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USAID and Science and Technology Capacity Building for Development

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USAID and Science and Technology Capacity Building for Development

**Anny Wong and Irene Brahmakulam
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This briefing presents an outline of the new emerging consensus on the role science, technology and innovation plays in economic development. It explores the extent to which the U.S. Agency for International Development (USAID) has contributed to endogenous science and technology (S&T) capacity building and promoting innovation to advance economic growth. It also examines ways to more fully optimize such contributions in the future. Three case studies were conducted on USAID efforts: public health in Russia, energy in India, and agricultural research in Africa. This project was undertaken at the request of the Bureau of Policy and Program Coordination at USAID.

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Outline

- **BACKGROUND**
 - Objectives of the Study
 - Methodology
 - Major Findings from Case Studies
 - Approaching S&T Capacity Building and Innovation
 - Recommendations
 - Case Studies

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This section provides definitions for science, technology, capacity and innovation as they are used in this study. It also provides a discussion on why it is important for USAID to think anew about building endogenous capacity for science and technology and promoting innovation to advance economic growth in developing countries.

Defining Science and Technology Capacity and Innovation

- Science and technology (S&T) is more than research and development (R&D)
- Science is knowledge
- Technology is the application of that knowledge
- S&T Capacity is the ability to adopt, adapt, apply, create and disseminate knowledge
- Innovation is a new function, form, or application that improves upon the state of the art

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Science is often associated solely or primarily with the hard sciences, such as biology, chemistry or physics. In this study, we take a broader view and define science as knowledge applied to the natural and social worlds. The word "science" is derived from the Latin word *scientia* meaning knowledge. Thus, science in the context of this study is knowledge of all kinds – embodied in the natural sciences, the social sciences, and arts and the humanities. Technology is the underlying know how to produce, utilize and evaluate products or solutions to problems. Thus, S&T capacity is the ability to adopt, adapt, apply, create and disseminate knowledge (Wagner et al., 2001).

Innovation is an improvement in technology to produce new goods or a better way to produce goods. Innovation grows out of the S&T capacity available in an economy. It can be a product or a process. Innovation occurs when technology users, such as manufacturers, building contractors or farmers, use knowledge and tools at their disposal to create new functions, forms, or applications to provide a superior solution to problems or address opportunities. Innovation thereby increases productivity and the competitiveness of an economy, and contributes to economic growth

Science and Technology are Critical to Economic Growth

- S&T Capacity Gap is linked to the Development Gap
- S&T capacity enables sustained, proactive pursuit of development goals and innovation for problem-solving
- Developing countries urgently need S&T to face development challenges
- Developing countries have limited capacity to absorb/adopt new knowledge and tools or to grow them at home to advance economic growth

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Knowledge has always been an essential factor in development. It has become an even more decisive factor in competitiveness, growth, and wealth creation in today's global economy.

Challenges such as growing population, environmental degradation, diseases, sustainable agriculture, and trade standardization among others also compel the search for new knowledge and tools to find solutions and exploit opportunities to sustain economic development (Daly, 2002).

Research that supports S&T makes a positive contribution to economic growth and poverty alleviation (Sachs, 2000; Wagner et al., 2001; UNDP, 2001). Domestic investment in building S&T capacity, and linkages to other countries, are determinants of competitiveness in the world economy (Mayorga, 1997). Narrowing the S&T gap is thus one step that policy makers should look to when considering steps toward narrowing the economic gap between industrialized and developing countries.

However, most developing countries do not have the same level of capacity to generate new knowledge as advanced countries. They rely on foreign direct investment, imports or donor assistance to acquire new knowledge and tools. This relative weakness in S&T capacity limits their ability to absorb or adopt imported knowledge and tools or to foster them at home to support economic development (Skolnikoff, 1993).

International Cooperation is Needed to Build S&T Capacity

- South-South cooperation is insufficient to build S&T capacity in developing countries
- Need new models for international cooperation to
 - Make assistance more directly supportive of S&T capacity building
 - Make S&T capacity building more relevant to economic growth
 - Make S&T capacity building financially and institutionally sustainable

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There is widespread international agreement that South-South cooperation, a popular notion at one time, is not enough to build S&T capacity in developing countries. Today more than 90% of global investment in R&D and innovation occur in the industrialized countries. Developing countries cannot look to themselves to find the latest in technological breakthroughs or resources to support research, development, information dissemination and other activities to build critical masses of knowledge, institutions and policies to sustain S&T capacity building for economic development.

Moreover, recent research indicates a need for new models for international cooperation to build S&T capacity. At present, international assistance still has to fully establish and exploit linkages between S&T capacity building and economic growth. New knowledge and tools that sit in universities or government research laboratories will not improve incomes and alleviate poverty or produce other benefits. Scientific and technical transfers also will not take root and grow domestically without incentives and means for users to adopt them or to build upon them to better address local needs.

Hence, there are several tasks for those interested in promoting economic development. First, there is a need to find ways to make R&D investment and other activities more directly supportive of S&T capacity building. Second, efforts are needed to connect such activities to economic growth. Building S&T capacity is necessary but not sufficient to spur economic growth. Promoting innovation through institutional and market reforms among others are critical to the transfer, adoption and diffusion of new knowledge and tools to increase productivity and address various development problems. Third, making S&T capacity building financially and institutionally sustainable is part of the challenge.

Time for USAID to Think About S&T and Innovation

- Help developing countries to realize sustainable economic development
- Advance U.S. national security and foreign policy interests
- Support the Millennium Challenge Account

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In addition to new insights about the nexus between S&T capacity and economic growth and the broad agreement that international cooperation is necessary to advance S&T capacity in developing countries, there are other reasons why USAID should take a serious look at how it can better contribute to S&T capacity building.

First, research that supports sustainable development requires a country to have a sufficient level of S&T capacity to address development challenges and exploit development opportunities. Putting sustainability into practice is particularly difficult for developing countries because they have the most limited S&T capacity.

Second, increasing S&T capacity in developing countries has direct bearing on U.S. national security and foreign policy interests. Their weakness in S&T capacity can have potentially adverse effects on U.S. national interests. For example, public health threats in foreign countries can spread to the U.S.

Third, the Millennium Challenge Account (MCA) will increase U.S. development assistance by 50% over the next three years, or a \$5 billion annual increase over current levels by FY 2006. MCA funds will go to developing countries with domestic settings that favor trade and investment. This means they need to show a strong commitment to good governance, health and education, and have economic policies that foster free enterprise and economic growth. To do this, countries need knowledge and tools to improve their institutional and human capacity to compete in the global economy. Hence, improving capacity for S&T and innovation is critical to countries that qualify for MCA funds and those wanting to qualify for MCA funds.

Outline

- Background
- **OBJECTIVES OF THE STUDY**
- Methodology
- Major Findings from Case Studies
- Approaching S&T Capacity Building and Innovation
- Recommendations
- Case Studies

This section presents the objectives of this study.

Explore and Think Strategically About USAID's Role in S&T Capacity Building

- Explore whether and how USAID contributes to S&T capacity building and innovation for development
- Encourage USAID to think more strategically about S&T and innovation for development
 - Because USAID is in a unique position to help facilitate public-private partnerships in S&T capacity building and innovation
 - Because USAID is well placed to help address cross-programmatic issues

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A number of U.S. government agencies are involved in various aspects of international cooperation. Many international cooperation activities contribute to building S&T capacity for the U.S. and its collaborators.

USAID is a major U.S. Government sponsor of international S&T activities in the U.S. government, particularly in the form of technical assistance (Wagner, Yezzil and Hassell, 2001) even though S&T capacity building is not an explicit USAID program, sector goal or activity. Moreover, USAID has broad involvement in improving education, public health, public sector reform and other activities deemed necessary to support economic development. Appropriate investment in the larger policy, regulatory and economic setting is important for building S&T capacity and promoting innovation to support economic growth. Hence, it is worthwhile to examine whether and how USAID efforts have increased S&T capacity and innovation.

For USAID to more fully optimize its resources, a more strategic approach to thinking about S&T capacity building and innovation is necessary. There is now improved understanding about the relationship between S&T capacity and economic development, as well as the conditions necessary for innovation to produce economic benefits. Also, USAID is in a unique position to mobilize both public and private participation to build S&T capacity and promote innovation for economic growth. The agency has long experience in working with government and private entities in developing countries and its emphasis on collaborative approaches would help to bring together appropriate partners and help leverage resources, particularly in cross-programmatic issues.

Outline

- Background
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- **METHODOLOGY**
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This section describes the methodology used in this study and provides brief introductions to the three case studies.

Methodology

- Literature review
- Interviews with U.S. government officials and non-government experts
- Three case studies to examine how USAID has contributed to building endogenous capacity for S&T and innovation

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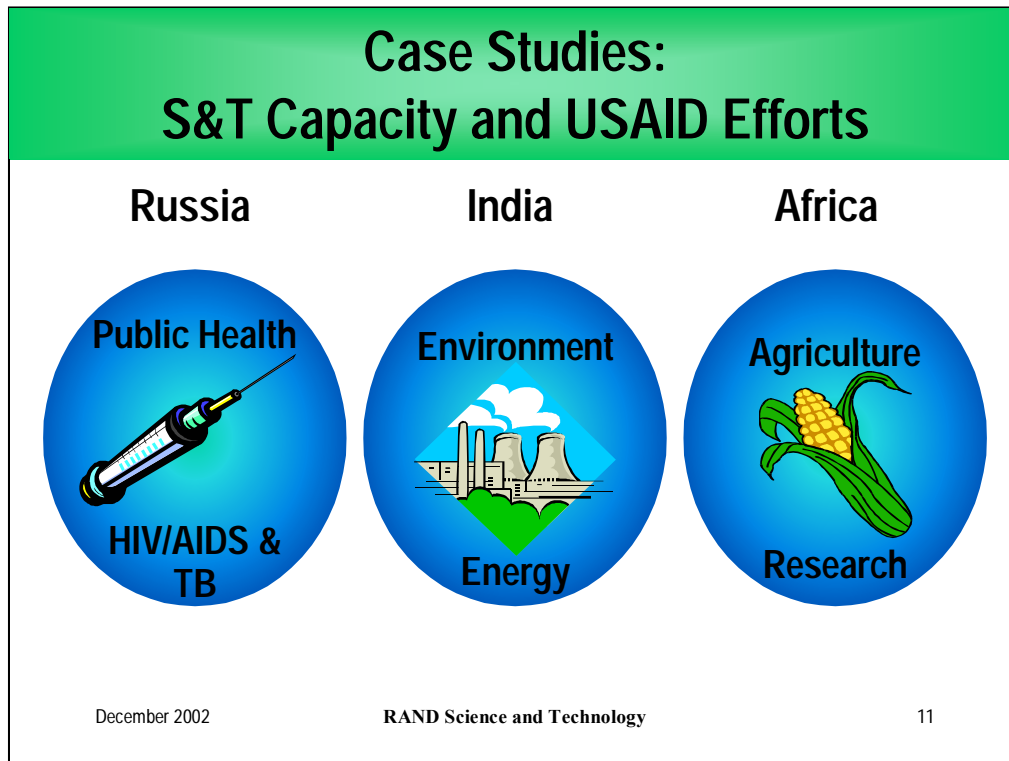
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This study used the three-part methodology listed above to explore the question of whether and how USAID activities contributes to S&T capacity building. Background information for this study was drawn from printed reports of the U.S. and other governments and international organizations, books, journal articles, and newspapers. Information was also obtained via the Internet from the web sites of U.S. government offices, international organizations, non-profits, industry, and other bodies.

The RAND project team conducted interviews in person and via the telephone with a number of U.S. government officials in USAID and other mission agencies, as well as experts outside USAID on development, public health, energy, and agriculture. The purpose was to obtain relevant information not available in the published literature, as well as more recent activities that still have to be documented.

The three case studies on public health in Russia, energy in India, and agriculture in Africa were chosen in consultation with USAID officials for their relevance to the USAID mission. These cases were seen as both addressing the specific needs to support long-term, equitable economic growth and advancing U.S. foreign policy objectives.

The criteria for choosing the cases included their ability to represent a range of country conditions and levels of S&T capacity. We sought to identify USAID activities that contribute to S&T capacity building to provide lessons to support USAID consideration of next steps for involvement in these countries and work areas, as well as insights that may find application in other countries and programmatic areas.



Russia: The exponential growth in HIV/AIDS, TB and other infectious diseases in the last decade threatens economic growth, undermines civil society, and hurts transition to democracy in Russia. Populations outside Russia are also at risk in our highly mobile world. For example, cases of multi-drug resistant TB of the Russia strain have been found in the U.S. This case examines USAID experience in working with a country that has a high level of basic capacity in S&T.

India: A population of more than one billion people imposes a tremendous strain on India's infrastructure and environment. India is now the world's sixth largest and second fastest growing producer of greenhouse gases. Coal is India's major energy source but existing power plants are inefficient and demand far exceeds supply. Conditions are expected to worsen in the coming years without radical changes. USAID aims to strengthen existing power capacity to meet this growing demand and to reduce pollution. This case examines USAID experience in working with a country with considerable basic capacity for S&T.

Africa: Agriculture is by far the major source of employment, income, and food for populations in Africa. In Sub-Saharan Africa, more than 70% percent of the population depends on agriculture for their livelihood. Significant improvement in agricultural productivity is thus central to poverty alleviation and sustainable economic growth in African countries. In the past decade, USAID has worked to increase African capacity for agricultural research and to make agricultural research financially sustainable. This case examines how USAID takes a regional approach to S&T capacity building when resources at the national level are scarce.

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This section presents major findings and observations drawn from the case studies. These findings are in four groups. The first group of findings addresses the questions of whether and how USAID has contributed to S&T capacity building and innovation in the problem areas and countries examined. The second group highlights requirements for S&T capacity building and innovation in these problem areas and countries. The third group describes barriers to S&T capacity building and innovation in these problem areas and countries. The fourth group highlights issues for USAID to think about if the agency chooses to play a more proactive role in building S&T capacity to support economic development.

Findings and observations here focus on the larger thematic issues. References to the sources of information and insights from the case studies are indicated by [R] for Russia, [I] for India and [A] for Africa, along with a page number. Hence, [R29] refers to the Russia case and slide number 29. Readers can use this to obtain more details from the case studies which are at the end of this report.

Improved S&T Capacity and Innovation are Side Benefits of USAID Activities

- USAID activities have contributed to increase endogenous S&T capacity in the cases examined
- But S&T capacity building and innovation are not typically explicit USAID objectives or directly linked to development goals
- A more strategic approach could optimize USAID S&T investment and increase local capacity to sustain S&T capacity building and innovation

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USAID support for international S&T cooperation is mainly in the form of technical support. U.S. scientific or technical know-how are transferred to developing countries to help address specific challenges to economic development. [R29, I38, A45]

However, S&T capacity building is rarely an articulated objective in USAID activities. As a result, increased capacity for S&T is largely a side benefit in the cases examined. For example, USAID assistance to fight HIV/AIDS and TB in Russia provided training for thousands of Russian health workers. In Africa, USAID assistance to improve linkage between national and regional agricultural research institutions helped to reduce redundancies and leveraged knowledge and resources across institutions and national borders to enhance agricultural research, productivity and trade.

In addition to contributing to S&T capacity growth, USAID has been a catalyst for innovation. Its push for market and regulatory reforms, education, and other activities helps to create environments that promote innovation. For example, working with the Indian government to introduce institutional and market reforms in the power sector provided incentives for Indian engineers and entrepreneurs to develop, produce and apply energy efficient technologies. [R33, I42, A49]

The fact that USAID is able to help increase in endogenous S&T capacity and innovation even without an explicit policy is because many of its efforts have introduced not only new knowledge and skills, but also enabled their deployment through institutional and market reforms. [R35, I41, A49] However, the lack of awareness of the connection between S&T capacity and economic growth means that support may not be fully optimized or directed to make such efforts sustainable locally in the long-term. [R36, I43, A50]

Increasing S&T Capacity Building and Innovation Requires Several Actions

- Coordinated government, academia and private efforts to build a dynamic economic infrastructure and an environment that promote S&T capacity building and innovation for economic development
- Necessary top-down changes in laws, policies and regulations and institutions
- Information, outreach, and innovative financial, marketing and product warranty and performance schemes to spur adoption of new knowledge and tools

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Frequently in developing countries, government is the lead funding source for science and new knowledge and tools produced in universities and national research laboratories rarely make their way to commercialization and widespread use to increase productivity and solve other problems in development. [R33, I41, A46] For this reason, well-coordinated efforts among government, academia and the private sector are essential to create and sustain a dynamic economic, legal, and policy infrastructure and a supportive environment for S&T capacity building and to promote innovation for economic development. [R36, I43, A50]

Through consultation and other activities, government, academia and the private sector can identify new policies, laws and regulations to reform or create new institutions that can tighten links between economic growth and S&T capacity building and innovation. An environment that is open to economic competition and supportive of good governance helps to increase transparency and encourage private investment. The latter, in particular, will facilitate technology transfer, adoption and innovation. [R34, I42, A49]

New knowledge and technology must also be accessible to support adoption and to produce benefits. Users cannot or will not adopt new knowledge and tools, whether transferred from foreign sources or produced domestically, if they do not have the means or the motivation to acquire them. Information and outreach, such as training and pilots, can increase awareness about new knowledge and tools to users, beneficiaries and regulators. Users must also have the financial means to adopt new knowledge and tools. This may require innovative financial, marketing and product warranty and performance schemes among others to enable users to purchase, apply and maintain new knowledge and tools in ways that will create real benefits for them. [R34, I41, I43, A48]

Challenges to S&T Capacity Building and Innovation in Developing Countries

- Limited S&T capacity (institutional and human)
- Lack of financial resources
- Non-competitive private sectors in developing countries
- Lack of political will, stable policies, law enforcement
- Short-term needs override long-term investment in S&T

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Most developing countries have limited S&T capacity. The limited S&T capacity that exists is also often fragile, embodied in a small number of individuals and a few institutions and dependent on outside support rather than any national S&T infrastructure or domestic means to make them sustainable. Capacity for innovation, too, is weak and fragmented. This prevents new knowledge and tools from gaining widespread application and restricts their potential to spur economic growth and produce other benefits for development. This reality frustrates both internal and external efforts to foster sustainable economic development.

As the case studies show, when S&T capacity building is attempted, it typically occurs only within narrowly defined areas. Moreover, innovation is limited because researchers do not know what the market wants and users find few incentives or means to adopt new knowledge and tools.

Many barriers hinder sustained S&T capacity building and promoting innovation for economic growth in developing countries. Shortage of human and institutional capacity are common problems. Economic policies that do not favor competition and weaknesses in the rule of law do not spur innovation or attract foreign direct investments. Lack of political will to implement reforms, maintain stable policies, enforce laws, and pursue good governance also hinder S&T capacity building and innovation. Finally, governments must balance competing demands for finite resources. For developing countries, resources available are particularly constrained so that public investment decisions often are driven more by short-term demands than long-term goals. As a result, long-term and sustained investment in S&T capacity building is rare. [R36, I43, A50]

Points to Ponder

- There is limited awareness of USAID contributions to S&T capacity building and innovation for development
- Greater internal awareness will facilitate more strategic thinking to optimize USAID resource use and advance U.S. national security and foreign policy goals
- More external awareness will expand USAID role and participation in international discussions on S&T and development

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Our research found that USAID has helped to build S&T capacity building and promote innovation for economic development but there is limited awareness of this USAID contribution within and outside USAID. This phenomenon may be due to the fact that there is no explicit USAID policy for S&T capacity building and promotion of innovation and there has been little documentation of its S&T efforts and their impact on economic development. Neither has there been open USAID articulation of the link between S&T capacity building and promoting innovation for economic development. [I43, A50]

USAID can do much to advance S&T capacity and promote innovation for economic development. Greater awareness of USAID S&T efforts and their contributions will help the agency to better leverage resources and relationships to advance its mission and accelerate economic growth in developing countries. USAID is in a unique position to encourage public-private partnerships for S&T capacity building and innovation. It is particularly placed to address cross-programmatic issues, e.g., establishing linkages between investments in health, education and institutional reforms and economic growth.

Toward this end, increased internal awareness of USAID contributions will support more strategic thinking to optimize agency resource use and advance U.S. national security and foreign policy goals. More open discussions within USAID and improved USAID coordination with the Executive Offices and other U.S. agencies responsible for S&T, global trade and development, and foreign policy will support the USAID mission and benefit the U.S. as a whole. Also, increased external awareness of USAID contributions will bolster USAID participation in international S&T and development forums and help USAID to better use its resources to lead, coordinate, and consolidate actions by international development assistance organizations and partners in developing countries.

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- **APPROACHING S&T CAPACITY BUILDING AND INNOVATION**
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This section examines frameworks to think about building S&T capacity and promoting innovation in developing countries. The first two slides address key issues in and approaches to S&T capacity building in developing countries. The third and fourth slides focus on how innovation might be promoted through the establishment of a national innovation system and describe the prerequisites for a national innovation system in developing countries.

Keys to S&T Capacity Building for Economic Development

- S&T capacity building is a long and cumulative process
- Good governance is imperative
 - Need laws, regulations, professional standards and ethics
- No single technology or S&T capacity building formula guarantees economic growth
- S&T policy of a developing country must focus on niches, locations, markets and priorities

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Building S&T capacity at the national level is important for a country to effectively interact and compete in the international arena. S&T capacity building is a long and cumulative process (Juma and Konde, 2002). Building S&T capacity requires more than building laboratories and technology transfer. Stable investment in human and institutional resources is necessary to adopt, adapt, apply and develop new ideas and technologies.

Good governance is imperative to encourage such investment and to maximize their effect on economic development. Laws and regulations are needed to protect physical and intellectual property, and they must be effectively and efficiently enforced. In this connection, the presence of professional standards and ethics creates a larger social atmosphere to demand and uphold good governance.

It is important to remember that no single technology can guarantee economic growth or achievement of other development goals and there is no single formula for S&T-based economic growth. For example, many rural communities can now access public services and market information via the Internet, but few have endogenous capacity to modify this technology to better fit local conditions. Hence, the basic principles of capacity building have to be adapted to specific needs and goals of different countries and regions (Juma, 1999; Fabayo, 1996).

Greater resource and capacity constraints in developing countries compel their S&T policy discussions to be more niche-oriented and specific to location, market and priorities. Such economies also need to continuously invest in and monitor progress in building S&T capacity in order to rise above the "bottom of the technology ladder" (Lall, 2001). However, S&T investments that are beyond the absorptive capacity of a country can result in waste and failure rather than increase their scientific and economic productivity.

Regional Approaches Can Also Aid S&T Capacity Building

- Regional approaches leverage existing resources, mechanisms and comparative advantages
- Organizing principles are shared concerns and similar goals and conditions, NOT geography
- Success of frameworks and mechanisms depends on larger institutional, legal, economic and social settings
- Frameworks for regional S&T capacity building
 - Clusters
 - Local Cottage Industries
 - Centers of Excellence
 - Networking

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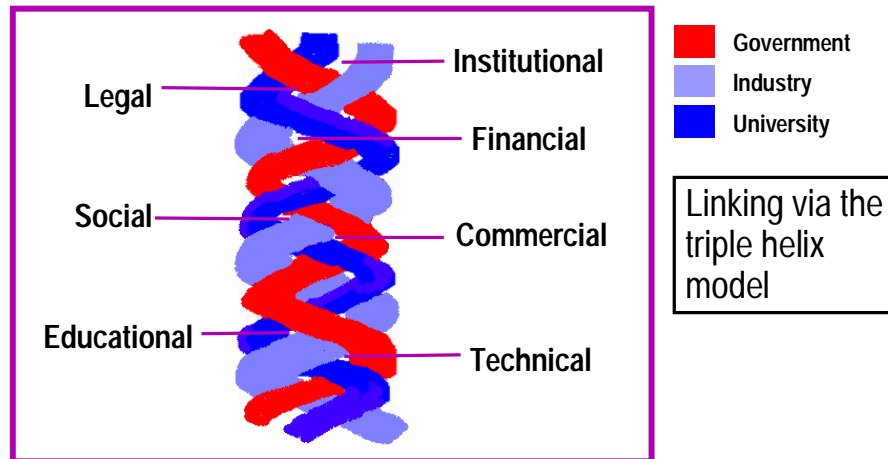
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S&T capacity building, though focused at the national level, is not restricted to it. Globalization facilitates knowledge and technology transfer, and countries share similar problems and hold comparative advantages. Regional approaches, thus, provide opportunities to leverage available resources and optimize their application to build S&T capacity at the national level.

Moreover, there is growing interest in using regional approaches to build S&T capacity in addition to binational cooperation and coordinating assistance through international organizations. In this regard, the openness of a country's national innovation system (to be discussed in the next slide) has been observed to affect a country's participation in international S&T cooperation and how much they can benefit from it to increase competitiveness in the global economy (Niosi and Bellon, 1994).

It is important to note that geography is not the sole or even primary determinant of regional cooperation. Instead it is shared concerns and goals (e.g., controlling pest infestation), similarities (e.g., soil and climatic conditions), and sometimes the presence of established mechanisms (e.g., regional S&T policy and trade forums) that facilitate the building of cooperative S&T relationships. Models for regional S&T cooperation include clusters, local cottage industries, centers of excellence and networking. Each has its own distinctive features and strengths. Selection depends on which model might best serve to leverage available resources, address shared problems, and contribute to national S&T capacity building. Although different in form or structure, they are not exclusive in practice.

A National Innovation System (NIS) Links S&T to Economic Growth



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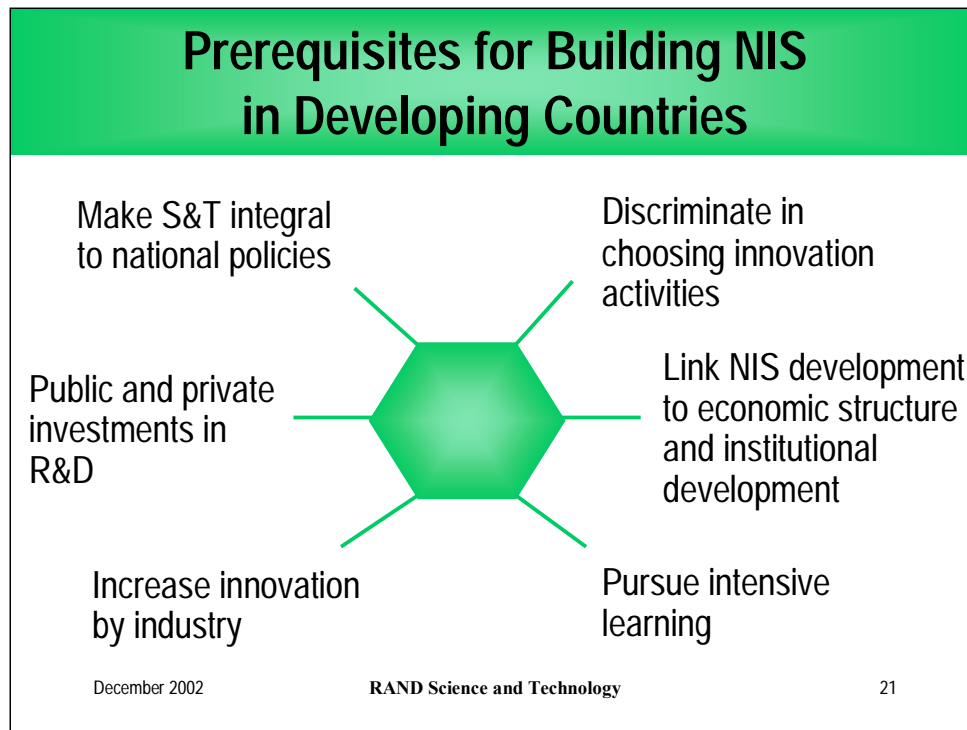
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“Competitive advantage is created and sustained through a highly localized process” (Porter, 1990). Improving S&T capacity is necessary, but it is not sufficient to generate economic growth. Building a national innovation system (NIS) provides the environment to apply science and technology to solve practical problems, such as increasing productivity and competitiveness in the global economy.

Niosi, Saviotti and Crow define NIS as “...the system of interacting private and public firms (either large or small), universities and government agencies, aiming at the production of science and technology within national borders. Interaction among those units may be technical, commercial, legal, social and financial, inasmuch as the goal of the interaction is the development, protection, financing or regulation of new science and technology.” The triple helix model shown above is one way to illustrate what it takes to construct and maintain an NIS (Etzkowitz et al., 2000). Dynamic interaction among government, academia and industry is critical to identify development challenges, channel funds to find potential solutions through research or other activities, and encourage their application to overcome development challenges and increase economic competitiveness. In addition, an NIS emerges and is sustained in an environment that has educational, technical, commercial, social, financial, legal and institutional systems that are supportive of S&T capacity building and economic growth.

Most countries have some kind of NIS. Differences among NIS across countries are for the most part due to differences in their history and culture, which can influence the types of institutions, laws and policies present and their competitiveness (Porter, 1990). Asymmetric development of the world economy and differences in growth rates across countries have also been attributed to divergences in NIS (Freeman, 1997).



Building an NIS is different from increasing S&T capacity. It has its own requirements and several major ones are listed above. These priorities are not listed in a hierarchical or sequential order and are not exclusionary in their implementation.

First, science and technology must be made integral to all national policy discussions. The goal is to identify where and how innovation might be promoted to support economic growth. Second, a country has to discriminate in choosing where and how to increase innovation since resources are always finite and comparative advantages exist in some areas but not others. Third, NIS building must be linked to economic and institutional development because the latter can affect the environment for innovation. Fourth, developing countries need to conduct “intensive learning” to catch up with the industrialized countries (Gu, 1999). One way is to improve the quality of education and research institutions. Another is to exploit a latecomer’s advantage and learn from the industrialized economies, such as imitating their S&T institutions and economic, legal and institutional infrastructure.

Fifth, developing countries must increase and accelerate innovation in the private sector to have a real impact on productivity and economic growth. Toward this end, the environment (legal, institutional, economic) in which industry operates has to be supportive of diffusion and use of innovation. Financing, technical support, standards, and clear policies and regulations, among others, need to be present to motivate industry to adopt and invest in innovation (IDB, 2001). Sixth, public and private investment in R&D are needed to build S&T capacity, which is the source of knowledge and know-how for innovations. Making public and private support complementary can more fully optimize resource use and avoid redundancies and gaps.

Outline

- Background
- Objectives of the Study
- Methodology
- Major Findings
- Approaching S&T Capacity Building
- **RECOMMENDATIONS**
- Case Studies

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This section puts forth recommendations based on interviews and findings from the case studies, as well as considerations of approaches for USAID to link S&T capacity and innovation to economic development. These recommendations aim to encourage more strategic thinking about how USAID might contribute to S&T capacity building and promoting innovation for economic development if the agency chooses to be more proactively involved in this task. We suggest areas for strategic focus and a conceptual framework to think about where opportunities might exist for USAID to optimize its resources.

Think Strategically About Building S&T Capacity and Innovation

- Increase awareness about the nexus between S&T and development and USAID contributions
- Develop capacity for S&T policy analysis
- Articulate explicit USAID policy on S&T capacity building and innovation for economic development
- Align USAID S&T policy with U.S. national security and foreign policy interests
- Make S&T an integral component of cooperation with other U.S. agencies and other development partners

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Evidence from the case studies indicates that USAID has contributed to S&T capacity building and innovation. However, much of USAID contributions occurred as a side benefit rather than an intended outcome of its activities. The agency's involvement in providing technical support and encouraging institutional and economic reforms puts it in a strong position to use its resources more strategically to build S&T capacity and promote innovation for economic development.

If USAID chooses to be more proactively involved in building S&T capacity and promoting innovation for economic development, then the agency needs to develop capacity for S&T policy analysis, articulate an explicit USAID policy for these tasks, and align it with U.S. national security and foreign policy interests.

A first step for USAID is to increase internal awareness about the link between S&T capacity and innovation for development, as well as to increase internal and external awareness about how USAID efforts contribute to S&T capacity building. Without internal awareness, USAID will not be able to mobilize the organization to think more strategically about how the agency can better use its resources.

As for increasing external awareness about USAID contributions to S&T capacity building, it is important to enable USAID to make S&T an integral component of cooperation with other U.S. agencies and other development partners. At present, USAID is rarely seen as a S&T agency, but findings from this study shows evidence to the contrary.

Focus on Building S&T Capacity and Innovation for Economic Development

- Assimilate new knowledge and tools to existing systems
- Promote sustainability in efforts
- Build S&T capacity and promote innovation in tandem
- Utilize both national and regional approaches
- Create and strengthen professional bodies and promote good practices
- Exploit cross-sectoral application of technologies

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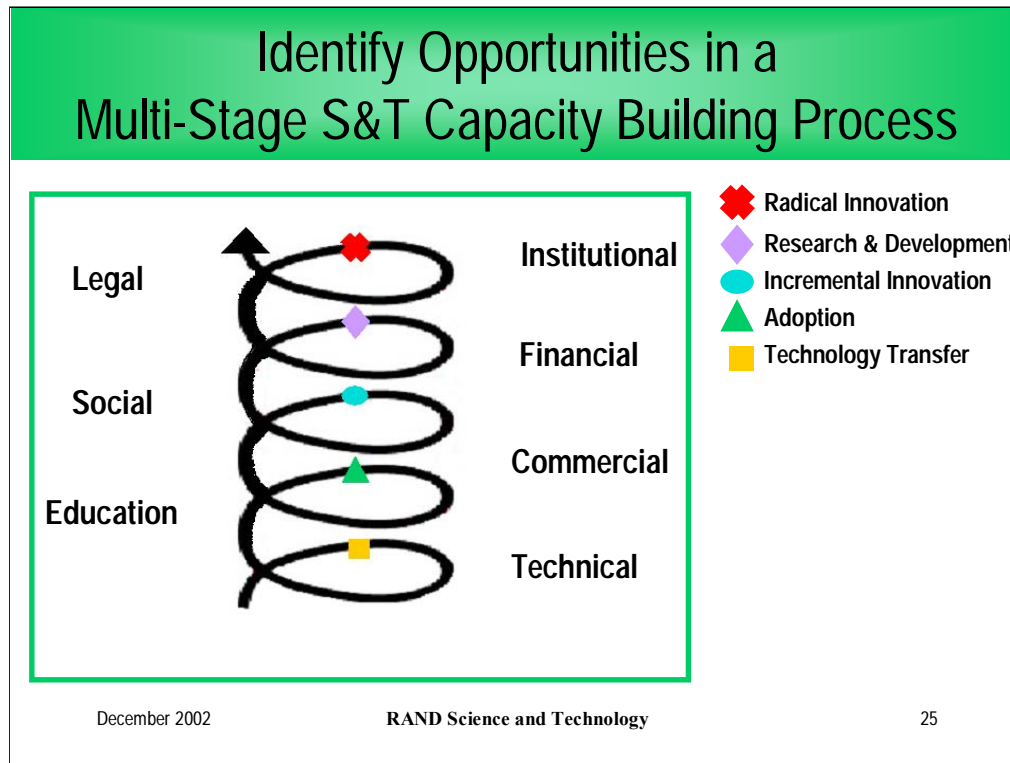
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Most economies have some capacity for education, training and research. The extent of this capacity, as well as the laws, regulations and policies present will impact S&T capacity building. Dismantling existing institutions and power structures is often difficult, if not impossible. Less resistance might be encountered if new knowledge and tools are assimilated into existing systems, building upon them and changing them from within over time rather than trying to change them overnight.

Since S&T capacity building is a continuous and cumulative process, it is critical to make institutions, financing, human capital, policies and other requirements sustainable. Demonstration or pilot projects often occur in unique settings where there is substantial political and resource commitment. In a regular setting, whether a technology is transferred and disseminated depends heavily on various conditions in the larger setting. For instance, a lack of financing options and laws that discourage innovation would bar private entrepreneurs from using a new technology. Thus, building S&T capacity in tandem with national innovation systems might better connect knowledge and tools production to their application to generate economic growth and other benefits.

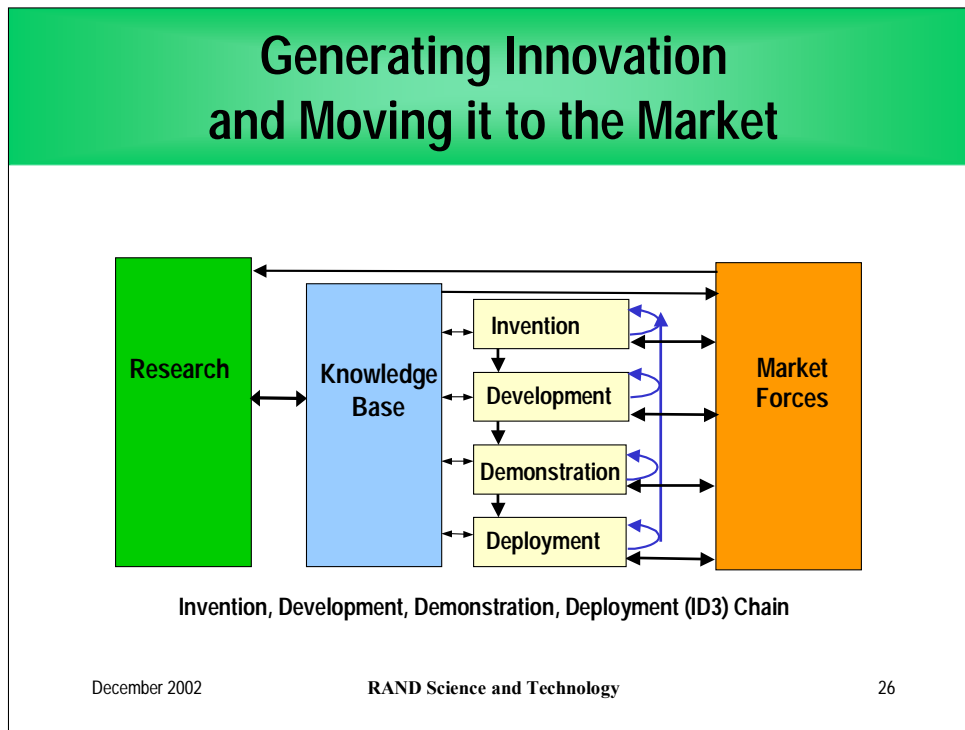
Using national and regional approaches simultaneously to build S&T capacity and promote innovation will better leverage available resources. It will also strengthen ties between people and institutions, facilitate cooperation, promote technology diffusion, and foster trade and standard development within and across borders. In this connection, creating and strengthening professional bodies and promoting good practices will have beneficial effects. Finally, cross-sectoral applications of technologies should be exploited to optimize S&T investments. Innovation research grants and information outreach are two ways to encourage this.



Since building S&T capacity for economic development is a continuous and cumulative process and countries have different capacity levels, S&T capacity building can be viewed as a multi-stage process to help identify opportunities for USAID involvement. The emergence of these stages of S&T capacity building is strongly influenced by conditions in the larger society. For this reason, USAID support to help create settings conducive to S&T capacity building is as important as direct support for R&D, technology transfer, training and other activities that are more typically associated with S&T capacity building.

For countries with the lowest level of S&T capacity, *technology transfer* and training is a first step. Exposure and experience increase capacity to *adopt* new knowledge and tools and enable their integration into existing infrastructure, or they might lead to the building of new infrastructure to utilize them. Capacity growth over time through training, investment, and licensing among others will allow *incremental innovation*, that is, imported knowledge and tools are modified to better solve local problems.

Continuing growth of S&T capacity and maturity of the innovation system will spur and sustain purposeful *research and development*. At this stage, new knowledge and tools are produced locally and the economy is capable of diffusing knowledge and tools through manufacturing, commerce and other activities. Continuing S&T capacity growth will lead to *radical innovation*. Radical innovations are new knowledge and tools that significantly increase the competitiveness of an industry or an entire economy. These are scientific and technological breakthroughs that other economies will want to import and/or emulate.



For S&T capacity building to generate economic growth and other benefits for development, a society has to be able to generate new knowledge *and* use it to create useful tools. It then has to take these tools to the market for user adoption. The “ID3 Chain” diagram shown above proposes a conceptual framework for policy makers to consider the complex and dynamic relationships that connect different components, stages and participants that are involved in creating new knowledge, inserting it into products, and bringing these new products to the market (Hassell, Wong et al., 2002). Four features in this framework are particularly noteworthy.

First, research generates new knowledge but it alone does not increase economic growth. A knowledge base, in the form of scientists, engineers, technicians, and skilled workers, is necessary. It is the result of investment in research, education and industry. A strong knowledge base means more people are able to perceive problems, propose solutions, adopt new problem-solving tools and effectively use them.

Second, the distinction between deployment and market acceptance reflects the reality that being able to put products on shelves is different from getting users to buy them. The latter is influenced by market demand, cultural preferences, and access to finance among others. This suggests that market reforms are necessary for new knowledge and tools, whether imported or homegrown, to be adopted by users.

Third, the feedback loops underscore the importance of organizational and technological linkages for interaction and/or communication to promote research and innovation activities that are relevant to the market. Fourth, the ID3 chain suggests the possibility of a self-sustaining model to produce new knowledge, tools and innovations for economic development.

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- **CASE STUDIES**

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The three case studies exploring the USAID contribution to S&T capacity building and innovation to fight HIV/AIDS and tuberculosis in Russia, to promote energy production in India, and to improve agricultural research in Africa are presented in detail.

Each case study provides an overview of the problem and USAID program and/or activities in that area. Details are also provided on the source and/or level of funding and allocations. Next, USAID strategy, approach and activities are described. Based on interviews and analysis, USAID contributions to S&T capacity building and innovation in the areas and countries examined and the lessons learned are presented. The last section describes challenges and opportunities to continue S&T capacity building in these areas and countries. Analysis and proposals in this section are based upon input from experts the research team had spoken to. These proposal, in particular, aim to address issues in the larger context of building S&T capacity and promoting innovation for economic development for anyone interested in these matters.

Russia – Public Health

- Explosive growth of HIV/AIDS and TB infections
 - Infection and mortality highest among young people
 - Potential to infect populations outside of Russia
- For HIV/AIDS: prevention among high-risk groups, training health workers and laboratory equipment upgrades
- For TB infection: introduce proven diagnosis and treatment approach

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USAID assistance for Russia is part of a broader agency strategy for all the Newly Independent States (NIS). HIV/AIDS and STD prevention and TB treatment and control are top priorities for USAID in Russia's health and social sector reform. Other priorities are women and infant health, health care quality and reform, and health partnerships. These priorities were identified by the U.S.-Russia Health Committee, which was formed in 1994 under the U.S.-Russia Bilateral Commission.

Promotion of democratic and market reforms is the main thrust of USAID activities in Russia. However, emphasis on humanitarian assistance, particularly in health and social services, increased as economic difficulties throughout much of the first decade of the Russian Federation severely impacted the health of the Russian population. One indicator is the decline in Russian life expectancy between 1987 and 1994.

Although the overall death rate has returned to the early 1980s level, the death rate among the 15 to 30 age group has remained high. Experts are particularly concerned by the high rate of HIV/AIDS and TB infections among this age group. Without drastic actions to curb these diseases, Russia could lose as much as 10 to 15 million of its population by 2015. Premature deaths among the 15-30 age group, the workers of tomorrow, will severely cut productivity and threaten long-term economic growth in Russia (National Intelligence Council, 2000).

USAID activities to prevent HIV/AIDS (and STD diseases in general) emphasize prevention among high-risk groups, training of health workers, and laboratory equipment upgrades. In fighting TB, USAID is helping Russia to adapt and implement diagnosis and treatment approaches that have shown success in many other parts of the world.

USAID is a Top Donor for HIV/AIDS and TB Prevention in Russia

- USAID is a top donor for HIV/AIDS prevention and the largest donor for TB treatment and control in Russia
- Since 1992, USAID has spent over \$120 million on health work in Russia and trained more than 10,000 Russian health professionals
- USAID funds for HIV/AIDS and TB are growing in Russia
 - HIV/AIDS: \$2 million in 2000 to \$5 million in 2002
 - TB: 1.3 million in 1999 to \$1.8 million in 2002

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The United States is the largest donor of bilateral assistance to Russia. The Freedom Support Act (FSA) approves U.S. assistance to NIS. FSA provides the bulk of U.S. assistance to Russia and nearly all USAID funds for Russia. Between FY 1992 and FY 2000, USAID funds and obligations to Russia reached a total of \$1,954 million. In FY 2000, USAID programs were about \$61 million of \$168 million allocated under FSA (U.S. State Dept., 2001).

USAID assistance for health programs ranks third behind its support for private enterprise growth and privatization programs in Russia. Since 1992, USAID has provided over \$120 million for health programs in Russia and trained more than 10,000 Russian health professionals. USAID is a top donor for HIV/AIDS prevention in Russia and the largest single donor for TB treatment and control in Russia. USAID funds for "Special Initiatives" and "Cross-cutting Programs" provide additional support for health care improvement, training, and exchanges with Russia.

There has been overall growth in USAID funds for HIV/AIDS prevention and TB treatment and control worldwide in the last several years. USAID support for HIV/AIDS prevention in Russia has grown from \$2 million in 2000 to about \$5 million in 2002. For TB treatment and control, USAID funding began in 1999 at \$1.3 million and projected to reach \$1.8 million in 2002.

Russia Has the World's Fastest Growth Rate in HIV/AIDS Infection

- 10-15 million of Russians expected to die from HIV/AIDS by 2015
- Russia first dismissed the problem and numerous constraints hamper responses
- Today Russia has large high-risk population
 - 3 million injecting drug users
 - Over 10 million sexually transmitted disease cases
 - Large sex industry

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The Russian government estimates there are 130,000 HIV/AIDS cases among its 145.5 million people, but international experts think it is 2.0 to 2.5 times higher. Until 1994, Russia had very low levels of HIV infection. By 2001, more than 40,000 new HIV-Positive diagnoses were reported in just 6 months – more than the 29,000 infections recorded between 1987 and 1999. UNAIDS reported that Russia now has the fastest growth rate of HIV/AIDS infection in the world. At this rate of infection, 10 to 15 million Russians could die from the virus by 2015 (National Intelligence Council, 2000).

In Russia, the majority of reported HIV infections are related to injecting drug use (IDU), which is widespread among young people, especially men. Young women are also increasingly at risk. The male-female ratio for newly detected HIV cases has narrowed from 4:1 to 2:1 (UNAIDS, 2001). The prevalence of STD infections among virtually all age groups and the presence of a large commercial sex industry in a largely conservative culture further complicate education and treatment efforts.

In addition, Soviet and then Russian authorities first ignored HIV/AIDS, which was considered a disease of the West. The first national anti-AIDS program in Russia was not launched until 1993. Moreover, the old Soviet health system that Russia inherited emphasizes control over prevention so there was little impact in slowing HIV/AIDS infection. Severe economic problems in Russia also cut federal funds between 1996 and 1998, which delayed the development and implementation of a national response. Lack of networking among organizations dealing with HIV/AIDS within Russia also hampered efforts to assess the scale and characteristics of the problem and to develop and implement response strategies.

TB Resurgence is Killing Many Young Russians

- Russia has highest mortality rate for TB in Europe
- Civilian infections more than doubled from 1990 to 2000
- Prison TB cases tripled between 1993 and 1999
- Contributing factors: Poverty, poor nutrition and weaknesses in Russian health system

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Today Russia is a leading hot zone for TB, particularly the multiple drug resistant (MDR) strains. Poverty, poor nutrition, shortage of public funds for drugs and treatment, outdated treatment techniques, and lack of public awareness have fueled the number of TB infections and mortality across Russia in recent years.

Until the collapse of the Soviet Union in 1990, the old Soviet health infrastructure had been fairly successful in controlling the disease. TB infection rate fell to its lowest in 1990 and 1991 at 34.2 cases per 100,000 population, down from more than 100 cases per 100,000 population in the early 1960s. However, by 1999, an estimated 358,000 civilians were infected and the infection rate reached 95 per 100,000 population in 2000. Mortality rate also nearly tripled between 1990 and 2000 to 20 deaths per 100,000, and 40% of the deaths were among patients below the age of 39 years.

The problem is worse in the Russian prison system. Between 1993 and the first half of 1999, the number of infections nearly tripled from 35,000 to 98,261 cases and between 25% to 40% are MDR strains. Moreover, these infected prisoners are spreading TB to the general population: About 30,000 prisoners with active TB are released each year. Another 240,000 released each year are believed to carry a latent form of the disease that can turn infectious over time (PHRI).

The demographic profile of TB patients reflects another dimension of this public health threat. TB used to affect the middle aged or elderly in the Soviet era. Today 40% of those who die from TB are below 39 years old. The Russian government recorded an eight-fold increase in mortality among teenage males between 15 and 19 years and a six-fold increase among men aged 20 to 24 years (PHRI). In other words, TB is now a prime killer of the workforce in Russia today and tomorrow.

USAID Emphasizes HIV/AIDS Prevention

- Surveys and pilot projects have improved services for high-risk groups, upgraded labs and introduced new methods for STD diagnosis and treatment
- Trained more than 10,000 Russian health professionals
- Russian NGOs learned from world experts, now they are teaching other Russian NGOs
- Russian government is slowly adopting new thinking and policies toward HIV/AIDS

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The USAID anti-HIV/AIDS strategy for Russia was developed in consultation with the Centers for Disease Control (CDC), non-governmental organizations (NGOs), and the Russian Ministry of Health. The first implementation period was from 1998 to 2000, with a review in 2000. A follow-on strategy for 2001 through 2003 is being implemented. High-risk populations, e.g., intravenous drug users (IDUs) and commercial sex workers, are the primary foci in both strategies. Moscow City, Samara and Saratov *oblasts*, or regions, serve as demonstration sites. Both strategies use partnerships with other donors and local entities to increase Russian capacity. By February 2001, Russian NGOs that had worked with international experts began actively transferring knowledge, skills, and experiences to their Russian counterparts.

Population Services International (PSI) and CDC have been key USAID partners in developing and implementing both strategies. PSI conducted HIV/AIDS and STD awareness training with NGOs and prevention education for at-risk groups and the general public. CDC helped Russian STD and HIV/AIDS specialists to run training workshops and conferences on intervention and treatment. These efforts have trained more than 10,000 Russian health professionals and increased networking among them.

USAID also funded PSI, CDC and other partners to conduct surveys on high-risk groups for target interventions. Survey results helped to improve laboratory equipment and training and introduced new methods for STD diagnosis and treatment guidelines. A CDC laboratory and behavioral risk assessment study are helping Moscow City to improve health and social services for street children and adolescents, and a joint CDC-Russian study on congenital syphilis persuaded the Russian federal government to urge active interaction among women, STD and children's health experts.

USAID is Changing How Russia Treats and Controls TB

- Success in pilot projects and demo sites helps to spread the Direct Observation Treatment Short Course (DOTS) approach to more places
- Personnel training is changing diagnostics, treatment, surveillance and case management practices
- Education is curbing infection among health workers and cross-infection among patients
- Involving Russian NGOs is part of the strategy

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Introduction of the Direct Observation Treatment Short-Course (DOTS) has been a key focus for USAID's anti-TB work in Russia. The World Health Organization recommends it for national TB control programs worldwide. USAID has worked with WHO, CDC, the Russian federal government's Central Tuberculosis Research Institute (CTRI), the International Federation of Red Cross and Red Crescent Societies (IFRC), and others to implement pilot projects in Ivanova, Orel, and Vladimir oblasts to demonstrate the effectiveness of DOTS. These oblasts were chosen for their capacity to implement DOTS and their epidemiological situation. DOTS is now a part of their civilian TB care system. It has also been introduced to the prison TB hospital system in Orel, and assessments have been conducted in Ivanovo and Vladimir to identify drugs and laboratory equipment needed to implement DOTS in their prison health systems.

Beyond DOTS, USAID has worked other donors and the Russian Ministry of Health to improve data collection and treatment surveillance systems. In training, USAID co-funds a training center in Kemerovo oblast with the University of Alabama, and CDC and WHO are its main technical partners. Infection control courses in Orel and Ivanovo addressed infection among healthcare personnel and cross-infection among patients. Thousands of Russian health personnel have received instruction on standard protocols in infection control and drug resistance, training in data monitoring, microscopy, lab cultures, and infection control procedures. A sub-grant to IFRC and the Russian Red Cross helps to provide social support, e.g., hot meals, blankets, hygiene packages and psychological counseling, to TB patients in Orel. The goal is to encourage uninterrupted treatment and prevent the development of MDR strains.

Lessons Learned

- Russia has a high level of basic capacity, but Soviet legacies hamper transfers of new knowledge and tools
- Both top-down endorsement and bottom-up support are critical to knowledge transfer and its implementation
- Partnership with Russian government and private sector encourages Russian “ownership” and cooperation
- Sensitivity to local perspectives and priorities is vital
- Persuasion by demonstration is a good practice

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Capacity building in Russia to implement new approaches and techniques to fight HIV/AIDS and TB is aided by the relative high level of human capacity in Russia. However, many Soviet legacies hinder transfers of new knowledge and tools and block changes to the Russian health system. For example, as much as 80% of all Russian federal funds are spent on testing for HIV/AIDS and staff salaries rather than prevention activities. The use of hospital-based and specialized treatment over emergency and primary care in Russia also makes TB treatment more costly and less effective.

The partnership approach has enabled USAID to leverage resources of other donors and the expertise, skills, and networks of partners inside and outside of Russia. Nevertheless, sustained efforts to build S&T capacity ultimately depend on Russian commitment. High-level endorsement by the Russian government helped increase Russian federal resources, allowed lower Russian authorities and NGOs to work with USAID, and helped change national policies and laws. Bottom-up support from local authorities, health workers and NGOs was critical to real improvement in human and institutional capacity for long-term S&T capacity building.

Sensitivity to local sentiments and priorities helped USAID to devise appropriate strategies to counter Russian biases and resistance to the USAID-introduced approaches and techniques. For example, success of DOTS in Africa is rarely mentioned. DOTS is presented as WHO-recommended procedures and introduced to Russia by CDC and WHO experts who are highly regarded in Russia. Also, success of pilot projects persuaded the Russian government and health workers of the merits of these approaches and techniques. This makes demonstration a good practice.

USAID Contributions to S&T Capacity Building

- Increased technical capacity for HIV/AIDS prevention and TB treatment and control
- Successful demonstrations reducing HIV/AIDS infection and increasing TB treatment and control facilitated legal reforms and increased budgets to fight HIV/AIDS and TB
- Surveys and studies increased Russian knowledge about these two diseases

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USAID efforts to address HIV/AIDS and TB in Russia has contributed to increased Russian S&T capacity to deal with these diseases.

There is increased technical capacity for HIV/AIDS prevention and TB treatment and control through education and training programs for Russian health workers, including those working for NGOs, laboratory equipment updates, and professional forums and conferences. The latter, in particular, has the effect of enhancing professional networks for information dissemination about the spread of these diseases and treatment outcomes.

Successes in reducing HIV/AIDS infection and TB treatment and control at the various demonstration sites across Russia have built support for the new approaches introduced by USAID among local health officials and many health workers. Local governments, in particular, have become more eager to adopt the new approaches introduced by USAID. Survey findings and exchanges among high level health officials between the two countries have also helped to persuade the Russian Federal government to introduce laws and increased funding for HIV/AIDS prevention and TB treatment and control. These measures help to support Russian cooperation with international development partners like USAID and improve Russian S&T capacity to fight these diseases.

Challenges and Opportunities

- Integrate new techniques to fight HIV/AIDS and TB into the general health care system in Russia
- Counter institutional and cultural resistance through concurrent top-down and bottom-up changes
 - Deepen institutional and economic reform of health sector
 - Expand and improve training for health professionals
 - Increase networking to share experience and build support for reform

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Experts we spoke to for this study said that institutional and economic reform of the Russian health care system is critical for the new techniques to take hold and be integrated into the general health care system. Although Russia has a high level of technical know-how to facilitate the adoption of these techniques, there is considerable institutional and cultural resistance to change.

The Russian health bureaucracy is massive and it depends heavily on Russian federal funding. Medical researchers, administrative personnel, and health care professionals are all part of this overburdened and under-funded system. In the face of uncertainties, there is a general resistance to any change that is perceived to threaten their authority and jobs.

Nevertheless, there are opportunities to improve the Russia health care system and reduce the number of HIV/AIDS infections and TB cases. The Russian government and health researchers and workers acknowledged that HIV/AIDS and TB will have a severe impact on Russia's economic future unless urgent actions are taken. USAID efforts described in this case study show that small incremental changes can make a positive difference over time. Institutional and economic reforms will make research, training, public education and drug supply and deliverable more financially sustainable. Expanding and improving training for Russian health professionals to do supervision, monitoring, and surveillance will lay a foundation for a prevention and evidence-based approach to public health. Centers of excellence and other regional frameworks, professional meetings and information and communication technologies will support information sharing and networking among Russian health researchers and workers.

India – Energy and the Environment

- Energy production is inefficient and has severe human health and environmental impact
- USAID response:
 - Transfer energy efficient technologies
 - Promote power sector reform
- This focus is in line with USAID strategic goals, its energy initiative for South Asia and Indian Government priorities

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Increasing energy efficiency is a priority for USAID in India. Since the early 1990s, the Indian government has increased economic growth, investment flow and trade through major reforms. However, existing power generation technology and institutions are unable to cope with rising demand. Moreover, inefficient use of high-ash coal, in particular, has severe health and environmental impact.

Due to the high costs of replacing coal-based plants, existing plants will likely continue to operate for the next two decades (EIA, 2002). With that in mind, USAID promotes clean energy development, efficient energy use, and pollution reduction in key industries in India. USAID-sponsored activities are carried out through direct cooperation with other donors and Indian partners, including NGOs, industry, research institutions, and all levels of government. In terms of technical expertise, USAID frequently turns to the U.S. Department of Energy and utilizes the considerable endogenous science and technology capacity available in India. All these activities have benefited from the momentum created by the economic and institutional reforms in India.

The focus on energy efficiency is in line with one of USAID's major strategic goals, which calls for environmental protection for long-term sustainability. It links directly to USAID's South Asia Regional Initiative in Energy, which attempts to substitute a portion of the coal used in India's power plants with cleaner fuels produced in neighboring countries, as well as to share best practices at a regional level. Moreover, the focus corresponds to the Indian government's efforts to establish a Bureau of Energy Efficiency (BEE) to provide a policy framework for national energy conservation efforts and to implement energy efficiency programs throughout the country.

Funding for Strengthening Existing Power Capacity

- USAID funds for environmental protection in energy, industry, and cities are growing in India
 - From \$8.9 million in FY2000 to \$16.6 million in FY2002 through Development Assistance and Economic Support Funds
- Support also through the South Asia Regional Initiative for intra-regional trade of natural gas and hydroelectric power

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In the last two decades, USAID support for India averages about \$157 million per year. Funding for India comes under several internal accounts. The account for Food and Disaster Assistance under Public Law 480 Title II provides the largest budget for USAID activities in India. Other major USAID accounts for activities in India are the Child Survival and Disease Programs Fund, the Child Survival and Health Programs Fund, the Development Assistance Fund, and the Economic Support Fund.

USAID assistance in India for energy and environmental programs ranks second behind child survival and nutrition programs. USAID funding for energy and environmental programs has doubled from \$8.9 million in FY2000 to \$16.6 million in FY2002. Funding for these efforts is allocated under the Development Assistance Fund and the Economic Support Fund.

Assistance is also provided through the South Asia Regional Initiative (SARI) to promote regional trade in hydroelectric power and natural gas, and to create partnerships and networks for the exchange of ideas. SARI covers India, Bangladesh, Sri Lanka, Nepal, the Maldives and Bhutan.

The new USAID Strategic Plan for India (FY2003-FY2007) proposes \$20 million for energy conservation and technology commercialization projects.

India's Increasing Demand for Power

- India is the world's sixth largest and second fastest growing producer of greenhouse gases
- Power sector alone accounts for 48% (71 million tons) of India's carbon emissions
- Future growth will require a doubling of current power-producing capabilities
- However, future capacity needs cannot be met, with existing inefficiencies of the power distribution structure

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India is the world's sixth largest and second fastest growing producer of greenhouse gases. Data from India's National Ambient Air Quality Measuring Network indicate that 14 of India's 20 largest cities have air quality that is considered "dangerous." This is in large part due to the inefficient power sector, which produces 48% (71 million tons) of India's carbon emissions. The dependence on high-ash coal for power generation in India, particularly its industrial sector, is a major problem.

India's power sector has increased its capacity from 30,000 MW in 1981 to about 104,000 MW in 2002, but power capacity still falls 30 percent short of demand. Although 6,000 MW of capacity will be added each year over the next 4-5 years, India still will not meet the targeted capacity of 111,500 MW by 2007. Chronic power shortages and poor power quality are made worse by inefficiencies in power generation and distribution. The State Electricity Boards (SEBs) are responsible for the generation, transmission, and distribution of electricity for each state. Their deteriorating performance over time has incurred enormous financial losses. Inefficiencies in the distribution structure have been attributed to irrational tariffs, archaic industrial processes and equipment, and inadequate policies related to energy efficiency, standards, labeling and financial incentives.

In response to these problems, the India government enacted the Energy Conservation Act in 2000 and established the Bureau of Energy Efficiency in 2002. The BEE's mission is to guide industry to achieve substantial energy saving through voluntary measures and self-regulation. The Ministry of Power is working to make SEBs more efficient, accountable and autonomous. USAID provided policy support to the Indian government to develop the Act and establish the BEE and its business and action plans.

USAID Strategy Promotes Efficient Energy Development and Power Sector Reform

- Assistance focuses on increasing efficiency and commercialization of energy technologies
- Systemic reform to facilitate energy development (e.g., financial, regulatory, market, policy)
- Facilitate technology dissemination and adoption
- Adoption of certified environmental management systems (ISO 14001)

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Energy and the environment has been a major focus for India and USAID in recent years. USAID's current strategy for energy and the environment in India is composed of several projects to promote clean energy development, efficient energy use, and pollution reduction in key industries, as well as power sector reform. Our sources highlighted several of these USAID activities.

The Program for Acceleration of Commercial Energy Research (PACER) worked through the Industrial Credit and Investment Corporation of India (ICICI Ltd.) to develop energy efficient, alternate fuel and renewable energy technologies. The program allocated R&D funding based on market needs, by requiring that a manufacturer, R&D institution, and an end-user apply for the grant as a consortia to forge a linkage among the three entities.

The Greenhouse Gas Pollution Prevention Project increases both the efficiency of coal-fired power plants and the use of biomass fuels in selected industries. The Energy Conservation and Commercialization Project promotes commercialization of energy efficient technologies by addressing market, economic, regulatory, policy and institutional barriers inhibiting their usage. The Financial Institutions Reform and Expansion Project develops commercially viable urban infrastructure finance systems through demonstration projects and capacity building.

USAID has also created a number of environmental/energy centers throughout India. These centers facilitate technology dissemination, consultation among stakeholders, and promote technology adoption. Finally, the Clean Technologies Initiative assists Indian industries to adopt certified environmental management systems and enhance their capacity to incorporate best practices and technologies for enhanced productivity and profitability.

Lessons Learned

- Commercially viable technologies succeed – environmentally superior technologies are not enough
- Building on S&T capacity enables a higher rate of success in technology transfer projects
- Regulatory, financial, market, policy and institutional reforms are vital to long term and lasting improvements

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Our sources observed that the most successful energy projects are those that are commercially viable while producing environmental benefits. Environmental benefits alone are not enough to encourage adoption of a new technology. The likelihood that technologies are sustained increases if they are commercially viable.

USAID has been able to conduct successful demonstration projects in India. The key is that USAID has been able to build upon India's existing science and technology capacity and momentum of economic reforms to introduce new ideas. India has shown the will to make internal changes as evidenced by the Energy Conservation Act 2000. Moreover, USAID has been opportunistic, exercising interventions where relevant. For example, encouraging the sugar industry to use biomass fuels under the Greenhouse Gas Pollution Prevention Project cuts down consumption of fossil fuels for power generation. Another source of success is USAID responsiveness to the needs of local partners, which enhances commitment by the local partner. USAID has also been critical in choosing local partners. For example, USAID chose to work with Indian industry associations, which were more able to identify "good" industry partners for environmental management, than the Indian government offices.

Existing S&T capacity enables higher rate of success in technology transfer projects, but regulatory, financial, market, policy and institutional reforms are vital to long term and lasting improvements. Huge financial losses due to poor billing, metering, payment collection and theft of power persist even as new technologies are curbing pollution and increasing efficiency. Environmental laws and regulations are necessary and must be enforceable to improve private sector compliance.

USAID Contributions to S&T Capacity Building

- A market-driven approach for technology transfer and commercialization
- A biomass power generation model with grid sell-back
- Information sharing and technology dissemination
- The adoption of ISO 14001 environmental management certification systems and procedures

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USAID efforts build upon India's existing S&T capacity in the power sector. PACER, as a USAID-funded activity, ended in the late 1990s. ICICI Ltd., an Indian-owned bank, has now taken that lead in spawning venture capital in India, continuing the market driven approach for S&T. Conditional grants through this program sponsor technology transfer to help start technology-based enterprises with a focus on energy and the environment. Those who fail do not have to pay back their grant, while those who succeed pay back 200 percent of the sum received. High success rate has generated a pool of about \$20 million for additional grants.

Biomass fuels are promoted as an alternative to fossil fuels. Cogeneration in the sugar industry using biomass fuels, in particular, is increasing. Nine sugar mill power plants are up and running, of which eight are currently selling power to the grid. For these sugar mills, power production has become their primary revenue source. This initiative has also resulted in the creation of training programs, workshops and information dissemination for sugar industry professionals.

At the local, regional and national levels, research and information centers created with USAID support, such as Environmental Information Centre and the Centre for Power Efficiency and Environmental Protection have increased information sharing, technology dissemination, and industry partnerships to promote technology adoption.

Indian industry associations that partnered with USAID have also taken the lead to promote adoption of ISO 14001 certification by Indian factories. Adopting environmental management systems enable companies to improve environmental performance and to be more competitive in international markets.

Challenges and Opportunities

- Document program performance and analyze costs and benefits that will guide future policies and actions
- Further reform institutions in energy sector, esp. the State Electric Boards, to rationalize resource allocation and improve power generation and distribution
- Improve energy efficiency at private household level

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A first task would be to document program performance and analyze their costs and benefits. A great deal of knowledge about how USAID brought together partners and enabled forums and processes for partnership building to produce energy efficient technologies and their adoption has yet to be fully documented and analyzed. Such information will support performance measurement and impact assessment by USAID, the Indian government and others interested the energy sector in India, and help guide future policies and actions to promote public and private investment.

Second, further institutional reform in the Indian energy sector, particularly the State Electric Boards, will rationalize resource allocation and improve power generation and distribution. Experts spoken to believed that greater autonomy for SEBs will allow them to make better use of state funds and work with private partners to improve business operations. Allowing them to give franchises to private power distributors might help to upgrade infrastructure and improve power production and distribution. Also, state power subsidies could go instead to education, health and other areas to build social capital.

A third major task is to increase energy efficiency at the private household level. Industry has been the main target for energy efficient technologies, but heavy state subsidies for cheap (and unreliable) electricity for private households has larger economic and environmental costs. Unreliable power supply means that households have to rely on small power generators for backup and use less energy efficient water pumps (which apparently can better withstand sudden power surges when power goes out and returns). The former increases air pollution and greenhouse gas emission, and the latter wastes water as the pumps are typically left running at all times.

Africa – Agriculture

- Urgent need for S&T and innovation in agriculture to stimulate economic growth in Africa
- Renewed interest in agriculture among African policymakers
- USAID investing at regional and national levels to promote
 - Sustainable agricultural research
 - Dissemination of research and technology

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The vast majority of people in Africa depend on agriculture for their livelihood but hunger is a constant threat. High population growth compounded by falling agricultural productivity, human capacity degradation, environmental stress, institutional decay, global competition and other problems. However, endogenous capacity for agricultural research and technology dissemination in Africa is very limited. For decades, most African governments have favored investment in other economic sectors. Research funded by donors, though useful in many instances, does not always build sustainable S&T capacity. In some instances, research agendas become driven more by donor interests than domestic priorities.

Research over the past decade has given rise to a new perspective toward rural poverty reduction. Research shows that rural households depend on more than farm-based income for their livelihood and agricultural self-sufficiency has not increased food security. These findings indicate that agricultural research has to go beyond crop research to cover non-cropping activities, e.g., improving market efficiency, promoting agribusinesses and trade, and developing innovative finance options to disseminate agricultural research and technology.

At USAID, the importance of agricultural sector development to rural poverty alleviation in Africa is well recognized. The Africa Bureau emphasizes sustainability in agricultural research in Africa and explicitly connects its results to rural household income growth. A renewed interest in agriculture among African policy makers and donors, including the U.S., further underscore the need for S&T and innovation in Africa to find short- and long-term solutions to food security and economic growth.

Funding for Regional R&D and National Capacity to Adopt Technology

- USAID funds supports a variety of agricultural research and training institutions in Africa
- New USAID strategy focuses on strategic assistance for regional R&D and national capacity to adopt technology
 - Because agriculture research institutes and policies in African countries are often weak in knowledge transfer and dissemination

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For decades USAID has supported agricultural research in Africa through contributions to national agricultural research institutions or international agricultural research centers like the Consultative Group on International Agricultural Research (CGIAR).

USAID funding for agriculture and rural development is now part of a larger Africa-wide strategy for sustainable development. Food security is a top priority and raising agricultural productivity is considered key to economic growth. Total USAID research support for African countries was \$51 million in FY 2001. Of this sum, \$15 million or 30% went to agricultural research. This made agricultural research the largest research area for USAID in Africa. In the same year, USAID also supported agricultural extension and technology transfer (\$21.4 million) and agribusiness development (\$24.2 million) in Africa.

The first USAID plan for agricultural research in Africa was introduced in 1985. Since then USAID has emphasized building sustainable agricultural research. USAID agricultural research support focuses on countries with basic capacity to produce technology and strengthening their capacity to adapt and disseminate technology. Research connects farm-based and non-farm based activities necessary to achieve the ultimate goal of rural poverty alleviation. For instance, studies try to identify the tangible economic and social benefits of agricultural research and to devise innovative institutional and financing options to support agricultural research and technology dissemination. Funding also goes to study how existing regional commodity networks can be used to promote agricultural trade and overcome institutional and policy barriers to technology dissemination at the national level.

Research Needs to Produce Economic and Social Benefits

- Many problems are worsening the vicious cycle of poverty and environmental degradation in Africa
- Need institutional innovations in international and national agricultural research systems
- Need private sector involvement in innovation
- Need to strengthen endogenous capacity to fund and disseminate research

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Over the years, African governments have made only minimal investment in infrastructure for agricultural productivity. Farmers find it difficult to access basic productivity inputs, such as fertilizers, animals traction and seeds, as well as more advance agricultural technology. Weaknesses in market information, transportation and other components of the output infrastructure make it difficult for farmers to profit from their labor. High rural population growth, small farm size and land tenure practices also affect agricultural productivity in Africa. An emerging threat is the high levels of HIV/AIDS infection in African countries. The disease is cutting labor productivity across all economic sectors, including agriculture, and knowledge and human networks deteriorate as more people succumb to the disease. All these factors feed the vicious cycle of poverty and environmental degradation in Africa.

For these reasons, more recent studies assert that agricultural research has to be result-oriented. Innovative policies, institutions and financing mechanisms are needed in international agricultural research institutions and national agricultural research systems alike to turn research results into tangible economic and social benefits. Structural barriers to innovation must also be removed. Also, economic and trade policies have to encourage rather than stifle private sector involvement in agricultural research (World Bank, "What is the..."; Juma, 1999; Christensen, 1994; Edwards et al., 1997).

Strengthening African capacity for economic impact assessment would also help the development of a future research agenda and national policymaking. At present, the impact of research and technology on agricultural productivity are largely unknown. As a result, redundancies and gaps in agricultural research are widespread and investments on technology development and dissemination lack focus and have limited success.

USAID Strategy Emphasizes Regional-National Linkages

- Strategic Framework and Strategic Plan (1998-2003)
- Assistance focuses on building S&T capacity at regional level to leverage resources, avoid redundancies and address gaps at national level
- Strengthen and innovate strategies, policies and institutions at national level to maximize impact of research results

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The 1985 Plan for Supporting Agricultural Research and Facilities in Africa underscores that improving agricultural technology is crucial to improving agricultural productivity, relieving hunger and generating economic growth. USAID funded agricultural research through its own projects and through contributions to international agricultural research centers.

Findings from research generated by the 1985 Plan and inputs from governments and researchers in Africa helped formulate the new Agricultural Strategic Framework and Strategic Plan (1998-2003). The Strategic Framework focuses on technology development and transfer with a strong emphasis on their adoption by end users for the explicit purpose of improving productivity and economic growth. The means to achieve this goal is to promote regional economic trade, investment and integration, and to improve the environment for cross-border agricultural research.

The Strategic Plan focuses on improving food security through trade and investment in agriculture. Strong emphasis is placed on strengthening African technical know-how, market efficiency, and increasing private sector participation in agricultural research. Regional R&D agendas are developed to reduce duplication and share costs. Sub-regional strategies try to identify market opportunities, encourage cooperation in R&D, create partnerships and build knowledge and information systems. There is also emphasis on training in agricultural policy analysis and impact assessment, storage technology, integrated pest management and natural resource management.

Lessons Learned

- Building research capacity is critical, but other capacities are also essential to enable application of new knowledge and tools
- Technology must address constraints and concerns among users to win acceptance and create benefits
- Financial and institutional innovations are essential to overcome barriers to the adoption of new technologies

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Building S&T capacity for agricultural research is important but doing this alone will not bolster agricultural productivity or improve livelihood. A society has to have institutional, management and planning capacity to foster S&T capacity growth and promote innovation for economic development.

Research has to be relevant to the needs of the society. Moreover, whether research results can increase productivity and income, improve nutritional gains or reduce environmental impact depend on their adoption. Adoption, in turn, depends on costs, accessibility, and market conditions. For example, without financing or training, potential users may be deterred from adopting a specific technology. Also, increased productivity in a closed market will drive commodity prices down and hurt the producer, rather than increase economic benefits.

Hence, appropriate strategies, policies and institutions are needed for sustained agriculture-led economic growth to occur in Africa. Institutional innovations in national agricultural research systems and improving their ties with international agricultural research centers will facilitate research cooperation and transfer of knowledge and technologies. Dissemination of research results to end users requires institutional and financial innovations at the national level. These include new models for reform and investment in outreach, training, and infrastructure. Changes in the larger policy and economic setting, e.g., improving market efficiency and opening trade, increase incentives for users to adopt new technologies. The merits of a technology and even financial support for adoption are insufficient to increase technology adoption and promote innovation, unless users and innovators can expect direct benefits.

USAID Contributions to S&T Capacity Building

- Increased endogenous scientific capacity to create new knowledge
- Improved institutional linkages and introduced innovations to make agricultural research more relevant and financially sustainable
- Increased endogenous capacity to disseminate and adopt new knowledge and tools

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Research produced under the 1985 Plan gave guidance to further research and activities under the Agricultural Strategic Framework and Strategic Plan. Research focused on commodities with high impact on nutrition, employment and income, such as staple crops like edible legumes, roots and tubers. Such efforts produced new knowledge and tools to increase agricultural productivity and nutritional gain in many instances. Institutional innovations were also implemented. For example, information outreach to agribusiness associations supported diffusion of research results and their application to increase productivity. More active and stronger agribusiness association also strengthened commodity trade networks inside and across countries. Household incomes increased as a result of these networks, which helped to boost trade and reduce transaction costs for inputs, such as seeds. These networks also facilitated technology development and dissemination when users spoke about their experiences to persuade others and provided feedback to technology providers or promoters. Financing innovations, like microfinancing, also made it possible for users to adopt technology and cycle funds back to technology developers and innovators.

Linking agricultural productivity to trade has promoted changes in economic and trade policies in many African countries and has increased domestic and transborder trade. Agricultural research has been complemented by training in storage technology, agricultural policy and economic impact analysis to make this outcome possible.

Expanding regional research and trade networks have also helped to disseminate technology across countries in the continent. At least 118 new technologies have been introduced in 31 African countries through collaborative regional activities.

Challenges and Opportunities

- Identify most promising niches for future investment based on analysis of past and current efforts
- Deepen reforms to support technology dissemination and innovation for economic growth
- Improve information and communication infrastructure to support research and trade
- Expand education and training in agricultural research and agricultural technology deployment

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Scientific centers of excellence exist in several countries in Africa, along with national and international agricultural research centers active in some areas of research. However, with few exceptions, there is a severe lack of capacity among African countries to translate research results into economic and social benefits. Hence, research and its transformation into useful tools and their adoption are still more haphazard occurrences than systematic outcomes of functioning national S&T and innovation systems.

As in the Russian and Indian cases, documenting USAID efforts can provide valuable insights into conditions favorable to S&T capacity building, innovation, technology adoption, and productivity gain. Analysis of the costs and benefits will also help to guide future strategies and actions by USAID and others interested in alleviating rural poverty in Africa. It is particularly important to identify the most promising niches for investment given the scarcity of human and resource capacity in most African countries in order to address the most urgent needs and exploit the most lucrative opportunities.

Simultaneously, deeper changes in the larger institutional, policy and economic setting at the local, national, and regional level are crucial to promote technology dissemination and innovation for economic growth. In this connection, improving Africa's information and communication infrastructure can better link researchers at all levels, and to accelerate research dissemination to users, enable feedback to researchers and industry and support agricultural trade and commerce.

Finally, expanding education and training in all areas (scientific research, policy analysis, impact assessment, etc.) will help enlarge the knowledge base available to produce and use new knowledge and tools generated by agricultural research.

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