Silicon Valley may be a cloud and a state of mind rather than a physical location. For anecdotal evidence supporting this thesis, see Thomas Friedman's column in the April 18 New York Times (http://www.nytimes.com/2010/04/18/opinion/18friedman.html) This column describes the experience of a recent US-based start-up company that "was inspired by Cuban and Indian immigrants to America and funded by St. Louis venture capitalists. Its prototype is being manufactured in Uruguay, with the help of Israeli engineers and constant feedback from doctors in India and Chile. Oh, and the C.E.O. is a South African, who was educated at the Sorbonne, but lives in Missouri and California." This story suggests that global connections rather than physical proximity and clusters may be the key to success in an increasingly flattened, globalized world. Inclusive innovation implies that many of the most path-breaking, disruptive innovations will be coming from the South, rather than from typical northern destinations. If so, the "cloud" will have many more nodes than before and inclusive innovation will play an increasingly important role in technology development and diffusion. This Action Plan can be seen as nurturing some of these incipient nodes so that developing countries can participate in these new global trends.

[11] Watkins and Ehst, Science, Technology and Innovation: Capacity Building for Sustainable Growth and Poverty Reduction, World Bank, 2008, available at www.worldbank.org/sti, P. 7.

country; (iii) pass it along to scientists in universities, research institutes, and private businesses who can perform the "translational" or "developmental" research to adapt this technology for local use; (iv) transfer or diffuse this technology to farmers and local entrepreneurs who will use it to produce more knowledge-intensive, higher value added goods and services; and (v) develop new entrepreneurs and attract existing entrepreneurs from inside and outside the country who can start new businesses on the basis of this "new-to-the-country" technology.[12]

Figure 4: Innovation and Technology Entrepreneurship



India: A Technology Challenge

A key technology challenge for Indian agriculture was to mitigate drought and salinity due to climate change and inefficient water usage. Sathguru (India) was known to the Government of India and was asked if they could locate a relevant technology. Sathguru staff had a long standing cooperation and network of contacts with Cornell University (USA), a leader in agricultural science.

Cornell University and Sathguru identified a technology developed within Cornell that could address this problem. A consortium of leading Indian public sector rice research institutions and Indian seed companies was formed by Sathguru in India. The technology from Cornell was licensed to a prominent private sector seed company as well as to several public sector institutions including the Indian Council of Agriculture Research (Rice Research center), the International Center for Genetic Engineering and Biotechnology (ICGEB), and Tamilnadu Agriculture University in Coimbatore, South India. Sathguru is now in the process of licensing this technology to Bangladesh Rice Research Institute. These technology transfer agreements were put in place between Cornell and the Indian partners so that the Indian partners could acquire the technology without any fear of intellectual property infringement.

[12] For example, see the 2007 report by the National Research Council of the National Academies and the Nigerian Academy of Science entitled, Mobilizing Science Based Enterprises for Energy, Water and Medicines in Nigeria, available at http://www.nap.edu/openbook.php?record_id=11997 .

Sathguru is the technology manager for this initiative and facilitated the technology licensing from Cornell University as well as pooling some other patents that were outside the purview of Cornell, the primary developer of this technology. Sathguru has also facilitated the internal transfer of technologies among partners. Sathguru has created a consortium of developers that are being funded for their collaborative research by the Department of Biotechnology, the national research funding organization of the Indian Government. Initial efforts at Cornell to transfer the relevant technologies were supported by USAID. Sathguru, as the project manager, is closely monitoring regulatory advancement of the product, its field efficacy and its economic advantage due to incremental crop production. Sathguru's services are compensated by sharing future royalty flows when the private sector licensees commercialize the technology and sell to farmers.

The important feature of this partnership is the two-pronged approach of licensing to a for-profit seed company to realize financial return while concurrently licensing the Indian public sector organizations (above) for pure public good. The public sector partners are engaged in development of popular varieties aimed at providing seed support to resource poor farmers. The private sector partners are engaged in developing hybrids and adding to their product lines for commercial farmers. The further licensing of technologies to innovative start-up firms is being explored. This transferring of technology to research institutions which could incorporate the technology into Indian rice enabled these new and improved seeds to be developed by Indian seed companies which then can sell them to local farmers. The process thus is one of: spin-in, R&D, and spin-out/diffusion.

Initial results, over the last four years, are proving that the technology can provide incremental yields up to 25 percent in highly stress prone conditions. The results from this partnership are still in the laboratory, but are expected to benefit about 6 million farmers in India who will be able to grow salt-and-drought tolerant rice. A socio economic impact study carried out by Virginia Tech (USA) estimated that this technology transfer across South Asian nations has the potential to trigger a billion dollar economic benefit to the rice growers within 5 years of its commercialization.

Meeting these objectives involves addressing three discrete but closely related challenges:

1. Assessing the existing legal framework and national innovation capacity for technology transfer and diffusion, and recommending policy changes to facilitate this process
2. Building the institutions to carry out these activities
3. Training local staff to handle these specialized tasks.

Partnerships have a vital role to play in all three sets of activities. The Bank can help to organize and finance these activities. But it does not have the technical staff to implement them. Therefore, to help countries build this dimension of STI capacity, the Bank will work in close collaboration with a wide range of partners.

Assessing the legal framework and national innovation capacity

Countries will not be able to engage in technology transfer and technology commercialization if they do not have an appropriate legal and regulatory framework in place to support these activities. At a minimum, this means that regulatory and legislative obstacles to technology transfer and technology commercialization should be identified and improved policies drafted and put in place. For example, changes may be required in the country's intellectual property (IP), regulatory and legal framework, and new and improved incentives may be needed to facilitate spinning in technology via licenses and spinning it out to the private sector from government owned research institutes or university labs. In addition, it will be important to provide clear, transparent incentives for distributing royalties, legal authorization for university professors or scientists in government research institutes to work on these commercial activities, and career opportunities for faculty who engage in these economically and socially relevant research programs.

A review of the legal and regulatory environment should focus on such issues as:

- **Intellectual Property**. (i) Identify regulatory and legislative obstacles by comparing a country's IP and legal framework against those from other countries which have supportive frameworks and innovation ecosystems for spinning in and spinning out technologies. **(ii)** Review the national IP regime to ensure that it is consistent with the needs and requirements of specific sectors. (iii) Review the existing IP regime for consistency with World Bank Group policies and guidelines on the protection of indigenous knowledge. (iv) Recommend any necessary changes to preserve and commercialize such knowledge to meet the needs of communities and turn these into viable businesses and develop mechanism for benefit sharing for indigenous populations (e.g. traditional medicines – which can be marketed as therapies to developed countries).
- **STI policy and institutional review**. Conduct broad STI policy and institutional reviews to assess national innovation capacity. This would include technology assessments and interviews with scientists at universities, other secondary and tertiary education and training institutes, and research institutes, to assess their attitudes, desires, and fears, how targeted are these institutions on local problems and how to improve targeting, etc.
- **Review legal and regulatory obstacles that hinder university-industry linkages, including new laws in some countries on university ownership of inventions**. For example, can the university sign contracts to license technology to SMEs? Who gets the proceeds and who decides how they will be used?
- **Incentives**. Best practices should be identified and applied to incentivize and deliver innovation and technology commercialization at local universities and research institutions, e.g. tenure decisions, IP ownership, outside compensation policies, conflict management, and others. There are many examples of global good practice in assessing

know-how and technologies for their commercial potential, and in constructing the necessary technology management systems, in both developed and developing countries.

To implement this legal assessment, the Bank can:

- Work with national governments and local stakeholders to organize legal, policy and institutional reviews of the technology transfer and technology commercialization framework.[13]
- Incorporate these reviews into its work program and encourage governments to incorporate these issues into their PRSPs (in the case of IDA countries).
- Mobilize donor funding, perhaps via the creation of an STI trust fund, to finance the cost of these reviews.
- Mobilize partners with the requisite expertise to assist with these reviews. In most cases, the technical expertise needed to conduct these reviews does not exist in the Bank. Rather, it exists in partner organizations such as the World Intellectual Property Organization (WIPO)[14], law schools specializing in IP, and business schools. However, while these organizations have the requisite technical expertise, they often do not have the capacity to organize this sort of multi-dimensional, wide ranging review. The Bank can use its ongoing dialogue with the government to help mobilize government and local stakeholder support for these reviews and it can use its convening powers to help mobilize relevant partners to help carry out these reviews.

To begin this program the Bank could:

- Organize a working group meeting to define the scope and content of the review, in collaboration with relevant technical and government partners, interested bilateral and multilateral stakeholders, and other non-Bank professionals with relevant technical expertise.
- Assess what existing support is being or has been provided by other international organizations, such as WIPO to better synchronize assistance.
- Identify pilot countries where this review can be rolled out. The pilot countries would cover a range of income levels and STI capacity starting points and would include

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[13] In countries with a strong focus on inclusive innovations, these legal and policy reviews can be combined with the policy reviews proposed in the inclusive innovation section of this Action Plan. Indeed, there are significant overlaps between some of the ideas promoted in the inclusive innovation section and this section. Rather than viewing this as duplication, we see this as validation that the general concepts and recommendations are valid in a wide range of contexts and from a diverse range of vantage points. These reviews would also be built upon review and assessment work already undertaken in several client countries.

[14] WIPO is the UN agency responsible for cooperation among states in the field of IP and is charged with ensuring balance and efficiency in the international IP system.

relatively sophisticated middle income countries as well as countries just starting on the STI capacity building process.

- Mobilize funding from the Bank and others to conduct the reviews.
- Evaluate results of the review, apply lessons learned, and expand the pilot program.

Building the institutions to facilitate this process

A supportive legal environment is necessary but not sufficient for an effective technology transfer and commercialization program. It must be supplemented by the establishment of an Innovation and Technology Entrepreneurship Center (ITEC) to handle all the technical chores associated with spinning-in, adapting for local use, and spinning-out technology. This organization can either be a newly established entity or an existing unit within an established organization (and Inclusive Innovation Center, infoDev incubators, or university technology transfer centers, for example) that is retrofitted to carry out these new functions. The ITEC can be a public or private entity. A range of possible structures should be assessed including national, regional or networked organizations. However, at least in its earliest stage, it could focus on one or two economically relevant sectors.

ITECs can serve a number of generic functions:

- They can act as technology research and scouting organizations, systematically searching for and evaluating available solutions, finding and spinning in relevant technology, passing it to local research institutes that can modify it for local use, and then spinning it out to the private sector. The spinning-out function would ideally entail two steps – transferring the technology and know-how to local enterprises that will embed it in goods and services and getting these goods and services into the hands of farmers and producers. Via this mechanism, the ITEC will help to promote entrepreneurship and SME development as well as technology upgrading and value addition.
- They can form networks with technology transfer organizations in other countries – both developed and developing. This will help to foster formal and informal mechanisms to evaluate technology, coordinate global learning, make better use of existing tools and advisory services, and develop more effective knowledge transfer partnerships.
- They can carry out market analyses of the technologies they work with (including cost-benefit analyses), encourage systematic feedback from end users – local farmers, village residents, create and maintain linkages with the private sector organizations and institutions that could supply relevant technological solutions, and support private sector efforts to mass produce and market the most relevant technologies.

The Bank could finance the establishment of these organizations in the course of its normal project operations. To roll-out this program the Bank could:

- Organize a working group in collaboration with relevant technical and government partners, interested bilateral and multilateral stakeholders, and other non-Bank professionals with relevant technical expertise, to define and determine the scope and content of generic TORs for a model ITEC, keeping in mind that these model TORs will then be modified to suit the specific needs and circumstances of individual countries.
- Identify pilot countries where this program can be rolled out. The pilot countries would cover a range of income levels and existing level of experienced technology transfer professionals. These countries would include relatively sophisticated middle income countries with experience in finding and license technology, spinning it in, spinning it out, and which are practicing some technology transfer management skills - as well as countries just starting on the technology transfer and management process.

Training staff to handle these highly technical, specialized tasks

Many developing countries lack the technical skills needed to carry out the activities that ITECs would be expected to perform. Comprehensive, organized training mechanisms will have to be organized and developed, with the training provided by partners with the necessary specialized skills and experience in technology licensing, entrepreneurship support, etc.

The Role of the World Bank: Building Innovation and Entrepreneurship Partnerships

Partners are available, willing and able to support the activities outlined above. The World Bank can convene the partners to begin working on selected pilot programs, organize the process, arrange financing for partner-led capacity building activities, and take the lead in working with governments in those pilot programs to support the establishment of ITECs, organize the legal, policy and institutional reviews, and incorporate all of these activities into the country's Poverty Reduction Strategy Papers (PRSPs).

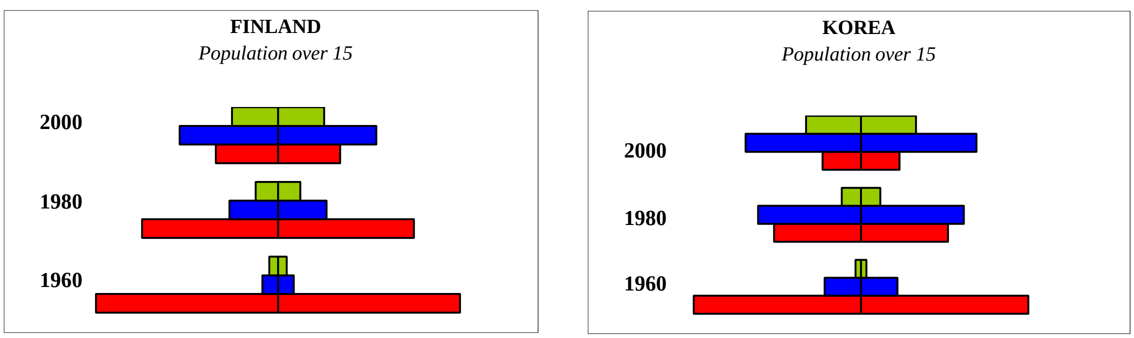
Potential partners would include, but not be limited to WIPO, the Franklin Pierce Law School, UNCTAD, the Association of University Technology Managers (and their non-US equivalents), IFC, and infoDev.

IV. Training the Next Generation of Knowledge Workers

CHALLENGE:
MANY COUNTRIES ARE PUTTING RENEWED EMPHASIS ON SCIENCE, TECHNOLOGY, AND ENGINEERING EDUCATION. HIGHER EDUCATION ENROLLMENT IS GROWING RAPIDLY, BUT FACULTY TO TRAIN THE NEXT GENERATION OF KNOWLEDGE WORKERS CANNOT KEEP PACE WITH THE RAPIDLY INCREASING DEMAND.

When Finland and South Korea embarked on their STI capacity building journeys nearly 50 years ago, the vast majority of people in both countries left school with only a primary education. A much smaller share of the population completed secondary education and an even smaller percentage completed tertiary education. Over the next 40 years, however, the relative share of the population that completed secondary and tertiary education grew dramatically and the share with only a primary education shrank correspondingly. (Figure 5)

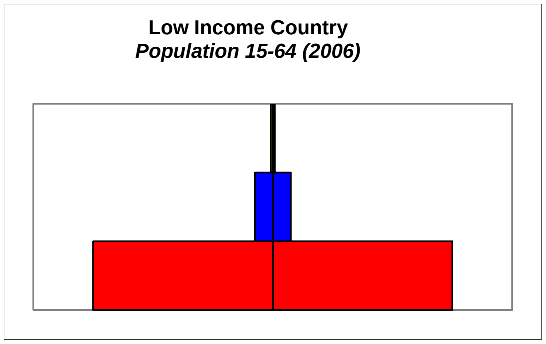
Figure 5: Educational Attainment



Red = Primary, Blue = Secondary, Green = Tertiary

Now consider educational attainment in the typical low income country. (Figure 6) For all intents and purposes, they are striving to achieve what Korea and Finland accomplished 50 years ago -- namely universal, high quality primary education. Fortunately, in many countries the share of school-age children who are receiving at least some primary education is growing substantially thanks to a concerted effort on the part of the Bank, various donors, and developing country governments. However, in many of these same countries, only a small fraction of the children who complete primary school go on to complete secondary and higher education.

Figure 6: Educational Attainment in Low Income Countries

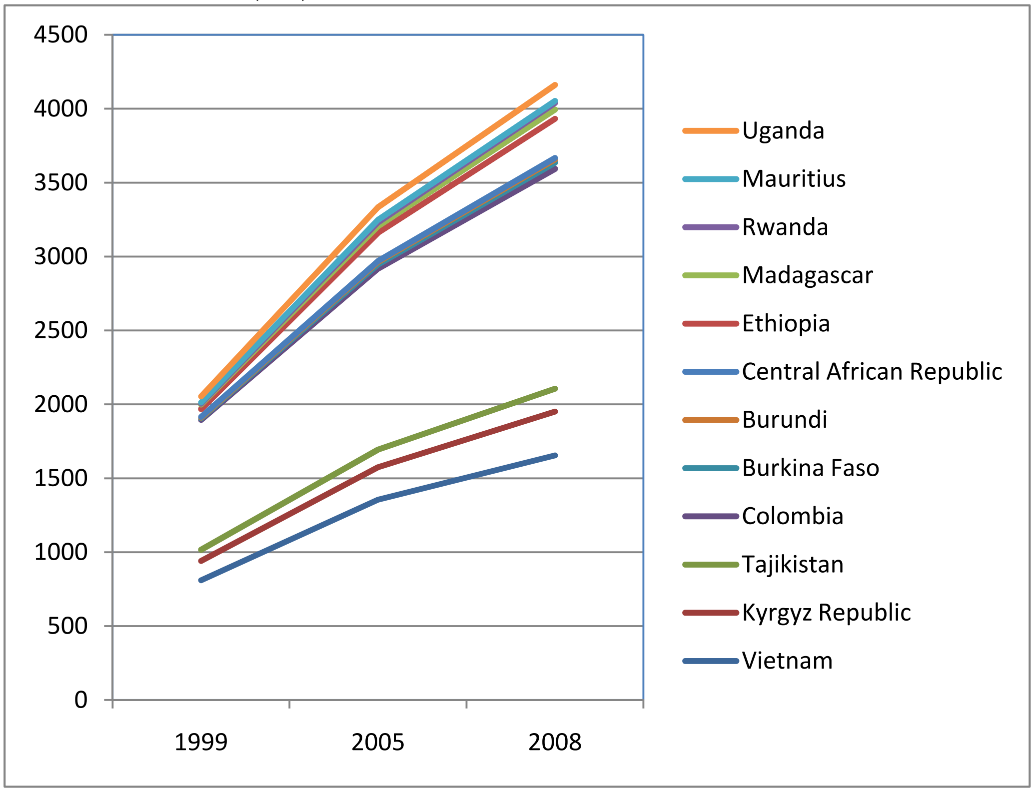


For these countries, therefore, one objective must be to expand the percentage of primary school students who go on to complete secondary and/or higher education. However, another equally important goal must be to increase the share of the population specializing in science, math, engineering and other technical subjects at the secondary and higher education levels. This is especially crucial for women who are significantly underrepresented in the sciences. Otherwise, developing countries simply will not have the technical capacity needed to achieve the MDGs, diversify the economy, generate wealth, improve health care delivery systems, etc., nor to prepare subsequent generations to do so. So while achieving universal primary education is still a critical priority, building higher education capacity cannot be ignored. Both objectives must be pursued concurrently.

In fact, tertiary enrollment levels are rising dramatically in a number of African countries. Yet even though absolute enrollment rates are still far below satisfactory levels and university faculties are having difficulty keeping up with the burgeoning demand, enrollment rates will have to continue increasing if these countries are to have any hope of building the STI capacity they need to meet their high priority social and economic development objectives. But at precisely the time that enrollments are increasing, faculty numbers are failing to keep pace with enrollment in the best of cases and shrinking in the most typical case.

Table 1: Tertiary Education Enrollment Trends in Selected Countries (in thousands)

Source: World Bank EdStats (2010)



Two indicators are most telling. First, in country after country, faculty positions are being filled by professors who have only a bachelors or masters degree. For example, a recent report on Tanzania noted, "The extent to which bachelor degree holders make up an important part of the professoriate, and the large proportion of Master's holders, is a clear indication that the country needs more qualified staff, if the teaching and research mandates of universities are to be enhanced. The shortage of doctoral degree holders also limits the extent to which high quality doctorate students can be trained."[15] This problem is not confined to low income countries. In Colombia, for example, only 12% of the university faculty has a Ph.D.

Second, as faculty members age and begin to retire, many universities will lose some of their most experienced, and academically qualified, teaching staff. A recent report on Ghana notes, "With a retirement age of 60, and public universities catering to the vast majority of students, it is clear that the next decade will be very challenging for staff replenishment to meet the needs of students as 31% of current staff in those institutions will be retiring. In fact the fact that public and private universities depend on staff members who are passed their retirement ages for 13% and 9%, respectively, of their staff complement, is a clear manifestation that it is imperative to

[15] University Leaders Forum, National Snapshot: Tanzania, P. 5

cultivate a requisite number of new generation academics to sustain the mandate of these institutions."[16]

Knowledge Workforce Solutions through Partnerships

Many developing countries are caught in a vise between rapidly increasing higher education enrollments and static or declining faculty rosters. How can they escape this trap? Partnerships may help them jump start the capacity building process by allowing countries to build STI capacity when they do not have the indigenous capacity they need in order to meet the higher education demand.

At least four types of higher education partnerships can be envisioned:

Regional University Networks

Partnerships can support the formation of regional university networks that would provide graduate and undergraduate training in a broad array of science and engineering disciplines. Individual universities may not have the financial and human resources to provide high quality training in the full range of science and engineering disciplines required by their countries. Regional university networks enable universities in one or many countries to link on the basis of each institution's academic strengths, enabling institutions to harmonize their capacity building programs on the basis of an agreed division of labor. Networks benefit from economies of scale and maximize the efficient use of scarce, indigenous STI capacity, thereby broadening the array of STI capacity building programs that a region could support.

For example, the Regional Initiative in Science and Education (RISE), funded by the Carnegie Corporation of New York and administered by the Science Initiative Group in Princeton, N.J., is brokering partnerships between consortia composed entirely of African universities. It established a competitive mechanism whereby consortia of universities submitted proposals outlining how they intended to band together to offer a comprehensive graduate science education program in a specific subject area.[17] To date, RISE has funded five networks of African universities. Each network is expected to receive approximately $800,000 per year for 2.5 years, with the possibility of a 3-year renewal. Grant proceeds can be used for such purposes as student fees, conferences, travel and communications between institutions, lab supplies etc. By comparison, the Asian University Network/Southeast Asian Engineering Education

[16] University Leaders Forum, National Snapshot: Ghana, P. 5

[17] The existing eligibility criteria and application procedures are available at: http://sites.ias.edu/sig/system/files/pdfs/RISE_RFP_-_Final.pdf

Development network (AUN/SEED-net)[18] program establishes a partnership between a **network** of 11 Japanese universities, on the one hand, and a **network** of 19 SE Asian engineering schools, on the other hand. In other words, it is a partnership between two networks.

Scaling up these network partnerships would expand the number of networks operating in the same region and the number of regions covered by these existing network programs. These additional networks could cover a wider range of science and engineering disciplines, possibly including undergraduate science and engineering education, medical and nursing education, and other technical fields.

University Partnerships

Partnerships between universities in countries that are trying to build STI capacity and universities in countries that already have STI capacity can strengthen STI capacity building programs in developing countries.

For example, the Egypt-Japan University of Science and Technology (EJUST) is a partnership between Egypt and Japan to establish an entirely new science and technology institution in Egypt. Faculty and curricula will be drawn, at least in part, from a consortium of seven Japanese universities. The remaining faculty positions, (i.e., those which are not filled by professors seconded from Japanese universities) will be filled via an open, international recruitment. EJUST will have its own, modern governance structure and curriculum. There will also be an explicit attempt to ensure that students are exposed to both theory and modern research methods and that they receive the hands-on experience that employers demand. In this sense, EJUST will inject additional STI professorial capacity into the Egyptian university system and provide a model for teaching, curriculum, and governance of a modern S&T education/research institution. Other universities in the region and elsewhere, including the Nelson Mandela Institutes that are being established in four campuses in Sub-Saharan Africa, can emulate this model if they wish and employ EJUST graduates to bolster their current faculty rosters. But EJUST does not purport to directly address the faculty, curricula, and governance problems confronting existing institutions in the region.

By comparison, the Africa-U.S. Higher Education Initiative (HEI) is designed to strengthen the capacity of existing African higher education institutions through partnerships between African and U.S. higher education institutions over a sustained period. The objective is to help these institutions contribute more effectively in key priority areas for development (science and technology; agriculture, environment and natural resources; engineering; business, management and economics; health, and education and teacher training). The Association of Public and Land-Grant Universities (APLU) has spearheaded the development of this Initiative in collaboration

[18] http://www.seed-net.org/index.php

with the Higher Education for Development Program (HED) and funding from USAID which is currently funding 33 grants of $50,000 from the 300+ proposals submitted, to support planning for long-term collaboration between African and US higher education institutions.[19]

There is also a need for direct funding direct linkages (eg, laboratories at one institution in a developed country with a laboratory in a developing country). Institution-wide activities are effective but what is most effective is the direct linkage between scientists, without the bureaucracy and heavy weight of country-to-country or institution-to institution connectedness. In today's world, with internet, videoconferencing, skype, etc., the top-heavy arrangements (dating back to the fifties and sixties) are not needed. Direct connectedness is far more versatile, flexible, and effective.

In order to scale-up these initial partnership initiatives, the following issues would need to be addressed:

- There is a need for multi-year funding so that these initial partnership overtures can be converted into sustainable entities. This support is typically difficult for single governments to provide in the context of their annual appropriation cycles. Therefore, some sort of longer term, stable funding mechanism will be required.
- Appropriate partners will be needed to administer, monitor, and finance a scaled up initiative. These might include other multi-lateral or bi-lateral donors, foundations, private sector entities and universities/research institutes.
- These partnerships need to be directly linked in with developing country governments and aligned with the relevant ministries to gain the required domestic support.

Global Science Corps[20]

A Global Science Corps (GSC) would provide an immediate, large scale infusion of trained faculty and researchers in countries facing rapidly growing enrollments and faculty shortages. It would help to provide the additional faculty members needed to implement the two partnership initiatives described above. Modeled loosely on the Peace Corps, the GSC would deploy science and engineering professors and researchers from countries with strong scientific capacity to developing countries in Africa, Asia, Latin America, and the Middle East for periods of a year or longer. GSC Fellows would work with local scientists to conduct high quality, locally relevant research and to expand the roster of qualified science and engineering professors in the host countries. These scientists and professors could work in both new and existing institutions.

[19] For a list of award recipients, see http://www.hedprogram.org/Portals/0/PDFs/Final%20List%20of%2020%20Applications%204.29.09.pdf

[20] Variants of this proposal have been put forward by Dr. Harold Varmus during his keynote address at the 2010 Global Forum, and also by Dr. David Strangway from Canada.

A major talent pool for the GSC could be Diaspora scientists or retired professors/newly minted graduate students with no prior ties to the country in which they will be serving. Ideally GSC participants would both teach and conduct research.

In order to implement this initiative, the following issues[21] would need to be addressed:

- **Funding.** Significant funding would be required. For example, if the annual cost for one GSC Fellow is $100,000, the total annual cost for 1000 GSC Fellows would be $100,000,000 including salaries, accommodation, ICT, lab equipment, travel, insurance, etc. This is a fairly modest sum relative to the aggregate annual aid budgets of the largest 10 or 15 donors. Nevertheless, dedicated funding would have to be set aside for this program.
- **Allocation of GSC Fellows.** Should GSC Fellows be scattered widely over a large number of universities, or should they be concentrated in a relatively small number of "centers of excellence" or in universities that are also participating in some of the other partnership initiatives outlined in this Chapter? The former would support more wide ranging STI capacity building programs; the latter would support a sufficient mass of scarce STI resources in a smaller number of institutions and promote synergy between partnership initiatives.
- **Eligibility Criteria for Host Institutions.** How would host institutions be selected? What eligibility criteria should they be required to meet? For example, should host universities be required to demonstrate how the GSC Fellows will complement the university's strategic plan for STI capacity building? Should the university's strategic plan be embedded in a broader national STI capacity building program? Should host institutions be required to contribute financially to the program, e.g. by providing housing for GSC Fellows?
- **Administration.** Who will administer the program – a foundation especially established for this purpose that will receive funds from donors, vet requests to host GSC Fellows, and process applications to serve as GSC Fellows? Might the GSC become an adjunct to the Fulbright Scholars program and administered through CIES? Or should individual donor governments each administer its own independent program?

Engineering Capacity Building

Many of the innovations tailored to surmount poverty and sustainability issues in the developing world will be designed and executed by engineers. Programs need to be designed to enhance engineering curricula and produce partnerships between engineers in the developed world with local NGOs and government ministries to address local problems in developing countries. Engineers, whose degrees are based on international standards of quality, are critical to provide

[21] This is only a partial inventory of critical implementation issues. Other issues will be included and addressed if and when this initiative moves towards actual implementation.

an essential skilled workforce. Programs such as Engineering for the Americas (EftA), Engineering for Change (ASME/IEEE) and the Asean University Network/Southeast Asia Engineering Education Development Network (AUN/SEED-Net) have a great deal of potential to achieve these goals. Scaling-up engineering education initiatives through partnerships can have an immediate impact on providing on-the-ground solutions to problems and build capacity at the same time.

The Role of the World Bank: Building a Knowledge Workforce

There are potential complementarities between higher education capacity building programs supported by other foundations and development partners, and World Bank higher education projects. For example, GSC fellows could be channeled into RISE networks and applications for new HEI bilateral partnerships could be encouraged from universities that are part of RISE networks. This would potentially strengthen the coherence of individual partnership programs and help to convert indigenous existing institutions into *de facto* centers of excellence.

The World Bank can play a critical role to provide complimentary and value added services in each of the proposed initiatives described in this module. The Bank cannot build the needed STI capacity alone, nor does it have the scientific and technological resources to do so. The universities and institute partners will need to be in the lead while the Bank lays a strong foundation to magnify the impact of the initiatives and ensure their sustainability. For example, the GSC will not be effective if the proper governance and institutional strength is not present (along with other issues described in the “vicious circle”). The Bank support also needs to facilitate the establishment of more STI programs on a regional scale and have more regions covered by STI programs. In many cases, these solutions can be implemented within existing Bank programs or new programs may be established to support these solutions.

Therefore, to so support these initiatives, the Bank will:

- Organize a working group of relevant officials and stakeholders to develop detailed implementation plans and operating procedures, address all of the outstanding planning, design, and implementation issues outlined above, and conduct extensive consultation and outreach programs.
- Mobilize all of the key partners to implement these initiatives. There is currently wide support, in principle, for these initiatives, but someone will have to take the lead in bringing together stakeholders to approve this strategic partnership initiative.
- To the extent possible, ensure that World Bank programs build on the progress generated by these partnership initiatives and vice-versa. This will require more regular consultations between the World Bank, other development partners, and organizations

actually working to build STI capacity on the ground. The World Bank can take the lead in convening these periodic consultation meetings.

- Link each of these individual partnership initiatives to each other so that there is greater synergy between them. For example, GSC Fellows could make a substantial contribution to regional networks, and university partnerships could enhance their potential effectiveness by placing GSC Fellows in the host country institution.
- Work with university administrators, local stakeholders, international partner organizations, and national government officials to improve the governance of local research institutes and universities. The GSC Fellows and the other partnership initiatives discussed in this chapter will not have a sustainable, long term development impact unless research institute and university governance are put on a sounder footing. The World Bank, in collaboration with its regional development bank partners, is well placed to organize this dialogue and then to finance the implementation of desired reforms in the course of its normal advisory work and lending operations. The university partners and other organizations engaged in STI capacity building have the technical capacity to help build STI capacity, but not the capacity to organize this policy dialogue.
- Finance complementary investments in the higher education and R&D sector that individual partners are unable to finance. For example, this might include financing to organize a national or regional Millennium Science Initiative (MSI) program focused on finding Bottom of the Pyramid (BOP) solutions, upgrade laboratory equipment, teaching infrastructure, subscriptions to e-journals, establishment of e-libraries, computerization and ICT-readiness, national scholarship programs to send graduate and undergraduate students abroad for a year or two of study in a so-called “sandwich” program, small grant programs administered by national governments to encourage local scientists to work in partnership with local industry and focus their research efforts on critical economic and social development problems, etc. The precise composition of each World Bank financing package would vary from country to country and would be determined in consultation with the government and other stakeholders.