S&T POLICIES AND STRATEGIES FOR SUSTAINABLE DEVELOPMENT

Editors

Hameed A. Khan
M.M. Qurashi
Irfan Hayee

August 2008

Commission on Science and Technology for Sustainable Development in the South

13

COMSATS' Series of Publications on Science and Technology

S&T POLICIES AND STRATEGIES FOR SUSTAINABLE DEVELOPMENT

Editors

Hameed A. Khan
M.M. Qurashi
Irfan Hayee

August 2008

Commission on Science and Technology for Sustainable Development in the South

S&T POLICIES AND STRATEGIES FOR SUSTAINABLE DEVELOPMENT

Editors

Hameed A. Khan
M.M. Qurashi
Irfan Hayee

Published: August 2008

Printed by: *M/s New United Printers, Islamabad*

This book is published under the series title, *COMSATS' Series of Publications on Science and Technology*, and is number 13th of this series.

Copies of this book may be ordered from :
COMSATS Headquarters
4th floor, Shahrah-e-Jamhuriat
Sector G-5/2, Islamabad, Pakistan
email: comsats@comsats.org.pk
Website: www.comsats.org.pk
Ph: (+92-51) 9214515-7, (+92-51) 9204892
Fax: (+92-51) 9216539

Price: US$ 10 or equivalent

Commission on Science and Technology for Sustainable Development in the South

S&T POLICIES AND STRATEGIES FOR SUSTAINABLE DEVELOPMENT

TABLE OF CONTENTS

FOREWORD

Human history is full of events and eras whereby humanity in general was faced with grave challenges for survival, be these in the form of natural calamities, social needs, or economic conquest. The human struggle has been going on since long and has seen the ups and downs of individuals, groups and nations who have or have not equipped themselves with the right tools and skills from time to time. This struggle for the survival of the fittest is still on, and it challenges only the ones that have a realization for it, while others would succumb to their ultimate fate in the wake of being literally 'resource-poor', viz both intellectual and infrastructural capacity.

The overwhelming mass of 'scientific knowledge' of today is the real essence of all the human struggles. It is the product of precise planned, patient, potential and prosperous cognitive endeavors made over centuries for improving the state of life and adding the meaning of quality to it. The impetus in this human struggle was built with the paradigm-shift in focus and efforts towards generating and gaining scientific knowledge and developing technologies to serve the interests of a group, a nation or a region. The role of science and technology is now well-established as 'rescue agents'; however, there still is a necessity of awakening and enlightening us to 'rescue from what?'.

It is only in the relatively recent past that humanity as a whole has given itself the title of 'one nation', after the realization that we are rapidly consuming the endowed resources of our planet earth, in an unsustainable manner, and using it to nullify the progress of others. It was after all this understanding of many years of struggle by humanity that we have resolved to 'live and let live' and coined the term, 'sustainable development' in the first earth summit in Rio de Janeiro, thus insisting on the paramount role of science and technology. It was for the first time that the concept of planning at global scale was initiated and documented in the form of 'agenda 21', Millennium Development Goals, etc.

Having said this and taking account of our brief history, man appears as the only species with intellect and the skill to survive and prosper. We must plan and coordinate our developmental activities accordingly, as responsible states and nations. The issue of progress and development now has gone beyond the boundaries of national development, though it has roots in local empowerment and social justice. The discussion on this broad domain of "S&T Policies and Strategies for Sustainable Development' has now attained great importance and drawn the attention of the 'most influential' (the developed world) and 'most needy' (the developing countries) equally. It is a high time to ponder practicably and prepare ourselves appropriately to meet the challenges of the present day, as well as ensuring a prosperous future.

This realization being the need of the hour, I am pleased to say that this book by COMSATS is a timely effort to highlight the important issues of S&T policy-planning, and gives useful directions to address the same. This compilation of valued contributions from experts in various fields of Science and Technology gives good insights into the subject and explicitly defines guidelines for a sound S&T policy-framework, keeping in view the perspective of developing countries. I must say that this book is a crucial step towards reinforcing the need to develop and implement effective S&T-policy in the developing countries. The understanding of the importance of S&T policies and strategies comes with a responsibility to devise sound plans for formulation and implementation of S&T policy. This book establishes a base for the scientists and S&T policy-makers to identify and devise proper framework, according to the point of view of developing states.

I must appreciate the pro-active role of Dr. Hameed A. Khan, who has always given leadership and shown resolve to come up with useful scientific publications from the platform of COMSATS, which itself is motivated and commissioned to undertake scientific initiatives with a regional perspective. I must also applaud the group of authors who have contributed to the content of this publication and done justice to the topic. The admiration is also for the team of professionals at COMSATS, who with their marathon efforts have been bringing out a series of such publications.

Finally, I recommend this book to the scholarly and policy-making circles of developing countries.

(Dr. Ishfaq Ahmad, *N.I., H.I., S.I.*)
Advisor Planning Commission on
Science & Technology, Govt. of Pakistan

INTRODUCTION

Science and technology have led the world towards innovative solutions to today's multi-faceted challenges, at the same time, providing the foundation for economic growth and development and safe guarding the degrading ecosystem. Breakthrough advances in the fields of information technology, biotechnology, materials sciences, health sciences, renewable-energy technologies and other scientific areas, in the last few decades, have revolutionized our way of living, and have upset the power structures for those who pursued excellence in science and technology and shifted it towards sustainable development.

The first and foremost need is to realize and assert the importance of science and technology for achieving sustainable human development. Thereafter, this will help in taking corrective measures in addressing critical issues, such as the available skill-sets of personnel, infrastructural capacity, funding options, institutional networking, and regulatory framework to conduct scientific research and carry out technological development.

To meet the challenges of our globalized economic systems, we need to commit ourselves to the development of human-capital and ensure sustained learning-process within the public and private institutions to foster a culture of innovation. It is essential to direct the policies concerned with the development of human-capital, science and technology and innovation towards improving the scientific-base, raising per-capita income, generating employment and alleviating poverty.

In order to fully exploit the benefits of science and technology, proven to be the engines for sustainable development, third-world countries need to devise policies that would promote science and technology, as well as mobilize S&T resources from across the globe and link them with their respective national systems. For this purpose the institutionalization of S&T under a sound policy is required for proper planning and for laying the foundation of S&T system of a country, as well as for effective execution of S&T activities. There is a strong need to develop coherent and relevant S&T policies across the developing world, through formal institutions that can provide the base necessary for formulating such plans and policies that are capable of influencing the very terms in which policies are conceptualized and implemented.

The debate about sustainable socio-economic development has given additional complexity in the understanding of policies and strategies. Most of the developed and some developing countries are well aware of the complex mosaic on which they have to formulate their clear vision regarding suitable policies and strategies to be adopted on sustainable socio-economic development. However, in the continuously changing international socio-political environment, and due to internal problems, many developing countries find it extremely difficult to formulate firm policies and plans workable for longer periods of time.

The various sections of this book have been compiled, keeping in view the above-stated realities. This compilation is a humble effort on the part of COMSATS to highlight and address issues relating to long-term S&T policy-making and implementation in the developing countries. It is necessary for me to formally acknowledge the efforts of all the authors and co-authors of this book. Also, I would like to particularly express my gratitude to the team at COMSATS, who has made all out efforts in editing, composing and designing this book, especially Dr. M.M.Qurashi, Mr. Irfan Hayee, Ms. Sadia Nawaz and Mr. Imran Chaudhry.

I sincerely hope that this book fulfills the objectives with which it was conceived, that is, of disseminating information on issues related to S&T policy in the developing world, particularly in various policy-making and development circles. I am hopeful that this book will prove to be worth every reader's time and attention as well as encourage COMSATS to bring out even better and useful publications in the future.

(Dr. Hameed A. Khan, *H.I., S.I.*)
Executive Director - COMSATS

SECTION - A

POLICIES

MOBILIZING SCIENCE & TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT: THE ROLE OF S&T POLICIES

Hameed A. Khan[*], Irfan Hayee[**] & Sadia N. Swati[***]
[*]Executive Director, [**]Sr. Assistant Director (Programs) &
[***]Assistant Director (Programs)
COMSATS Headquarters, Islamabad, Pakistan

ABSTRACT

The importance and significance of science and technology as ever-growing and useful phenomena along with their central role in the development, growth, productivity and prosperity of the world is a globally accepted idea. Today, more than ever, science and its applications in the form of technology are indispensable for development. Science has contributed immeasurably to the development of modern society and the application of scientific knowledge continues to furnish powerful means for solving many of the challenges facing humanity.

The knowledge-divide has been perpetuated by the uneven, insufficient, or, at times, non-existent financial resources and a lack of sound technical and human capacity to support it. The work of scientists in developing countries is often obstructed by poor infrastructure, fewer opportunities for collaboration and prohibitive investments in research. Inadequate policy-frameworks are another contributing factor.

The capacity to mobilize and use science and technology (S&T) resources is increasingly being recognized as an essential component of strategic planning for sustainable development, and this much needed capacity comes from knowledge and information. Efforts to mobilize S&T for sustainability are more likely to be effective when they are directed to overcoming the boundaries set by the 'knowledge divide' and 'digital divide'.

1. INTRODUCTION

The notion of sustainable development is usually understood in terms of treating the issues of poverty, environmental management and economic development together, in the face of many difficult challenges. The classical concept of development has witnessed a paradigm-shift whereby now the emphasis has moved from the mere achievement of material well-being of states to the enhancement of welfare of human beings in the social, economic and environmental contexts. By enhancing human capabilities and well-being, expanding of choices and opportunities for men, women and children, sustainable development creates an environment in which human security is guaranteed and individual human beings can develop their full potential and lead a life of dignity and freedom. The basic objective of sustainable human development, therefore, is to create an enabling environment for people in terms of quality of health, education and standards of living. This objective, however, is usually pushed aside, particularly in developing countries, in favor of other immediate concerns, such as the accumulation of commodities and financial wealth.

It is a well-known fact that the world is changing at a rapid pace, driven by science and technology (S&T). The 21st century is believed to be an era when societies increasingly will be shaped by advances in science and technology. Science and technology are believed to fortify the foundations of our collective wisdom and abilities to address global challenges. Scientific discoveries transform the way we think about our universe and ourselves. The success of well-developed countries is largely to be attributed to the progress made towards using science and technology to improve the quality of life and overall management of society, economy and the environment. While the North mostly made full use of scientific and technological knowledge and information for its own development, the South lagged further behind, mainly due to ineffective mobilization of scientific and technological knowledge and resources. It has given inadequate attention to building capacity in the arena of science and technology (S&T), which together is the engine that drives knowledge-based development that is so essential to social and economic progress.

Today's era of globalization, marked by numerous challenges and opportunities, emerged with the spread of S&T applications. To make socio-economic progress, a country has to develop and utilize its scientific and technological capacity in the most efficient way. The accumulation of scientific knowledge and its technological applications is accelerating rapidly, and, therefore, we seek solutions in invention and innovation of new technologies, in large part, to some of the world's looming challenges in order to achieve sustainable development.

The global reality is that many innovations fail to reach those who need them the most, and benefits are not shared equitably. Such maldistribution is further confounded by troublesome trends in demography, urbanization, health, education, and environment, which serve as the major stumbling blocks on the paths towards any real indigenous development, and will continue to do so in the foreseeable future, if not dealt within time.

Despite all the successes and failures of the past, associated with science and technology, S&T is still the only driving force that can ensure continuous development, improve standards of living for all, safeguard human interests on our mother planet, re-generate and multiply our resources, re-address the issues of environment, give a boost to national economies and, most importantly, benefit human societies and civilizations on the social front. The resolve of 'one nation' – the present human civilization – should be to achieve sustainable development that implies "win-win" situation for all, and that can only be possible through collectively mobilizing and harnessing the available scientific and technological resources, appreciating the role and significance of scientific research, prioritizing social and environmental issues over economic, in its true spirit, as well as by extending cooperation and support in regional and global issues alongside national priorities. The landmark of sustainable development can be realized, provided all the above-stated areas are put under a well-devised and thorough policy and strategy framework.

Besides many others, the first and foremost need is to realize and revitalize the importance of science and technology for achieving sustainable human development and thereafter take corrective measures to address issues of importance, such as the available personnel, infrastructure, investment, institutions, and regulatory framework to conduct scientific research and technological development.

The present trend is clearly not tenable, nor can the present system which has led to it form the basis of sustainable development. As described by Khosla in 1998, the failure of development, and the role of science in it, can primarily be ascribed to inadequate policy-level attention to:

- The provision of basic social services, such as health, education and shelter, not necessarily by government-run programmes;
- The changes needed in the structures of society, economy and government – most of which are continuations of centuries-old colonial practices, unsuited to the needs of today;
- The need to create systems of local governance and empowerment of communities to design their own futures;
- The choices we must make among possible developmental goals and technological options;
- The national priorities for scientific research.

2. REALIZING THE INEVITABILITY OF SCIENCE & TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT

Sustainable development, no doubt, is a daunting challenge faced by mankind simultaneously at the local, regional and global levels. The developing countries of the South have entered the 21st century, facing enormous challenges that hinder their efforts to move towards economic progress and sustainable development.

Advancement in science and technology depends on the broad sharing of information and knowledge. Major approaches to maintaining sustainability, including poverty-alleviation, providing food-security, improving healthcare, overcoming the alarming water crisis, reducing environmental degradation, maintaining biodiversity, tackling climate change, all critically require scientific knowledge for their strategic implementation.

The capacity to mobilize and use science and technology is increasingly being recognized as an essential component of strategies for promoting sustainable development, and this much-needed capacity comes from knowledge and information. Efforts to mobilize S&T for sustainability are more likely to be effective when they are directed to removing the boundaries set by the 'knowledge divide' and 'digital divide'. A lack of knowledge and information, as in the case of the developing countries, can pose a serious challenge to sustainable development. On the other hand, knowledge if used effectively can offer widespread opportunities for achieving sustainable development, as is evident in the case of the developed countries. Knowledge and its application, in the form of scientific research and appropriate technologies, are believed to be at the forefront of achieving economic, social and environmental sustainability.

Technological progress plays a highly productive role in economic growth and development. Primarily it gives us a fair bit of relief in our day-to-day life: it is through technological progress that we now are better equipped to harvest our lands and have higher yields; produce and provide electricity and power, whenever and wherever we want; forecast weather; contact and communicate information and knowledge to as far an area as it can be; commute swiftly and frequently, thus, in short, we have to an extent attained freedom of want and continue to do so through technology.

Despite the phenomenon of rapidly growing populations and their multitudes of needs and wants, science and technology have helped us keep the much-needed pace. It is due to S&T that we are able to create more jobs, provide breakthrough improvements in healthcare and educational systems, as well as help ourselves in adding greater value to goods and services at lower prices for consumers.

3. CONTRIBUTIONS OF SCIENCE AND TECHNOLOGY AS IMPORTANT TOOLS FOR SUSTAINABLE DEVELOPMENT

To no surprise, the global community unanimously acknowledges one fact and that is the importance of science and technology for sustainable development. Without a doubt, scientific knowledge and appropriate technologies are central to resolving the economic, social and environmental problems that make current developmental paths unsustainable. The extracts of many global summits and conventions suggest that the transition towards sustainable development is inconceivable without science, engineering and technology, as these are the groundwork for addressing immediate human and social needs, while preserving the earth's fragile life-support systems.

Science and technology serve as key players in the systematic bridging of the developmental gap between the nations of the South and the North. Their propagation and essential implementation, keeping in view their pivotal importance, is the means of achieving true sustainable development. S&T are rightly considered to be vital for creating wealth and improving the quality of life in the contemporary society. They are increasingly recognized to be central to the social, environmental and economic origins of sustainability challenges, and to the prospects for successfully dealing with them.

Science and technology have also played a crucial role in bringing about the increases in agricultural yields and distribution-systems that have helped to keep most of the world from famine, in some cases at the cost of significant environmental degradation. Disease prevention would have been a remote concept, had science and technology not invented breakthrough cures and preventive techniques. Although it is also true that industrial wastes and hazards polluting the ecology have created new and tough diseases for mankind to deal with. Promoting transitions toward sustainability in the 21st century will require much more than improvements in the production and effective use of science and technology, which will be essential components of most of the solutions. Indeed, S&T are mere tool whose deployment determines the ensuing results. The need is to amalgamate and analyze natural sciences along with social sciences, so as to correctly interpret the consequences of particular S&T applications, as well as implementable solutions for prospective side-effects.

Sustainability is a slow process, and it treats different socio-economic problems in an interconnected manner. However, the relationship between different phenomena is not necessarily linear. It may be that while development is achieved in a few areas of concern, others may deteriorate or remain unchanged for the time being. Whatever the case, science and technology are the crux of sustainability and true development in underdeveloped, as well as developed parts of the world. It is high time that the policy-makers and strategists of the world bring forward scientists and researchers to take part in strategic decision-making processes affecting the global environment, so that S&T may be practically inculcated in the policies and future plans of the world.

4. THE ROLE OF S&T POLICIES IN MOBILIZING S&T RESOURCES FOR SUSTAINABLE DEVELOPMENT

Scientific and technological capacity is considered essential for sustainable economic development of a country. These capacities are built from pro-active approach of a government in providing funding for research and development (R&D); creating an environment that encourages and contributes to innovation, as well as linking the public, private and academic sectors to work towards the promotion of science and technology. A country's science infrastructure is a national treasure, and scientific research, an investment in its future.

In order to mobilize science and technology, the engines for sustainable development, the countries need to devise policies that would promote science and technology as well as link S&T resources from across the globe with their respective national systems. For this purpose the institutionalization of science and technology in the form of a sound S&T policy is required for proper planning and for structuring the S&T system of a country as well as for effective execution of S&T activities. There is a strong need to develop coherent and relevant science and technology policies across the developing world, through formal institutions that can provide the environment necessary for formulating such plans and policies that are also capable of influencing the very terms in which policies are conceptualized and implemented.

This would result in appreciating and recognizing the value of both science and technology as important tools of socio-economic development and then applying these to solving the socio-economic problems in these countries. In return, this would also create a strong link between the scientific community and the people from various walks of life, whereby investment in science and technology would be returned through meaningful advancement in socio-economic goals. In order to meet the challenges of the 21st century, through useful applications of science and technology, policies are required that promote discovery and sustain the excellence of the nation's scientific research enterprise, as well as respond to the nation's challenges with timely, innovative approaches, thereby accelerating the transformation of science into national benefits. We have a growing level of international consensus today on issues, such as, environmental, public health, food insecurity, climatic changes and biodiversity.

At the policy level, it is envisaged to assess the relationship that exists between science and technology and national & regional sustainability, with the aim to design a better framework and devise more effective methodologies. As a result of this increased attention, numerous fact-finding studies, discussions, conferences, and workshops should be organized that directly address the question of how science and technology can contribute more effectively to achieving goals of sustainable development by the world's nations.

5. SOME POLICY-DIRECTIONS FOR S&T DEVELOPMENT AND PRINCIPLE GUIDELINES

One of the leading and fast developing countries – Malaysia – in its 'S&T Policy for the 21st Century', has very comprehensively presented the principle dimensions and guiding principles for embarking on the roads to progress as well as for maintaining the pace, in order to achieve development through science and technology. Developing countries can make use of these guiding principles, as given here under:

Commitment
Ensure that there is national commitment to S&T that translates into solid investments by both Government and industry and the widespread adoption of new technologies to enhance export competitiveness. A supportive and responsive institutional framework is critical if S&T is to flourish.

Concentration
Optimize the utilization of resources in strategic priority-areas.

Capabilities
Improve the nation's capability in appreciating, acquiring and applying S&T knowledge and skills, through education, training and life-long learning.

Capacity
Strengthen the nation's capacity, through expanding and upgrading the S&T infrastructure.

Collaboration
Promote smart partnerships and synergy among public research institutions, universities, industries and nations, to enhance its effectiveness.

Commercialization
Enhance nation's ability to commercialize R&D outputs into competitive products and Services that meet market demands.

Culture
Foster a pervasive culture of creativity, innovation and entrepreneurship in S&T, through creation of an environment that encourages risk-taking, rewards market-driven ideas, supports science and innovation and inspires interest in S&T careers.

Community
Enhance support and active participation of the community in S&T development relevant to their daily lives and in accordance with acceptable norms and ethics.

At the heart of policy formulation, the countries need to take into account all the three dimensions of development, social, economic and environmental. Some of the goals that the developing countries should prescribe for themselves are indicated as follows:

- To build national capability to generate, select, import, develop, disseminate and apply appropriate technologies for the realization of the country's socio-economic objectives and to rationally conserve and utilize its natural and human resources.
- To improve and develop the knowledge, culture and the scientific and technological awareness, and promote the development of traditional, new and emerging technologies.
- To make Science and Technology (S&T) activities more productive, efficient and development-oriented.

These goals can be achieved by undertaking a number of comprehensive and concrete measures, as follows:

- Formulation and implementation of S&T plans, programmes and projects to accelerate the country's socio-economic development; self-sufficiency in food production and satisfying the need for other basic necessities with due attention to environmental protection.
- Application of science and technology for awareness and control of environmental conditions and for the conservation and rational utilization of the natural resources.
- Develop, strengthen and modernize the country's engineering and technology base to build a strong national economy and to assist other production sectors which are necessary to meet the demand for basic consumer goods.
- Expand and raise the quality and understanding of science and technology education at all levels of the educational establishments in all regions.
- Facilitate conditions to create favorable & supportive relations between S&T education, R&D, and the production activities.
- Promote, encourage and support the participation of urban and rural women in Science and Technology (S&T) education, application, employment, management and in the decision making processes of policy matters.
- Establish a national S&T information network capable to acquire S&T information relevant to national developmental needs and suitably process it for dissemination to potential users in government and private sectors.
- Develop the capacity and the mechanism to search, choose, negotiate, procure, adapt and exchange technologies that are appropriate and environmentally sound.
- Ensure that technologies transferred are appropriate and that the necessary material inputs and human resources are available and when deemed necessary develop capacities to modify/alter and adapt the technologies to make them

suitable to the natural endowment of the country.

- Establish a system to encourage and support applied and basic S&T research in areas appropriate to the needs of the country.
- Encourage and support the publication of books, research results, journals and periodicals of S&T interest.
- Build capability and methodology to identify the scientific content of traditional technologies; improve & change those that are useful for wider dissemination and diffusion.
- Establish efficient mechanisms for a speedy dissemination and application of Research and Development (R&D) results.
- Develop conducive working environment and an appropriate career and promotion structure for scientists and researchers and encourage & support the establishment of professional and amateur associations.
- Encourage and support the participation of scientists and researchers in national, regional and international conferences, symposia and workshops.
- Grant awards and prizes for outstanding innovations and productive achievements in the fields of Science and Technology (S&T).
- Establish an efficient national patent and technology transfer system to promote and support local technological innovations and creative achievements.
- Promote locally developed material inputs.
- Encourage the private sector and its capital to participate in S&T development activities through the provision of tax and other incentive mechanisms.
- Mobilize resources for S&T development and strengthen international cooperation.

6. PREMISE FOR S&T POLICY-FRAMEWORK

Science and technology have the potential of producing the most wondrous alternative energy systems, enhancing agricultural productivity (potential applications of which are bio-technology, genetic engineering, superconductivity, impressive recycling and recovery techniques), introducing low energy catalytic routes, integrated transport systems, efficient urban design systems, energy and material conservation…in theory and in practice, there is no limit to what S&T is capable of delivering. But all that science and technology that innovatory potential must be universally available and pro-actively sought after, in order to yield a sustainable environment. A coherent and concrete policy within the context of the three pillars of sustainable development – economic, social and environmental, integrated with the possible role of science and technology, is therefore essentially required for the realization of global sustainable development today.

In the light of confronted and potential global challenges, any S&T policy for sustainable development must have two directives. Firstly, that the developing and developed countries seek new ways of achieving an environmentally benign economic structure. And secondly, that an internationally cooperative mutuality develops, whereby all major trading blocs, competing ideologies, developed and developing regions, recognize need for equal partnership involvement in seeking and furthering the benign environmental trajectory.

The fruits of sustainable development are to be equally reaped by the next generations, which have as much right on earth's natural resources as the generation of today. And to cater to the needs of these upcoming generations, we must have the requisite knowledge and tools to precisely determine and predict future climatic conditions, population growth, food requirement & growth and related issues. Currently, our projections are not very precise because of the lack of necessary knowledge and tools for accurate prediction and assessment. The need therefore is not unlimited growth, but how much exactly to produce in a given span of time and under certain conditions, so that the future generations are catered to efficiently and are not deprived of their natural resource share. New methods of scientific prediction, therefore, need to be invented so as to determine the exact amount of world resources available and precise impact of various exploitative activities on these resources.

All in all, a comprehensive S&T application must be supplemented by the discovery of new sciences, which augment the precision capabilities of existing tools and techniques. New approaches need to be assessed and various scientific areas, especially social sciences, need to be viewed with a different perspective altogether, so that new parameters for measuring social, economic and environmental factors may be developed and efficiently put to use. Nonetheless, effective management of resources certainly helps in conservation and efficient use of these precious assets. Methods such as e-management or smart management must also be introduced for true sustainable development at individual and collective levels.

Another major factor to consider in any S&T policy for sustainable development remains the establishment of a positive, cooperative and peaceful environment, where everyone enjoys an "equitable" standard of living. These developments, however, are suppressed by the sole presence of poverty, which remains to date as one of the most important obstacles hurdling the way towards realizing global sustainable development. Nevertheless, there is no substitute for the need to inculcate the "basic human ingredient" of caring and mutual respect amongst the people of the world for the actualization of intended plans. It is therefore, only through these elements that the nations of the developed and developing regions can "feel for the need" of sustainable development and will be able to commit themselves practically towards the achievement of this idea.

The developing and the developed nations, who keep on shifting the burden of implementation on one another, must also review their attitude with thorough consideration for their own benefits and the benefits of the entire global community. The developing nations demand greater leverage and more time in the use of natural resources and a lower standard in respect of pollution control through use of non-renewable energy, so that they may be able to reach near to the development levels of the already developed nations. On the other hand, developed nations shift the burden on to the developing countries by asking them to be more conscious about pollution control, so that they may violate the "unwritten agreement" of the use of non-renewable energy, which otherwise undermines their plans for development.

Nonetheless, it is in the interest of sustainable development for all that the developed countries assume their responsibility for taking up measures to ensure future economic and social growth of the poor world and above all, be honest and sincere in the fulfillment of their commitment in this regard. In short, for the South the "means" for sustainable development is a pre-requisite, while for the North, the "will" to commit to global sustainable development is the key. It has already been ten years since the last "Earth Summit" and the promised results of this event are yet to be fully realized. The need today is to recognize that the world is running out of time and patience to sit down and redo "theoretical planning". It is about time that concrete steps for implementation are formulated and put in place, before the strategists of the world are confronted with worse problems than those at hand.

Science, technology and innovation can offer much more than anticipated if they are embedded within a more equitable and acceptable socio-economic framework. It has taken Europe and North America several centuries to reach to the level where they are today. However, no policy should envision the development standards of these regions as the benchmark for sustainable development, as socially, morally and ethically, these areas remain extensively perturbed.

Conclusively, it can be said that there is no way forward for developed or developing regions, but through sustainable development. In today's world, sustainable development is not just an environmental demand; it is a development necessity and the only concrete and comprehensive tool for achieving this necessity is science and technology.

7. AGENDA 21, MILLENNIUM DEVELOPMENT GOALS (MDGs) AND SCIENCE & TECHNOLOGY

In the Earth Summit of 1992, the world community conclusively agreed to commit and mobilize itself to address a wide spectrum of areas, and then at the turn of the century, Millennium Development Goals were spelled out as a challenge to the global community. Both the international resolutions and agreements greatly depend on fostering the S&T initiatives by the national governments to align them with the international commitments.

The Agenda 21 distinctly identifies science and technology as the means to combating poverty, changing consumption patterns, understanding population and demographic dynamics, promoting health, promoting sustainable settlement patterns and integrating environment and development into decision-making. Besides this, science and technology empowers and enables us for atmospheric protection, combating deforestation, protecting fragile environments, conservation of biological diversity (biodiversity), and control of pollution. S&T provides us the means to even inter-connect and develop and harness the roles of major groups that include children and youth, women, NGOs, local authorities, business and workers.

Millennium Development Goals (MDGs), which were set some eight years ago, also heavily rely on the thrust of science and technology. The Millennium Development Goals Report 2007, issued by the present Secretary General of UN, Ban Ki-Moon, suggests that there have been some gains and that success is still possible in most part of the world, it also points out that much more is needed to be done. He pointed out that there is a clear need for political leaders to take urgent and concerted action, or many millions of people will not realize the basic promises of the MDGs in their lives. Ki-Moon is hopeful that the MDGs are still achievable if we act now, saying that, "success in some countries demonstrates that rapid and large-scale progress towards the MDGs is feasible if we combine strong government leadership, good policies and practical strategies for scaling up public investments in vital areas with adequate financial and technical support from the international community".

Under the chapter 31 & 35 of Agenda 21, the emphasis has been laid on building the scientific and technological community and utilizing science for sustainable development, respectively. The article 31 of the subject agenda underscores the need for developing and nurturing the cooperative relationship existing between the scientific and technological community and the general public so that they form into a full partnership. It further states that:

- Improved communication and cooperation between the scientific and technological community and decision makers will facilitate greater use of scientific and technical information and knowledge in policies and programme implementation.
- Decision makers should create more favourable conditions for improving training and independent research in sustainable development.

- Existing multidisciplinary approaches will have to be strengthened and more interdisciplinary studies developed between the scientific and technological community and policy makers and with the general public to provide leadership and practical know-how to the concept of sustainable development.
- The public should be assisted in communicating their sentiments to the scientific and technological community concerning how science and technology might be better managed to affect their lives in a beneficial way. By the same token, the independence of the scientific and technological community to investigate and publish without restriction and to exchange their findings freely must be assured.
- The adoption and implementation of ethical principles and codes of practice for the scientific and technological community that are internationally accepted could enhance professionalism and may improve and hasten recognition of the value of its contributions to environment and development, recognizing the continuing evolution and uncertainty of scientific knowledge.

For Improving communication and cooperation among the scientific and technological community, decision makers and the public, the chapter under discussion suggests the following objectives:

a. To extend and open up the decision-making process and broaden the range of developmental and environmental issues where cooperation at all levels between the scientific and technological community and decision makers can take place;
b. To improve the exchange of knowledge and concerns between the scientific and technological community and the general public in order to enable policies and programmes to be better formulated, understood and supported.

And for Promoting codes of practice and guidelines related to science and technology, the objectives delineated:

c. To develop, improve and promote international acceptance of codes of practice and guidelines relating to science and technology in which the integrity of life-support systems is comprehensively accounted for and where the important role of science and technology in reconciling the needs of environment and development is accepted.
d. To be effective in the decision-making process, such principles, codes of practice and guidelines must not only be agreed upon by the scientific and technological community, but also recognized by the society as a whole.

8. ROLE OF GOVERNMENTS

Though it is for all the stakeholders and member of the society to contribute to the development and that too through science and technology, however, the national governments have to play their due role with utmost responsibility.

- It is expected from the government to:
- Direct its financial resources to the development of S&T infrastructure
- Promote science culture
- Build capacities of its human capital and transform into intellectual capital
- Build a network of science and technology institutions
- Encourage inculcating latest technologies in the developmental processes.
- Embark upon technology ventures
- Cooperate and build synergies with the international communities to educate, develop, equip and deploy its population with latest scientific knowledge and technological tools.
- Develop and heavily invest in the national innovation systems

The responsibilities entrusted to the governments viz science and technology under the Agenda 21 are enlisted as under:

a. Review how national scientific and technological activities could be more responsive to sustainable development needs as part of an overall effort to strengthen national research and development systems, including through strengthening and widening the membership of national scientific and technological advisory councils, organizations and committees to ensure that:

   The full range of national needs for scientific and technological programmes are communicated to Governments and the public;
   The various strands of public opinion are represented;

b. Promote regional cooperative mechanisms to address regional needs for sustainable development. Such regional cooperative mechanisms could be facilitated through public/private partnerships and provide support to Governments, industry, non-governmental educational institutions and other domestic and international organizations, and by strengthening global professional networks;
c. Improve and expand scientific and technical inputs through appropriate mechanisms to intergovernmental consultative, cooperative and negotiating processes towards international and regional agreements;
d. Strengthen science and technology advice to the highest levels of the United Nations, and other international institutions, in order to ensure the inclusion of science and technology know-how in sustainable development policies and strategies;
e. Improve and strengthen programmes for disseminating research results of universities and research institutions. This requires recognition of and greater support to the scientists, technologists and teachers who are engaged in

communicating and interpreting scientific and technological information to policy makers, professionals in other fields and the general public. Such support should focus on the transfer of skills and the transfer and adaptation of planning techniques. This requires full and open sharing of data and information among scientists and decision makers. The publication of national scientific research reports and technical reports that are understandable and relevant to local sustainable development needs would also improve the interface between science and decision-making, as well as the implementation of scientific results;

f. Improve links between the official and independent research sectors and industry so that research may become an important element of industrial strategy;
g. Promote and strengthen the role of women as full partners in the science and technology disciplines;
h. Develop and implement information technologies to enhance the dissemination of information for sustainable development.

As a positive response to calls, following the UN Conference on Environment and Development (UNCED) in Rio in 1992, for strengthening S&T programs targeted at sustainable development, most advances were seen as efforts of individual scholars and of institutions, such as the Third World Network of Scientific Organizations (TWNSO), the Commission on Science and Technology for Sustainable Development in the South (COMSATS), the Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI), and the South Center. However, it is with the beginning of a new era that specific and intense focus has been brought on science and technology and its potential to contribute to sustainability. This was given further voice at the World Summit on Sustainable Development (WSSD) in August 2002.

9. CONCLUSIONS

The science and technology policies should be clearly spelled out by the governments. This is particularly true for the developing countries, whereby they are 'resource-poor' considering intellectual and human capital and capacity, technological know how, basic infrastructure to adequately conduct scientific research and cooperative arrangements with countries and international agencies. In order to have long term development that is both sustainable and progressive, the developed countries as well as the developing countries need to invest in their human capital. Scientific excellence cannot be achieved in isolation and also cannot be bought by money; it must have stronger foundation, rooted deep inside the social and cultural behaviors of its nation. Investing in human capital has always proved and had a lasting effect and multiplying effect.

- Despite the growing consensus on all various global issues, such as poverty, illiteracy, scarce healthcare facilities, poor gross national productions, depleting natural resources and threatening climatic changes, the international community has yet to do a great deal of policy-making, planning, and implementation in order to deliver the benefits that science and technology has to offer, equitably and justifiably across all parts of the world communities and societies. This slackness on our part has a lot to do with national science and technology policies and frameworks, specifically due to lack of flexibility, depth and vision in the policies. In the same context, despite agreements on the inevitability of movement toward a knowledge-based future, inadequate attention has been given to building capacities in the arena of science and technology.

- Unfortunately most of the developing countries' governments are ill-equipped to understand the complex challenges and opportunities facing the world, and to realize the importance of new ways that are needed to ensure that science and technology are given the prominence needed to address a wide range of these increasingly urgent global problems.
- In order to create a world that can sustain not only the needs of our present generation, but that of our future generations as well, remedial measures to undo the errors of the past, preventive measures to make sure that destructive practices are not undertaken, management practices that create a policy-framework to track and monitor our initiatives, will have to be taken.

Now is the time for every major international agency and national government to assume responsibility for gaining the scientific and technological expertise that they will need in the twenty-first century. Decisions on how much federal funding to invest in research and development (R&D) and determining what programs have the highest priority are of critical importance.

REFERENCES/BIBLIOGRAPHY

- Khan. A, Hameed, et. al, 2006, 'Road to sustainable Development', COMSATS' series of Publications on science and Technology (7).pg 27-49, pg 125-149
- Khosla, Ashok., 'Science and technology for sustainable development" (1998). [Online]Available at: http://www.iisc.ernet.in/currsci/apr25/articles14.htm
- Malaysia's S& T Policy For The 21st Century [Online].Available at: http://www.mosti.gov.my/opencms/opencms/MostePortal/GEN/dstn2bi.pdf
- International Council for Science (ICSU),Series on Science for Sustainable Development No. 9 ,Consensus Report and Background Document, Mexico City Synthesis Conference, Science and Technology for Sustainable Development. (2002). [Online]. Available at: http://www.icsu.org/Gestion/img/ICSU_DOC_DOWNLOAD/70_DD_FILE_Vol9.Pdf
- Science and Technology Policy Council for Science and Technology Policy Japan's Science and Technology Basic Policy Report. [online]. Available at:

http://www8.cao.go.jp/cstp/english/basic/3rd-BP2006-2010-chapter1.html

- Stat%20Annex - UN MDG indicators. [Online]. Available at: http://mdgs.un.org/unsd/mdg/Resources/Static/Data/Stat%20Annex.pdf
- MDG Report 2007. [Online]. Available at: http://mdgs.un.org/unsd/mdg/Resources/Static/Products/Progress2007/UNSD_MDG_Report_2007e.pdf
- Agenda 21 chapter 31. [Online]. Available at: http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21chapter31.htm
- Agenda 21 chapter 35.[Online]. Available at: http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21chapter35.htm

SCIENTIFIC CULTURE: A PRE-REQUISITE FOR SUSTAINABLE DEVELOPMENT

Khwaja Yaldram
Pakistan Science Foundation
Constitution Avenue, G-5/2, Islamabad, Pakistan

ABSTRACT

Education in science is not just about learning the laws of nature and to be able to manipulate it, more importantly it should inculcate in us the scientific spirit. To be able to analyze, think objectively, act rationally, not to take anything on face-value, to doubt, to question and to challenge authority, are some of the hallmarks of a scientific culture that a quality education should inculcate. It is this lack of a scientific culture and not necessarily a lack of education that has turned us into a society that is a victim to blind dogmatism, debilitating traditionalism and irrational fanaticism, a society prone to emotional and irrational acts. In this chapter we discuss this lack of scientific culture and creative thinking in general in the Islamic World with particular focus on Pakistan. Some remedial measures are also presented. It is presumed that a society based on a scientific outlook will be inherently more dynamic, progressive, forward-looking and self-sustaining

"Hardly anyone can understand the importance of an idea: it is so remarkable. Except that, possibly, some children catch on. And when a child catches on to an idea like that, we have a scientist. These ideas do filter down (in spite of all the conversation about TV replacing thinking), and lots of kids get the spirit - and when they have the spirit you have a scientist. It's too late for them to get the spirit when they are in our universities, so we must attempt to explain these ideas to children". (Richard P. Feynman 2001).

1. GALILEO VERSUS THE PROFESSORS

Galileo Galilei (1564-1642), a teacher of geometry and astronomy at the University of Padua (Italy), published his theories and invited scholars and churchmen to check his evidence supporting the heliocentric theory. He did not foresee the hostile reaction he received. When he invited a certain professor of philosophy at the University to look through his telescope and see for himself the moons of Jupiter, the professor merely laughed and declined. He knew, from logic alone, that Jupiter could not have moons, and he knew on theological grounds that the earth was the centre of the universe and that God had assigned such significance to the number seven and that there could only be seven heavenly bodies. As the professor put it:

“ There are seven windows given to animals in the domicile of the head… from this and many other similarities in nature, such as the seven metals,…we gather that the number of planets is necessarily seven. Moreover these (alleged) satellites of Jupiter are invisible to the naked eye, and therefore can exercise no influence on the earth, and therefore, would be useless, and therefore do not exist. Besides (from the earliest times) men have adopted the division of the week into seven days, and named them after the seven planets. Now, if we increase the number of planets, this whole and beautiful system falls to the ground.”

To quote Feynman (2001) “A scientist is never certain. We all know that. We know that all our statements are approximate statements with different degrees of certainty; that when a statement is made, the question is not whether it is true or false but rather how likely it is to be true or false” He goes on to add “Now the freedom to doubt, which is absolutely essential for the development of the sciences, was born from a struggle with the constituted authorities of the time who had a solution to every problem, namely the church. Galileo is a symbol of that struggle-one of the most important strugglers.”

2. PRESENT PREDICAMENT

Fast forward to the present times, and one is not surprised to find teachers and scientists using similar arguments to support a pet hypothesis, not necessarily in science but in all spheres of life. Although we do not hesitate to use the fruits of science to our advantage, we still consider it to be a necessary evil, to be tolerated and paid lip-service. Somehow we feel insecure as Muslims and consider our beliefs to be threatened by the scientific outlook. To answer the question: Why the Muslims in a broader context and Pakistanis in a narrower context have turned away from reason and doubt, one has to go back in history and try to follow the development (or otherwise) of scientific culture amongst the Muslims.

3. BEGINNINGS OF SCIENCE

Science had its birth the moment man set foot on this planet, and its growth represents the question of “how” and “why” (Bernal 1944). Science really made itself felt when these questions became important i.e. when man started on his way to civilization. We can trace the first thread of the story of science in the Sumerian-Babylonian civilization, whence it traveled westward to Phoenicia and Egypt, its goal being Greece. The Greeks relied unreservedly on the intellect and sought to solve everything through imagination. Speculation and theorization were their favourite vocations. It was common Greek belief that every phenomenon could be explained through logic and discourse. It was not deemed necessary to back theories by means of practical experiments. The succeeding Roman civilization made use of the scientific achievements of the Greek without contributing in any significant way to its advancement. With the advent of Christianity, scientific study was in general discouraged. Early Christianity surrounded itself with dogmas and introspection. Libraries were set on fire, and whatever books and manuscripts remained were transferred to underground cellars to rot. This was the general state of affairs from the downfall of Greeks till the rise of Muslims.

4. RESPECT OF KNOWLEDGE IN ISLAM

Islam is the religion of wisdom, and wisdom is knowledge. Quest for knowledge is the birth right of a Muslim, and the Holy Quran and the teachings of the Holy Prophet emphasize the creation and the acquiring of knowledge as bounden duties of a Muslim, "from cradle to the grave", hence the Holy Prophet (PBUH) exhorted every Muslim to seek knowledge, even though for if he may have to go to China unlocking its gateways. The Quran is replete with passages inviting the reader to study the phenomena of Nature around him, for in the smallest and what may appear to the eye the most insignificant act lies a challenge to human thought. The ant and the bee are much too trivial to merit the attention of the casual man but they offer a world of wisdom to those who care to pause and ponder. The Quran lays great stress on the value of finding the nature of things, for it is the knowledge of creation which will lead man to the knowledge of the Creator (Hitti 2002, Hoodbhoy 1991, Ali 1980, Ahsan 2001).

5. CONTRIBUTIONS OF MUSLIMS TO SCIENCE

The rapid spread of Islam in Asia, Europe and Africa provided a great stimulus to science and culture. The patrons of Islamic scientists were the reigning caliphs. Abbasid caliphs like Al-Mansur, Haroun-al-Rashid, Al-Mamun and Al-Mutawakil encouraged science in a way unparalleled anywhere else. The Abbasid period was followed by the Omayyad Caliphs at Cordoba and the petty Emirs of Spain and Morocco. Around 1200 A.D science in the Islamic countries reached its apogee.

The impression that the Muslims merely translated the Greek writings and served as a bridge between the Greek civilization and modern Europe is not true. The Muslims, apart from translating Greek works into Arabic, undertook painstaking experimentation and observation. Many of the discoveries associated with western scientists like Newton, Galileo etc. had already been made by the Muslim scientists. Iqbal has very succinctly described the contribution of the Muslims:

i. It was, I think, Nazzam who first formulated the principle of "doubt" as the beginning of all knowledge. Ghazali further amplified it in his "Revivification of the Sciences of Religion", and prepared the way for "Descartes' Method".
ii. Abu Bakr Razi was perhaps the first to criticize Aristotle's first figure, and in our own times his objection, conceived in a thoroughly inductive spirit, has been

reformulated by John Stuart Mill.

iii. Ibn-i-Hazm in his “Scope of Logic” emphasizes sense-perception as a source of logic; and Ibn-i-Taimiyya, in his “Refutation of Logic” shows that induction is the only form of reliable argument. Thus arose the method of observation and experiment.

iv. It is a mistake to suppose that the experimental method is a European discovery. Duhring tells us that Roger Bacon’s conception of science is more just and clear than those of his celebrated namesake. And where did Roger Bacon receive his scientific training? In the Muslim Universities of Spain. Indeed part V of his “Opus Majus”, which is devoted to ‘perspective’, is practically a copy of Ibn-i-Haitham’s Optics.

v. The first important point to note about the spirit of Muslim culture then is that for purposes of knowledge, it fixes its gaze on the concrete, the finite.

6. END OF ISLAMIC RENAISSANCE IN SCIENCE

This great Islamic renaissance in science came to an end around 1350 A.D. (Afzal Iqbal 1981, Jamil Jalibi 1984). The reasons can be summarized as:

i. During the early spread of Islam, most of those who joined the Islamic fold were merely a bunch of self-seekers. Their main aim in accepting Islam was to guard their self-interests. Once they joined the Islamic fold they felt more at ease in twisting the true meaning of Quran. Rationalism to them was an anathema which had to be crushed at all costs. Then and only then they hoped, to use Islam to guard their interests. During the reign of the more illustrious caliphs these people kept a low profile only to show their true colours when the time was ripe. This phenomenon of switching of loyalties is akin to what we still witness amongst our elected representatives.

ii. The traditionalists or those who thought that scientific outlook posed a danger to the hold of the priests over the masses were always on the look out for an excuse to revert back to pre-Islamic concepts. Their success, mainly due to the rationalists own irrationality, sealed the fate of scientific culture amongst the Muslims. Ever since, the Muslims have adopted an attitude that is a complete negation of what Islam stands for. It has been turned into a static religion, more concerned with the proper observance of ceremonial rites than to its actual substance. Muslims have become mere spectators in a world that is witnessing a revolution nearly every year in science. The idea of a dynamic religion, to be interpreted according to the changing local and global conditions, is not in the interest of the priests, whose hold on the people is subject to their remaining illiterate and irrational in their approach. It is sufficient to quote Ibn Khaldun (AD 1332-1406), one of the greatest social historians, to illustrate this point. He writes in his Muqaddama (Ibn

Khaldun[4] 1967):

"We have heard, of late, that in the land of the Franks, and on the northern shores of the Mediterranean, there is a great cultivation of philosophical sciences. They are said to be studied there again, and to be taught in numerous classes. Existing systematic expositions of them are said to be comprehensive, the people who know them numerous, and the students of them very many……Allah knows better, what exists there…..But it is clear that the problems of physics are of no importance for us in our religious affairs. Therefore, we must leave them alone."

iii. Science flourished as long as the rulers wished it. Scientists were employees of the courts. Science never found any roots amongst the masses, and never got assimilated into the culture of the Muslim society. Muslim scientists left behind no lasting institutions in the form of universities, societies or academies.

7. PLIGHT OF SCIENCE AND SCIENCE-EDUCATION IN PAKISTAN

7.1 Hold of the Feudal and Clergy

There are other reasons that are peculiar to the geopolitical situation of Pakistan. The feudal hold over the political set up of the country ever since its inception has seen a systematic erosion of science and for that matter any kind of rational education in the country. The interests of the feudal and the priests go hand in hand. They flourish in a climate of ignorance. It is, therefore, not very hard to conjecture why in spite of the lofty claims of the highest government functionaries, nothing concrete has ever been achieved. Education has remained and will continue to remain at the lowest level of the policies of successive governments.

7.2 Plight of Education

With so little being spent on education it is no wonder that we produce teachers who are ill-prepared to teach science. Our college training in the sciences turns out technicians of extremely circumscribed vision. Teachers of science who are inadequately prepared in their subject matter, and who have great gaps in their knowledge of it, tend to teach by the book. This is one of the things that should be anathema in science, which, if anything at all, has endeavoured to eliminate authoritarianism. The influence of an authoritarian and bigoted teaching of religion reinforces the trend towards conformity and acceptance of ideas, without questioning and analysis.

7.3 A Living Curriculum

The chief criticism of existing curricula are that they are over-loaded, confused, and out-of-date. What is required essentially is the work of modernization and revision. We must do this while emphasizing, all the time, the provisional and progressive nature of science in such a way as to avoid the criticism that no knowledge should be taught until it has stood the test of time. For this, teaching of the history of science should be of the greatest value.

7.4 System of Examinations

The whole career of an educated citizen from the age of five onwards depends on his performance on a series of examinations. These have become the most powerful influence of miseducation. It is dangerous for anyone, not backed by money or superabundance of genius, to try and take examinations lightly. For the rest, all knowledge must be gauged by the criterion of its value for examination purposes. This results in a deliberate shutting off of interest at just those points of uncertain knowledge where interest is most required.

7.5 Political Will

In respect of political will, we need something on the pattern of Japan during the Meiji period (late 19th century). The Meiji emperor took five oaths - one of these set out a National policy towards science - "knowledge will be acquired and sought from any source, with all means at our disposal, for the greatness and security of Japan".

7.6 Education and Scientific Culture

The official figure for the literacy rate in Pakistan is now approaching the 40% mark. This includes of those who can hardly sign their names and can probably just recite the Holy Quran. If we conservatively put this figure at around 20%, then the actual educated class is hardly 10% of the total population. Of this, less than 1% get any sort of scientific education. The very insignificant minority that end up with a science degree are not necessarily very keen proponents of scientific culture. They would continue to follow the scientific method as long as they see that it is not in conflict with their cherished religious beliefs. As soon as they sense even an iota of doubt they would rather close their minds to scientific reasoning than to religious dogmatism. Majority of our scientists fall into this category. A scientific degree does not necessarily mean a scientific culture, rather a scientific culture is the outcome of a rational and objective approach towards life; a thinking process that accepts and rejects facts on their merit; a way of living that has no place for fanaticism, dogmatism and bigotry.

8. COMMISSIONS AND COMMITTEES ON EDUCATION IN PAKISTAN

There has been no dearth of well-meaning commissions and committees that have been formed to submit grandiose reports. All these reports have pointed out the shortcomings in the field of science and technology and have proposed ways and means of removing them. The first report of Education and Scientific Commission, presented to President Ayub Khan on 5th Sept 1965, became a casualty of the Indo-Pak war. It took another twenty years to chalk out the National Science Policy, which was announced in 1984 (Ministry of Science & Technology, 1984) but is now all but forgotten. There is no tangible follow-up to the National Technology Policy formulated in 1993 (Ministry of Science & Technology, 1993). In 1995 the government appointed Mr. Munir Ahmed Khan to chair a high-level committee on Science and Technology, whose report is yet to be made public (Prime Minister's High-Level Review Committee on S&T 1996). This was followed by a futuristic programme formulated by Mr. Ahsan Iqbal, Chief Coordinator of the Prime Minister's 2010 programme (Ministry of Education, 1998). The latest in the series, "VISION-2030", released by Planning Commission of Pakistan (Planning Commission of Pakistan, 2007) sets the following strategies for achieving the education goals for the country:

- Enhance the scale and quality of education in general and the scale and quality of scientific/technical education in Pakistan in particular.
- Increase public expenditure on education and skills generation from the present 2.7 per cent of GDP to 5 per cent by 2010 and a further doubling by 2015
- Generate the environment which encourages the thinking mind to emerge from our schools. At the school, college or university level, this requires well-paid teachers - teachers who have a maximum level of prosperity and self-esteem. This is the easy part; finding enough good teachers will be the difficult part.

While our past history presents a bleak picture regarding developments in Science and Technology, one can at least take lessons from the past failures and make projections for the future. Some of these are enumerated, in order of their importance.

9. IQBAL'S VISION

Allama Muhammad Iqbal, the renowned national poet of Pakistan, regards scientific culture (creativity) as the sine qua non for the Islamic Renaissance. To make way for it, the Muslim mind has to be liberated from the sterility of half a millennium of intellectual stagnation and the stranglehold of obscurantist orthodoxy. The stamp of feudalism on our cultures has to be obliterated and the outdated medieval imprints on our thoughts have to be got rid of (Iqbal 1999).

"Anyone who does not possess the faculty of creativity To me he is nothing more than an unbeliever".

We do not have the courage to face harsh realities. As Iqbal puts it; "We do not change ourselves, instead we change the Quran." No wonder the Muslim world is so deficient in producing original thinkers, philosophers and scientists.

Science, philosophy, literature and arts cannot flourish in an atmosphere vitiated by bigotry, fanaticism, intolerance, conservatism and irrationalism. They need a Weltenshaung (world view) whose key-note is humanism, enlightenment, tolerance and rationalism. Iqbal gives a clarion call for Ijtihad, for "Originality of thought and action."

As he puts it: "The originality of thought and action means a passion for revolution. It means a renaissance of the ummah. It produces miracles. It transmutes granite into purest pearl. Iqbal attaches so much importance to creativity that he goes to the extent of saying: "Anyone who does not possess the faculty of originality is to me nothing more than an unbeliever."

Creativity is not possible without intellectual curiosity. Therefore, Iqbal enjoins: "Would you ensnare the phoenix of knowledge? Rely less on belief and learn to doubt." Here Iqbal joins hands with Descartes, the founder of modern mathematics and modern philosophy, who embarked upon his odyssey of discovery with the dictum: "In order to reach the truth, it is necessary, once in one's life, to put everything in doubt." In the words of Iqbal, "To exist in real time is not to be bound by the fetters of serial time but to create it from moment to moment, and to be absolutely free and original in creation. In fact all creative activity is free activity." He goes on to maintain, "Of all the creations of God, man alone is capable of consciously participating in the creative life of his Maker." Iqbal makes man a co-worker with God, because he too possesses the faculty of creativity.

To Iqbal, creativity is the Summum Bonum, the ultimate determining principle in any ethical system. Creativity pre-supposes freedom. In the words of Iqbal, "Goodness is not a matter of compulsion; it is the self's free surrender to the moral ideal and arises out of a willing cooperation of free egos. A being whose movements are wholly determined cannot produce good.". Creativity implies a ceaseless quest for for self-realisation, a yearning for new visions and a constant struggle to attain the unattainable.

10. CONCLUSIONS

As we start the new century, the question arises whether we can meet the challenges that this century is going to throw up before us. The answer will depend upon how we handle the problem of education.

According to the rough government estimates, there are over 145,960 primary schools, including 37,000 mosque schools, in the public sector in Pakistan (National Education

Policy 1998). The number of secondary and high schools is 14,590 and 10,000, respectively. Unfortunately not one of these meets the standards of a modern school, either by way of learning-environment or the programme of studies, or by way of management. It is as if the policy makers have decided to have one set of standards for the rich, attending elite public schools, and another for the poor, attending ill-managed government schools.

Given this attitude of the policy makers, and in the absence of a vision and political will, what is needed to change this attitude is to establish a new paradigm by improving a set of government schools, where modern textbooks can be taught using modern teaching-methodology; where professionalism, and not political expediency, determines the learning and management environment; where education is based not on rote-learning but on understanding of concepts and on conceptual development, where students enjoy safe and adequate physical infrastructure, where autonomy is given to the school administration, and where learning is fun.

This would give education that imbibes in the students a spirit of scientific culture, a faculty to reason and think rationally with a purpose. Can government schools be made comparable to the best of private schools? The government considers this idea as idealistic and too ambitious. It is neither, it can be done. The fact of the matter is that it has never been taken up with any conviction and seriousness.

Conventional wisdom attributes the failure of the government in providing modern education to corruption and to an absence of political will. Both factors are there , but a more important factor is the mediocrity and a medieval mindset that has continued to dominate the so called reform efforts, both by the government as well as the donor-creditor institutions (Dawn-Review 2008). It is a common belief that more money is the solution to improving the educational sector, without appreciating that unless policy-changes are effectively implemented, money will have no major impact on public-sector education. It is, therefore, not surprising that having spent large amounts of tax-payers' money and millions of dollars of donors, efforts at improving government schools have shown no significant change.

REFERENCES

- Afzal, I., 1981, Culture of Islam, Institute of Islamic Culture, Lahore
- Aitzaz, A. 2001, The Indus Saga, Nehr Ghar Publications
- Ameer, A. 1980, The Spirit of Islam, Pakistan Publishing House
- Bernal, J.D 1944, The Social Function of Science, Lowe and Brydone Printers
- Feynman, R.J. 2001, The Pleasure of Finding Things Out, Penguin Books
- Hitti, P.K. 2002, History of the Arabs, Palgrave Macmillan
- Hoodbhoy, P.A. 1991, Muslims and Science, Vanguard.

- Ibn Khaldun 1967, The Muqaddamah: An Introduction to History, London
- Iqbal, A.M.1999, The Spirit of Muslim Culture. In Six lectures on the Reconstruction of Religious Thought in Islam, Institute of Islamic Culture
- Jamil, J. 1984, Pakistan: The Identity of Culture, Royal Book Company
- Ministry of Education 1998, National Education Policy 1998-2010.
- Ministry of Science and Technology 1984, National Science and Technology Policy
- Ministry of Science and Technology 1993, National Technology Policy and Technology Development Action Plan
- Munir A. Khan 1996, Prime Minister's High Level Review Committee on Science and Technology
- Planning Commission of Pakistan 2007, Vision 2030
- The Review – DAWN, 13-19 March 2008, Education-A challenge for the better

BUILDING INFORMATION-SOCIETIES IN THE DEVELOPING COUNTRIES TO MEET SOCIO-ECONOMIC CHALLENGES OF THE 21ST CENTURY: SOME POLICIES AND STRATEGIES

Hasibullah
Advisor (International Affairs)
COMSATS Headquarters, Islamabad, Pakistan

ABSTRACT

The emerging challenges of the 21st century facing the developing world in particular can be successfully confronted through the aegis of information and knowledge networking. Information and Communications Technologies (ICTs) provide effective means to build information-societies and knowledge-based economies for addressing our socio-economic issues of illiteracy, lack of awareness, health, population explosion, food insecurity, as well as a poorly developed industry and low gross national products (GNPs).

The three sets of activities, i.e., Infusion of knowledge in the societies, application of appropriate S&T to the development projects, as well as creation of sustainable information societies, provide the foundation for reasonably prosperous societies. Creation of sustainable information-societies is the need of the hour, which in fact gives impetus to development by channeling and appropriately directing the most on-time and up-to-date information to the decision-makers and executing agencies.

Building information-societies is not a rapid process, it is therefore necessary that sustained efforts must be made by governments and participation of private enterprises and other members of the society should be ensured. Also sound policies and planning should be made for building infrastructure for ICTs, training and educating human resources in this domain, as well as establishing knowledge centers and information-hubs to take the central roles through networking.

1. UNDERSTANDING THE SOCIO-ECONOMIC DEBATE

In the contemporary history, hardly any intellectual activity has been seen as prolific as the debate on socio-economic development. One would not be terribly surprised by this fact, only if one tries to understand that the matter relates directly to the most innate and fundamental needs of human beings. The diversity in perceptions, ideals, morality, demography and the knowledge pedestals existing among the nations and various segments of the societies provide not only the reasons for a great variety prevalent in the intellectual colours of the debate, but also a good cause for the perpetuity of such a multifaceted debate.

The above-mentioned intellectual stimulus has led to a dichotomy of perceptions between the rich and developed societies on one hand, and the poor and the developing societies on the other, obscuring the actual truth about socio-economic development. The whole world seems to have so untiringly debating on the problem of widening the prosperity gap between the haves and and have nots, but neither the very promising diagnostic nor preventive prescriptions have made any real difference so far. The existing ground realities in the world are a clear proof of this discomforting situation. And it is the ground realities alone, which prove or disprove the truth of any claim or proposition.

The developed and developing countries see the socio-economic development in different ways. For developed nations, the socio-economic development means approaching the utopia of their fantasies whereas for the developing and the poor countries it is a matter of the most fundamental biological requirements – clean drinking water, food, shelter, healthcare and literacy, not to speak of human dignities and human rights. The existing pattern of interaction between the developed and developing world, with business as usual paradigm, to try to ameliorate the situation, does not really seem to be working nor it has any optimistic outlook for the present century. Drastic measures are not on the plate of the haves, nor are the have-nots in a position to absorb the drastic measures if ever put in practice. It will take quite a long time before the have-nots could create competencies and capacities to benefit from any such drastic measures. The dilemma seems to be intensifying in the coming years.

The debate about sustainable socio-economic development has added additional complexity in the understanding of policies and strategies to undo the state of dilemma as has been mentioned above. The more one reads about sustainable socio-economic development in the light of extensive ramification of its seemingly unsettled parameters, the more one becomes confused about the reality of the debate. In the beginning, the idea of sustainability revolved around the environment and its future impact on the coming generations. But soon it became entangled with economy, sociology, morality, psychology, mindsets, cultures, politics and what not. It would be a very welcome moment in the history of the modern world if a simple, unambiguous, useful, practicable and assured treatment of poverty, hunger, disease and ignorance is available to the underdeveloped and developing world. That might be the moment when the human race will start expecting a peaceful, prosperous and happy future for itself.

It may be a worthwhile approach if the poor and developing countries abandon, at least for a a short while, the idea of "bridging the socio-economic gap" and replace it with 'narrowing the gap' with the developed world. This realistic approach could greatly change the whole set of policies and strategies of the developing countries to get out of the existing inhuman living conditions because the targets will then become well within their reach and control. It will provide a way to readjust their mindsets to abandon very high expectations of attaining wealth in the shortest possible time. It must be understood that unrealistic expectations take the nations nowhere, whereas practicable policies and strategies always yield some useful results. It is always wise to give due credence to the proverb, "something is better than nothing".

How can the developing societies expect to achieve "something" in the existing, highly competitive market-driven world. The existing rules of the game do not allow any concessions to the poor and developing countries. The only meaningful dialogue between 20% rich controlling 80% resources of the world, and 80% poor enjoying only 20% of the whole world's wealth, is possible when both sides have something substantial to gain from each other. All other interactions or dialogues will be of little value for any fruitful consequences. The developing world has already put itself into a disadvantageous bargaining position in this regard due to its past mistakes. The dilemma is that they have a lot to offer but are unable to do so, whereas the developed world is unwilling to offer much although they are very well able to do so. The developing world has to create a realistic understanding, approach and vision of its future socio-economic development.

The poor and developing societies have historically borne the major brunt of the negative consequences of economic progress of wealthier nations. Migration of resources and skilled manpower from the developing countries to the industrially developed countries, prevention of the free flow of knowledge from the rich and developed countries to the developing ones, denial of equity in wealth distribution among the partner world communities, unequal sharing of burdens of industrial negativities and concentration of economic bonanzas to a few ethnic, cultural and racial entities are some examples in this regard. In future, the developing world is anticipated to suffer much more than the rich world due to the negative consequences of environmental degradation and climate change. The developed world is expected to exert tremendous political pressure on the developing countries to curtail the latters' industrial progress since the fear of higher energy-demand of the developing countries is expected to result in increased green-house gas-emissions.

Such a scenario alongwith a large number of other social requirements, which demand immediate attention of the developing countries make the sustainable socio-economic debate more complex and remote from desirable solutions in a shorter period of time. The remedies prescribed by the Western think-tanks are too expensive and need a lot of time before they are expected to start working. The underdeveloped world cannot afford to wait too long. Can one see a way out of this quagmire? Can the poor and developing nations identify with certainty a selected number of issues on which they should focus their attention and try their luck? And can these marginalized nations pick up a few tools on which they can reasonably rely for their better future? It may be fair to believe that such an approach, though too simplistic in nature, could have more chances of making progress. Other ambitious approaches have not worked in the past and are not working in the present. One should learn lessons from dismal outcomes of such glossy initiatives as, Kyto Protocol, Millennium Development Goals, WEHAB pronouncement and all other arrangements, which were undertaken to reduce poverty, disease, hunger and illiteracy in the world. Even the high-sounding organizations like WTO, ASEAN, EU, DAVOS and several G-digited summits have disappointed the poor and developing world. The stark reality is that poverty, hunger, disease, social divide and violence are on the rise. A separate, innovative and country-specific approach by the developing nations to realistically tackle their socio-economic problems is the only way left to move forward. And in moving forward the developing countries may not choose to adopt overambitious policies or go after such sophisticated technologies which they cannot handle properly.

2. CHALLENGES AHEAD

Most of the developing countries are well aware of the complex mosaic on which they have to formulate their clear vision regarding the suitable policies and strategies to be adopted on sustainable socio-economic development. Due to the continuously changing international socio-political environment and internal problems, many developing countries find it extremely difficult to formulate firm policies and plans workable for longer periods of times. But there are certain issues, which cannot be ignored even in these difficult circumstances. With all the prevailing set-backs, decisions have to be made sooner rather than later to save as many vital interests as possible to ensure economic progress. Selection of these priorities in the beginning of the 21st century by the developing countries to carry out any kind of socio-economic development, sustainable or not, becomes crucial for each one of them. A failure in this selection and then avoiding serious working on them will not only devastate the developing and poor countries but will also have negative repercussions on the well-being of the rich countries.

There are several challenges, big and small, hovering around the entire world in this century. These challenges will progressively hit the economies of the developing countries with ruthless force. Those on the peak will be (1) Food insecurity (2) Energy insecurity and (3) Environmental degradation. These challenges will be compounded and aggravated by uncontrolled population explosion and internal conflicts in the developing countries. Whereas these challenges can, to a certain extent, be brought under the control of the developing countries with good governance and international cooperation, the others linked to the global market interests of the big, powerful and influential economies would remain fairly out of their reach. The developing countries need to seriously adopt policies and strategies to create appropriate defence against such strong impacts emanating from the developed world so that they could save their economic, social and security interests when they are dealing with the looming challenges of this century.

The immediate socio-economic difficulties of the developing countries due to the above three major challenges have already started appearing on the horizon. Rapidly increasing world-food prices, skyrocketing fossil-fuel costs, fast-growing energy demands, particularly in Asia, risky experimentations on biofuels, hybrid automobiles, slow progress in alternative sources of energy, lukewarm attitude towards the potentials of nuclear energy, high probability of the extensive use of coal for energy production, extremely low global commitments on environmental issues, failure of WTO initiative, fastly rising prices of metal ores and so many other factors have close relationships with the above-mentioned challenges. These socio-economic impediments can grow further in the coming decades due to the attainment of high capacities of storage and hoarding, excessive profit-taking and economic compartmentalization of privileged zones such as European Union, OECD, ASEAN, etc. The above three major challenges of 21st century will remain a nightmare for the developing world unless some remedial steps are taken urgently with well-focused attention. Specific policies and strategies will be needed by the developing countries to walk on the intricate and bumpy tracks of development.

The above challenges are huge and difficult for the poor and developing countries to address adequately the requirements of sustainable socio-economic development. However, if there is strong will and serious commitment to move forward, there are still some open avenues which have promise and hope for the progress. Some of the most obvious include infusion of knowledge in the societies, application of appropriate science and technology to the development projects through strong institutions and creation of a sustainable information society. These three activities provide dependable building blocks on which strong and reasonably prosperous societies can be built. Strategic deployment of resources by each developing nation would be a pre-requisite for achieving tangible results.

3. TRIAD FOR DEVELOPMENT

The three components of the socio-economic developmental triad, as mentioned above have been discussed extensively during the past several decades. Knowledge and appropriate science and technology are a bit expensive propositions for the poor and developing societies. Scientifically underbaked projects, based on faulty policies and strategies, have rendered extremely limited benefits to the masses. Only a few pockets of the privileged segments of the societies can extract some advantages out of such ventures. It is obvious that these kinds of ventures cannot meet the challenges of socio-economic development across the board in any underdeveloped country. While emphasis on the sustained investments in knowledge-creation and employment of appropriate science and technology for socio-economic progress is important, a relatively more affordable, cost effective and reliable tool should be envisaged, which could not only boost the outcome of knowledge and technology programmes, but also catalyze their effects to promote accelerated progress. This tool can very well be the third component of the developmental triad, i.e., creation of a sustainable information society.

Many analysts are of the opinion that the advent of information technology has come as a bonanza for the socio-economic development in the developing world. The way it has rapidly evolved during the past century, demonstrates a marvel of technology and business entrepreneurship. Starting from telephone, radio and moving onto telegraph, transistors, telefax, television, internet, fibre optics, electronic trade and business and so on, have revolutionized the entire spectrum of global societies, poor or rich. Continued expansion through new technologies employing space stations and perhaps nanotechnology, will bring more wonders to the coming generations. Today a very large majority of the world's developing population can easily afford to buy and extensively use mobile phones. On a larger scale the information and communication technologies (ICTs) have a great potential to facilitate the attainment of higher socio-economic goals for the developing countries. ICTs can also prove to be a strong defence against the onslaught of growing poverty in the developing world arising out of the imminent challenges as identified earlier. A significant paradigm shift across the poor and the developing world is most likely to take place as a result of the ICTs. Those who will make a timely and judicious use of this beneficial opportunity will definitely have better chances of survival in this increasingly competitive world. However, like other scientific and technological developments, information-based societies will also face a variety of challenges and opportunities due to these technological developments. Introduction of the sustainability dimension, in the socio-economic development in the developing world, raised on the pedestal of information and communication technologies will add a separate set of policy and strategy considerations for each nation.

By no means the trend of the above-mentioned analysis be regarded as if the other two components of the triad, i.e., knowledge and appropriate science and technology, are being underestimated for their potentials in the socio-economic development of the poor nations. On the contrary, a sensible policy and workable strategy to promote knowledge and appropriate S&T for its blending into the third component of ICTs, is absolutely essential to gain any meaningful outcomes of the efforts to create a useful information based society. Specialized skills in technologies and their applications to provide the foundation for information-based society is an essential pre-requisite, which needs to be reviewed and upgraded continuously as technological advancement does not take any pause. If seen carefully all the three components are mutually inclusive and reinforce each other for overall purpose of the creation of the information-based society. The ultimate gain, no doubt, would be the accumulation of knowledge by the developing countries, which is the real wealth for making progress in these countries. The only outstanding feature of the ICTs is that they are already out in a big way in the open market and are, thus, within reasonably easier access of the developing world. This has come as a great advantage to a large number of poor and developing countries in a cost-efficient manner. The avenues are, thus, open for moving forward.

4. POLICIES AND STRATEGIES TO MOVE FORWARD

Like many other sustainable socio-economic development programmes of the developing countries, the creation of information-based societies needs extremely careful examination by each nation. In this particular case when the ICTs have largely diffused into many societies, there will be several examples and models available which could be considered for adoption. The well-known proverb, "Think global, act local" applies befittingly in this context. The information-based societies are supposed to be closely linked within themselves and with the outside world. This makes the developing countries' plannings, policies and strategies a formidable task. Right choices at right times have to be made without falling prey to the influences of hypes, which often prevail upon the thinking processes of the decision-makers in the developing countries.

Having realized that policies and strategies for an information-based society in the developing countries have to be tailor-made for their particular circumstances, the common emerging challenges in this century will nevertheless be constituting an important set of matching components on which the proposed policies and strategies will have to be made. As stated earlier, the most crucial challenges for the developing countries are going to be food, water, energy, unemployment and environment. The expected seriousness of these challenges is going to aggravate further down the present century, therefore, the information-based society in the developing world must give top priority to these challenges. Strong policy decisions to address the above-mentioned challenges must be taken now at the national level, in all the developing countries giving highest importance to agriculture and learning skills, to manage natural resources and their utilization in the most efficient manner. A well-informed and well-connected society will have much more chances of doing this than an isolated and un-informed society.

ICT policies have important synergies with other national policies. An integrated approach, wherever possible, will bring better benefits towards the objectives of socio-economic development. Usually ICT policy can render useful outputs by adopting an integrated approach involving technology policy, industrial policy, telecommunication policy and media policy. Technology policy provides for innovation which creates new technologies, the industrial policy helps shaping industrial structures and their changes, telecommunication policy addresses the nature of transmission infrastructure, whereas the media policy defines the framework for provision of electronic media content. It may be possible that convergence of these ICT policies could create some implementational problems, but the chances of these problems can also be expected in the industrially developed world where complex relationships and interconnections exist between economy, resources and regulations. In developing countries where such inter-relationship is not very complicated, the integration of policies becomes more probable.

Awareness, education and training, financial investment and good governance are key requirements in the developing countries to successfully face the socio-economic challenges of this century, which can be met by the ICTs. Urban populations in many developing countries have already taken advantage of ICTs in improving their lot. It is the rural population which has to be convinced more to employ ICTs for their socio-economic improvements, although an appreciable headway has already been made in this direction. ICTs can also provide reliable information to the remote rural populations about the benefits which the other communities have obtained from ICTs. As the awareness level is gradually increasing in the rural areas, education and skill for acquiring higher incomes would be needed before the poor rural populations could safely and convincingly come together to pool their resources for investment purposes. Governments, private businesses and multinationals should see great returns by providing necessary inputs in the rural segments of the developing societies. As the challenges identified earlier are all interconnected, investments for ICTs in agriculture, water resource management, environment and energy, will bring improvements in these sectors and simultaneously increase the employment opportunities.

5. POLICY-CONSIDERATIONS FOR DEVELOPING COUNTRIES

Some pertinent considerations for policies in the anticipated areas of imminent challenges facing developing countries may be summarized as below:

- **Food and Agriculture**

    - Encouraging new and safe biotechnologies
    - Stopping land degradation due to erosion, water-logging and salinity
    - Improving rural infrastructure
    - Establishing rural financial markets
    - Enhancing knowledge-generation and its diffusion
    - Removing constraints to market access
    - Policy institutionalization for productivity growth
    - Checking migration of rural population to urban areas
    - Providing incentives for agro-business

- **Water Management**

    - Improving irrigation systems in agriculture
    - Expanding safe drinking water supplies
    - Improving institutional and technical capacities
    - Preparing workable action plans
    - Preparing workable disaster preparedness and planning details
    - Protecting aquatic ecosystem
    - Expanding water-shortage capacities

- **Energy**

    - Energy accessibility in rural areas
    - Improving energy efficiency through technological innovations.
    - Energy saving cultural change
    - Maximum commercialization of renewable and alternate energy sources for remote and rural populations
    - Advancements in the fossil-fuel power generation systems
    - Encouraging mass transportation systems in the urban areas, use of clean fuels and popularization of bio-mass fuel in the villages
    - Promotion of nuclear energy as clean and assured source of energy

- **Environment**

    - Reducing dependence upon chemicals (pesticides, insecticides, fertilizers, etc.) in agricultural and horticultural sectors
    - Strict implementation of chemical and other pollutant discharge regulations of industrial wastes into agricultural lands and irrigation streams
    - Serious and massive campaigns for extensive tree plantations
    - Increasing use of commercial solar and wind energy for low-voltage appliances in the remote and rural areas
    - Checking deforestation through timber bans in the construction sector
    - Discouraging extensive private transportation and replacing it with efficient

mass transport systems in the urban populations

6. TECHNOLOGY SUPPORT

Some of the above simple considerations are also included in the action plans recommended by the WEHAB group of the World Summit on Sustainable Development, Johannesburg, South Africa, held in 2002. These policy considerations and action plans need specific technology-support for which ICTs play a central role. Connectivity of the population engaged in socio-economic development processes through various initiatives is absolutely essential for the success of these processes. Technology and industrial policies will have to be closely integrated with ICT policies and also media policies by the developing countries with unique focus on the outcomes required. Technology support islands in the rural and agricultural areas alongwith training and information facilities, at cheaper costs can be constructed with most of the available expertise in the developing world. Such technology support centres will not only help achieve the socio-economic uplift goals but also create attractive possibilities for reversal of rural migration to the urban areas. It is, however, necessary that technology support by such means should be fully oriented to agro-industry and agro-business, and not serve as the satellites of major industrial or multinational interests. Appropriate combinations of ICTs can greatly help achieve such objectives in a more economically strengthened ruler society. Luckily many rural societies have already reached an acceptability threshold of ICTs, they have only to move a little ahead to extend this acceptability to include the areas of applications linked with the identified challenges.

Interlinks between rural and urban population will also gain new strengths when ICTs start showing profits to local industry and businesses. Technology support gaps between the various geographical locations will reduce by the new entrepreneurs for their own benefits in dealing with simpler applications like solar-powered lighting, telephones, radio transmissions and receptions, mobile phones, biogas production and its domestic consumption, windmill power for remote villages' basic utilities and water traction for greenhouse sprinklers, small hydal power dams for regulated irrigation and so on. Correspondingly industrial production of low-tech appliances and machinery will be encouraged in the adjoining towns and industrial estates. Concept of incubation parks based on urban-rural participation for ICT-supported socio-economic developmental programmes in the selected areas of identified challenges will provide a useful input from the R&D and educational institutions in this regard. Governments in the developing countries must give serious thought to such educational and training programmes in their national planning procedures.

7. SOME CONSIDERATIONS AND GUIDELINES FOR NATIONAL STRATEGIES ON ICTs

The analysis and discussion given in the previous segments on the information based societies in the developing countries converges on the overall conclusion that a well-informed and well-connected developing society has more chances of socio-economic development than a uninformed and disconnected society provided good policies and strategies are employed. A well-considered mix of integrated policies and stand-alone policies has to be decided by the developing nations on which relevant strategies will be built. Needless to say that the types of affordable technologies and ICTs within the available or procurable resources of a developing nation will be the sole choice of that particular nation. Sustainability is an important criterion for policy and strategy considerations in this regard but certainly it does not take the overall priority in a large number of poor and developing countries.

Well-considered policies lead to well-designed strategies. This also applies squarely to ICT policies and strategies, both of which should be worked out in an integrated and harmonious manner. Although a lot of literature is available on ICT strategies, yet it is pertinent to pick up only that part of it which can have the potential to respond well to the needs and requirements of the developing countries. The UN Commission on Science and Technology for Development (UNCSTD) while considering the applications of ICTs for creating economic and social benefits for everyone, has concluded that such applications have both advantages and risks. Whereas the advantages include socio-economic progress, the risks include the possibility of a widening gap between the rich and the poor. In order to mitigate the chances of risks, a close coordination between the governments, business sectors and civil society would be imperative. The Commission has suggested some key considerations and strategy guidelines for ICT-based societies, both developed and developing. These guidelines are generic in nature but provide enough insight for designing the strategies to suit the needs of a large number of developing nations. Briefly they include:

- Producing and using ICTs to social and economic advantage.
- Developing human resource for effective national ICT strategies.
- Managing ICTs for development.
- Accessing ICT networks.
- Promoting and financing investment in ICTs.
- Generating and accessing scientific and technical knowledge.
- Monitoring and influencing the international rules and regulations governing ICT applications.

These general strategies are amplified in the suggested guidelines contained under each topic, however, they serve the purpose of making selections for actual policy decisions by each nation according to its specific socio-economic priorities and requirements.

Working on the above-mentioned guidelines for ICT strategies, one can draw more specific strategies for the developing and the least developed countries. Again they will need a selective adaptation for the developing and the least developed countries separately. As the costs of several important ICTs are gradually decreasing in the international market, the acquiring of such ICTs and their effective applications is also becoming more affordable for the developing and least developed countries. Sharing of ICT resources alongwith networking among the developing societies can make the wider adaptation more probable. The ICT strategies which could be considered by the decision makers in the developing countries may include the following:

- Benefits of ICT to be made accessible to all segments of the society and not merely to the privileged or influential ones. The benefits of prosperity and wealth generated through ICTs should be equitably distributable among all layers of society.
- If an information-based society has acquired a certain established pattern linked with the areas that do not answer the new challenges of the present century then a new strategy needs to be made and employed to re-focus on the importance of the new challenges, without disrupting the progress being made on account of strategies addressing the previous issues.
- As the major emerging challenges for the developing countries in the present times are related to food and agriculture, clean drinking water, energy, health and environment, the strategies to design and create ICTs for information- based society should have direct focus on these identified problem areas.
- ICT strategies should lay special emphasis on creating technicians, their quality training and capacity upgradation, for providing efficient support to the ICT technologies and ICT infrastructure. This would include technicians in the field of agriculture, civil works, water projects, electric power generation and distribution, forestry and timber works, food production, preservation and distribution, fire fighters, hospital para-medics and medical equipment handlers, clean industrial processes and waste disposal handlers, urban and rural health workers and so on. Specialised vocational institutions, built on ICT-based curricula meant to create an information-based society, should be created in abundance around rural areas to divert employment away from already overcrowded urban population where employment opportunities are fast coming to a saturation phase.
- Strategies should focus on reversing the rural migration to urban areas. ICTs support to rural economy like providing incentives to create rural food markets, village handicraft outlets, multinational wholesale outlets and godowns, electric

and mechanical workshops, first aid medical units, production units of rural use items, etc., can provide significant strength to retract the rural population already migrated to the cities and towns. Only a moderate infrastructure can greatly support such medium-level enterprises in the rural areas.

- Local and national ICT infrastructure should be built after taking into confidence the local civil society and other sections of the stakeholders. Local civil society knows more about the local requirements than the planners placed in remote areas.
- A central coordinating ICT organization should be created by the government to manage the technical sustainability, modification and upgradation, software and hardware backstopping, user complaints and trouble-shooting. This organization should be given a say in the local and national governmental policy-making and planning departments.
- The majority ownership of ICTs should be progressively allowed to the private enterprises, keeping a strict control on the emergence of monopolies and cartels.
- Appropriate state control and legislation should be created to effectively check the misuse or criminal use of ICTs.
- ICT-based industry and businesses having proven track records of public welfare should be provided with financial and social incentives such as tax rebates, awards, foreign exchange facilities, etc.
- Preference should be given to the ICT-trained staff for postings in the foreign missions, under the information and commercial consulates, to promote ICT related trade and businesses.
- Mechanisms should be built to establish international technical cooperation and networking for the easy access to latest ICT technologies, products and know-how.

Good governance, socio-political stability and firm commitment of the stakeholders is necessary if any of the above-mentioned strategy and policy guidelines have to work or to impart economic or technical benefits to the society. The private businesses and enterprises are to play a major and leading role to provide adequate financial investments in order to transform the developing and under-developed societies into truly information-based societies. Building information society has several interlinking aspects among government establishments, businesses and industry, civil society, educational and training institutions. A vibrant economic activity can be triggered and sustained by the involvement of all the relevant stakeholders, particularly the private sector and government, once well-planned strategies are put into place for the inclusion of ICTs into the overall scenario. It must be recognized that ICTs offer great potential for creating economic and social benefits for all the citizens. Developing and least developed countries should not lose this opportunity when it is within the reach of most of them. One can hope for a much better socio-economic future for the developing world by adopting ICTs to build strong information societies in the present century.

8. CONCLUSIONS

- It is well-established that information-based societies have higher potential for economic growth and social prosperity as compared to uninformed, semi-informed and unconnected societies.

- Developing countries can build information societies without excessive difficulties by appropriate applications of prudently chosen ICTs. Ample opportunities exist for the developing countries to create information societies during the coming years of this century.

- Sound policies and workable strategies are necessary for sustainable information societies. Integrated ICT policies provide better outputs as compared to the isolated or stand-alone policies.

- The emerging challenges of the 21st century facing the developing world in the most vital areas of food and energy security, environmental degradation, epidemics and population explosion can be successfully confronted through the aegis of ICT-based information societies.

- ICTs can greatly help creation of small and medium-scale rural economic zones in the developing countries. These zones not only provide opportunities to create local prosperity but also have the potential to reverse population migration from the rural areas to the already problem-stricken urban areas.

- The ICT policies and strategies to build information societies in the developing countries will benefit the nations only if the ICTs are accessible to all the segments of the society and not restricted merely to the privileged ones.

- Building of information societies in the developing countries is not a rapid process nor the benefits of the information societies appear quickly. Sustained efforts by the governments, committed involvement of private enterprises and acceptance of change in lifestyles by the civil society are necessary requirements for the establishment of a good information society to render its socio-economic benefits to the nation.

- Alongwith the benefits, the ICTs can also elicit risks, primarily due to their misuse or unethical social practices. The societies must be able to exercise strong moral and legal pressures against such risks.

- Developing and the least developed countries can do without going into the complexities of sustainability concepts linked to their socio-economic development. Policies and strategies addressing the pressing needs and priorities of the developing countries should be the foremost concern while embarking upon the path to develop information societies.

- Continuous capacity-building for upgrading, maintaining and ICT-backstopping is a necessary requirement to sustain the benefits of an information society. Appropriate policies and strategies in this regard can also help create indigenous capacities for ICTs and their infrastructure in the developing countries.

- International cooperation, for information-sharing and utilization through efficient networking, augments the effectiveness of the prudently established information societies in the developing countries.

BIBLIOGRAPHY AND FURTHER READING

- Conference Report "Towards a Sustainable Information Society, June 2000.
- Khan, Hameed A. et al. (Editors), Road to Knowledge Based Economy, COMSATS' 10th Series of Publication, 2007.
- R. Mansell and U. Whn (Editors), Information Technology for Sustainable Development, ISBN-0-19-829410-7, March 1998.
- UN World Summit on Sustainable Development Report, Agenda Item 8, 22 Aug. 2002 (A/conf. 199/L.4).

SECTION - B

STRATEGIES

COLLABORATING FOR SUCCESS

R. J. Peterson
Department of Physics, University of Colorado Boulder CO.
United States of America

ABSTRACT

Among the first to navigate across the newly flat globe have been groups or collaborations of basic scientists, most notably those requiring large investments in equipment and specialized teams. CERN, the noted center for nuclear and particle physics in Switzerland, led the way, with its development of electronic communication needed for research-collaborations making a key step towards the world we see today. As a scientist who has enjoyed and thrived in global collaborations of small to moderate sizes, This paper attempts to distill some of the lessons learned, with the goal of encouraging and mentoring a wider range of collaborative national, regional, or international efforts, with benefits to be sought in the more local and applied research topics needed for development of nations and communities lacking their own critical masses to solve important problems.

1. INTRODUCTION

If an observation, measurement, or theory is obtained by a researcher, it is not 'science', since scientific truth is only that which can be verified, and that requires the existence of at least one more person to carry out that verification. Then, and only then, is the result to be considered scientific. But how does one person gain the confidence in his or her result to present that initial result to the public arena? The best possible way to verify results is to work with other researchers during the development of the result, for instant feedback, in what we might call the 'microscientific method' This is probably the greatest gain to be made from working in collaboration. Better—the more differently the minds of your partners work, the more exacting is the test of the idea being developed, and the wider the range of connections to other ideas, knowledge and experience. These connections will commonly amplify the relevance of the results. More practically, teamwork and collaborative efforts are very attractive to those who offer funding for science.

2. GETTING STARTED

The greatest gain from collaborations in scientific endeavors might be the intellectual one just described, but there are many others. Some scientific projects have scales beyond what an individual, an institution or even a nation can carry through. Perhaps the largest of projects are those requiring the design, construction and operation of large items of equipment, such as the 26.6 km circumference LHC particle-accelerator, being built by CERN in Switzerland at a cost of 3.2 billion Swiss Francs and including the efforts of thousands people from 50 countries. Other large particle-accelerator projects have followed this model, and so have large telescopes, as well as the new International Thermonuclear (ITER) plasma device, and space missions. There are surely lessons to be learnt from how such vast associations are formed, managed, operated, with particular interest in how the nations, institutions and individuals involved are motivated and rewarded. If these mechanisms can be understood, we might apply the lessons to collaborations at the smaller scales needed for useful and sustainable development, on whatever scale may be appropriate.

The first necessity of a project is some idea or some question, asked as clearly as possible. For the LHC, the most focused question is on the existence and properties of a new particle, the expected Higgs. The thinking of many very smart people has been involved for years in establishing the expected existence and the need for understanding of this exotic object. Similarly, for a practical or development need, the more sharply focused the question is, the easier it is going to be to create the means to address it. Even at this first step, the need for cooperation of minds and ideas is surely vital, particularly for the critical thinking needed to evaluate the validity of the question, just as it was to justify the requests for funding the LHC. In writing these words, I am always aware that I am not a good editor of my own thoughts, and by writing alone at my desk I am not gaining from this first critical review of my thinking. Fortunately, at least my spelling can be checked by today's electronic machinery!

The Team and the Leader: Then, how is this idea or question or need to be addressed? Most of the questions we face in our scientific endeavors have become quite complex, but we also gain from a very rich array of tools, devices and connections to address complex problems. Often, several very different skills are needed to utilize this array of tools, and again we see the need for collaborations. Who should be in our team? In the many collaborative projects I have worked in, I have seen the value of experts, some very particular in their focus, enthusiasts, who do not care that something might not really be possible, and dreamers, who see the more distant possibilities. And there does need to be a boss. In the large collaborations, the title is usually 'spokesman', as the one carrying the public responsibility for the success of the team, starting with the proposal for the means to carry out the project. It is important that members of the team being formed have ample opportunities to discuss their contributions and questions informally, well before the words of the plan and the proposal are written. Then, the designated spokesman (or spokewoman) is the editor of the proposals.

A proven start for this step is to hold these early discussions in the hallways and at the lunch tables. This may happen at conferences, within educational and research institutions, or (now) by the virtual hallways of informal electronic communications. I have found the virtue of speakers at conferences usually to be evokers of ideas, which can then be clarified, debated and amplified in the hallways. Since conference lecturers have been forced to condense all they have to say into all-too-brief talks, they can be the focusing lenses of results, questions and ideas. This model relies upon the important role of conferences in the ecology of science today, and we should all attend as many as possible.

A senior, perhaps even a very senior, researcher can have the most important role in creating a team, using his or her reputation to nucleate the group, and using that same reputation to match the goals and needs to the appropriate funding source. It may be too much to expect this person to stay up all night on data taking, staring into a microscope or marching through the swamps in search of specimens. The reputations are built partly on achievements, but the important asset for the new collaboration is the trust one can place in the leadership. If the most senior member of the team being formed is not willing to be the spokesman, another could be chosen, although the spokesman of the group may be largely a figurehead without harm to the progress of the project.

But what if you and a few friends have a great idea or face a great need, and have no senior to ask for advice, mentorship and possible leadership? A bit of survey of the literature or a few minutes with a search-engine are likely to provide a few names. Contrary to what many young researchers may think, most seniors in science want young colleagues to come to them for just what may be needed to develop a collaboration. Since you will first be reviewing the relevant literature to understand the context of your question, it is easy to note the names of those making progress in the same general area. Publications, by their very nature, are always out of date, but can give a good view of who is doing what. After some small number of contacts is made, assembling the rest of the group can be easy, since the number of connections and ideas grows so rapidly.

As a collaborative research team is formed, it is important to be sure that everyone agrees (or at least closely enough) on the goals, means and hoped-for recognition. If the group exceeds ten or so, a smaller executive committee is a good idea. It is best to create and agree to some written simple memorandum of understanding. This should include the acceptance of responsibilities, and possibly deadline, and be clear about the rules for just which names go onto the final publications, or other acknowledgements.

3. FINDING THE MONEY

Now it is time to write a proposal, with funding as the usual object. Money grows on trees in the scientific business of today, and the proposal needs first to find the appropriate tree, and then seek to meet the stated goals of the funding-agency by way of the work you will carry out. These goals and conditions will always be spelled out on the websites of the agencies or the foundations, but it is much better to call, email or visit the responsible person before starting the proposal. You can sketch out your goals, and your needs, and why they should welcome the opportunity to help you. The website will also contain the rules for proposals. These should always be followed absolutely exactly. If there is a flood of incoming proposals, any program manager or reviewer can save a lot of work by immediately rejecting those that do not follow the rules, and not even have to read them. These rules may include a word-count, font-size or even margins. It's their system, so do not fight it.

While in the early discussions, you might be able to find some examples of successful proposals. In the United States, all funded National Science Foundation (NSF) proposals are public information. Any pending or rejected proposals are not. Or, ask a colleague for a sample of a proposal he or she has submitted, whether successful or not. Also, this can give you access to the comments of the reviewers. Of course the proposal itself is a collaborative effort, and all relevant collaborators should be involved in writing or reviewing it. After submission, each member of the collaboration will need access to the proposal carrying their names, but you need not share it any more widely. The NSF, by the way, has a division of international research, and your possible US collaborators can ask for funds from this source to meet their share of the effort.

In your proposal, nothing will succeed as much as success, so do include any tantalizing observations or preliminary data you may have. Since this is not a publication, you need not be modest or exact. If students or other junior investigators will be part of your team, be sure to point out the long-term value to the field, the funding agency and the globe of the educational experiences to be gained. Some agencies give bonus points to work from young investigators.

Multiple Sources: The idea of team work and collaboration extends to the funding worlds as much as to the practicing scientists. 'Cost sharing' is always to be desired. To the funding agency, it is a sign that someone else cares about the work, confirming their good judgment in adding their share of the funding, as well as stretching the funding itself. After your project succeeds, all contributors to its execution can take full and total credit for its success. Sometimes, cost-sharing funds can be in hand when the proposal is written, but more commonly the contributions are conditional. If

NGO-A provides one third, will Government Agency-B, give one half, provided that the Hosting University-C funds one sixth? It is not only hard cash that can count as a contribution, but also time, work space, travel-support, student-support and a very wide range of expenses, some of which might be underway in any case. Use the leverage. If the collaboration you are forming includes researchers from several institutions, ask for a bit from each, to share the burdens and the glory. If the funds are to be spent in the local institution or country, be sure to point out to the local contributors the fact that the money is not actually going anywhere.

If your proposal is not funded, that is only the start. We as scientists can learn from our experiments, even those that do not go well. Do write or call the program-officer to say thank you for the effort and time, and stay in touch. Consider the comments of the reviewers very carefully, and share all with any of your collaborators. If you are not the actual proposer, ask that you be kept fully aware and involved in all stages of the proposal, even the bad news. Then rework that proposal, and try again, perhaps at some other agency. There are programs with a vast overload of worthy proposals and therefore with very low chances of success, so it is not a major criticism to be turned down. *If you are funded, try to get a start before the money arrives, since time to complete the project will always be short. Make sure that your supervisors, town mayor, and newspaper editors know of the success of your proposal , what the results will mean, and how the project will help their community*. Since this is a collaboration, each member can take such credit, and each supervisor or local official may take pride in the success of their researcher. Success always has many fathers!

4. GETTING THE WORK DONE

This should be the easy part, since you have thought through what to do and have probably done similar steps before. But now you are a member of a collaborative team, and the rules and methods are not the same as for solo work. Even if the proposal does not include or the funding agency does not demand a work-schedule, *a collaboration of researchers needs a clear constitution of who does what and when. This must be written, so as to preclude confusion. Regular meetings, by email or by modern electronic systems, such as blogs, can keep everyone aware of your progress*. Of course, you may be side by side in the laboratory or out in the field together, with no need to become too formal, but if your team is interdisciplinary, inter-institutional or even international, a regular system of communication is needed. It is often useful to create a system of internal reports, approaching the quality of final publication. This provides practice and polishing of the writing, makes the most secure sharing of results among yourselves, and can be shown to funding program managers and others as proof of progress. In very large collaborations, such internal reports are even more vital, since much of the community caring about the work are within the group. Such internal reports can also be the citable bases for student reports, theses and dissertations.

If the grant is to each institution, spending your money is simple, but if the funds come to one central institution or person, a clear and transparent spending-system is needed. If overhead has been included in your grant budget, the sharing may be complex, even more in need of transparency.

Modern methods and instruments can amass vast oceans of data quite easily, and your collaboration may have more to look at than can be digested by any one of you. A system of sharing the data among the collaboration is needed to give each researcher access. Since there will be a range of talents and aims among your team, this access can give a range of results, possibly beyond what you originally proposed. Redundancy of analysis is possible, and the consistency of results obtained by different individuals can become a powerful confirmation of your results. Since so much of the analysis will be the result of computer codes, each written by some human being, we are more in need of redundancy and double checking than ever. The internet was actually invented at CERN to provide just this kind of data sharing.

5. PUBLISHING, AUTHORSHIP AND CREDIT

Having the final results does not mean that you are done, since the perspective of science is to put results before others, for judgments and for applications. There is also that thrill of pride that we all feel when we see our work, our thinking, and our insights accepted by our community. The right journal or other means of publication will vary from field to field, with major international journals usually more interested in the major and widely generalizable results of scientific studies. National or regional journals, even with a bit less prestige, may be better suited to your work, especially if you hope for applications to regional or local problems. I suggest early email or other communications with the editors of a range of journals to find the right home.

Serial publication, putting the same work in different journals, is usually frowned upon, but if your collaboration includes colleagues from several nations or areas, it may be appropriate to submit your work to several journals. The point is to make a difference and have an impact. A leading author might be from the same nation as the journal, for instance.

But, who goes first? Fortunately, you all agreed to the rules for authorship at the start of the project. *First authorship is usually taken to be the place of honor, and it is certainly fairer to first put the name of the most responsible author.* Precise ordering of contributions can be impossible, and so alphabetical order can be used to indicate that the work is truly that of the entire collaboration. Everyone who contributed significantly to the work should be on the author list, and those who helped without responsibility should be thanked in the acknowledgments at the end of your work. *Also, and never, never forget this step—be sure to thank and acknowledge your source of funding, and even the program manager by name*. Sending a copy of your paper to that individual is a nice touch. Also, all those who contributed to your cost-sharing deserve a copy of your work.

Publication and Progress-Reports: Large collaborations may select a publication-committee, of three or more, best from different institutions, to evaluate the work and to make sure credit is appropriately given. If student-work, as a thesis or dissertation, may result from your efforts, these should be as consistent as possible with the group result, but it may be unwise to insist only upon complete agreement. *Interpretations, even very fair ones, may differ, and that is the whole point of science.*

Since the future of your field will be carried by the younger authors on your group-paper, you want to smooth their way as much as possible, perhaps even erring on the side of generosity in the author-list, especially for students. Remember what it felt like to see your name first time in print, and give that sense of gratification to your next generation.

Progress reports may be required by funding-agencies, but are always sent and read by the agency with a non-critical eye. This is only progress, and it is only the final result that counts. But do have conversations on an informal basis with any and all of your funding agencies. Be sure to re-read your proposal before any of these conversations. Your program manager will be reading it soon after or even during your communication!

Often, especially in local and applied questions or projects, internal reports are the preferred means to get your results into the right hands and minds. This allows a wider use of primary data, since the readers will know the area and the issues. These should be written so as to withstand wider scrutiny than just the expected readers, since the world of science is now so flat. Your work may hold the details needed to solve some very large issues in future, and only your results, *properly presented and archived*, can give the results of your observations of some event that may be transient. Always write for posterity.

That leads to the question of intellectual property. It is generally accepted that any work published in a journal becomes the property of the community of science, and the results of your work may be quoted and used freely for any intellectual purpose. You will want to make sure that your prose and your data-presentation would never allow any misinterpretation of your work and all the hours you put into it. If there is potentially market value in your results, you will need to protect your priority *before* submitting the paper for publication. Patent and other protective laws vary widely, so you will need to talk with a local expert. Samples, such as cell-lines, will need environmental and forensic protection, as well as the merely legal.

6. AFTER SUCCESS

Your collaborative papers are published in the most appropriate journals, and you are ready to move on. Since each scientific success stands on the shoulder of those before, so it is perhaps appropriate to arrange to stand upon your own shoulders, a feat unknown to any gymnasts. Assist other members of your team as they go onto the next steps, attend meetings and show off your successes, and use whatever preliminary results (from your funded work that may apply) to write the next proposal and form the next collaboration. That first one was the hardest.

7. CONCLUSIONS

Success can be achieved by collaborating with other researchers, especially during the phase of development of results. This phenomenon of collaboration and networking amplifies relevance of the results and encourages systematic efforts and opens gateways for other breakthroughs, besides attracting funding from capital venture. It is proposed that scientists from developing countries collaborate with each other in a wide range of their national, regional, or international efforts, particularly applied research. The series of formal steps to be followed in order to ensure success in scientific collaborations include: reaching clarity on issues and precisely identifying problem-areas; bringing dynamic and vibrant leadership to take up the task; making use of wide range of funding channels in a cost-sharing manner; frequently communicating, both horizontally and vertically, with each other using quickest means; publicizing the research findings and passing on due share of success and credit to individuals for their efforts, and finally looking ahead and supporting the partners in their future endeavors in a collaborative manner.

SCIENCE AND TECHNOLOGY FOR ACHIEVING MILLENNIUM DEVELOPMENT-GOALS

Anwar Nasim* **and Ikram Abbasi****
*Adviser Science, **Program Officer
COMSTECH Secretariat, Islamabad, Pakistan

ABSTRACT

This paper focuses on the role of science and technology in the achievement of Millennium Development Goals (MDGs). All eight MDGs are discussed one by one, with their particular relevance to science and technology. Possible policies and strategies have been suggested for the developing countries, to help them adopt S&T in accordance with their existing capacities, competencies and resources for achieving millennium development goals and to prioritize MDGs according to their specific national priorities. Such evaluation is primarily based on the available statistical data for the specific country. The example of Pakistan is used to illustrate this approach.

The role and importance of science and technology in the socio-economic uplift is also highlighted with examples, to show how science, technology and innovation are helpful, and how developing countries can achieve socio-economic development.

1. DEVELOPMENT

At the outset it is important to define the word development. The Cambridge dictionary defines the word 'development' as CHANGE [when something or someone grows or changes and becomes more advanced] MAKE [when something new is made] and START [when something starts to happen or exist][1]. If we sum up this definition into a national-development scenario, we can say that "when a country starts growing by adopting changes and producing valuable goods, resulting in the initiation of a process that leads the way to economic development and something starts to exist, that country is on the way to development".

The word development is used to define many situations, but this paper focuses on the economic dimension of development. "Economic development is the development of economic wealth of countries or regions for the well-being of their inhabitants."[2] From a policy-perspective, economic development can be defined as "efforts that seek to improve the economic well-being and quality of life for a community, by creating and/or retaining jobs and supporting or growing incomes and the tax-base."

Nations around the world, whether developed or developing, are striving to achieve the ultimate economic well-being and quality of life for their people. On measuring the quality of life of people living in different parts of the world, the world can be divided into various categories namely developed and underdeveloped, North and South, rich and poor, high, medium and low human-development, etc. The following are some statistics indicating the level of development in Pakistan (Table - 1).

Table – 1: Status of Health in Pakistan

Human Development Index (HDI) Rank	136
Human Poverty Index (HPI-1) Rank	77
Children under weight under age 5	38 %
Population below income poverty line	32.6 %
Population (millions)	158
Births attended by skilled health personnel	31 %
Physicians per 100,000 people	74
Population using improved sanitation	59 %
Population using improved water source	91 %
Population undernourished	24 %
HIV prevalence	0.1 %
Tuberculosis prevalence per 100,000 people	297
Life expectancy at birth	63.6
Infant mortality rate per 1000 live births	79
Maternal mortality ratio Reported per 100,000 live births	530
Literacy rate	49.9 %
GDP US$ billions	110.7
Public expenditure on health % of GDP	0.4
Public expenditure on education % of GDP	2.3
Unemployed people (thousands)	3566

Source: *Human Development Report 2007-2008*

2. KNOWLEDGE

For countries in the vanguard of the world economy, the balance between knowledge and resources has shifted so far towards the former that knowledge has now become perhaps the most important factor determining the standard of living - more than land, than tools, than labour. Today's most technologically advanced economies are truly knowledge-based.

World Development Report, 1999

In the present world, the often discussed concept is the “Knowledge Economy”. Knowledge is thought to be the foremost tool to achieve the desired development. Natural resources are importance wise considered as the second. Today, oil is thought to be the most precious natural resource. If we ask why, the only answer could be the existence of many kinds of machines and vehicles, from cars to aeroplanes, for which oil works as a soul to keep them alive. Let’s suppose for a few seconds that we exclude these human made machines from our current world. Will oil remain as precious as it is today? By considering this, we can imagine the role of knowledge in the development of societies. If a country has abundance of natural resources and has no knowledge to develop them into products, or even no knowledge about how to use them, those resources are of no use. So, knowledge is one of the most important factors that takes nations out from the dark well of poverty and despair.

He who receives an idea from me receives instruction himself without lessening mine; as he who lights his taper at mine receives light without darkening me.

Thomas Jefferson

3. SCIENCE AND TECHNOLOGY

We all know that knowledge has many branches for development of the different dimensions of human beings; however, for achieving the material development we need to excel in science and then in technology. Science deals with the world that is accessible to the senses of the human being. Technology is the application of the knowledge, gained through scientific experimentation, to achieve something that is usable by human beings. Science cures human beings, and provides luxuries of life. So we can say that science and technology advances human being towards better living conditions.

4. MILLENNIUM DEVELOPMENT GOALS (MDGs)

The Millennium Development Goals (MDGs) are the end-product of numerous UN development conferences, from the 1960s to 1990s. The first, second and third UN Development Decades (1960s, 1970s, 1980s) focused largely on economic growth. In the 1990s, debates about development focused on the need to establish macroeconomic stability, strong institutions and governance, to enforce the rule of law, control corruption, and provide greater social justice. As a result, the MDGs reflect the emerging role of human rights in the international community, focusing on the economic, social and cultural rights enumerated in the Universal Declaration of Human Rights (rights to food, education, health-care, and decent standard of living). The Goals also reflect a mixture of economic theory and human rights, since a variety of human-rights advocacy groups and civil-society organizations participated in the drafting of the Goals.

The International Development Goals, drafted in 1996 by the Development Assistance Committee of the Organisation for Economic Co-operation and Development (OECD), also strongly influenced the MDGs. Seven of the eight MDGs are exactly the same as the OECD goals. Like the OECD goals, the first seven MDGs are time-bound and measurable. The eighth MDG is not time-bound, but instead more of an aspirational goal. The UN also simulated the manner in which to OECD goals relied on bilateral donors to further their development goals. Unlike the OECD goals, however, the MDGs were formally adopted by developed and developing countries alike.

The primary objective is to cut poverty in half, across the globe, by the year 2015. The eight MDGs are to:

i. Eradicate extreme poverty and hunger;
ii. Achieve universal primary education;
iii. Promote gender-equality and empower women;
iv. Reduce child-mortality;
v. Improve maternal health;
vi. Combat HIV/AIDS, malaria, and other diseases;
vii. Ensure environmental sustainability;
viii. Develop a global partnership for development.

Goals one through seven are mutually reinforcing and are aimed at reducing poverty. The eighth goal, global partnership for development, is the means to achieve the first seven. Each goal has a set of targets and indicators, designed as a "road map" for achieving the MDGs. The targets and indicators were drafted to measure the progress of each country, on an international level.

The Millennium Development Goals are premised on six core-values viz:

i. Freedom,
ii. Equality;
iii. Solidarity;
iv. Tolerance;
v. Respect for nature; and
vi. Shared responsibility.

Each one can be traced to an economic, social, or cultural right, originally set forth in the Universal Declaration of Human Rights (arts. 22, 24, 25, 26) and later enumerated in a separate treaty, the "International Covenant on Economic, Social and Cultural Rights". While achieving the MDGs will not mean that human rights are being universally respected, the international community generally agrees that the Goals are a step in the right direction towards that end. One important aspect of the Goals is that, during the drafting process, the targets were intentionally tailored to cognizable human rights. This was done so that members of the General Assembly would view the targets as more of an obligation than aspirational development-goals. As obligations, countries must not only refrain from violating the targets, they must also take affirmative steps towards realizing the goals.

Taken as a whole, the MDGs have been influential in the international community. In some countries the goals have roused democratic debates about governmental performance, fostering political freedom and open debate. The Brazilian President Luis Inacio da Silva, for example, used the MDGs as his political platform for his presidential election.[3]

Let us analyze, one by one, what role science and technology can play in achieving these MDGs.

5. THE ROLE OF SCIENCE & TECHNOLOGY IN ACHIEVING MDGs

5.1 Eradicating Extreme Poverty and Hunger

Biotechnology can provide solutions to eliminate extreme hunger and poverty. Biotechnology helps in producing high-yield crops, this technique enables breeders to develop new varieties of seed that can tolerate extreme weather-conditions, as well as combat different pests. Biotechnology also helps in increasing storage-life of grain, etc.

The World-Bank Development Report, titled "Agriculture for Development", say "Agriculture is a vital development tool for achievement of the Millennium Development Goals, that call for halving by 2015 the share of people suffering from extreme poverty and hunger". This report states that three out of every four people in developing countries live in rural areas and most of them depend, directly or indirectly, on agriculture for their livelihoods. It recognizes that overcoming abject poverty cannot be achieved in Sub-Saharan Africa without a revolution in agricultural productivity for the millions of suffering subsistence farmers in Africa.

The World-Bank report also emphasizes that Asia's fast-growing economies, where most of the wealth of the developing world is being created, are also home to 600 million rural people living in extreme poverty, and that rural poverty in Asia will remain life-threatening for millions of rural poor for decades to come. This report is cautious that there is a risk that fast-moving biotech crops can easily be missed by developing countries if the political will and international assistance support is *not* forthcoming.[4]

Agricultural biotechnology is a range of tools, including traditional breeding-techniques that alter living organisms, or parts of organisms, to make or modify products; improve plants or animals; or develop microorganisms for specific agricultural uses. Modern biotechnology includes the tools of genetic engineering. Biotechnology provides farmers with tools that can make production cheaper and more manageable. For example, some biotechnology crops can be engineered to tolerate specific herbicides, which makes weed-control simpler and more efficient. Other crops have been engineered to be resistant to specific plant-diseases and insect pests, which can make pest-control more reliable and effective, and/or can decrease the use of synthetic pesticides. These crop production options can help countries keep pace with demands for food, while reducing production costs.

Genetically-engineered plants are also being developed for a purpose known as phytoremediation, in which the plants detoxify pollutants in the soil or absorb and accumulate polluting substances out of the soil, so that the plants may be harvested and disposed off safely.

In addition to genetically-engineered crops, biotechnology has helped make other improvements in agriculture not involving plants. Examples of such advances include making antibiotic production more efficient through microbial fermentation and producing new animal vaccines through genetic engineering for diseases, such as, foot- and-mouth disease and rabies[5].

Developing countries should critically examine the benefits of this new technology and adopt it to reap the benefits of new techniques developed by biotechnology, so that they can grow more food for their people.

5.2 Achieving Universal Primary Education

Information Technology has the potential to reduce illiteracy. Through the proper use of this technology, distance-learning programmes can be introduced. Video-conferencing can help in spreading knowledge to the far-flung areas. Personal Computers and CDs also have an important role in educating people; electronic lectures can be distributed among the people in rural areas for learning through listening.

Information and communications technologies (ICTs) are dramatically and rapidly transforming secondary and post-secondary education in developed nations to a degree scarcely imaginable a generation ago. High schools, colleges, vocational schools, universities, and advanced research institutions are being profoundly affected, at all levels and in myriad respects. ICT has affected distance-learning, allowing school-calendars to be designed to accommodate the needs of individual students, on the one hand, and the faculty, on the other, thus moving many elements of the educational process into the virtual world. This hugely increases the “market of potential learners”. Such technology-mediated instruction can be accessed 24 hours a day, from almost any location, opening opportunities for working students, parents of young children, and those with disabilities to attain their educational goals. ICT is changing the developed world’s attitudes and approaches to education. By transcending traditional physical and spatial constraints, ICT brings to millions of people, of all ages, ethnic groups, and socio-economic levels, unprecedented educational opportunities-whether they are on-campus or off, attending vocational institutions, or receiving technical education and vocational training at a distance. It is able to do this in a cost-effective, sustainable way. Generally speaking, the more learners participating in a technology-mediated program, the lower the per-student cost. Historically, there has been an inverse relationship between technological capability and cost.[6] Getting benefit of ICT, universal primary education can be achieved and literacy rate can be enhanced effectively. Developing countries should adopt the techniques from the advanced countries, to benefit from this information technological revolution.

5.3 Improving Health Status

The three health-related MDGs are: reduce child mortality; improve maternal health; combat HIV/AIDS, malaria, and other diseases. Biotechnology has brought revolutionary developments in the field of medicine to combat dangerous diseases, such as, diabetes, hepatitis, and different kinds of cancers. Interferon and insulin are some examples of such scientific breakthroughs.

We are now moving into gene-therapy, gene-mapping, in-vitro fertilization, monoclonal antibodies and DNA fingerprinting.

Gene-therapy is the insertion of genes into an individual's cells and tissues to treat a disease, and hereditary diseases, in which a defective mutant allele is replaced with a functional one. In most gene therapy studies, a "corrected" gene is inserted into the genome to replace an "abnormal," disease-causing gene. A carrier called a vector must be used to deliver the therapeutic gene to the patient's target-cells. Currently, the most common type of vectors are viruses that have been genetically altered, to carry normal human DNA. Viruses have evolved a way of encapsulating and delivering their genes to human cells in a pathogenic manner. Scientists have tried to harness this ability by manipulating the viral genome to remove disease-causing genes and insert therapeutic ones.

Target cells, such as the patient's liver or lung cells, are infected with the vector. The vector then unloads its genetic material containing the therapeutic human gene into the target-cell. The generation of a functional protein-product from the therapeutic gene restores the target cell to a normal state.[7] On April 14, 2003, the International Human Genome Sequencing Consortium, led in the United States by the National Human Genome Research Institute (NHGRI) and the Department of Energy (DOE), announced the successful completion of the Human Genome Project more than two years ahead of schedule.

The international effort to sequence the 3 billion DNA letters in the human genome is considered by many to be one of the most ambitious scientific undertakings of all time, even compared to splitting the atom or going to the moon.

"*The Human Genome Project has been an amazing adventure into ourselves, to understand our own DNA instruction-book, the shared inheritance of all humankind,*" *said NHGRI Director Francis S. Collins*. The flagship effort of the Human Genome Project has been producing the reference sequence of the human genome. The finished sequence produced by the Human Genome Project covers about 99 percent of the human genome's gene-containing regions, and it has been sequenced to an accuracy of 99.99 percent. In addition, to give researchers a better understanding of the meaning of human genetic instruction-book, the project took on a wide range of other goals, from sequencing the genomes of model organisms to developing new technologies to study whole genomes. As of April 14, 2003, all of the Human Genome Project's ambitious goals have been met or surpassed.[8] Modern molecular medicine encompasses the utilization of many molecular biological techniques in the analysis of disease, disease-genes and disease-gene function. The study of disease-genes and their function in an unaffected individual has been made possible by the development of recombinant DNA and cloning techniques. The basis of the term, recombinant DNA, refers to the recombining of different segments of DNA. Cloning refers to the process of preparing multiple copies of an individual type of recombinant DNA molecule. The classical mechanisms for producing recombinant molecules involve the insertion of exogenous fragments of DNA into either bacterially-derived plasmid (circular double stranded autonomously replicating DNAs found in bacteria) vectors or bacteriophage (viruses that infect bacteria) based vectors. The term vector refers to the DNA molecule used to carry or transport DNA of interest into cells.[9] Defects in DNA leads to diseases.

Stem cells have the remarkable potential to develop into many different cell-types in the body. Serving as a sort of repair-system for the body, they can theoretically divide without limit to replenish other cells as long as the person or animal is still alive. When a stem-cell divides, each new cell has the potential to either remain a stem-cell or become another type of cell with a more specialized function, such as a muscle cell, a red-blood cell, or a brain cell.[10] The vast bulk of pharmaceutical drugs presently on sale are synthetic chemicals derived either directly by chemical synthesis or by chemically modified molecules derived from biological sources. Biopharmaceuticals are considered to be recombinant protein-drugs, recombinant vaccines and monoclonal antibodies. Biopharmaceuticals are becoming increasingly relevant in biological applications, but are still only a small part of the pharmaceutical industry.

Biotechnology will also accelerate screening, producing speedy bioassays and will lead to the production of new drugs. Biotechnology will almost certainly vastly reduce the huge costs presently incurred in product development of new drugs. New medical treatments based on biotechnology are appearing almost daily in the market. These include:

i. Therapeutic products (hormones, regulatory proteins, antibiotics)
ii. Prenatal diagnosis of genetic diseases
iii. Vaccines
iv. Immunodiagnostic and DNA probes for disease identification
v. Gene therapy[11]

Through the proper adoption and application of these advancements, we can hopefully achieve the above-mentioned health-related MDGs.

5.4 Ensuring Environmental Sustainability

Bioremediation is the use of biological systems for the reduction of pollution from air or from aquatic or terrestrial systems. Micro-organisms and plants are the biological systems which are generally used. Biodegradation with micro-organisms is the most frequently occurring bioremediation option. Micro-organisms can break down most compounds for their growth and/or energy needs. These biodegradation processes may or may not need air. In some cases, metabolic pathways, which organisms normally use for growth and energy supply, may also be used to break down pollutant molecules. In these cases, known as co-metabolism, the micro-organism does not benefit directly. Researchers have taken advantage of this phenomenon and used it for bioremediation purposes.

Bioremediation techniques can be used to reduce or to remove hazardous waste, which has already polluted the environment. These can also be used to treat waste streams before they leave production facilities: end-of-pipe-processes, etc. Applications of bioremediation include waste-water and industrial effluents, drinking and process water, soil and land treatment and solid wastes.

Environmental biotechnology has a career extending back into the last century. As the need is better appreciated to move towards less destructive patterns of economic activity, while maintaining improvement of social conditions inspite of increasing population, the role of biotechnology grows as a tool for remediation and in environmentally-sensitive industry. Already, the technology has been proven in a number of areas and future developments promise to widen its scope. Some of the new techniques now under consideration make use of genetically modified organisms, designed to deal efficiently with specific tasks. As with all situations where there is to be a release of new technology into the environment, concerns exist. There is a potential for biotechnology to make a further major contribution to protection and remediation of the environment. Hence, biotechnology is well positioned to contribute to the development of a more sustainable society. As we move into the next millennium, this will become even more vitally important as populations, urbanization and industrialization will continue to climb.[12]

Regulatory policies: Regulatory policies, or mandates, limit the discretion of individuals and agencies, or otherwise compel certain types of behavior. These policies are generally thought to be best applied in situations where good behavior can be easily defined and bad behavior can be easily regulated and punished through fines or sanctions. An example of a fairly successful public regulatory policy is that of a speed limit.

6. COMPETENCIES/ CAPACITIES

"Specifically, capacity-building encompasses the country's human, scientific, technological, organizational, institutional and resource capabilities. A fundamental goal of capacity-building is to enhance the ability to evaluate and address the crucial questions related to policy-choices and modes of implementation among development-options, based on an understanding of environment potentials and limits and of needs perceived by the people of the country concerned". Capacity Building - Agenda 21's definition (Chapter 37, UNCED, 1992)

Capacity Building is more than training, and includes the following:

- Human resource development: The process of equipping individuals with the understanding, skills and access to information, knowledge and training that enables them to perform effectively.
- Organizational development: The elaboration of management-structures, processes and procedures, not only within organizations but also the management of relationships between the different organizations and sectors (public, private and community).
- Development of Institutional and legal framework, making legal and regulatory changes to enable organizations, institutions and agencies, at all levels and in all sectors, to enhance their capacities.[13]

When we look at the developing countries' competencies, we hardly find any; the mainstay of these economies is agriculture. Some natural resources are there, but developing countries are not technologically so rich to transform raw materials into high-valued products. To achieve the millennium development goals, developing countries should focus on agriculture and apply new techniques provided by biotechnology. By Excelling in agriculture with the application of modern knowledge, such as biotechnology, developing countries can succeed in alleviating poverty and hunger, which is the core issue faced by the poor countries today. These countries should not only become food-growers but they must become manufacturers of high-quality food products.

The most important asset developing countries have is their youth. Developing countries must prepare policies to train manpower and employ them right after they finish their training, to reap the benefits of those trained persons. The big problem for the developing countries is unemployment, they have youth but they don't have ability to utilize them: that's why developing countries are still developing. There is only one way forward, that is, only trained people can transform raw materials into high-valued products and these products can earn huge foreign exchange.

Developing countries must be very careful and cautious in the use of their existing resources, whether these resources are in the form of natural resources, such as oil, coal, etc, or in the form of money. Highly managed use of these resources can also help poor countries to support their common people and emerge from the curse of poverty. Ultimate management of resources and their use can be equally or even more beneficial than the resources itself.

7. NATIONAL DEVELOPMENTAL STRATEGIES

The outcome document of the 2005 United Nations World Summit called on countries to prepare national development strategies, taking into account the international development goals agreed upon in the various United Nations Summits and Conferences of the past two decades. In order to assist countries in this task, the United Nations Department of Economic and Social Affairs (DESA) commissioned six notes for policy-makers, both in the government and civil society, in major and interconnected areas relevant to the formulation of national development strategies: macroeconomic and growth-policy, trade policy, investment and technology policy, financing development, social policy and state-owned enterprise reform. The preparation of the notes received generous funding, in part from the United Nations Development Programme (UNDP).

The policy notes, authored by experts in these fields, draw on the experience and dialogues of the United Nations in the economic and social areas, complemented by outside knowledge. The notes have been reviewed by Professor Joseph Stiglitz and other distinguished academics, as well as by development specialists from United Nations entities. However, the views expressed in the policy notes are those of the authors and do not necessarily reflect those of the United Nations. The notes provide concrete suggestions on the means to achieve at the national level, the internationally-agreed development goals synthesized in the United Nations Development Agenda. The policy notes are meant for providing those at the country level who shape and set policies, with a range of possible alternatives to the standard policy solutions that have prevailed over the past two decades, rather than to prescribe any single course of action. The notes serve to help countries take advantage of and expand their policy space - their effective room for maneuver in formulating and integrating national economic, social, and environmental policies.

Readers are encouraged to see these notes as complementary inputs into the debate at the country-level on development challenges faced and the policies needed to meet them. The issues chosen are vital pieces of the policy-mosaic that underlies national development strategies, which are ultimately geared to achieving sustained economic growth, with social inclusion and environmental protection.

REFERENCES

1. Cambridge Dictionaries Online. Available at: http://dictionary.cambridge.org/define.asp?dict=L&key=HW*689 [Accessed 28 April 2008]
2. Wikipedia the free Encylopedia. Available at: http://www.wikipedia.org [Accessed 24 April 2008]
3. University of Iowa Center for International Finance and Development. Available at http://www.uiowa.edu/ifdebook/faq/faq_docs/Millenium_Develpment_Goals.htm [Accessed 24 April 2008]
4. Arsenio M. Balisacan., 2008. Poverty Reduction: What We Know and Don't [Online] SEAMO SEARC. Available at: http://www.searca.org/web/ [Accessed 23 April 2008]
5. USDA's Agriculture Biotechnology Website. Available at: http://www.usda.gov/wps/portal/!ut/p/_s.7_0_A/7_0_1OB?navid=BIOTECH&parentnav=AGRICULTURE&navtype=RT [Accessed 30 April 2008]
6. Asian Development Bank. Available at: http://www.adb.org/Documents/Reports/ICT-Education-Training/prelims.pdf [Accessed 24 April 2008]
7. Wikipedia the free Encylopedia. Available at: http://en.wikipedia.org/wiki/Gene_therapy [Accessed 30 April 2008]
8. National Human Genome Research Institute. Available at: http://www.genome.gov/11006929 [Accesed 30 April 2008]
9. Molecular Tools of Medicine. Available at: http://www.med.unibs.it/~marchesi/molmed.html#intro [Accessed 30 April 2008]

10. Stem Cell Information, the national Institute of Health. Available at: http://stemcells.nih.gov/info/basics [Accessed 30 April 2008]
11. Nasim A., Masud N., Ashfaque N., 2006. Biotechnology for Sustainable Development. In Khan, HA ed., 2006. Road to Sustainable Development, Islamabad: Commission on Scinece and Technology for Sustainable Development in the South (COMSATS), p. 161-181.
12. European Federation of Biotechnology. Available at: http://www.efb-central.org/images/uploads/Environmental_biotechnology_English.pdf [Accessed 23 April 2008]
13. Defining Capacity Building. Available at: http://www.gdrc.org/uem/capacity-define.html [Accessed 30 April 2008]

POLICIES AND STRATEGIES FOR SUCCESSFUL PROJECT-MANAGEMENT ATTRIBUTED TO SOCIO-ECONOMIC UPLIFT OF THE DEVELOPING COUNTRIES

Hasibullah
Advisor (International Affairs)
COMSATS Headquarters, G-5/2, Islamabad, Pakistan

ABSTRACT

It is well known that developing countries, as compared to the developed ones, usually lack competencies and capacities to even fully benefit from the S&T assistance and programmes offered by the donor organizations. Well-planned projects are generally the most practicable tools to implement the programmes successfully. Any set-backs in the implementation of the projects adversely affect the qualitative, as well as quantitative outputs of these programmes.

The success of project management largely depends upon policies and strategies devised on the basis of clear definitions and understanding of the various component activities involved. These policies and strategies should be sensible, flexible, practicable and transparent. Cumulative build-up of management experience leading to indigenization will help the countries' capabilities to acquire better opportunities of future international cooperation and this process can repeat itself with sustained efforts, adding incremental benefits for the management organizations of the developing countries.

1. INTRODUCTION

Sustainable socio-economic development has always been the most cherished dream of every developing country. Concerted efforts by international donor agencies and the national governments have been going on for several decades to translate this dream into reality. A wide range of experimentation, carried out all over the world in this regard, has convinced the policy-makers that an appropriate mix of economic and S&T projects, under integrated and well-planned programmes can produce the optimum results based on science and technology. Developmental projects have, thus, become an essential part of many programmes, which aim at bringing about sustainable socio-economic progress in any country, particularly in the developing world. Specialized UN agencies like WHO, FAO, UNDP, UNIDO, IAEA, etc., are increasingly employing S&T based projects all over the developing world to boost the outcome of their developmental programmes.

In essence, the projects assume the core importance in the developmental efforts and, therefore, deserve serious attention of the concerned stake-holders. It is vitally important that the developing countries strive exceedingly hard to acquire mastery in the good management of projects, in addition to acquiring mastery in creating strong and healthy development programmes. Past experience, spread over several decades, clearly shows that socio-economic projects, employing science and technology have not succeeded very well in a large number of developing countries, primarily because of bad management-practices. Unfortunately this reason alone has caused formidable hindrances in sustainable socio-economic progress of many developing countries. One major cause of low achievements in project- management practices is the existence of disharmonious management-cultures among the developed and the developing countries. It takes a long time before the project managers with various social, cultural, economic, political and technical backgrounds and their management-methodologies can adjust to each others' strengths and weaknesses. The disadvantage of this kind of working relationship mostly affects the developing countries or the recipient partners. Due consideration to this latent parameter must be given, whenever policies and strategies for successful project-management are envisaged.

Whereas S&T based projects greatly improve the outcome of the socio-economic programmes, the developing countries usually tend to place undue importance on the inclusion of high technology in their developmental projects, despite the fact that they lack appropriate human and infrastructure resources through such purposes. Even expected leap-frogging in the economic advancement by the S&T supported programmes without, enough competencies, capacities and other relevant resources, usually does not take place which results in the disappointment of programme managers. The need of appropriate sciences and technologies, as against all sciences and technologies, becomes a necessity for sensible planning in the developing countries. Defining appropriate sciences and technologies for specific socio-economic developmental purposes, their sound assessments and clear prioritization requires highly-skilled and experienced professionals whose sustained availability must be ensured for successful management of the projects and programmes.

The discussion on policies and strategies relevant to sustainable socio-economic development through the deployment of S&T based projects can be extremely wide in scope and multifaceted in nature. In order to attempt to outline a meaningful and concise discourse relevant to the successful management of projects involving science and technology for sustainable socio-economic uplift in the developing countries, the choice of issues in the ensuing text will remain limited to essential components, such as sustainable development, project-management, socio-economic and socio-political scenarios. Based on these components, some specific aspects of policies and strategies will be brought under discussion. Practical experience and ground realities will form the basis and foundation of the arguments, albeit recognizing the due importance of a vast array of theoretical or empirical information already available in the literature.

2. PRE-REQUISITES FOR PROJECT DEVELOPMENT

Before considering the policies and strategies for successful project-management, it must be realized that certain prerequisites are absolutely necessary for the birth, existence and progress of the projects and these are closely linked with all the stake-holders involved. The prerequisites are:

i. sustained willingness and commitment
ii. matching competencies of the managers with the project-demands
iii. institutional and organizational capacities
iv. welfare and satisfaction of the work-force
v. adequate, timely and assured availability of financial resources
vi. a well-tested system of accountability, and
vii. transparency in the project activities. Most of these prerequisites are dependent upon the political stability of the country where the projects are located, appropriate national laws, administrative procedures, good governance and intellectual freedom.

It is obvious that all these prerequisites cannot be ensured effectively in a vast majority of developing countries. This ground-reality must be realized by the policy-makers and strategists while formulating policies and strategies for such countries. Each country will have a unique design of the projects to be implemented and, therefore, a sound assessment of the predisposition of the country towards a particular project or projects will have to be made before proceeding further. In many cases the country-profiles prepared and provided by the developing countries for assessment purposes are not entirely reliable. Hence, a thorough verification of the facts mentioned in such profiles has to be undertaken before designing the projects and their subsequent management. In such circumstances, the practical solution is not to press for meeting all the desired prerequisites at the same time, but to select the best options available in order to base the structure of the intended project. Under such restrictive conditions, the processing of the project may not be abandoned unless there is a reasonable doubt suggesting the total failure of the project. The experience indicates that many projects with restrictive availability of the prerequisites do achieve their objectives, though not in their entirety, but with reasonably good outcomes. Selection of the most workable parameters among the available restrictive options to make the project workable, in a given set of conditions, depends upon the quality of management and the experience of the manager. In case several projects are envisaged to form a programme of socio-economic development, with the support of science and technology, a set of most promising projects having synergetic effects should be selected as a policy matter, although all pre-requisites for each project component of the programme may not be readily available for execution of the programme.

3. UNDERSTANDING THE POLICIES, OBJECTIVES AND STRATEGIES

It is often observed that project planners are not very clear about the exact definitions of policies, objectives and strategies, while deciding about various design-aspects and dimensions of the project. Varying perceptions and understanding of the definitions prevail at different times and at different places. Usually, policies are mixed up with strategies and the outcomes misconstrued with objectives. If these and other ambiguities are not properly addressed, right at the pre-project stage, successful execution of the project usually cannot take place. The following sequence, with clear understanding of each component, needs to be kept in view while deciding the execution of the projects (see Figure-1).

- The first step is the policy making. Usually policies are driven by political or economic compulsions or exigencies and reflect the will of the executing agency to undertake the project or not. The strength of this will in turn stimulate the means for the arrangement of resources. Once the policy is made, the objectives of the

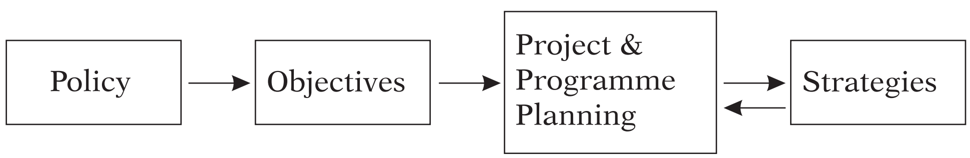


Figure - 1: Steps in Devising Strategies

  project are clearly decided and defined. Objectives should not be confused with the outcomes or results of the project. After deciding on policy and objectives the next step would be the planning of the project. Planning is a wide term and includes several aspects about the nature and duration of a project. The planning also involves preproject studies (including feasibility), design, implementation and evaluation aspects. The planning also takes into account, where deemed necessary, certain other aspects such as the possible integration of a project with other projects at national or regional levels for cumulative and synergized benefits. When all these aspects have been clearly defined and decided, the ensuring necessity will be to decide how best various relevant parameters of the project can be put in place on an appropriate time line, in order to secure the maximum achievement of the objectives. Strategy involves handling or manipulation of resources and opportunities, deployment skills and vision for timely maneuvers from start to the end of the project in order to seek as much success as possible.

- Strategies and planning are interlinked with each other. A previous experience of devising and employing strategies of science and technology based projects for socio-economic development can greatly help the planning process. Similarly, already available experience of planning clears the perceptions on strategies. However, it is necessary that the previous steps of objectives and policy have been fully taken care of. Strategies should be formulated in accordance with the nature of programmes and projects and, therefore, they should be decided after the programmes has been firmed up. Sometimes the other way round takes place when strategy is wrongly considered to be a part of programme planning and not as a tool of successful programme implementation. Engagement of project managers and experts, in line with the above mentioned understanding, on the various phases of programmes and projects proves to be more effective and fruitful. Solid experience and unambiguous data flows out of clearly understood and logical sequential phases of the projects which can be reused for other programmes and projects.

4. PROGRAMMES, PROJECTS AND SUSTAINABLE SOCIO-ECONOMIC DEVELOPMENT

For successful management of sustainable socio-economic uplift projects in the developing countries aided by science and technology, it is useful to present a clear comprehension of the defined limits of programmes and projects and also to acknowledge the importance of the fluid nature of the term "sustainable socio-economic development". Programmes are generally made to cover a wide range of developmental objectives. Programmes may comprise an aggregate of unconnected activities or may constitute integrated activities to address thematic demands. Programmes consist of individual self-contained activities called projects. Like programmes, the projects have purpose, design, implementation plans and evaluation or impact studies. Programmes and projects may be divided into sub-programmes and sub-projects for strategic or funding reasons. Programmes and projects can be national, regional or inter-regional in nature. The core activity is usually the project which defines the success or failure of a programme. Owners of programme and projects can be governments, private corporate organizations, NGO's, etc., working either on individual basis or in partnership with other entities. The programmes and projects pertaining to sustainable socio-economic development involving science and technology are mainly run by national governments or in cooperation with international or UN agencies like the World Bank, the Asian Development Bank, the Islamic Development Bank, World Health Organization (WHO), Food and Agriculture Organization (FAO), International Atomic Energy Agency (IAEA), UN Development

Programme, UN Children Fund, UNICEF, UN Industrial Development Organization, UNESCO, ISESCO, European Union (EU), Japan international Cooperation Agency (JICA), OIC (COMSTECH), COMSATS, etc., and also with NGO's. An intimate knowledge of the missions, objectives, ways of working, project administration and other relevant aspects of these agencies, is absolutely necessary for successful project management.

Sustainable socio-economic development in the developing or underdeveloped countries is not an easy task, albeit great popularity enjoyed by this concept at the global level. Several donor organizations and governments give preference to this category of developmental activity over other simpler forms. Many poor countries do not find sustainable development as attractive as straight development mainly due to their compulsions to address promptly the scourge of poverty, hunger and disease. There is a significant trend among many poor and developing countries to undertake development projects under the category of sustainable development and to convert them, as much as possible, into simple development projects, eliminating, more or less, the needs of future generations, a concept inherent in the definition of sustainable socio-economic development. Under such circumstances, it is difficult to manage the projects very successfully as the design of the projects cannot accommodate the changes desired at the later stage of implementation.

In order to manage the sustainable socio-economic development projects successfully, it is necessary that the implementing entities must make a clear understanding of the requirements of such projects. Otherwise, it is very likely that the element of sustainability is left out from the benefits and outcomes of the projects. A lot of literature is available on the understanding and conception of sustainable development (Brundtland, G., Khan, H.A. Editor and literature therein). An informative Article (Aftab A. Khan, The News, Feb. 2008) on economic angle of sustained development presents a useful reading on policy proposals having emerging consensus. The main areas discussed are: macro-economic development framework, sectoral policies and investments, integration with the world economy, role of the state, poverty alleviation, careful identification of priorities and peaceful resolution of internal and international conflict. On the side of science and technology, although a vast and multifaceted information is available, yet it is necessary that the most appropriate science and technology should be selected to effectively address the needs of the prioritized projects. A careful mix of R&D and applied engineering and technology within easy access of the technical manpower of the developing countries in the areas of agriculture, health, industrial resources, environment and energy will help providing solid foundation for the useful projects. In a majority of developing countries, access can be made either through transfer or purchase of technology or through technical cooperation programmes. For successful project management in this case, the managers should have easy reach to these resources. They should also have competencies and capacities of high standards and qualities. In addition to science and technology as well as the economy, the third most relevant component of the projects will be the integration of concepts of various social sciences. Public awareness, acceptance of changing social norms due to the impact of science and technology, change of the mindset, flexibility to adopt new life styles and capacity to absorb the social shocks of advancement etc., have to be given due weightage and importance in designing the programmes and projects. These aspects will constitute essential components of various phases of project development, i.e., policies, plannings, conceptual and detailed design, implementation and impact analysis. The project teams must, therefore, include sociologists, psychologists, social workers and other relevant experts in addition to scientists, engineers and economists.

Three types of projects are generally employed for science and technology based socio-economic developmental programmes, sustainable or otherwise, in the developing countries. They are national, regional and inter-regional in character. Most of the projects are donor-funded and are greatly influenced by the policies and wishes of the donor agencies. In several cases the donors are able to provide valuable technical and management assistance to the project implementers in the developing countries. These opportunities are theoretically available in all the three types of projects mentioned above. The benefits of national projects in the developing countries are usually much more than the regional or inter-regional projects, primarily due to the problems of coordination and instability in political relationships. Regional and inter-regional projects are successful only in a very limited number of cases where

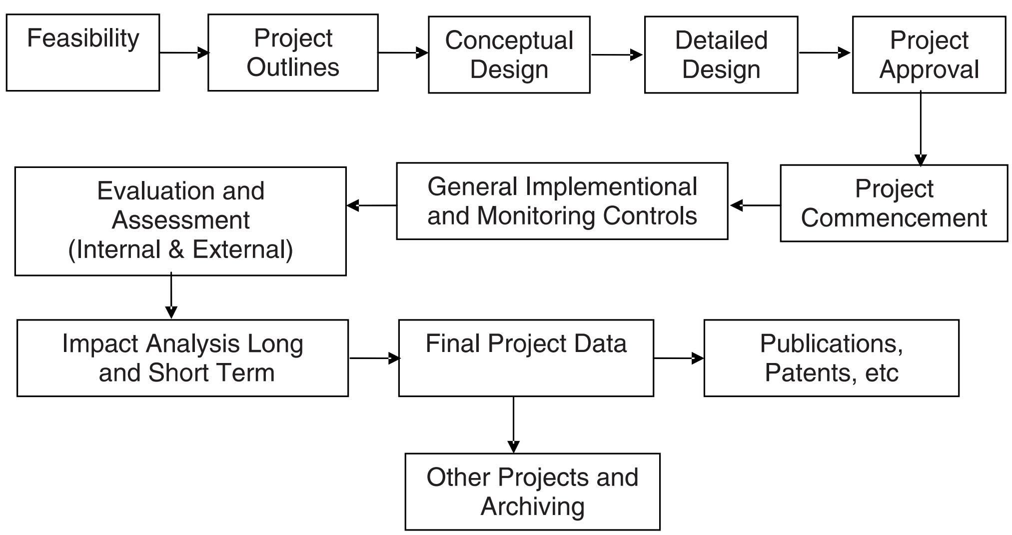


Figure - 2: Programme Cycle

significant interdependence of resources; technical, financial and logistical, prevails among the partners. Such constraints are abundant in a large number of developing countries. Further, national projects can be more beneficial for the country because they are focused on specific national needs and requirements and enjoy more government backing due to political reasons. Regional and inter-regional projects require high performance and efficiencies of the management teams to succeed in a fully effective manner. However, regional and inter-regional projects can have better prospects of success when undertaken under the umbrella of a sound international organization. Therefore, for a more successful outcome, the management teams of the developing countries should be apt enough in making right choices for the mix of national, regional and inter-regional projects for socio-economic development. Inclusion of the objectives of sustainability in the design mix-adds an additional component which requires extremely high levels of motivation, commitment and cooperation of the project partners in addition to their technical expertise. Successful conclusion of regional and inter-regional projects brings rich expertise to the developing countries, which helps in planning better projects in the future.

Successful project management attributed to S&T led sustainable socio-economic development can be considered by the following well-tried, simple and straightforward project sequence:

Major part of the above general sequencing is linked with the objectives and planning phases as described earlier in this write-up. The project managers have to exercise strict controls on the projects at all times. Intensive coordination skills and efficiencies are needed to fulfil the management requirements for successful operations linked to the above-mentioned project phases. In case of regional and inter-regional projects such coordination becomes more important. In these cases the general administrative controls have often had to be divided among the project collaborating entities. Individual evaluations of the divided project segments have to be undertaken by the concerned partner but overall evaluation and impact analysis is performed preferably by the combined expert teams. Decisions regarding intellectual property rights, if any, or publications are also made by all the participating authorities. The implementational phase of the project sequence is the most crucial among all the phases and often proves to be the deciding activity for success or failure of the projects. Appropriate modifications in the sequential phasing of the projects may also be needed in case of regional and inter-regional projects, which may very well be introduced at the design phase by the project counterparts. Frequent changes and alterations at any stage cause wastage of project time and financial resources. But this unrecommended practice becomes more damaging at the implementational phase. Long experience of project management by well-reputed management organizations has clearly shown that disturbances at the implementation phase of the project often lead to failures, particularly in the underdeveloped and developing countries where extra finances and other concerned resources are not easily available to take care of such disturbances.

Programmes, comprising various categories of projects, and corresponding budgets should be planned and scheduled in a systematic manner in a reasonable time frame before the commencement of projects. Confirmed programmes and budgets, agreed by various stake-holders help in making the projects a success. When the projects have to be carried over in the next programme and budget arrangements due to any reasons beyond the control of the managers, or due to the expectation of having better results at a later stage of the project, the detailed adjustments must be made well in advance. Failure of this management activity usually renders the furtherance of the project prone to difficulties or even to a total collapse. Programme cycles in national planning or at management platforms of regional or inter-regional projects with accommodative provisions for the incoming projects are always useful for a successful project management of the overall programme. Such arrangements are more important when a large proportion of the project is intensively based on science and technology and is being designed for developing countries where prompt procurement of equipment, machinery, material and other project paraphernalia is not easily possible.

5. POLICIES AND STRATEGIES RELEVANT TO THE DEVELOPING COUNTRIES

Developing countries must have their own policies and strategies for the S&T based socio-economic programmes and projects. International donor agencies usually follow their official objectives and mandates while assisting the developing countries' development programmes. This tendency influences the projects of the developing countries and often drags the entire ambit of the project away from the needs and priorities of the recipient countries. The project managers of the developing countries must sit together with the experts of the donors to chalk out the detailed objectives, dynamics and outcomes of the programmes and projects. More the participation of the stake-holders, more will be the chances of success of the projects. Particular importance should be given to the end-users whose views and opinions must be heard because the end-user is the best person who is aware of the local aspirations, needs, expectations and the operating conditions.

Policies and strategies will vary in the cases of national, regional and inter-regional projects. While more management control is possible in the national projects, it is less so for the regional and inter-regional projects as they demand more cooperative spirit, flexibility and degree of mutual accommodation. Developing countries should not indulge in highly ambitious policies and strategies. Importance should be given to sustainability of the outcomes of the development projects and programmes. On many occasions this may not be entirely possible but efforts should, nonetheless, be made to gain expertise in conducting projects as successfully as possible for meeting the immediate and dire socio-economic needs. Once this is achieved, the journey to sustainable development may become easier. A clear policy on this regard will immensely help the project managers to undertake the project more successfully.

No matter how sound the policies and strategies may be, the major impediment in the projects' success in the developing countries comes out to be the lack of implementation potentialities. The institutional weaknesses, professional rivalries, defective chains of command, delays in executive decisions, political instabilities, fragile law and order situations and other similar factors seriously affect the implementability of the project work. The project management team has limited control on such contributing factors. It is usually not possible for a limited number of project managers available to overcome hurdles existing as a result of above-mentioned factors. The developing countries have to establish specialized agencies having human resource specifically trained to have the ability to lead the project managers through such difficulties. National policies and strategies should accommodate such special arrangements and requirements, in addition to other related policies and strategies to provide assistance to the project managers. This arrangement greatly helps the management to enhance the quality and efficiency of the project and also to ensure better chances of success. Monitoring the implementation phases of the project is the next important management tool which determines the fate of the project. Apt monitoring by the project manager with timely rectifications is essential for the success of the project.

There are no standard formulas for policies and strategies which are universally applicable to the developing countries for devising management techniques for successful completion of the project. Each developing country will have different receptibility for plans proposed to bring about socio-economic uplift in its existing social set up. The project policies and the implementation strategies should suit the recipients' specific receptivity capacities. Good management practices applied and proved successful in one country may not work equally well in other countries. This type of inconsistency increases the work load of the project management teams. The complexity of management due to the interaction of such diverse parameters as sociology, economics, science and technology, engineering, financing and administration increases significantly when integrated projects interlinked with socio-economic uplift programmes are employed under separate management arrangements. In such circumstances, special policies and strategies are to be devised for applying to the projects.

Developing countries, having limited back up resources, cannot afford to entertain high profile, high-sounding, expensive, time-consuming and confusing policy and strategy options. Donor assistance from the developed world should be clearly transformable into simple, straightforward, understandable, crisp and doable proposals at the time of negotiations. In case of regional and inter-regional projects to be carried out among the developing countries, the same policy should be adopted and brought to the same working platform as mentioned above. In developing countries, the chances of projects' success and efficient management increase manifold by adopting simpler and commonsense approaches.

6. URGENCIES, PRIORITIES AND THEIR ADOPTION

A large number of developing countries have not, so far, manifested enough conviction in the significance and importance of science and technology in their development processes. It must be realized that now, in the twenty-first century, the power of science and technology for socio-economic progress has become even more relevant than before and the developed world will increase the thrust of science and technology for their ever-increasing prosperity-edge over other nations. Science and technology is vital for the progress of developing countries and there is an absolute urgency for the developing countries to change their mindset about this matter. Major policy shake-ups in the national planning must be made in the developing countries so that science and technology should be able to find its rightful place in their national efforts directed towards socio-economic progress.

For a meaningful programme of sustainable socio-economic progress in the developing nations, the priorities must be established on very realistic grounds. When science and technology becomes a significant component in the overall planning, the priorities will include:

a) creation of a critical mass of extremely competent, world class and resourceful project managers,
b) creation of specialized quality institutions to act as knowledge reservoirs focusing on sustaining socio-economic development,
c) establishing educational and training organizations, specifically dealing with education for sustainable development (ESD) including curricula on science and technology based development,
d) establishing centralized high-powered coordination organizations for integrated action among crucial stake-holders like university R&D, industry R&D, planning commissions, ministries of industry, health, agriculture, environment, finance, education, economic affairs, foreign relations, etc.,
e) independent professional project audit and evaluation authorities,
f) highly reputable NGO's and,

g) media.

In most of the developing countries, the above-mentioned stake-holders and organizations do actually exist but they are usually scattered and pursuing isolated activities.

To bring them together for integrated and coordinated functioning, is usually not out of reach of the developing countries. Most of the organizations linked with science and technology, socio-economic programmes and regulatory authorities in the developing countries are engaged in performing duplicate and overlapping work resulting in considerable national losses. Appropriate organizations and institutions should be selected and brought together under one overall set-up enjoying autonomous powers to work with unity with one another under one umbrella for well-defined objectives, goals and clear road maps having time-structured programmes. This is not a high-tech job and many developing nations can accomplish it within a span of a few years time provided there is a political will to do so. Needless to say that very sound assessment competency must also exist in the developing countries to base the exact course of activities to be undertaken on the above-stated details.

Decisions to adopt policies and strategies should not be made in separate pieces or in isolation with each other. Adoption means acceptance tied with implementation. This is the stage where the project management has to play its most crucial role. For successful project management, the managers will devise an optimum work plan based upon the competency, integrity and efficiency of the centrally coordinating body whose profile has been presented in the above paragraphs. The most important factor in adopting the policies and strategies is the timing of adoption. Hastily adopted policies and strategies often lack timely coordination with other contributing and aiding factors and the project managers may need to wait till these factors become operational. On the other hand, a relaxed and slow approach may cause loss of the positively subscribing and aiding factors, disappearance of opportunities and financial losses. Any wrong step at this stage may create disappointments and even psychological panic in the management teams resulting in the loss of confidence. For successful adaptation and subsequent working of the policies and strategies, all project stake-holders must decide about the adoptional plans prior to the commencement of actual project work. A smooth and well placed adoption plan helps the project managers to land into a more successful project implementation phase.

7. SUCCESSFUL PROJECT-MANAGEMENT THROUGH INTERNATIONAL COOPERATION

International cooperation covers all the three types of socio-economic development projects having science and technology components, i.e., national, regional and inter-regional. These projects may be under the sponsorship arrangements by international donor agencies or could be organized under bilateral or multilateral agreements among the developing countries. The project arrangements may then be specified in detail through subsidiary agreements and memoranda of understanding. The project under international cooperative agreements are, by and large, collective efforts involving project teams, government organizations, NGOs and corporate bodies. Legal matters such as dispute resolution, intellectual property rights, privileges and immunities of the non-resident project team members, financial matters, etc., are also important ingredients of the project management which add further intricacies to the overall project arrangements.

Better project management arrangements are needed for handling the socio-economic uplift programmes involving multilateral cooperation agreements. For successful outcome of such projects and programmes the following considerations have to be given importance:

- Deep involvement of all stake-holders from the start to the end of the project, i.e., negotiations, pre-project studies, design, implementation, evaluation including impact analysis and dissemination of the information on project outcome.
- Freedom of exchange of the project managers among the participating countries, i.e., travel facilities, visas, residence arrangements, etc.
- Easy customs clearance procedures for entry and exit of equipment, materials, machinery, spare parts, technical information and other scientific literature.
- Efficient logistical support for personnel, project-materials, access to distant field areas, surveys and interviews.
- Administrative support of local authorities for project work and project teams' safety and security.
- Dedicated organizational support for local supplies, secretariat services, vehicles, storage facilities, working space and communication facilities.
- Appointment of project officers, liaison officers and other essential staff for day to day technical, administrative, financial, legal, social and public relations work linked with the projects.
- Specialized services for the medical and personal needs of the project management team and allied staff.

Several international donor programmes require sub-contracting some of the project segments to organizations of their own choice. The developing countries' management teams would be in a much better position to complete the project on time, if these sub-contracts are awarded to the competent companies existing within the clusters of the participating countries, or otherwise make a selection of such companies or the sub-contracting organizations in consultation with the donors and sponsors. Sub-contracting should be done in an equitable and transparent manner among the project partner countries. Efforts should be made that the sub-contracting arrangements are intercommunicative, to the maximum extent possible and transfer of technology may also take place. On several occasions the donor organizations choose to outsource a part or several parts of a project to countries which are not the participating countries. Under such circumstances, the recipient project countries do not enjoy much control on the decision or mechanism of outsourcing. Project design stage is the appropriate time to negotiate the outsourcing arrangements which are favourable to the project recipient countries. Too much outsourcing, especially spread over many countries, often encompasses delays which hampers the success of the projects.

Attractive incentives for every participating country in a regional or inter-regional project, must exist and be available to every partner at the agreed stages during the progress of the project. Concrete results and tangible outputs during the project implementation must be visible and the benefits should be transferred to every partner country in a timely manner in order to keep the interest of the partners fully alive in the ensuing phases of the project. Inadequate outputs or their delayed rewards to the partner countries often create disappointment, lack of trust in the project management or uncertainty in the projects' completion. These factors result in watering down the interest of the participating countries in the subsequent phases of the project and on many occasions causes the abandonment of the project much before its actual completion. In addition to this aspect, the management teams of the projects under international cooperation must provide enough dividends to the donor or sponsoring agencies to satisfy their missions and serve as a credit to them alongwith creating a sense of achievement out of it. Every successful project in the developing countries adds to the cause and credibility of the international donors, sponsors and cooperative organizations.

Project evaluations under international cooperative arrangements are relatively simpler and straightforward in national projects as compared to the regional or inter-regional projects. National project data can be independently verified with multiple sources within the country whereas data compiled in regional and inter-regional projects is usually in the processed or semi-processed form and integrated in nature which renders verification more cumbersome as the sources of data are spread over many places in the different participating countries. Verification efforts are generally not very profoundly pursued when the projects are reported to have achieved success but in cases where there are shortcomings or failures, the causes of setbacks and failures become difficult to trace. The project managers, government agencies involved and other stake-holders are usually shy in volunteering the information regarding real causes or sources of failures. In certain cases the shrouded and concealed facts come to surface at the time of external audits which causes embarrassment both for the international cooperative agencies and the project implementers. One way out of this unpleasant situation is that regular evaluations should be conducted at appropriate stages during the implementation of the projects in consultation with the monitoring teams. For this purpose, a separate evaluation department, totally independent of the project management team, should be instituted which should be reporting to the relevant national authorities participating in the projects in conjunction with the international organizations involved in the cooperation agreements. Internal evaluations are important and useful for comparison purposes but they often lack the full agreement or consensus of the project implementation teams. In developing countries, if a project deviates from its correct path, it is difficult to rectify the wrong steps already taken. The project tends to take a continuously deviated course till the termination stage arrives and consequently the project takes a different shape than anticipated at the design stage. It is, therefore, essential that appropriate strategies should be put in place right from the start of the implementation, within the best competencies of the project managers, to ensure minimum deviations from the targets at the end of the project. Integrated approach for regional and inter-regional projects of the evaluation mechanisms, in conjunction with monitoring processes, becomes even more significant when international project cooperation agencies are involved.

8. THE WAY FORWARD

The future of the poor and developing countries largely depends upon the way they manage their own affairs. Leadership in management, its competency, quality and capacity, is the key to the success in any domain, political, social, economic and technical. These four basic ingredients are directly involved in the sustainable socio-economic uplift of the developing countries. Strengthened project management culture having enough flexibility and adaptability for absorbing the management variances of other management cultures is an overwhelmingly significant aspect for successful management of projects based upon science and technology. Policies and strategies for successful project management must take into account the above mentioned factors. Specialized project management teams in various contributing disciplines for sustainable socio-economic development should be prepared and be ready to successfully handle all possible opportunities which will present themselves to the developing countries on their journey to prosperity and development.

Policies and strategies must be made and put in place by the developing countries to keep the efforts of socio-economic development totally insulated from the influence of politics. Project management schools having professional standards of international calibre, specializing in the subjects of sustainable development, social and physical sciences, environment, project implementation techniques, interpersonal and communication skills, etc., should be created within the developing countries with local professionals. Intergovernmental alliances of such management schools should be encouraged for obtaining wider experience and better business opportunities. The governments should reserve special quotas for these management schools for participating in national development programmes and projects. The governments should also formulate sound policies and strategies to allow the professionals of these management schools to participate, on preferential basis, in the projects of other governments in the areas of sustainable socio-economic development. Active attachment of these specialized management schools should be ensured, with relevant government, semi-government, autonomous and private organizations, while making policies and strategies. The existence of all these capabilities, professional organizations and their infrastructure must be widely advertised regularly as a policy matter both inside and outside the developing countries. Presently very few project management institutions of sufficient strength and reliability are known at national or international level. For future socio-economic progress in the developing countries, the above-mentioned organizational arrangements will have to be given their due place in national planning processes so that they can smoothly evolve into strong institutions.

Knowledge is the foundation on which the developing countries can reliably base their prosperity, strength, self-esteem, international recognition and territorial integrity. The above-mentioned capabilities, skills, professionalism and management qualities for successful project execution in socio-economic development will only be available through large and sustainable reservoirs of quality knowledge. Education and training in applied social and physical sciences and technologies for developmental purposes is crucial for any meaningful success of the related projects. Acquiring, absorbing and utilizing knowledge, must be given top priority in national development planning. Special arrangements should be made to induct education of S&T-based sustainable development in the curricula of high schools, colleges and universities. Considerable insight into this particular aspect of sustainable socio-economic development can be gained by an excellent report published by the World Bank entitled "Knowledge for Development". This report contains material that can greatly help improve the knowledge and efficiency of the project managers, not only to achieve overall maturity in project execution, but also in formulating the policies and strategies for all the responsible decision-making authorities. The developing countries must look ahead, focusing on the priority of quality knowledge to acquire competencies for successful project management of their socio-economic requirements, and also on policies and strategies to acquire sufficient capacities to undertake such programmes. Out of all the relevant components of capacities, the capacity to absorb knowledge and then apply it sensibly in the domain of science and technology, presents the most arduous challenge. This is simply because of the fact that efforts to be made, time required and cost to be incurred in the education and training in the domains of science and technology, are generally much more than any other allied disciplines of sustainable socio-economic development.

Developing countries usually do not demonstrate enough patience to endure the prolonged efforts needed to acquire sufficient scientific and technological capacities for their professionals to successfully undertake nations' socio-economic projects. Extraordinary skills and experiences are required by the project managers to devise most optimum pathways from the difficult and seemingly improbable situations normally prevalent in the developing countries. Capacity-building in science and technology has attracted the attention of countless experts and scholars and resultantly volumes of useful literature is available for the guidance of various stake-holders. However, a straightforward, simple and concise treatment of this complicated and multifaceted topic has been given in the Inter Academy Councils' publication entitled, "Inventing a Better Future – A Strategy for building worldwide capacities in science and technology". This report, though addressing all the developed and developing countries, presents special features on capacity-building in science and technology in the developing and the least developed countries. Future policies and strategies for the project-management professionals of the developing countries can be safely based upon the contentions made in this report. Developing countries embarked upon the programmes of sustainable socio-economic development through science and technology can also draw valuable information from this report on ways and means leading to indigenization of knowledge generation, competency-enhancement and capacity-building. Indigenisation of project-management capabilities through the experience gained from international cooperation is another important policy matter, which the developing countries will need to pay special attention to while looking into their future developmental avenues. Cumulative build-up of management experience leading to indigenization will help the countries' capabilities to acquire better opportunities of future international cooperation and this process can repeat itself with sustained efforts, adding incremental benefits for the management organizations of the developing countries.

While looking ahead into the future requirements of the developing countries for managing their socio-economic programmes and projects, it has been anticipated that there will be a significant gap between the demand of the well-qualified and experienced project managers and their actual timely availability. Rapidly increasing populations in the developing countries and joining of these countries in the regional and inter-regional trade agreements like ASEAN, SAARC, etc., and pressures from WTO will require more competition and stronger supporting economic activities. This will increase compulsions of the developing countries to acquire and retain the services of quality project managers and related organizations. Therefore, both medium-term and long-term policies and strategies will be crucial to meet these demands, especially when the indigenous competencies and capacities are involved. The governments will have to put in place appropriate mechanisms to attract and retain such talent and experience by offering strong incentives. Such incentives are not usually beyond the reach of many developing countries. Timely investment in the human resource domain will enable the developing countries to earn good dividends in the future. Sensible policies and strategies must be formulated and implemented by the developing countries in this regard.

9. CONCLUSIONS

The above brief discourse of policies and strategies related to successful management of sustainable socio-economic development projects in the developing world leads to the following conclusions:

- Management of S&T-based project on sustainable socio-economic development is a highly specialized professional discipline. A large number of developing and least developed countries suffer from acute shortage of relevant competencies and capacities in this field. There is an urgency to address this avoidable set-back. Refinements in the relevant policies and strategies are also necessary in order to ensure quality management of the projects. In several cases programme failures, and consequent donor assistance losses, occur due to unsuccessful management of the projects. Developing countries may not be able to achieve poverty-reduction targets set by international socio-economic initiatives like Millennium Development Goals, largely because of the inappropriate project-management policies and strategies and shortage of professionally competent project-managers.
- Governments and business enterprises of the developing countries play a crucial role both in creating and evolving institutionalized project-management competencies and capacities. Professional, educational and training organizations dealing with interdisciplinary subjects, including management, social and physical sciences, law, etc., need to be created to meet this specific requirement.
- The success of project management largely depends upon policies and strategies devised on the basis of clear definitions and understanding of the various component activities involved. *Policies and strategies* should not be mixed together, to avoid confusion in the planning processes. Policies precede strategies

and involve the concept of political and administrative decisions, to achieve the pre-determined objectives through programmes and project activities. Strategies involve deploying various available resources and capabilities in an optimum manner to attain the objectives as considered in the policies. Project components, i.e., design, implementation and evaluation take due care of the concepts contained in the policies and strategies. Pre-determined parameters of these concepts and activities are extremely helpful in the various project-execution phases, especially when multiple management teams are involved.

- Developing countries need not adopt blindly the management policies, strategies and techniques dictated by the developed countries. Each developing country should acquire the capability of formulating such policies and strategies indigenously, which could meet their own specific requirements in the most useful way. These policies and strategies should be sensible, flexible, practicable and transparent.
- Differences in the project-management cultures in various countries can hamper cooperation among the managers of these countries. Professional bodies dealing with project-management should create opportunities for North-South and South-South exchanges, both for business and training purposes. This will greatly help to harmonize the diverse management-cultures among the developed and the developing countries.
- Selection of the technology appropriate for socio-economic uplift projects is a crucial matter and needs to be made very carefully by the developing countries and the least developed countries. The optimized scientific and technical packages to be applied should be well within the competencies and capacities of the project-management teams and the project implementers. They should also be easily understandable to those project-designers and implementers whose expertise lies outside scientific disciplines but are closely attached with the project from the domain of social sciences and development-economics. Aspiring for very high-tech applications without the existence of ample knowledge and expertise, backstopping capabilities, assured technological supplies, well-tried logistics and other essential supporting facilities, leads to disappointments in later phases of project execution.
- Continuous upgradation of project-management personnel, through education and training, capacity enhancement and business contracting, both nationally and internationally, becomes a necessary requirement after enough maturity in professional domains is attained and the management organizations decide to enter into bigger contractual arrangements. Appropriate policies and strategies are required to deploy local and overseas resources so as to attain the requisite enhancement in professional leadership, which is necessary for the survival of project management organizations. All stake-holders will need to assume responsibility to play their role in a timely manner.

- The most important factor contributing to successful project-management of any programme, particularly the science and technology based socio-economic development projects, would be the nature of the working environment, contractual incentives and general satisfaction of the project management personnel. The leadership support received and the avoidance of disputes will directly influence the performance of the managers and other staff. Dedication, loyalties and sympathies of the project-team is essential for the success of the project, which can only be inspired by the human-resource department of the project authorities. Developing and the least developed countries usually ignore this important factor, which needs to be properly taken care of, right at the policy-making phase of the projects.
- Existence of monopolies of project-management organizations pose restrictions in the creation of overall quality management-services across the nation. State policies should be directed towards elimination of monopolistic trends by encouraging competition through the creation of multiple project-management organizations both in private and public sectors. Strategies to employ the influence of effective antimonopoly authorities, in conjunction with other transparent regularity authorities, produce useful results. This greatly helps in improving the quality of management-practices, which in turn assists in better project outcomes.
- Projects can be saved from failures if due care is given to strengthening the harmony among the administrators, financiers and the technical managers for avoiding delays in decision-making or other bureaucratic indifferences. A common detracting factor is the inability of the administration to check the gap between timely decisions and the prevalent inflationary pressures in the markets. Inclusion of appropriate and effective remedial measures at the planning stage greatly help the smooth and timely execution of the projects.

- Finally, it is always the quality rather than quantity which should be the focus of all the policies and strategies aimed at creating project management capacities and competencies sufficient to cater for the success of science and technology based projects on sustainable socio-economic development. Quality project management propositions may appear more expensive than non-quality ones, but at the end they deliver better dividends.

The above-stated articles pertain to main policy and strategy issues, which the developing countries generally face while deciding about the socio-economic development projects. It is obvious that these issues and their treatment given in the main text represent only some of the major considerations that provide an overall sketch or a road map to the policy-makers, strategists, financiers, project designers and project managers when taking decisions on the nature of S&T-based projects for sustainable socio-economic development. More incisive and deeper analytical treatment of each aspect will flow out of these discussions which will form the basis of the detailed design of the programmes and projects and their individual management-components. Acquisition of knowledge on the policies and strategies for successful project-management of sustainable socio-economic projects, based on scientific and technological applications, is not a one-time learning process but entails continued efforts by the professionals and the states. Developing countries need to exercise patience and endurance to gain command on this evolutionary process.

REFERENCES AND FURTHER READING

- Brundtland, G., Our Common Future, 1987, Oxford University Press.
- Khan, H.A (Editor), Road to Sustainable Development, COMSATS Series of Publications on Science and Technology (7), 2006.
- Ibid, 10th Series, 2007.
- Khan, A.A., Emerging Consensus on Policy Prescriptions for Sustained Economic Development, The News (Pakistan), p.15, 2008.
- Knowledge for Development (World Development Report), Oxford University Press, 1998-99.
- Inventing a better future – A strategy for building worldwide capacities in science and technology, Inter Academy Council report, 2004.

IMPORTANCE OF S&T POLICIES AND STRATEGIES FOR DEVELOPING COUNTRIES

Urooj Deedar[*] & Narmeen Khalid[*]
[*]*Assistant Directors (Programs)*
COMSATS Headquarters, Islamabad, Pakistan

ABSTRACT

Science and technology have profoundly influenced the course of human civilization. Science has provided us remarkable insights into the world we live in and the scientific revolutions of the 20th century have led to many technologies, which promise to herald wholly new eras in many fields. It should be ensured to the fullest that these developments are being utilized for the well being of nations.

The emphasis is on devising policies and long-term plans to justifiably reap the benefits offered by science and technology and to safeguard ourselves and the future generations from the insecurities expected and prevalent today, particularly in the form of poverty, hunger, illiteracy and poor economic growth. This calls for having indigenous National Science and Technology Policy-framework for socio-economic development, in particular for the developing countries. The need of the hour is to fully engage S&T with societal wants, so that all the stakeholders may be involved in a meaningful collaboration.

1. INTRODUCTION

Over the past century, advancement in science and technology has been a key driver of human and societal development, vastly expanding the horizons of human potential and enabling radical transformations in the quality of life enjoyed by millions of people.

Both, science and technology have made unprecedented impact on economic growth and social development; knowledge has become a source of economic might and power. This has led to increased restrictions on sharing of knowledge, to new norms of intellectual property rights, and to control regimes for global trade and technology. Scientific and technological developments today also have strong ethical, legal and social implications. There are high concerns in society about these. The ongoing globalization and the intensely competitive environment have a significant impact on the production and services sectors. This in turn has dramatically increased awareness about existing global differences in standards and conditions of living and in the domain of political rights and freedom.

Science is becoming increasingly inter- and multi-disciplinary, and calls for multi-institutional and, in several cases, multi-country participation. Major experimental facilities, even in several areas of basic research, require very large material, human and intellectual resources. Science and technology have become so closely intertwined, and have reinforced each other that, to be effective, any policy needs to view them together. The continuing revolutions in the field of information and communication technology have had profound impact on the manner and speed with which scientific information becomes available, and scientific interactions take place.

Globalization is bringing far-reaching changes that affect all of us. New technologies and more open borders have not only led to increasing economic interdependence, but also to new social patterns and relations between countries and people. The explosion in technological advances has allowed the flow of available information to be shared by many people around the world.

Because of all this, a nation's S&T system has to be infused with new vitality to play a decisive and beneficial role in advancing the well being of all sections of its society. A nation should be firm in its resolve to support science and technology in all its facets. It must recognize its central role in raising the quality of life of the people of the country, particularly of the disadvantaged sections of society, in creating wealth for all, in utilizing natural resources in a sustainable manner, in protecting the environment and ensuring national security. Hence, it becomes necessary for the governments and people of the developing countries to reaffirm their commitment to the growth of science and technology, which in turn must spark and fuel the march of their national development.

2. RATIONALE OF S&T POLICY

Science and technology policy represents the articulation of how the modern state and society at large view the relationships and instrumentalities between scientific and technological change and social and economic development. The effectiveness of S&T policy is essentially a function of how realistic and comprehensive the understanding of decision-makers is of these interactions and relationships. On another level, S&T policy reflects the tremendous optimism that is still present today regarding the potential of science and technology, properly developed and applied, to solve the pressing problems of humanity.

The concept and practice of S&T policy is based on the presumption that direct and indirect intervention by the state in scientific and technological activities and processes is necessary, in order to achieve the desired social, economic, and political goals. The justification for S&T policy and state-intervention derives from certain principles:

i. Technological progress may not proceed in the desired direction without influence by government, leading to poor technology-choices, inappropriate allocation of resources, and distorted patterns of industrialization.
ii. The returns from scientific research are too long-term to expect market-forces to encourage private investments in R&D in areas beneficial to society. Government must therefore intervene to rectify this "market failure," by itself investing, or by enacting policies to encourage private investment.
iii. Forsyth adds that the pressures of competition in international trade can push developing countries towards labor-intensive techniques in a narrow range of products, even though a diversified industrial base is preferable. Government intervention is needed to protect and nurture those components of the industrial base that are unlikely to evolve spontaneously. This is the "infant industry" argument.
iv. Certain areas of technology are unlikely to develop by themselves, for example the service sectors (health, education, etc.). Therefore, they require a direct role of the state. This is particularly important in developing countries, with their large populations and severe inequalities of income. The state, as the guardian of the social well-being of the population, becomes obliged to try to channel scientific and technological activities, so as to improve the living conditions of the people. For developing countries, with a pressing need, science is seen as a solution to social problems, such as food, housing, employment, and health, and in many countries S&T policy was initially undertaken with considerable hope and enthusiasm.
v. There is also a strong political rationale to S&T policy, particularly in the industrialized countries. The development of the atomic bomb, which many see as a watershed in the evolution of science-policy, established science as a "national asset" for some countries. Nations undertook scientific projects to achieve political, and often military, goals. In the post-Second World War environment of growing international competition, science policy emerged as a strategic weapon for countries. There was an obvious correlation between the emergence of international crises and the increases in expenditures on R&D. In this regard, S&T policy clearly derived, to a major extent, from military needs and priorities.

These arguments form the basis for the evolution of S&T policy in both the industrialized and developing countries. There are debates within the field around these and related issues, and as we shall see later, there are new arguments being put forward both in favor of and against the need for S&T policy. It is within the broad context of S&T policy that debates continue over such issues as brain drain, technology transfer, intellectual property, and the relative importance of basic versus applied science.

3. IMPORTANCE & OBJECTIVES OF S&T POLICY

The technology gap has brought into the open a dilemma being faced by developing countries i.e. what mix of new, conventional, and traditional technologies should they use, and what is the appropriate balance between importing new technologies and using conventional and indigenous ones. Technology choice gives a crucial dimension to the development process that evolved in relation to shifts in development thinking.

The role of the S&T policy is to promote scientific research and research training in the sciences and encourage technological progress, for the purpose of strengthening the foundations of a country's R&D culture and boosting the competitive capacity. The principal function of science and technology (S&T) policy is to express the priorities set by the Government and indicate the improvements to be made in support structure for research and development work. It also serves to guide those who participate in implementing the policy, in selecting appropriate strategies towards established goals. It is important to provide appropriate framework for cooperation among the public actors in science, technology and innovation and to strengthen their links with business life and society at large, which benefit from their activities. These actors can either be in a state of competition, co-operation, or both at the same time.

In order to promote socio-economic development in developing countries, the following areas need to be strengthened through a proper S&T policy framework:

3.1 Promotion of Basic Research

Basic research is the source of tomorrow's discoveries and new capabilities. This long-term research will fuel further gains in economic productivity and quality of life. To generate research-results of maximum international quality that contribute to the expansion of the intellectual property of the human race and accumulation of knowledge and technological innovation leading to the future development of a state, it is important to promote basic research across a wide spectrum of disciplines. Over the past years, it has become necessary to further promote basic research, in order to create revolutionary scientific and technological knowledge. In order to continue to generate research results, it is important to build a flexible and competitive research-environment that is open both domestically and internationally, while at the same time working to improve the quality of research personnel.

The entire research system should be guided by either a panel of experts, an organization or a group of experienced eminent scientists, who can provide the outlines and specific mega national projects to enhance partnerships responsive to national and international needs. Such selected projects can then be assigned to different groups of qualified scientists. For this systematic approach, the development of policy instruments is very crucial. These instruments will support the scientific development in strategic areas of priorities, according to the country's own needs, such as biotechnology, nanotechnology, ICTs, agriculture, or healthcare.

3.2 Improving Scientific and Technological Infrastructure

The critical size of human resources and infrastructure, and the amount of investment to improve scientific and technological infrastructure, illustrates how science and technology are considered of little importance in developing countries.

In developing countries, economic growth can mainly be enhanced by a S&T policy. However, science and technology can play their role in development only when the integrity of the whole enterprise is preserved research institutions, universities, publications research priorities and the education of creative scientists, as well as those active in science. Thus, the simplest strategy in developing countries is first of all, to increase the percentage of budget that is to be devoted to universities and research institutions for improving the scientific and technological infrastructure.

Developing countries should understand the fact that perceiving investment in sciences as a time-consuming, wasteful and costly activity will bring further limitations on their economic growth.

3.3 Encouraging Research and Innovation

A World Bank report (1996) recommends that a "National Knowledge System" model aimed at building the institutions that help create and sustain innovation, imitation, and knowledge networks guide the strategies of developing countries policymakers. The 1998 World Development Report of the Bank, which concerned the "knowledge and development", emphasizes, "Poor countries and poor people differ from rich ones not only because they have less capital but because they have less knowledge." Developing countries, if they are to acquire knowledge, must establish the institutional, organizational foundations for technological innovation.

The future of S&T development is very much dependent on the emergence and use of innovative actions and exploration of suitable policy options. Recognizing that scientific advances and technological changes are becoming increasingly important in developing a knowledge-based economy, emphasis will be given to support S&T development that promotes productivity-driven growth and provides for competitive advantage. This will entail the mastering of technology and knowledge and harnessing them for widespread application in all sectors of the economy. In this regard, the

Government should facilitate and enhance further the collaboration of the public and private sectors in R&D activities through effective policies so as to contribute to the development of a comprehensive national innovation system.

Measures should be undertaken to restructure existing R&D institutions to undertake more market-oriented activities, promote technology applications in industry, as well as expand and strengthen S&T manpower. At the same time, the creation of new institutions to expand the R&D base, particularly in new and emerging areas, should also be considered.

3.4 Promoting International S&T Cooperation

The mandate of the government should be to identify, facilitate, and promote international cooperation in the emerging and frontier areas of science and technology under bilateral, multilateral or regional framework. They can achieve this through promoting interactions between governments, academia, institutions and industries. A specific focus should be on the areas of common interests through a reciprocal arrangement that benefits both the partner countries and organizations.

3.5 Establishing a Regime of Intellectual Property Rights (IPR)

The increasing volume of scientific and research activity raises the importance of protecting intellectual property and knowledge assets. Effective intellectual property protection is a key element to economic growth because it provides for strong incentives for both domestic and foreign investment in developing new technologies and new consumer goods. Intellectual property is the generic term for patents, trademarks, copyrights, geographical indications, plant variety protection, and related laws, all of which grant certain rights to those who invent new ideas and products. These laws are important for not only industrialized countries, but also for emerging countries as well, because they provide the engine for advancement.

Specifically, intellectual property protection policies will guarantee a period of exclusivity to the individuals or companies who invest their money, time and energy in inventing new technologies e.g. information technology, pharmaceutical products, breeding new plant varieties, and other innovative activities, which help to ensure that the individuals or companies can recoup their investment and profit from their investment in different scientific activities. Intellectual property benefits not only the innovator, but also the consumer and the recipient of technology transfer. An effective intellectual property rights regime will help to promoting sustainable economic growth in the developing countries and will provide technical assistance to developing countries to build the infrastructure necessary to support scientific development.

4. STRATEGIC PLANNING AND IMPLEMENTATION

In order to achieve the objectives of a country's S&T policy, a specific implementation-strategy needs to be designed along with clearly defined programmes and projects, necessary resources and well-defined time-targets. Some of the generic elements of S&T implementation strategy are given below:

4.1 S&T Governance

Science and Technology governance is vital for the efficient working of S&T sector of a country. To improve S&T governance, there should be a continual assessment, classification and upgrading of S&T institutions, regular performance audit of S&T agencies and institutes, mechanisms to ensure continuity of plans and programs, coordination of national S&T efforts, strengthening of the monitoring and evaluation component of S&T governance, institutionalization of incentives for excellent performance, and harnessing of the full potentials of ICT in governance.

An appropriate mechanism should be developed through which independent inputs on science and technology policy and planning are obtained on a regular basis from a wide cross-section of scientists and technologists. Science and Technology based academies and specialized professional bodies can be utilized for this purpose. These inputs can then form a fundamental part of the planning and implementation of all programmes relating to science and technology, and assist in government decision making and formulation of policies in development sectors.

Recently there has been a great deal of public concern about issues such as food safety, environment, public health and innovation. Policy-makers from developed nations now know that public trust has to be rebuilt, especially as science and technology is now playing an increasing role in people's lives thanks to the emerging knowledge economy. And advances in subjects like stem cell research and embryology are throwing up ethical dilemmas for both regulators and the general public alike. Good science governance is therefore as important as it has ever been.

Fortunately social research has revealed that the public is both willing and able to engage in discussion about science and technology's impact on society. This has been recognized by policy-makers who are establishing programmes that set out to bring people closer to science policy-making. For example, the European Union's framework programme for research includes a 'Science and Society' Action Plan, and similar other initiatives.

A greater integration of the programmes in socio-economic sectors with R&D activities can help go a long way in ensuring a wider, more visible and tangible impact. This will call for a certain percentage of the overall allocation of each of the socio-economic ministries to be devoted for relevant programmes and activities in science and technology.

A concentrated strategy is necessary to infuse a new sense of dynamism in science and technology institutions. This will help strengthen the science and technology departments, agencies, academic institutions and universities. Mechanisms should be established to review on a continuous basis the academic and administrative structures and procedures in the science and technology system at all levels, so that reforms could be made to meet the challenges of the changing needs.

It should be ensured that scientists and technologists run all highly science-based Ministries/Departments of Government and all the major socio-economic Ministries have high-level scientific advisory mechanisms.

Governments should ensure continued existence of an Apex S&T Advisory Body, which will assist in formulating and implementing various programmes and policies. It should have appropriate representation of industry leaders, leading scientists and technologists and various scientific departments. Government should also make necessary budgetary commitments for higher education and science and technology.

4.2 Investment in Science and Technology

Investments in science and technology are increasingly important for socio-economic development. When national research and development activities are reviewed as a whole, it is noted that the advanced nations such as Australia, Canada, Japan, South Korea, the United States, and Northern and Western Europe all spend between 1.5 percent and 3.8 percent of their GDP on research and development. While developing nations with large economies have approached the lower-end R&D/GDP ratios of OECD countries (for example, India allocates 1.2 percent; Brazil, 0.91 percent; and China, 0.69 percent), most developing nations devote less than 0.5 percent of their GDP to research and development. National governments in developing nations should increase their spending considerably, certainly above 1 percent of GDP and preferably closer to 1.5 percent, in order to improve their conditions and develop further.

There are many examples of successful economies, such as those of the 'East Asian Tigers,' have achieved much by focusing on education and investing in research and development. The figures from South Korea (2.55 percent), Taiwan-China (1.97 percent), and Singapore (1.47 percent), and the considerable material benefits accruing to the people of those countries, are renowned stories of success.

4.3 Optimal Utilization of Existing Infrastructure and Competence

Science and technology is advancing at a very fast pace, and obsolescence of physical infrastructure and skills and competence, take place rapidly. Steps should be taken to network the existing infrastructure, investments and intellectual strengths, wherever they exist, to achieve effective and optimal utilization. They should be constantly upgraded to meet changing needs.

4.4 Strengthening of S&T Infrastructure in Academic Institutions

An initiative to modernize the infrastructure for science and engineering in academic institutions should be undertaken. It should be ensured that all middle and high schools, vocational and other colleges have appropriate science laboratories. Flexible mechanisms for induction of efficient faculty in key areas of science should be developed.

In order to develop the youth talent merit-based academic policies and procedures should be strengthened so that they can gain intellectual independence by climbing the academic ladder. To reduce barriers for change and for the conduct of interdisciplinary and trans-disciplinary research academic and governance structures should be modified. This reform should include promotion of an interaction of the physical, biological, and earth scientists with academics in the humanities and social sciences.

4.5 Funding Mechanisms for Basic Research

Basic research is designed to give us new discoveries; whereas applied research uses these discoveries to gives us tangibles. Basic research and applied research both use the same measuring instruments and methods and work together as one, but they are treated very differently in their goals and funding. Both are very important, but basic research gives us new discoveries and is inadequately funded. Therefore setting up of more efficient funding mechanisms should be examined, either by creating new structures or by strengthening or restructuring the existing ones, for promotion of basic research in science, medical and engineering institutions.

Creation of world-class facilities should be emphasized in accordance with national needs in particular fields, to enhance international competitiveness in areas. Indigenous expertise will be used to the maximum extent possible. This would help in nurturing high quality talent and expertise in experimental science and engineering.

4.6 Development of Human Resource

In order to attain development in developing countries a lot needs to be done for a nation's human resources, especially its science and technology (S&T) professionals. Steps like creation, maintenance, and continual upgrading of an education base, from primary school to university level, for training new generations of scientists and engineers, as well as others among the nation's future leaders; Generation of technological innovations; Capability to access and productively use new technologies; Full participation, as equal partners, in international initiatives designed to solve global problems should be taken.

There is need to progressively increase the rate of generation of high quality skilled human resource at all levels. This process would naturally entail reversing the present flow of talent away from science, by initiating new and innovative schemes to attract and nurture young talent with an aptitude for research, and by providing assured career opportunities in academia, industry, Government or other sectors. In order to encourage quality and productivity in science and technology, mobility of scientists and technologists between industry, academic institutions and research laboratories needs to be ensured.

For building up the human resource base in relevant areas, flexible mechanisms are required for academic and research institutions to enable researchers to change fields and bring new inputs into traditional disciplines, and also to develop inter-disciplinary areas. A continuing process of retraining and reskilling to keep pace with the rapid advances taking place in the world are necessary. Training should be given abroad to build up a skilled base wherever required.

Women must be provided significantly greater opportunities for higher education and skills that are needed to take up R&D as a career. Academies should support the higher education of women in science, engineering, and industrial management while advising governments to remove barriers to their education and employment.

Migration has significant economic social and cultural implication, both positive and negative. Though brain migration affects various areas, but science and technology have remained the most important area and probably the most ignorant from planning point of view in the developing countries. Loss of huge number of scientists, engineers, doctors and intellectual caused a detrimental effect on the development strategies and their remittances were never at par in term of loss of the quality brain. Science and Technology are fundamentally important for a nation to keep pace in the race of development. Effective mechanisms to facilitate the return of scientists and technologists to their home countries should be instituted, along with their networking, to contribute to their home country's S & T sector.

The number of teachers proficient in science and technology and the quality of their education should be increased. In many countries there is a dire shortage of such teachers who are unable to keep up with constantly evolving S&T developments, even if their formal training was first-rate. This results in a difficulty for them to provide up-to-date knowledge to their students or in fruitfully applying the most recent teaching innovations. Therefore schemes for continuing education and training of university and college teachers in contemporary research techniques and in emerging areas of science should be strengthened and new innovative programmes should be initiated.

4.7 Transfer, Diffusion and Development of Technology

A strong base of science and engineering research forms a crucial foundation for a vibrant programme of technology development. Priority should be solely placed on the development of technologies which address the basic needs of the population. Special emphasis should be placed on equity in development, so that the benefits of technological growth reach the majority of the population, particularly the disadvantaged sections, leading to an improved quality of life for every citizen of a country. These aspects require technology foresight, which involves not only forecasting and assessment of technologies but also their social, economic and environmental consequences.

The transformation of new ideas into commercial successes is of vital importance to the nation's ability to achieve high economic growth and global competitiveness. Accordingly, special emphasis should be given not only to R&D and the technological factors of innovation, but also to the other equally important social, institutional and market factors needed for adoption, diffusion and transfer of innovation to the productive sectors.

Intensive efforts should be launched to develop innovative technologies of a breakthrough nature. Simultaneously, efforts should be made to strengthen traditional industry so as to meet the new requirements of competition through the use of appropriate science and technology. This industry is particularly important as it provides employment at lower per capita investment, involves low energy inputs, and carries with it unique traditions and culture. Value addition and creation of wealth through reassessment, redistribution and repositioning of local intellectual, capital and material resource can be achieved through effective use of science and technology.

Deriving value from technology-led exports and export of technologies can be facilitated through new policy initiatives, incentives and legislation. This will include intensive networking of capabilities and facilities within a country. Rigid Quality

Standards, and Accreditation of testing and calibration laboratories according to international requirements, should be given an enhanced push to avoid non-tariff barriers in global trade.

A comprehensive and well-orchestrated programme relating to education, R&D and training in all aspects of technology management is also compulsory.

4.8 Promotion of Innovation

Today, for knowledge based economy innovation has become central to growth. Therefore innovation should be supported in all its aspects. A comprehensive national system of innovation should be available covering science and technology as legal, financial and other related aspects. There is a need to change the ways in which society and economy performs, if innovation has to fructify. The design of policies aimed at upgrading technological capabilities in developing countries should not ignore but develop the potential offered by existing local innovation and integrate it with transferred technologies.

4.9 Industrial and Scientific R&D

Efficient efforts should be made to achieve synergy between industry and scientific research. Scientists and technologists should be promoted to transfer the know-how generated by them to the industry and be a partner in receiving the financial returns. Industries should be encouraged to financially adopt or support educational and research institutions, fund courses of interest to them, create professional chairs etc. to help direct S&T endeavors towards tangible industrial goals.

4.10 Indigenous Resources and Traditional Knowledge

Traditional knowledge has often played a crucial role in the development of modern science. Examples from the past reveal various relationships between science and traditional knowledge. Indigenous knowledge should be developed and harnessed for the purpose of wealth and employment generation. Innovative systems to document, protect, evaluate and to learn from traditional knowledge should be strengthened and enlarged. Development of technologies that add value to a country's indigenous resources and which provide holistic and optimal solutions that are based on a country's need should be developed. A concerted plan for instance can help intensify research on traditional systems of medicine, to contribute towards fundamental advances in health care.

4.11 Technologies for Mitigation and Management of Natural Hazards & Disasters

Climate change poses a serious threat to our ability to achieve the millennium development goals. Science and technology plays an important role in any general strategy to address the problems of mitigation and management of the impacts of natural hazards. An intensive action plan to enhance predictive capabilities and preparedness for meeting emergencies arising from floods, cyclones, earthquakes, drought, landslides and avalanches should be drawn up. Measures to promote research on natural phenomena that lead to disasters and human activities that aggravate them should be taken up. This should be with a view to develop practical technological solutions for pre-disaster preparedness, and mitigation and management of post- disaster situations.

4.12 Generation and Management of Intellectual Property

Intellectual Property Rights (IPR), have to be viewed, not as a self-contained and distinct domain, but rather as an effective policy instrument that would be relevant to wide ranging socio-economic, technological and political concepts. The process of globalization is leading to situations where the collective knowledge of societies normally used for common good is converted to proprietary knowledge for commercial profit of a few. Action should be taken to protect indigenous knowledge systems, primarily through national policies, supplemented by supportive international action. For this purpose, IPR systems, which specially protect scientific discoveries and technological innovations arising out of such traditional knowledge, should be designed and effectively implemented.

Establishing Intellectual property rights is important to become a technology producer and attract investment in a country's R&D. Legislation with regard to Patents, Copyrights and other forms of Intellectual Property ensure that maximum incentives are provided for individual inventors, and to scientific and technological community, to undertake large scale and rapid commercialization, at home and abroad.

The development of skills and competence to manage IPR and leveraging its influence should be given a major thrust.

4.13 Public Awareness of Science and Technology

Science and technology flourishes when the level of public awareness is high. In particular, it is very important to engage the interest and attention of young people. There is a dire need to enhance public awareness of the importance of science and technology in everyday life, and the directions where science and technology is taking us. People must be able to consider the implications of emerging science and technology options in areas, which affect their lives directly, including the ethical and moral, legal, social and economic aspects. In recent years, advances in biotechnology and information technology have dramatically increased public interest in technology options in wide ranging areas. Scientific work and policies arising from these have to be highly transparent and widely understood.

Scientific knowledge should be promoted, through the promotion of science museums, youth contests, science-mobiles, scientific awards, planetarium, botanical gardens etc. Efforts should be made to convey to the young the interest in scientific and technological advances and to instill scientific temper in the population at large. Special support should be provided for programmes that seek to popularize and promote science and technology in all parts of the country. Such programmes should be developed that promote learning and dissemination of science through various national languages, to enable effective science communication at all levels.

A closer interaction of those involved in the natural sciences and technology, social sciences, humanities and other scholarly pursuits can help bring about mutual reinforcement, added value and impact.

4.14 International Cooperation in Science and Technology

Developing countries can get best out of science and technology by creating local capacity along with the cooperation of developed nations. Scientific research and technology development can grow greatly by international cooperation and collaboration. Common goals can be effectively addressed by pooling both material and intellectual resources. International collaborative programmes, especially those contributing directly to scientific development and security objectives, should be encouraged between academic institutions and national laboratories. Collaborations should be mainly with other developing countries, particularly the ones that share common problems and challenges. International collaboration in science and technology can be fully utilized to further national interests as an important component of foreign policy initiatives.

4.15 Fiscal Measures

Innovative fiscal measures are vital to ensure successful implementation of the policy objectives. New strategies have to be formulated for attracting higher levels of public and private investments in scientific and technological development. A series of both tax and non-tax fiscal instruments have to be evolved to ensure a leap-frogging process of development. The formulation of a focused strategy and the designing of new methods and instruments require inputs from economists, financial experts and management experts and scientists.

4.16 Monitoring

Effective, prompt, transparent and science-based monitoring and reviewing mechanisms should be significantly strengthened, and put in place wherever they are not available. It should be ensured that the scientific community is involved in, and responsible for, smooth and speedy implementation of the Science and Technology Policy.

5. CONCLUSIONS

It is now well-recognized that scientific knowledge has yielded technological applications that have been of great benefit to humankind. The applications of science and technology in the developing countries still suffer from drawbacks, particularly lack of awareness of its role in enhancing industrial development, which is reflected in low involvement and expenditure of the private sector in research and development. The general system of S&T research activities in developing countries is characterized by (i) weakness of coordination, and (ii) dispersal without common linkages and focused approach.

There exist many problems for the development of science and technology among the developing countries. Some of these are: inadequate S&T infrastructure, ineffective management and structure, isolation of S&T system from the national economic-planning process, lack of effective coordination mechanism, excessive reliance on imported technology, paucity of financial resources, dearth of research-equipment and technological information, lack of participation by the relevant elements of society in the S&T development, isolation of scientists from active centers of learning in the world, lack of effective S&T institutions at the grass-roots level, and a system of education that does not inculcate spirit of enquiry and curiosity for research. Consequently, there is no way forward for developed or developing regions, except through sustainable development. The need today is to fully engage S&T with societal wants, so that all stakeholders may be involved in a meaningful dialogue.

There is a greater realization, more now than in the past, that each country should develop its own National S&T Policy for socio-economic development, and also ensure the mechanisms for its periodical review, so as to synchronize with the socio-economic development-plans. This, however, cannot be possible without a sound S&T policy orientation and implementation. Sustainable development cannot be brought about in isolation or segregation; therefore, S&T capacity-building at the international, regional and sub-regional levels must be synchronized so as to achieve maximum benefits. The introduction of adaptable technologies in targeted areas is expected to provide the necessary results and, more importantly, strategic partnerships between the public and private S&T sectors to formulate policies would also produce requisite outcomes.

BIBLIOGRAPHY

- A. Bilsel and Ö. Oral (1995), "Role of Education, Science and Technology in Developing Countries" [Online] Available at : www.fie.engrng.pitt.edu/fie95/4c4/4c44/4c44.htm
- Athar Osama (2005), "The Top 10 Science and Technology Priorities for Pakistan", [Online] Available at: www.khwarzimic.org/takveen/ST-guidelines.pdf
- "Definition of Basic research", [Online] Available at: http://www.mext.go.jp/b_menu/hakusho/html/hpag200001/hpag200001_2_023.html
- InterAcademy Council (2003), "Inventing a Better Future" , [Online] Available at: http://www.interacademycouncil.net/CMS/Reports/9866.aspx
- Ministry of Science and Technology, Republic of Korea, 2003, "Public Awareness of Science and Technology in Republic of Korea", [Online] Available at: http://www.most.go.kr/
- National Science Foundation (2000), "science and technology policy : past and prologue", [Online] Available at: www.nsf.gov/nsb/documents
- "Office of technology policy (2004) , "Science and Technology policy infrastructure guidelines and references" [Online] Available at: http://www.technology.gov/Reports.html
- "S&T Policy: Priority Setting", [Online] Available at: http://www.fas.org/sgp/crs/misc/IB10088.pdf
- World Bank (1996), "World Bank Annual Report" [Online] Available at: http://www.worldbank.org/html/extpb/annrep96/annrep96.htm
- World Bank, 1998/99, "World Development Report", [Online] Available at: http://www.worldbank.org/wdr/wdr98/

SECTION - C

CASE STUDIES

S&T POLICY AND INNOVATION LEADS TO SOCIO-ECONOMIC DEVELOPMENT AND KNOWLEDGE-ECONOMY: CASE STUDIES OF U.S.A., TURKEY AND S. KOREA

Tajammul Hussain
Director General (International Affairs)
COMSATS Headquarters, Islamabad, Pakistan

ABSTRACT

No one can deny that the West has achieved the socio-economic status through the acquisition and application of science and technology (S&T). Science is a big domain and technology is its tool. New technologies are only created through research and innovation. Research in any society is actually spearheaded by the academia, and the impetus to the academia (universities and institutes of higher learning) is provided by the industry in that country. The linkage of the academia with the industry cannot be emphasized enough, because it drives the university students forward into the scientific depths of research needed by the industry for improving processes and products.

The developing world must realize the immense value of S&T research and innovation for creating new knowledge and emerging technologies. The countries of the South have to revamp their existing structure of S&T and innovation so as to bring change in the economy and prosperity of the country.

This chapter presents three typical successful cases of National Innovation Systems (NISs) in a developed and two developing countries. USA represents the case of a developed country, while Turkey and South Korea, being good examples of innovation, amongst developing countries are discussed hereunder.

1. INVENTION, INNOVATION AND COMMERCIALIZATION

The terms invention, innovation, and commercialization are commonly used in a number of overlapping ways to refer to the process of developing new technologies and incorporating them into new products, processes, or services. Confusion often results from the close ties between invention, innovation, and commercialization and from subtle differences in meaning of each term.

Invention refers to the act of devising or fabricating a novel device, process, or service. Invention describes the initial conception of a new product, process, or service, but not the act of putting it to use. Inventions can be protected by patents, though many inventions are not patented, and most patents are never exploited commercially.

Innovation encompasses both the development and application of a new product, process, or service. It assumes novelty in the device, the application, or both. Thus, innovation can include the use of an existing type of product in a new application or the development of a new device for an existing application. Innovation encompasses many activities, including scientific, technical, and market research; product, process, or service development; and manufacturing and marketing to the extent they support dissemination and application of the invention.

Commercialization refers to the attempt to gain profit from innovation through the sale or use of new products, processes, and services. The term is usually used with regard to a specific technology (e.g. "commercializing high-temperature superconductivity") to denote the process of incorporating the technology into a particular product, process, or service to be offered in the marketplace. The term "commercialization", therefore, emphasizes such activities as product/process development, manufacturing, and marketing, as well as the research that supports them. More than invention or innovation, commercialization is driven by expectations that a competitive advantage can be gained in the international marketplace for a particular product, process, or service. Knowledge Commercialization is an important example.

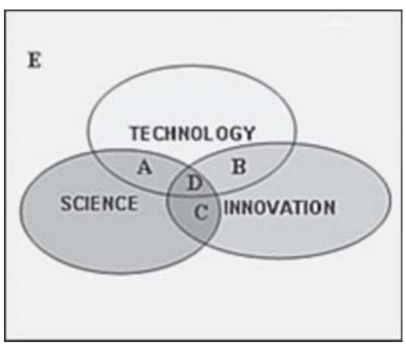
2. COMMERCIALIZATION OF KNOWLEDGE – ITS FUTURE

The world has now become a global knowledge-economy. The national trend of each country's economy has to be towards "Knowledge Commercialization", meaning the use of knowledge to produce economic benefits. Innovation includes knowledge creation and commercialization (new to the world) as well as knowledge diffusion and absorption (new to the market). Through effective knowledge commercialization, the economy of a country can prosper rapidly and this reflects in the form of an increased Gross Domestic Product (GDP). To sustain rapid population-growth and help alleviate poverty, the developing world needs to aggressively harness its innovation potential, relying on innovation-led, rapid, and inclusive growth to achieve economic and social transformation for prosperity. For that the developing countries need to have a sound innovation-policy ensuring the building of a comprehensive infrastructure for innovation.

Economic globalization has changed the World Economic Order, bringing new opportunities and challenges (Commission of the European Communities, 2006) and significant changes in the conditions for catch-up, with dire consequences for developing countries. In this new economic order, developing nations can no longer compete on the basis of their natural resource-endowments and local advantages. The experience of Brazil with sugarcane suggests that building scientific capacity and competences in the fields of natural resource-endowment and local advantages is a surer way to development.

3. SCIENCE, TECHNOLOGY AND INNOVATION (STI)

The innovative performance of an economy depends on how individual institutions and actors (e.g., education and research organizations; firms; funding institutions) perform in isolation and how they interact with each other as elements of a collective system of knowledge-creation and use. Without adequate development of these actors and institutions in the domestic and regional settings, the innovation system remains underdeveloped and anemic. The model, in Figure-1 presents, four possible distinct connections among the science, technology and innovation triad (i.e. domains A, B, C and D) together with a reactor (domain E), within which all of these take place. STI activities have to exist within the framework of the National Innovation System (NIS)



A = Science and Technology
B = Technology and Innovation
C= Science and Innovation
D = Science, Technology and Innovation
E =National Innovation System (NIS)

Figure - 1: Evolution of National Innovation System (NIS)

(domain E). The National Innovation System has been defined by Freeman (1987) as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies". Freeman's definition places emphasis on the interaction between the production system and the process of innovation. Ilori (2006) defines it as a constitution of elements and the relationships located within or rooted inside the borders of a state, which interact in the production, diffusion and use of new and economically useful knowledge. This definition emphasizes the economic usefulness of S&T activities. The success achieved by any nation in exploiting new, especially scientific, knowledge for growth and development depends on the effectiveness of the nation's National Innovation System (NIS).

Domain A, which represents the link between science and technology results in the generation of new, improved and cutting-edge knowledge and methods without obligatory regard to economic benefits. While this can bestow leadership upon any nation, it will not translate automatically into observable economic benefits. Global experiences have shown that the possession of advanced scientific capability does not robotically translate into development. As a matter of fact, huge expenditures in science do not equal to knowledge-intensive activities and industries. While S&T will hold some benefits for the developing nations, notably the creation of a critical mass of human resource, this alone does not guarantee the kind of growth that these nations seek.

In domain B, the kind of activities that would typically take place would relate to the acquisition of embodied technology and an aggressive pursuit of foreign direct investment (FDI) as a way to drive growth. The domain tells of a nation's potential for exploiting knowledge that is developed elsewhere. This potential, which we may call "absorptive capacity" or "diffusion", is particularly beneficial for developing nations as it lessens time and cost required to catch up. In fact, according to Polcuch et al (2005), in developing countries, technology-transfer from multinational corporations and from abroad is a fundamental source of innovation. Acquisition of embodied technology/equipment for both product and process-innovation is a major component of innovation. The crucial importance of capital goods as a source of innovation, even in developed countries, is confirmed by a survey of European enterprises, which shows that 50 percent of total innovation expenditure is embodied in plant, machinery and equipment purchased by industrial firms, with own R&D accounting for just 20 per cent (Evangelista et al., 1998, quoted by UNIDO, 2002).

Nevertheless, the advantages in this domain for developing countries are limited by two main factors. First, to secure advantages for latecomer firms, nations must be active in developing and deploying their capabilities to source and access relevant technologies. Resource constraints and institutional deficiencies make it unnecessarily difficult for most under-developed countries to even develop, let alone achieving speed in deploying capabilities. Secondly, the development of "special institutions" that accelerate and facilitate the catch up process is paramount. These institutions; such as the 19th century Deutsche Bank, Japan's Ministry of International Trade and Industry (MITI), Taiwan's Industrial Technology Research Institute (ITRI) and India's Ministry of Non-Conventional Energy Sources, among others; are largely absent in most of the developing countries, and where they exist, are either under-funded or "overloaded" with responsibilities beyond acting to bridge the gap between the technology-resources of the developed world and the aspirations of the developing nations to catch up.

The Science-Innovation link of domain C suggests the creation of new economically useful knowledge in a country. However, with the absence of technology, it becomes a particularly difficult and nearly impracticable link, for science will seldom yield any economic benefits in the absence of technology. Indeed, certain major scientific advances are even driven by technology. A classic example was given by George Porter (Nobel Laureate in Chemistry) who pointed out that "Thermodynamics owes more to the steam engine than the steam engine owes to science.”

In D, the triad of science, technology and innovation co-exist. This, no doubt, should be the aim of every developing nation. National scientific and technological efforts must be directed with clear economic benefits in mind. In fact, technological learning – a major component of innovative-knowledge application – is recognized as the critical factor that underpins successful industrial development. The rapid development recorded in East Asia in the second half of the last century and more recently, that of China, India and Brazil are illustrative of this.

For a nation to withstand competition in this era of globalization, there is a need for it to identify niche areas and build on it through the application of scientific methods. New technologies and industries may then be built around these areas of core competences. To achieve the foregoing, however, certain systemic weaknesses must be taken into consideration. This is especially so because the NIS, which acts as the reactor for all of the efforts discussed so far, ultimately determines to a reasonable extent as to how much results can and will be achieved. *Within this context, it is useful to review some of the key challenges to Science, Technology and Innovation (STI) development in developing countries, with a view to proffering solutions*.

4. INNOVATION AND DEVELOPMENT

The basic cause of the competitive advantage of nations and organizations is knowledge and realization that competition today is more dependent on exploitation-capabilities than on resource-endowments, as expounded in Prusak L., Davenport's Working Knowledge and Hamel G. and C.K Prahalad's Competing for the Future. Today, nations can no longer compete on the basis of just natural resource and locational advantages. This is exemplified in the fact that numerous industrialized countries are poorly endowed with natural resources and the least industrialized nations are those with rich resource and favorable climatic endowments. If anything, there seems to be a stronger relationship between countries' performance in S&T and their economy than other variables.

For instance, according to OECD's ‘The Second European Report on S&T Indicators’, the economic progress recorded in the 50 leading S&T countries is much higher than in the rest of the world. While the average wealth per capita in these 50 countries grew by 1.1% between 1986 and 1994, the per capita income of the other 130 countries of the world fell by 1.5% over the same period. From 1988 to 2001, the number of scientific articles published worldwide grew by 40%.

It has been argued that not all peripheral regions can become centers of technology-entrepreneurship like Taiwan and Israel, rather the nations that have invested heavily in higher education—particularly technical education—are the ones that are best positioned to compete in these industries. Most of the developing economies in Asia, Africa, and Latin America have failed to make such investments. In fact, most developing countries still spend less than 1% of their GDP on education. Consequently, the Human Development Index (HDI) and Gross Domestic Product Index (GDI), which are measures of the social well-being of a nation, are generally low for these countries. For example, the average GDI for Sub-Saharan Africa is 0.63 compared to 0.71 for East Asia and the Pacific and a world average of 0.75. In 2003, the HDI for Sub-Saharan Africa was 0.515, compared to 0.768 for East Asia and the Pacific and a world average of 0.741. This is inspite of the abundant human and natural resources that the African continent is endowed with.

Only when the local S&T manpower is appropriately educated with a scientific orientation would it become possible for them to undertake the scientific enterprise with some hope of success in the shape of technological advancement.

5. RE-CONCEPTUALIZING THE LINK BETWEEN SCIENCE, TECHNOLOGY, INNOVATION (STI) AND DEVELOPMENT

In today's fast-paced global economy, the lines between science and technology as independent fields of study have become more blurred. Historically, technology has benefited immensely from science, and it has, in turn, made the prosecution of science more productive through the development and application of new devices and techniques. As a result of this forward and backward linkage, the idea of science and technology as a hybrid concept is now widely accepted. S&T now refer, not to a pair, but a single unified concept, which is generally characterized by a number of distinct activities. These activities typically include: research and development, experimental development, innovation, and S&T services as well as S&T capacity building.

In the past two decades, innovation has evolved to become, not just an activity under S&T but also a key variable in the development-equation, due to the realization that a nation becomes competitive on the basis of knowledge, the application thereof and the speed with which new knowledge is acquired. Thus, the joining together, of science (increasing what we know), technology (applying what we know) and innovation (turning our applied knowledge into economic benefits and promoting the acquisition of new knowledge through learning-by-doing) is more useful than the singular contributions of science or technology. Indeed, until S&T capabilities are effectively diffused through innovation, the benefits derivable from S&T are not actually realized in the economy of any country.

6. INCREASED FUNDING FOR SCIENCE, TECHNOLOGY AND INNOVATION (STI)

With scarce local funding for research and innovation, much of the developing world, especially Africa, will remain industrially underdeveloped. Consequently, researchers from the developing countries rely on external donors, aid agencies and grant-giving bodies to sponsor their work and R&D efforts that don't guarantee relevance to local developmental needs. To reverse this trend, developing nations need to fund STI-related research more effectively. Current investment levels in STI must go up; in fact it has been argued that to achieve meaningful economic and social development, a country must invest at least 1 to 4 per cent of its gross national product (GNP) in S&T research. It would be a mistake for policy advisers to concentrate too much on the research element of R&D spending, without giving adequate attention to spending on development.

7. THE ESSENTIAL ROLE OF UNIVERSITY—INDUSTRY LINKAGE FOR THE SOUTH

While the academia and industry have their individual roles to play in the development, nevertheless bringing these two actors together is paramount for STI-led development. Academia and industry could be brought together through consultancies, contracts, research or network partnerships. It is not enough for a country or region to simply increase the total number of consultancies and contracts between academia and industry, because such arrangements are generally myopic, focusing narrowly on specific interests. By their very nature, they preclude serendipitous discovery and seldom generate publications or postgraduate work. Though they can supplement individual academic salaries and help retain staff, many are not officially reported, and may happen at the expense of teaching and research.

Network partnerships across academia, industry, government and international development-partners would be more beneficial significantly. Besides serving as instruments to address innovation market failures, these industry-academia-government partnerships could also act as mechanisms for 'informal' knowledge-transfer.

In the UK, for instance, innovative solutions are provided by academia for many real-life industrial problems under the Knowledge Transfer Partnership programmes that support joint supervision of PhDs by university and industry. As a consequence of the extensive policy-support for industry-academia relationship, it is not surprising that the degree of interaction between industry and UK-based universities has increased. Technology-transfer is thriving more in the UK, as reflected, among other indicators, by the increasing number of universities that have commercialization-related office activities (23 universities before 1990, 116 universities by 2002), and by the number of spin-off companies, created per $1 billion sponsored-research expenditure compared to the US. Also, the scientific outputs from university-industry research collaborations have been increasing in the UK. For instance, Calvert and Patel (2003) showed that between the early 1980s and late 1990s, joint university-industry papers increased from about a quarter to around a half of all industrial scientific output in the UK.

The following examples from South Africa illustrate the power of strategic industry-academia network-partnerships. Indeed, they exemplify the glory of the matrimony among science, technology and innovation. The Tree-Protection Co-operative Programme is a biotechnology-research network of large paper-firms and small timber producers, working on tree-pathogens with academic partners at the University of Pretoria, to the benefit of all. The university-research unit is building an international scientific reputation by producing a large number of postgraduate students and accredited publications. It has become a sponsored ‘centre of excellence' that attracts considerable research funding from government. The industry-partners depend for their competitive edge on the costly R&D and risk-management strategies that the network provides, e.g., the university-researchers provide DNA-technology to produce trees, resistant to pests and pathogens.

A second example of a successful strategic partnership is the remote-sensing Multi-Sensor Microsatellite-Imager project. In this research-network funded by government, the university, industry and government-partners work together to design micro-satellites that can supply affordable high-resolution imagery to African governments. The images can help monitor, regulate and manage resources, for example, water- distribution, crop-management and settlement-infrastructure. A Stellenbosch University laboratory conducts fundamental research for the network. A spin-off company manages the technology-development, while application-research is managed by a government-supported science council. Finally, a Belgian university and industrial partner develop specific technical components. Mutually beneficial network-partnerships like these — where university, industry and intermediary partners work towards a shared objective — generate knowledge and technological innovation for all. Such networks help universities to harness the innovation potential of their researchers, while maintaining the academic integrity. They meet industrial needs for technological progress and also contribute to national socio-economic development.

8. UNDERSTANDING THE ROLE OF POLITICS AND POLICY IN DEVELOPING COUNTRIES

In the words of Kenya's Minister for Science and Technology, "The first step to inculcating science and technology into our national ethos is the recognition by parliament that science, technology and innovation are critical tools for policy-formulation." This is an important pointer to the fact that sagacious politicians of the developing world do not want their countries to be left out of the global knowledge-economy, and are realizing that science can contribute to virtually every field of public policy.

Developing nations ought to become more aggressive in their approach in mainstreaming STI into national development. Universities have to become more proactive by pressuring politicians. Indeed, parliamentarians must be well informed if they are to stimulate, formulate and scrutinize science-related policies, and to ensure that such policies drive sustainable development.

Interdisciplinary programs sometimes arise from a shared conviction that the traditional disciplines are unable or unwilling to address an important problem. They may also arise from new research developments, such as in the field of nanotechnology, which cannot be addressed without combining the approaches of two or more disciplines. Examples also include quantum-information processing, which amalgamates elements of quantum physics and computer science; and bioinformatics, which combines molecular biology with computer science.

This kind of thinking has led to the establishment of Interdisciplinary-Research Centres (IRCs) in several universities to tackle challenges of research in basic-science. A typical example is the IRC in Polymer science and technology (Polymer IRC) that combines people from various discipline across four universities, giving a multi-disciplinary approach to the research.

9. NEED TO PROMOTE INTERDISCIPLINARY AND COLLABORATIVE RESEARCH IN THE DEVELOPING WORLD

Developing countries should also take up this challenge by putting more emphasis on research, which leverages on many disciplines to proffer solutions to their economic problems. The creation of such Interdisciplinary Centres of Excellence (ICoEs) in R&D will foster STI-led development by "doing science with real impact." The benefits accruable from the formation of these include, leveraging investment in development; recruiting best and brightest students and scholars to address the developing world's real problems (food, water, shelter, health, public policy, entrepreneurship, energy and the environment) through interdisciplinary teaching and research; strengthening the NIS by working with industry, business and government to close skill-gap by ensuring graduates that have the capabilities that employers are looking for, and that the developing world needs.

Work Environment: It is important to improve the environment within which researchers of the developing countries work, and how this affect their productivity. Factors such as organizational climate, work load, experience, and attitude towards research are important. The development of STI indicators for these developing countries is long overdue. Apart from that the funds must also be made available. Finally, an assessment of innovation- capability in industry would be very useful.

Collaboration: There is a clear relationship between developing countries' performance in STI and their economy. An important contribution to this quest for STI-led development is the new model of relationship between the science, technology and innovation (STI) triad and economic development, within a nation or region. researchers and institutions from developing world should aggressively pursue research-collaborations to address market-failures of innovation, effective resource-utilization, and act as mechanisms for 'informal' knowledge-transfer. Institutions and individual researchers also need to be aware of the role that politics and policy play in facilitating the STI-development. Capabilities, therefore, need to be developed in these regards. Furthermore, in formulating research-agendas, it must be borne in mind that two or more academic disciplines, integrating their insights to work together in pursuit of a common demand-driven goal, will yield better results.

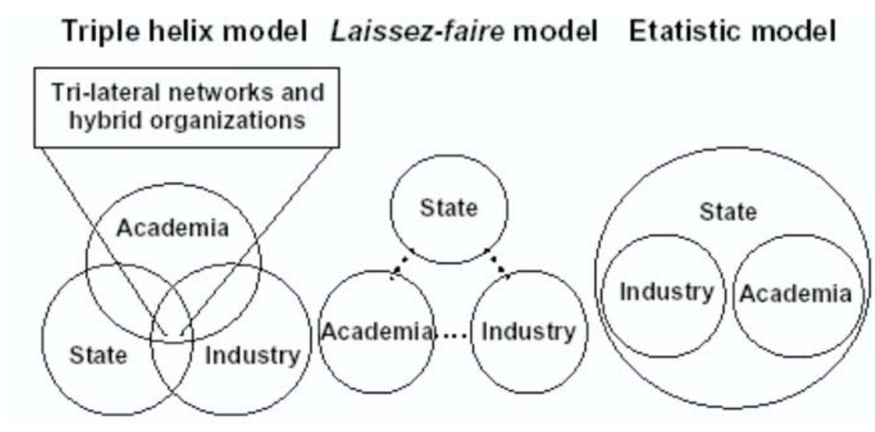


Figure - 2: From Etatistic to Triple Helix Model

After appropriately establishing the link between national development and the science, technology and innovation triad, we may describe and discuss the three case-studies of S&T policies of USA, Turkey and S. Korea, to see how this relationship works there.

10. POLICY ON SCIENCE, TECHNOLOGY AND INNOVATION IN DEVELOPED COUNTRIES: A CASE STUDY OF UNITED STATES OF AMERICA (USA)

United States of America (USA) remains the leader in innovation for the last 100 years. It is scientifically and technologically most advanced and still continues to be most innovative despite having active competition from many countries, including the United Kingdom (UK) and the Scandinavian countries, such as Sweden and Finland. An American style of knowledge-commercialization can be identified in the focus on new firm formation, emphasizing high-growth/high-risk strategies, with a significant role for the entrepreneurial university in the start-up process. In contrast to Europe, where a direct governmental role in innovation-policy is more acceptable, government tends to act indirectly in the US. Nevertheless, government plays an important part in commercializing knowledge through setting the rules of the game, sponsoring complex projects with spin-off potential, and by providing public venture-capital to start-ups. Paradoxically, since government is constrained from taking initiatives that are close to the market, its programs and policies encourage a higher degree of business-risk. Moreover, the requirements of some government-programs also encourage market-oriented firms to engage in research, and research-oriented firms to move closer to the market. There is also a reverse-flow from commercial opportunity to knowledge-creation that operates in parallel to bridging knowledge, with a similar emphasis on growth, if not on risk. Large firms contribute to both processes through their resistance to, as well as encouragement of, innovation.

10.1 American Innovation-Model for Knowledge-Commercialization

In the mid 19th century, an American system of manufacturing was identified, emphasizing the interchangeability of parts, first in the production of rifles and then of other precision metal-instruments. An American method of knowledge-commercialization, based on an entrepreneurial university, engaged in technology-transfer through patents and firm-formation, emerged in the early 20th century at Massachusetts Institute of Technology (MIT). The entrepreneurial academic model tied to venture capital was transferred to Stanford in the early post-war, where it also had independent origins in the late 19th century.

The traditional linear-model involves production of academic knowledge, typically based on government-funding, and dissemination to industry through publication and

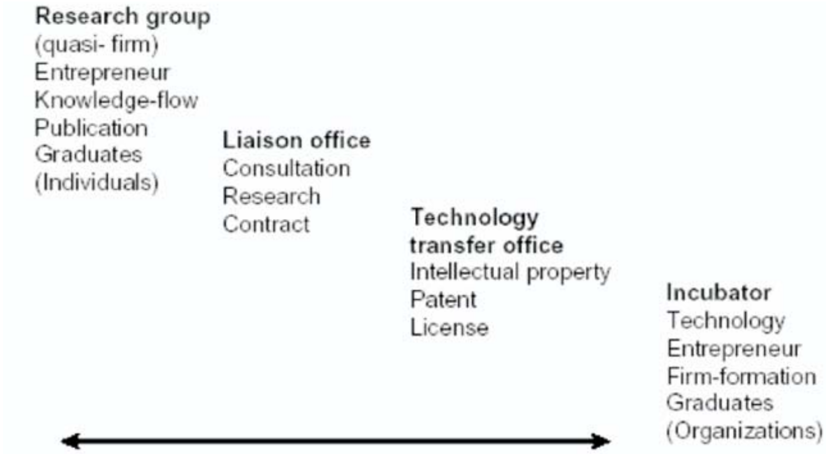


Figure - 3: Co-Evolution and Multi-Linearity of University-Industry Relations

consultation. However, given gaps identified as early as the 1930s in New England, and nationally in 1960s and 70s, it was realized that the linear- model could not realize its full potential as an automatic laissez-faire process. During 1930s, the President of MIT, Karl Compton, convinced a regional coalition, comprising academic, industrial and governmental leaders, that academic knowledge-commercialization was a potential economic-development model but to realize this goal, a more systematic support-structure was required. To encourage firm-formation, they established a venture capital instrument in 1940s with close links to the Harvard Business School and Boston Financial-Interests.

Thus, an "assisted linear" model of innovation, an organizational methodology for knowledge and technology-transfer, was invented, with at least two key elements: (1) a search mechanism, the technology-transfer and licensing office, to identify potentially commercializable knowledge that met the criteria for patent-protection; and (2), the venture-capital firm to provide a financial and organizational support-structure for the firm-formation process. The venture-firm originally provided both funding and business assistance. This latter function has, to some extent, devolved into the incubator-facility, an intermediary organization in between the transfer office and the venture-firm. Initially, both the technology- transfer and venture-capital functions were external to the university. Over a period of time they have been wholly or partially internalized, as well as applied to other firm-formation strategies in addition to those based on knowledge- commercialization.

10.2 The Role of American Government in Promoting Innovation

Indirect Industrial Policy method was implemented. A technology-transfer mission was generalized to the entire research-university system in 1980, by the Bayh Dole Act, which turned over intellectual-property rights from federally funded-research to the university, with the proviso that academic institutions make an effort to commercialize these rights. In addition, An NSF experiment of the late 70s, the Small Business Innovation Research Program, providing grants to explore the commercial potential of research was generalized to the entire federal research funding system. A set aside of funds for this purpose was mandated for each agency expending more than 100 million per annum. In effect, a public venture-capital mechanism was created that filled gaps in private venture-capital that was increasingly moving downstream. Since the funds were offered as grants with no matching fund-requirement, projects with a high business-risk could be supported. In addition, the Advanced-Technology Program, in the National Institute of Standards and Technology, was originally founded primarily to support research-collaborations among large corporations with potential for technological spillover, gradually shifted to supporting high-tech start-ups as its funding was cut, in effect conforming it to the general focus of supporting start-ups with high business and technical risk.

Direct intervention by U.S. Government has existed over the decades with varying intensity. Under conditions of war-time emergency or political exigency complex, government organized projects for technology-development, such as the Manhattan Project and the Apollo Program, which involved industry and academia. At a somewhat lower level of priority, international economic competition has also overridden Laissez-faire principles.

Thus, government supported the semiconductor-industry project for a joint laboratory, supported by government-funds, in order to develop new technology for the industry and forestall its loss to Japan and the Human-Genome Project. It was done with an aim to speed up the development of knowledge and technology in an area that was expected to provide the basis for new lines of medical research and industrial development. This approach is exemplified in the oft-stated theme," If we can go to the moon, why cant we… [replace with conclusion of your choice, e.g., cure AIDS,…]. Systems analysis was developed as a methodology to coordinate large-scale projects with a clear focus on a single expected result.

10.3 The American Universities' Function in Building Entrepreneurship

A broader entrepreneurial ethos pervaded US research universities, extending well beyond those few universities that took explicit steps to develop close relations to industry. The US research-university had an entrepreneurial ethos, even before technology-transfer and regional economic-development came on to the academic agenda. Fundraising for research was early-on an individual faculty-responsibility, rather than tied to the position. Junior and senior faculty alike had responsibility for setting their own research and obtaining support to realize their academic goals. This was originally a unique US academic element that is being universalized as other countries adopt the project-grant model as a means of funding academic research. On the other hand, US has more recently been moving toward block-grant model, in order to gain critical mass of research in certain areas by funding centers and groups of researchers, rather than individual investigators.

University-research groups have many firm-like characteristics, such as an entrepreneurial impetus, ongoing fund-raising responsibilities, personnel-management problems, and tasks of public relations in publicizing the groups' achievements. Thus, the cultural distance between academia and industry is often less than commonly perceived. During the 1980s academic bio-technology firm-founders noted that their tasks in founding a firm were not so different than running their research-group.

A parallel academic system, tied to agricultural innovation, the "land grant universities", was also created that fed into industrial innovation as agricultural research led to new products, as well as improved farming practices. These academic trends made it possible to rapidly expand the entrepreneurial academic scene as the potential arose in additional research-fields and the need grew in industry for infusion of new technologies.

10.4 The Multi-faceted Role of American Industry

A reverse-linear model that shares some of the characteristics of the linear model can also be identified, based on utilizing knowledge to solve problems in industry and the larger society. This model is typically more conservative and closer to the market than the traditional linear model. The industrial-research laboratory made a partial transition, first, from applying scientific methodology to improving existing products, to creating new products and processes requested by the firm, and finally to generating research products from the lab. In the mid 19th century technical innovation, for example, in the railway-industry came from operational employees who produced inventions in the course of their work. By the late 19th century a firm established the first formal research-laboratory, when GE hired Prof Willis Whitney from MIT. By the 1890s there were four industrial-research laboratories and by 1930 one thousand. At the highest level, industrial labs made the transition from supporting existing production-processes to creating new products, utilizing the methodologies of basic science. However, companies outside of the pharmaceutical industry are only occasionally willing to commit to development of a research-originated product. DuPont's nylon is the exception to the rule. IBM's conservative role in RISC computing is more typical.

An innovation that was realized within the research-lab was often taken up within the company only after it had been brought to completion elsewhere. The typical corporate decision-making process balanced the investment required by the new product against profits that could be made from further investment in existing products. It was typically decided that the former course of action was more rewarding and less risky than the latter. The potential for the new product-cannibalizing the market for the old, was also a counterweight to internal innovation. Sometimes, top management, like Xerox, simply did not comprehend the potential of its Lab's accomplishments or thought them too far a field from the firm's business-model. Failure to pursue product-development internally is an impetus to employees to spinout the technology in a new firm, whether supported by the firm or in spite of its prohibition.

Innovation in Business Concepts: There is a parallel start-up model to the one based on technological innovation: the firm based on a new business-concept that utilizes the available technology in new combinations. Thus, FEDEX, originating as a course project in an MBA program, combined air-transport with door-to-door ground delivery and communication systems, and linking customers and delivery employees. Dell is based on a concept of building computers to order from a set of specified options, delivering directly to the purchaser, utilizing capabilities of voice and computer-communications to interact with customers. The technological inputs to these businesses are based on available capabilities that are integrated into a common format and applied to a new purpose. Not surprisingly, firms change their orientations somewhat over a period of time. Thus, Dell now conducts close-to-market R&D in the U.S., India and Brazil. Microsoft, which originated by purchasing and repackaging software-innovations, now conducts advanced research in software and related areas, such as Baysian statistics, with longer range potential for product-development.

The Evolution of Venture-Capital: As venture-capital expanded, it moved away from its original function of bridging knowledge to commercialization. It also lost many of its early ties to academia by moving downstream to the later stages of firm-formation and industrial restructuring. In either of its formats, whether focused on early or later stage technologies, the venture model is the converse of the systems approach, whether in government or industry, with its focus on a strictly limited number of choices perceived as low risk. In the venture model, a variety of initiatives are encouraged, with a relatively modest level of funding at the early stages, in order to determine which are worth selecting for larger scale support. Since risk is spread over a variety of projects and approaches, a higher level of risk can be justified than if a single approach had to be chosen at the earliest stage. The larger return that can be expected from the success of a high-risk project is deemed more than sufficient to cover losses of unsuccessful ventures. Modestly, successful ventures are also produced but they are considered relative failures from the perspective of this high-growth/high-risk regime.

10.5 Successful Knowledge-Creation and Commercialization by America

The American Model of knowledge-commercialization is based on connecting the patent-system to the intellectual output of the university-research group, on the one hand, and integrating the research-group into an organizational network of transfer-offices, incubator facilities and venture capital-firms, on the other. Initially, at MIT this process used the traditional academic-committee process to review inventions and an external organization, the Research Corporation, to market the patents to industry. The next step was the creation of organization within the university, the technology-transfer office, to carry out this task on a more intensive basis. In either format, as a branch of the university or as a free-standing entity, a search mechanism was introduced to identify commercializable knowledge within the university, and to market it to potential users. Although these mechanisms were often created to move knowledge and technology to existing firms, there has been a gradual shift in focus to the start-up process, both to maximize revenues and to find an outlet for knowledge and technology that is beyond the purview of existing firms.

Conclusion: The essence of the American model is a focus on firm-formation in emerging-technologies. Reducing risk and compressing time-frames in the transition of knowledge to utilization is the primary objective. The bright side is driven by the potential for industrial and social innovation that new technologies make possible, such as the electric light in the late 19th century and nano-technology at present.

The common element in all of these approaches is the emphasis on knowledge-creation and commercialization, leading to rapid economic growth within the country in a short span of time. As we have seen, government, university and the private-sector play various roles in different combinations in this process. The government plays a major role in promoting knowledge-commercialization throughout America in all spheres of life. There is also a very strong cultural emphasis on the individual entrepreneur and his interaction with the industry.

Any method found in the United States can also be identified in other advanced industrial countries of the developed world. Nevertheless, just as the "American System of Manufactures" was identified in the 19th century, an "Assisted Linear Model" with a Triple Helix dynamic of university, industry and government "taking the role of the other" is the American method of bridging knowledge to commercialization, at present.

11. POLICY ON SCIENCE, TECHNOLOGY AND INNOVATION IN DEVELOPING COUNTRIES: A CASE STUDY OF TURKEY

Turkey is the most advanced country in the fields of science, technology and innovation amongst the developing and Muslim countries. It is also a member of the European Union (EU). It has successfully implemented a National Innovation System (NIS) throughout the country, in all public and private spheres, through effective coordination of government, academia and industry. Entrepreneurship is thriving in the country. Turkey's universities are actively involved in Research and Development leading to innovation.

Turkey has a long tradition of S&T policy-making, dating back to the 1960s. Especially after 1996, almost all stakeholders have been involved in the policy-making on science, technology and innovation policy-making. Due to a shared vision and strong commitment by stakeholders to the implementation of policies, the main goal, i.e. establishing a fully functioning National Innovation System (NIS), has been achieved to a great extent.

The Vision 2023 Project, which has been intended to eliminate any problems with NIS, was completed at the end of 2004 and the new S&T strategies were prepared, involving the largest stakeholders. This new policy-making process also showed an increased political commitment and a more evidence-based approach. TUBITAK recently, took first steps to ensure more coordination in the implementation of policy-strategies by conducting surveys among the actors of NIS to identify the level of progress and problems encountered during implementation.

The increased commitment of the government to S&T and the recent improvement of macro-economic conditions and political stability have given a new impetus to Turkish innovation-policy.

11.1 The National Innovation System of Turkey

The main actors in the National Innovation System (NIS) of Turkey are the government bodies, business enterprises and federations, universities, and other important players, such as contract research centers, technology parks, incubators and private-providers of funding. As seen in Exhibit-1, the Turkish National Innovation System (NIS) comprises all important elements. However, considering the large size of the country, much more is being done by NIS to increase its scale of operation. The intensity and quality of linkages and cooperation between specific components (enterprise sector, universities, public bodies, etc.) are being

Exhibit - 1: Selected Key Organization Within the National Innovation System

Type of Organization	Name of Organization (in English)	Website (where available)
Government and legislative bodies		
Government body	Supreme Council of Science and Technology	
Public	Scientific and Research Council of Turkey	www.tubitak.gov.tr
Public	State Planning Organization	www.dpt.gov.tr
Public	Under-Secretariat of Turkey	www.treasury.gov.tr
Public	Under-Secretariat of Foreign Trade	www.dtm.gov.tr
Public	Ministry of Industry and Trade	www.sanavi.gov.tr
Public	Ministry of Finance	www.maliye.gov.tr
Public	Ministry of National Education	www.meb.gov.tr
Private-sector organizations and entrepreneurship promotion		
Public	KOSGEB's Entrepreneurship Development Centre	www.gge.kosgeb.gov.tr
Public and private	Technoparks and TEKMERs	
Knowledge institutes (R&D and education bodies)		
Public and private	Universities	www.yok.gov.tr
Public and private	University Research Centres	
Public	Public Research Institutes	
Industrial research centres and innovation intermediaries		
Public	Marmara Research Centre of TUBITAK	www.mam.gov.tr
Public	University-industry joint research centres (USAMs)	www.tideb.tubitak.gov.tr
Financial system		
Public	Technology and Innovation Support Programmes Directorate of TUBITAK	www.tideb.tubitak.gov.tr
Public	Small and Medium Industry Development Organization	www.kosgeb.gov.tr
Not-for-profit foundation	Technology Development Foundation of Turkey	www.ttgv.org.tv
Private	Venture capital companies and private equity funds	

strengthened further. This is all under implementation for Turkey to reach its ambitious goal of 'establishing a well-functioning National Innovation System with all institutions'.

11.2 Government and Legislative Bodies

Turkey has well structured government-institutions in the NIS at national level. There is need in the system to involve more regional bodies for policy-making and implementation.

The Supreme Council of Science and Technology (BTYK) is the highest-level policy co-ordination body for science, technology and innovation in Turkey. It is chaired by the Prime Minister and is composed of the related ministries, high-level representatives of the government-bodies, universities and NGOs. The Scientific and Technological Research Council (TUBITAK), which reports to the Prime Minister, is responsible for the design of S&T policy. TUBITAK acts as secretary to the BTYK. The State Planning Organization (DPT) is responsible for the design and implementation of the Five-Year Development Plans and other innovation-related policies and programs, such as the 'e-Transformation Turkey' project, and is, thus, another important actor of the NIS.

The providers of public funds for innovation (the Under-Secretariat of the Treasury (HM) and the Under-Secretariat of Foreign Trade (DTM)), coordinators of policy-implementation (Ministries of Industry and Trade (MoIT), Finance (MoF) and National Education (MoNE) and the Council of Higher Education (YOK)) are also major players at government level. Another component of the NIS is the Turkish Academy of Science (TUBA) affiliated to the Prime Minister's office. It is mainly in charge of co-operation with academia and the support of academic research. The Turkish Patent Institute (TPE), the National Metrology Institute (UME), the Turkish Accreditation Agency (TURKAK) and the Turkish Standards Institute (TSE), affiliated with MoIT, are the other public organizations of the NIS. The Competition Authority, the Telecommunications Authority and the Electricity Market Regulatory Authority are the most important regulatory bodies within the Turkish Innovation System. Another actor is the Turkish Statistical Institute (TURKSTAT), which is responsible for providing statistical information related to R&D, innovation and industry, among others.

11.3 Private-Sector Organizations and Promotion of Entrepreneurship

Private sector organizations are a significant component of the National Innovation System of Turkey. According to the provisional results of the '2002 General Census of Industry and Business Establishments', conducted by TURKSTAT, there were 1,720,598 enterprises, 14.35 percent of which were companies of the manufacturing industry. The industrial sector is dynamic and export-oriented. However, investment in R&D and innovation by the private-sector needs further improvement.

The Entrepreneurship Development Centre of the Small and Medium Size Industry Development Organization (KOSGEB) and the Entrepreneurship Development Centers, established under the South-East Anatolia Project (GAP-GIDEMs), are the most important organizations promoting entrepreneurship. The technology parks and incubators are also important in this respect. There are 20 techno-parks in the country, established by universities and research-centers. KOSGEB runs 16 incubators (called as Technology Development Centers, or TEKMER) in cooperation with technical universities and industrial chambers. Both techno-parks and TEKMERs help in closing the gap between the business-sector and the research-community. There are also private incubators, such as the Ericsson Mobility World and the Siemens Business Accelerator.

There are a few business networks and formal clustering activities for some pilot projects and a lot more is planned to be implemented in this regard. The 'sectoral foreign trade companies', established by DTM, which form networks of SMEs, and the facilities for common use of the private-sector, founded by KOSGEB with regional umbrella organizations (ORTKAs and ORTLABs), are the most significant establishments for this purpose.

11.4 Knowledge Institutes (R&D and Educational Bodies)

Universities are the main institutions providing key knowledge and skills for innovation. There are 77 universities in Turkey, which together account for 64.3 percent of Turkey's total R&D spending. 53 of these are public and the rest are private. Three-quarters of universities have technical faculties and research-centers that also provide R&D and innovation-related services to the industry. Two thirds (67 percent) of universities provide management-programmes and courses. There are 1,492 faculties, institutes, higher schools and vocational higher schools in the country. Lifelong-Learning Centers, which mainly belong to regional universities all over the country, provide short-term training and certificate programmes for participants from the business-sector.

Major universities have established centers to create and disseminate knowledge. Among them are the Competitiveness Forum of Sabanci University and Turkish Industrialists' and Businessmen's Association (TUSIAD), which also coordinates the National-Innovation Initiative, and the Research Centre for Science and Technology Policies of the Middle East Technical University.

There are more than 100 public research institutes, most of which are quite active in establishing linkages with the business-sector: about one dozen centers carry out extensive industrial R&D.

EU-Turkey Business Development Centers, located in three regions of the country, as well as 25 regional offices of KOSGEB, provide training and consultancy to SMEs. There are a large number of public, private and non-governmental organizations providing consultancy and training on innovation-related matters.

11.5 Industrial-Research Centers and Innovation-Intermediaries

TUBITAK's Marmara Research Centre (MAM) (COMSATS' Center of Excellence and amongst COMSATS' Network of 16 S&T Centers of Excellence) is the largest and the most active research-centre doing innovative R&D in Turkey. It also runs a technology-park for high-tech enterprises. TUBITAK has five more R&D institutes that are active in information-technologies and electronics, defence industries, cryptology, agro-technology and genetic research.

Cooperation between business and research-communities is becoming stronger in Turkey. As highlighted in the 'Country Economic Memorandum' published by the World Bank, the main factors needing improvement for research-industry collaboration, are:

- communication between research-institutions and firms needs more intermediaries (such as technology-transfer offices, technology-parks, and university-industry technology centers), facilitating exchanges between the industry and research-communities,
- more incentives required to stimulate collaboration between universities and enterprises,
- companies' perception about the quality of Turkish S&T institutions needs an uplift to increase their interest in collaborating with local Turkish scientists and researchers,

University-Industry Joint Research Centers of TUBITAK are the major institutions that help development of a climate which is conducive to co-operation. Private, semi-public and non-governmental organizations have become increasingly important bridging-institutions between the private and public-sectors as well as academia, and act as a voice for the private-sector. As the umbrella organization of the business-federations, the Union of Chambers and Commodity Exchanges of Turkey (TOBB) plays an important role in the Turkish National Innovation System. TOBB acts as the hub of a network that has been formed by most of the non-governmental organizations (NGOs) and industrial chambers. Chambers of Industry, located throughout Turkey, mainly provide and disseminate information to their members. They are active in matters relating to innovation.

11.6 Financial System for Turkish National Innovation System (NIS)

The main institutions financing innovation activities in the private-sector include, the Technology and Innovation Support Programmes Directorate of TUBITAK (TUBITAK-TEYDEB), the Small and Medium Size Industry Development Organization (KOSGEB) and the Technology Development Foundation of Turkey

(TTGV). TUBITAK and DPT also provide finance for R&D activities in universities and research-institutes. All of these institutions make special efforts to act as intermediaries between the Government and the industry. They also promote establishment of linkages between the business and research-communities for innovation-related activities.

The Capital Market Board (SPK) is responsible for the development and implementation of the regulations for venture-capital and private-equity, among others. Such financing-mechanisms need further development in Turkey. There are a few companies making private-equity/venture-capital investments with limited amount of funds, and there is also need for business angels' networks or intermediary organizations for matchmaking purposes.

The mechanisms and institutions supporting the commercialization of research-results and the start-up of innovative businesses are being increased. Halkbank is the major bank providing credits to SMEs and entrepreneurs. Other relevant financial institutions include, Turk Eximbank, the Development Bank of Turkey and the Industrial Development Bank of Turkey. The Credit Guarantee Fund (KfW), which was established in partnership with related institutions, including KOSGEB, TOBB and Halkbank, provides guarantees for SME loans to facilitate risk-sharing and lending activities of Turkish banks.

11.7 Conclusions: Successful National Innovation System (NIS) of Turkey

The main strength of the Turkish National Innovation System (NIS) is the existence and diversity of main players. R&D and innovation-oriented; the existence of a dynamic and export-oriented private-sector; active semi-public and non-governmental organizations, acting as an intermediary between the public and the private-sectors; widespread knowledge-institutes and the existence of an entrepreneurial culture, are particular strengths of the system. A more effective and systematic network of lines of communication between the players is being implemented. With respect to the flows in the NIS, there are effective mechanisms facilitating human resources and knowledge flows between universities, firms and research-centers. In addition, regulation flows from government-agencies to innovation-organizations and financial flows from the government to the private sector are sufficient.

12. CASE STUDY OF SOUTH KOREA

Over the past 40 years, South Korea has shown a remarkable economic growth with drastic changes in its National Innovation System (NIS). In this case study, Korea's National Innovation System is evaluated by analyzing R&D investment, manpower, technological achievement and the individual innovation actors. Korea's National Innovation System (KNIS) has successfully evolved through the Korean government's S&T policies. In the early stage of Korea's development, Korea's Government Research Institutes (KGRIs) led the development of Korea's science and technologies, but gradually the private companies began to take the leading role in the development. Recently, as the economy grew and industries were developed, the lack of basic technology became the weak point of Korea's NIS. Realizing this, the government again took new initiatives in basic S&T and selected ten strategic technology areas to prepare for the next 10 years. In addition, a new S&T administrative system was set up to coordinate the overall national S&T policy, investment and evaluation. The Korean case implies that the government of developing countries should make every effort to make appropriate NIS according to the development status of their own economy, society and culture.

12.1 Introduction

Korea does not have enough natural resources. In addition, it has experienced difficult times such as the Korean War and Japanese colonization. However, Korea has achieved high economic growth over the past four decades. The annual real GDP growth averaged 7 percent or more during 1962-1994 and exports have increased from 2 billion dollars in 1960 to 557 billion dollars in 1996. In 1997, with the Asian financial economic crisis, the GDP growth rate showed the first minus 6.7 percent. But the economy has recovered rapidly to the previous level (over US $10,000 of GDP per capita) till 2003. [1]

In 2003, Korea was ranked 37th in overall performance among 60 countries and regional economies with GDP per capita of 12,638 and total GDP $ 605.7 billion. The development of S&T is also remarkable. In 2004, Korea was ranked 1st in the information technology infrastructure such as broadband subscription rate and 3rd in S&T achievement index that indicates patent productivity and patents granted to residents. It was also ranked 8th in technological infrastructure competitiveness performance among 60 countries. [2]

12.2 South Korea's National Innovation System (KNIS)

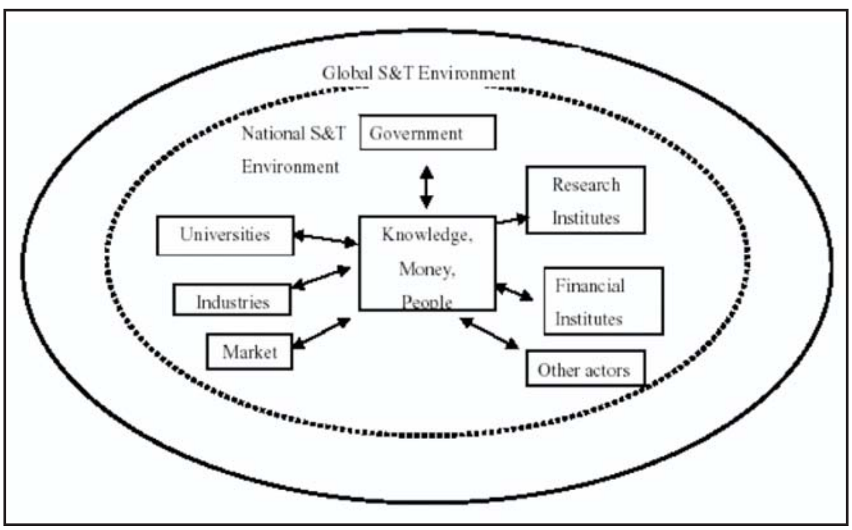
Korea is moving forward whilst other Asian countries are showing stagnant growth rate. Many researchers have pointed out Korea's strong NIS as the main factor. Private industries and Government-sponsored Research Institutes (GRIs) have also played critical roles in Korea's NIS.

In order to understand the development of Korea's National Innovation System (NIS), it is necessary to understand the basic socio-economic environment (Figure-4). Then, the NIS can be analyzed in the perspective of actors, input, throughput, output and policies (Figure-5). The role of the institutions and their relationship can be known well by analyzing the R&D expenditure. For instance, the amount of R&D expenditure by each organization and the flow of R&D expenditure show the characteristics of NIS. Then, the S&T manpower needs to be evaluated to understand the base of NIS. The final output can be measured in terms of economic growth, as well as specific technological achievements. The outstanding feature of the NIS concept is that it deals with the system itself rather than individual innovation players.

12.3 Innovation System and Knowledge Cluster

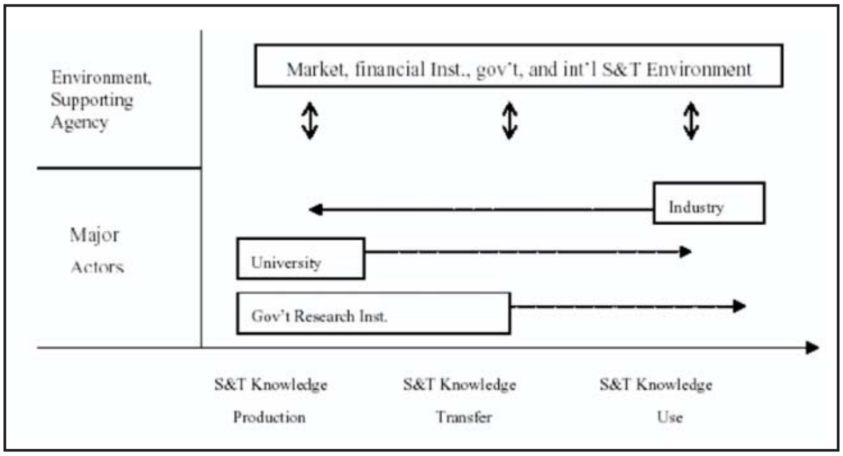
Science and technology policies have been evolving through the times. Nowadays, S&T is understood in the context of the innovation system, which means that there are many related players and the development and utilization of S&T take place through complex processes. The R&D does not lead to market automatically. To utilize the research results, we need organizations like technology-transfer center, venture capital, bank, managerial consulting company and entrepreneur.

In 1990s, the theory of National Innovation System (NIS) attracted the attention of many policy-makers. Globalization and regionalization of S&T has emerged as a big agenda in S&T policies as well. In addition, many people from various backgrounds started to study the innovation cluster. Saxenian (1994, 1999) analyzed the Silicon Valley and concluded that the culture and organizational network in the Silicon Valley



Source: *Science and Technology Policy Institute (STEPI), Seoul, Korea*

Figure - 4: Korean National Innovation System (KNIS)



Source: *Science and Technology Policy Institute (STEPI), Seoul, Korea*

Figure - 5: The Extended Roles of the Actors in Korean NIS

are the most important factors for its prosperity.

While the NIS model is a rather abstract concept, the innovation cluster model can give practical guidelines. Innovation takes place around a certain area under the interaction between market and innovation institutions. In this sense, innovation cluster is a reduced National Innovation System. The innovation cluster theory includes multi-disciplinary perspectives from sociology, economic geography, network theory, and industrial organization theory and it can be applied regardless of area. This systematic perspective implies that policy-makers should emphasize not only the quantitative aspect of S&T policy such as S&T investment and number of R&D personnel, but also the management of S&T resources.

The main elements in an innovation cluster are knowledge, money, and people. The main activities are knowledge creation, transferring and utilization in the market. For this purpose, all the innovation organizations interact with each other and exchange knowledge, financial and human resources. In traditional S&T policy, university is regarded as the institution that produces scientific knowledge only. However, there are many universities which also make some business out of their research. We can see that industry and GRIs also extend their roles. In addition, the financial institutes and consulting companies are critical agencies for R&D commercialization.

12.4 R&D Expenditure

Korea has been constantly increasing its R&D expenditure over the years. The total R&D expenditure in the field of science and technology for the year 2003 was 19,687.0

Table – 1: Total R&D Expenditure and Ratio to GDP

Year	R&D Expenditure (US$ Thousand)	Ratio to GDP (%)
1970	105	0.39
1975	427	0.42
1980	2,117	0.56
1985	11,552	1.52
1990	33,499	1.87
1994	100,098	2.44
1995	121,861	2.37
1996	128,857	2.42
1997	86,107	2.48
1998	93,862	2.34
1999	104,084	2.25
2000	109,935	2.39
2001	121,488	2.59
2002	144,328	2.53
2003	159,198	2.64[p)]

Note: [p)] *means provision*

Source: *Ministry of Science and Technology & Korea Institute of Science and Technology Evaluation and Planning 2004.*

Table – 2: R&D Expenditure in Major Countries

	R&D Expenditure (Million PPP Dollar)	R&D Expenditure (Unit: Korea=1)	Ratio to GDP (%)	R&D Expenditure per one person (PPP Dollar)
Korea (2003)	25,999.7	1.00	2.64	542.8
U.S.A. (2003)	284,584.3	10.95	2.62	964.0
Japan (2002)	106,538.2	4.11	3.12	838.4
Germany (2003)	54,283.6	2.09	2.50	657.8
France (2002)	36,618.0	1.41	2.20	598.0
U.K. (2002)	31,037.4	1.19	1.88	524.2
Finland (2002)	4,761.1	0.18	3.46	915.4
China (2002)	72,014.4	2.77	1.23	55.6

Source: *OECD, Main Science and Technology Indicators, 2004/1*

billion Won. R&D expenditure as a percentage of Gross Domestic Product (GDP) was 2.64 percent, which is an increase of 0.11 percent from the last year. As shown in Table-1, the R&D expenditure has been constantly increasing, and the ratio of the R&D expenditure to GDP has been continuously increasing as well. Table-2 shows, the R&D expenditure in Korea shows 1/10 of the U.S., 1/4 of Japan, 1/2 of Germany, but the ratio of R&D to GDP shows 2.64 percent, which is higher than other major countries.

12.5 The Flow of R&D Expenditure

Like many other countries, the major players are local governments, public research organizations, universities and industries. The government and the public sector provided 24.5 percent of the total R&D expenditure, whereas the private sector and foreign sector provided 75.1 percent and 0.4 percent respectively. It is interesting to see that the shares of government and public R&D expenditure in advanced countries were higher than that of Korea. The ratio of foreign source of funds in Korea was 0.4 percent that is lower than that of France (7.2%) and U.K. (20.5%) showing a similar percentage of R&D expenditure.

Public research institutes receive R&D funds mostly from the government and private companies manage their own. The universities receive some R&D funds from private sources. The R&D expenditure flow indicates that there is a relationship between private and public sectors and also with foreign countries. Especially the government-supported research institutes are less active in partnership with private sectors than the universities.

12.6 Total Number of R&D Personnel

In year 2003, 297,060 people engaged in R&D activities (researchers, research assistants, other supporting personnel) representing a 6.2 percent increase from the figure of previous year. Among the total research personnel, the number of researchers was 198,171 showing a 4.4 percent increase from the previous year. Accordingly, the number of researchers is 6.8 people per 1,000 total employments. [3]

12.7 Technological Achievements

The number of Korean patent registrations has grown rapidly in recent years. Korea was ranked 4th in the world in the number of patents and utility models applied in 1997, inventing 175,791 items that account for 3.7 percent of the world's total. In addition, the number of patents by Koreans is consistently increasing. In 2003, the patents by Koreans reached to 22,943 of all patents accounting for 65.6 percent. [4]

12.8 Establishment of Government Research Institutes

In early 1960s, Korea started its first modern R&D activity by establishing the Government Research Institutes (GRIs). From 1970s to 1980s, Korea had a remarkable growth in its GDP, which increased from 8 billion dollars in 1960s to 62 billion dollars in 1980 and 253 billion dollars in 1990. During that time, industries grew fast and increased their R&D investment with the establishment of their own R&D laboratories. Universities also began to play an essential role in providing high caliber human resources.

The government changed its research funding system from the lump-sum system to Project-Based System (PBS) in order to enhance research productivity in 1996. Before the introduction of PBS, manpower costs of GRIs were supported from the government budget. Under the PBS, GRIs have to charge the manpower cost to research projects and compete with universities and industries to get contracts. The PBS contributed to diffuse the competitive R&D funding system for creative researchers and the customer relationship and price concept in government R&D.

12.9 National R&D Program

The National R&D program was first initiated by the Ministry of Science and Technology in 1982. The program, which aims to strengthen technological capability and competitiveness, has made significant contributions to economic growth, as well as the improvement of the quality of life. Now, national R&D efforts are geared towards meeting the challenges in a move to a knowledge-based economy with a view to placing the nation among the ranks of the advanced economies by the early 2010s.

The current National R&D Programs include the 21st Century Frontier R&D Program, the Creative Research Initiative (CRI), the National Research Laboratory (NRL), the Biotechnology Development Program, the Nanotechnology Development Program, the Space and Aeronautics Program and so on. The 21st Century Frontier R&D Program was launched in 1999 to develop scientific and technological competitiveness in newly emerging areas. The government planned to invest a total of U.S. $ 3.5 billion over a period of ten years in this program that would comprise twenty-three projects in new frontier areas. Twenty-three projects have already been launched as of September 2003. [5]

In 1996, the government created the Korea Institute for Advanced Study (KIAS) as a worldclass institution for basic research. The Asia-Pacific Center for Theoretical Physics was also established in 1997 as a regional center for basic research. To facilitate basic research, the government also provided universities with modern research facilities through the Korea Basic Science Institute (KBSI), which maintain more than 300 sets of research equipment for joint use among universities. The Korean Advanced Institute of Science and Technology (KAIST) serves as a good model for the research-oriented university that Korea pursues. The Korean Government established KAIST in 1971, in order to generate world-top quality engineers.

12.10 The First Five-Year S&T Principal Plan

This plan made the framework for managing S&T development, including measures such as action plan for the S&T investment and national R&D, enhancement of public awareness of S&T, technical human resource development, promotion of technology-transfer, commercialization and globalization of S&T activities. This plan, which was finalized in December 2001, serves as the action plan for reaching the first stage of the development goal set in Vision 2025 and supplements the Five-year Plan for S&T Innovation.

12.11 The Long-term Vision for Science, Technology and Innovation Development

The major directions for S&T development set out in Vision 2025 include:

- Shift the national innovation system from government-led to private-led
- Improve the efficiency of national R&D investments
- Align the R&D system to global standards
- Meet the challenges and harvest the opportunities presented by new technologies

In an effort to realize the vision by the year 2025, the Korean government launched the 21st Century Frontier R&D Program and enacted the Science and Technology Framework Law that was put into effect in 1999. Based on this law, the government formulated the Five-Year Science and Technology Plan and National Technology Road Map.

12.12 Conclusion: Successful National Innovation System (NIS) of South Korea

This case study provides some lessons for other developing countries who want to enter the 21st century with S&T dignity and economic prosperity. A main strength of the KNIS is the strong commitment at the government level to promote scientific learning in its people. It is visible in the form of Government Research Institutes (GRIs), increasing R&D expenditure from Government, National R&D Program and Five-Yearly S&T Plans.

South Korea could be a role model for the developing world. Its successful NIS provides useful guidelines for ensuring the active role of all S&T players such as local governments, public research organizations, universities, industries and the private sector.

13. DISCUSSION

The developing world needs to realize the importance of innovation in order to achieve economic prosperity. Innovation through R&D plays a vital role in the process of knowledge-commercialization – the new global reality in economy and science – and, therefore, a sound policy of innovation and infrastructure is essential for developing countries to survive and thrive in the new millennium.

We have seen United States of America as an example of a developed country's innovation-system, the ideal role model for every country. Turkey's successful implementation of its NIS has been examined in detail also being the working role model for the rest of the fellow developing countries. South Korea has been studied in detail also in terms of its exponential growth in the sector of science and technology and innovation in the past decades. Korea is the most developed amongst the developing countries and, therefore, a beacon of lessons for other countries.

REFERENCES

1. Kim, L 2001, .Crisis, National Innovation, and Reform in South Korea ., Working Paper, MIT.s Center for International Studies. Available on-line http://web.mit.edu/mit-japan/www/Product/WP0101.pdf.
2. IMD (Institute of Management Development) 2003, World Competitiveness Report Lausanne, Switzerland
3. Bok. D. K., et al. 2002, "Development Strategy of Industry Cluster", Seoul: Samsung Economics Research Institute
4. Economy21 (Korean weekly magazine) 2004, 9, April
5. Hong, S. B, et al. 2001, Policy Research on Overseas Emerging Innovation Clusters and Global Open Strategy, Seoul: Science & Technology Policy Institute

BIBLIOGRAPHY

- Etzkowitz, Henry and Richard Spivack. 2001. "Information Infrastructure for Healthcare: An Evaluation of a Government-Industry Technology Development Initiative" Technology Analysis and Strategic Management, Vol. 13, No.4, December, 2001
- Etzkowitz, Henry, Magnus, Gulbrandsen and Janet, Levitt. 2001 Public Venture Capital: Government Funding Sources for Technology Entrepreneurs New York Aspen/Kluwer (2nd edition)
- Etzkowitz, Henry. 2002. MIT and the Rise of Entrepreneurial Science. London: Routledge
- Kenney, Martin ed. 2000. Understanding Silicon Valley: The Anatomy of an Entrepreneurial Region. Stanford: Stanford University Press See also Lee, Chong-Moo et.a;. eds. 2000. The Silicon Valley Edge: A Habitat for Innovation and Entrepreneurship. Stanford: Stanford University Press
- Kohler, Robert. 1991. Partners in Science: Foundations and Natural Scientists 1900-1945 Chicago: University of Chicago Press
- Servos, John 1990. Physical Chemistry from Ostwald to Pauling: The Making of a Science in America Princeton: Princeton University Press

- Smith, Michael.1983. “Selling the Moon: The U.S. Manned Space Program and the Triumph of Commodity Scientism.” In Fox, Richard and T.J. Lears eds. The Culture of Consumption: Critical Essays in American History. New York: Pantheon Books. See also McGrath, Patrick. 2002. Scientists, Business and the State, 1890-1960 Chapel Hill: University of North Carolina Press
- Wilson, John. 1985. The New Venturers: Inside the High-Stakes World of Venture Capital.Reading, MA: Addison Wesley

HEALTH AND ENVIRONMENTAL RISKS FROM POOR WATER-SUPPLY AND SANITATION IN DEVELOPING COUNTRIES - A CASE STUDY OF N.W.F.P., PAKISTAN

Bahadar Nawab
Assistant Professor, Department of Environmental Sciences
COMSATS Institute of Information Technology,
Abbottabad, N.W.F.P. - Pakistan
Email: bahadar@ciit.net.pk

ABSTRACT

Poor quality of water-supply and lack of improved sanitation are serious issues in many developing countries, particularly Pakistan. The ongoing efforts of escalating water-supply and sanitation-coverage might reduce the disease-burden on some people, but usually at the cost of ground and surface-water contamination due to pour-flush-pit latrines and flush-and-forget sanitation. This is evident from the fact that more than 95% of the wastewater in developing countries reaches to the surface or groundwater without any treatment.

A study was conducted by the authors that aimed to look into water-supply and sanitation issues from the perspective of relevant actors, local practices and personal observations. This Chapter highlights the learning made out of this study. Three villages in the rural North-West Frontier Province (N.W.F.P.) were selected for detail study. The study found that the so-called improved sanitation could not break the faecal-oral pathogen-cycle and there is an urgent need of innovation in the conventional sanitation systems. The water-supply and sanitation institutions are often weak and do not have the capability and intention to holistically address the issue. The policies and regulations are strong and fancy in papers, but could not match the ground realities. It is also not in line with the practices, perceptions, priorities and expectations of local people. There is a need that local people be heard and involved in devising water-supply and sanitation policies, and made solution together with them.

1. INTRODUCTION

In the context of combined effects of rapid population-growth, urbanization and quest for higher standards of living through overexploitation of natural resources, the quality of water-supply and improved sanitation has become a serious issue in many developing countries, particularly Pakistan. Access to safe-water and proper disposal of human excreta (improved sanitation) are basic needs and duly recognized human rights. All living beings strive to fulfil these needs one way or another.

The concern is therefore, not merely the access to water and excreta disposal, but rather the nature of access, safety and sustainability of services and at what cost and to whom (UN-Habitat 2003). The nature and quality of these parameters determine the quality of life of an individual, and status of society at large. Access to safe-water and proper disposal of human excreta has direct and indirect links with human-health (Wagner and Lanoix 1958). Water-supply and sanitation are no longer two different areas of work; rather these two are wedded together and have to be treated as such. Improving quality of drinking-water without improving sanitation and hygienic practices would have little or no positive impacts (cf. Vanderslice and Briscoe 1995; UN Millennium Project 2005). Also, the so-called clean water and disposal of excreta are not enough for disease-control, unless the pathogen-cycle is broken through wise management of water-supply and excreta (Langergrber and Muellegger 2005; Howard 2002). However, until now the main focus had been on water-supply and little attention has been given to sanitation in N.W.F.P., Pakistan.

Today, the water-supply and sanitation situation is so serious, especially in developing countries, particularly Pakistan, that it warrants collective efforts by international community and academia urgently. More than a billion people lack access to clean water and are forced either to fetch water from distance but often from unsafe sources, or buy it from vendors at a higher price. Similarly, more than two billion are without adequate sanitation and majority of them are either engaged in open defecation or other unhealthy modes of excreta disposal. The water-supply and sanitation services available to population also carry a big question-mark. A limited number of people in developing countries have both water-supply and sanitation-facilities in their premises; the majority of those receiving these services have either one or the other. In fact, the availability of water-supply, but not sanitation, may not necessarily represent an improvement of the situation, but instead a deterioration of it in terms of health. The poor water-supply and sanitation situation threatens economic development, healthy life, livelihood, quality of environment and host of other socio-cultural problems in most of the developing countries (Scott et al., 2004). Poor quality of water, sanitation and hygiene, account for almost two million deaths a year worldwide (UN Millennium Project 2005). Unsafe water, poor sanitation and hygiene, collectively, rank third among the top 20 factors that contribute to a high health-burden in a developing region, with only malnutrition and sexually transmitted diseases preceding them (WHO 2003).

Realizing this grave situation, various national and international efforts have been made during the last few decades to facilitate access to water-supply and sanitation in developing countries. The United Nations, for the first time, announced the 1980s as a decade of 'Clean Water and Sanitation for All'. The next major international development in the water-sector was the formulation of the Dublin principles*.

As a result of the above-stated efforts some progress in water-supply and sanitation-coverage has been made, but World Health Organization (WHO) found that despite international attention, water-related problems have worsened in many areas. The main reasons have been the adoption of wrong approaches and failure of government institutions (WHO 1986). Similarly, the Water Supply and Sanitation Collaborative Council (WSSCC 2004) reported that the UN's goal of 'Clean Water and Sanitation for All' came and went without bringing significant improvements to the lives of most of the world's poor. They found that the main reason behind this limited success appears not to be a lack of resources, but unwillingness to learn from past failures and adopt new approaches.

Recently, in 2002, in Johannesburg the UN has set a new goal of 'halving the proportion of people without safe-water and improved sanitation, by the year 2015'. To achieve this goal, different states and governments are making necessary institutional, financial and engineering arrangements to provide safe water and improved sanitation-facilities to their population. However, despite a lapse of six years, the progress especially on sanitation is much below the satisfactory level in many developing countries in Africa and Asia (UN Millennium Project 2005). In many countries the misperception among policy-makers still exists that technology and injection of more funds in water-supply and sanitation-sector will solve the problem. However, the fact remains that water-supply, sanitation and wastewater-treatment is less a technical and more an institutional, behavioral, cultural and economic issue (Kinly 1993; Appleton and Black 1990; Mara 2003).
Water-supply and sanitation are integrated and had profound impact on each other. Focusing either on water or sanitation alone, might not achieve the anticipated health and environmental benefits.

**Note: [In Dublin, Ireland, more than five hundred participants, including government-designated experts from about hundred countries and representatives of about eighty international, inter-governmental and non-governmental organizations attended the International Conference on Water and the Environment (ICWE), held in January 1992. The experts saw the picture of emerging global water resources as critical and adopted the following four principles.*

- *Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.*
- *Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.*
- *Women play a central part in the provision, management and safeguarding of water.*
- *Water has an economic value in all its competing uses and should be recognized as an economic good].*

Similarly, analyzing the issue of water-supply, sanitation and wastewater-handling, either from technical, socio-cultural or institutional aspects alone, could lead to over simplification of complex issues and misunderstanding of the critical phenomenon. Therefore, in this study water-supply, sanitation and wastewater-treatment are equally emphasized and is considered as one whole issue. Efforts are made to understand it through interdisciplinary perspective and integrated technical, socio-cultural and institutional arrangements, in order to develop appropriate technical solutions that would be acceptable to prevailing cultural practices in developing countries in general, and in Pakistan in particular.

Funding of conventional sanitation (e.g., water-based sanitation) and high-cost treatment-systems for wastewater (e.g., physical and chemical treatment systems) is often lost to other pressing social needs of the poor people. Therefore, alongwith technical factors, problems like affordability, skilled human resources, institutional abilities and community preferences in poor countries, are not in favor of conventional sanitation and treatment systems. Several researchers (see for example, Mara 2003; Loetscher and Keller 2002; Berndtsson and Hyvonen 2002; Mara 2001; Venhuizen 1997; Feacham et al., 1983) have found that water-borne sanitation may not be appropriate in water-scarce areas. They emphasize that bringing clean water through pipes and flushing it out onto the streets or through open drains with human excreta is neither logical nor wise.

The construction of highly technical solutions for sanitation is often politically motivated, costly and is less helpful in minimizing the sufferings of the poor. Many of the well-intended, conventional sanitation and wastewater-treatment facilities in Pakistan, for example, have had unintended environmental and social consequences. Instead of serving as sanitation facilities, they often become a nuisance and health-risk for the local dwellers. Conventional approaches have, thus, not been able to solve the problem of water-supply and sanitation, and in most cases it has further aggravated the issue. Similarly, the widely used pit-latrines have proven to represent a risk for groundwater contamination where the soil is permeable and the groundwater is shallow (Reed 1994; Dillon 1997; Gosselin et al., 1997). The new discourse of ecological sanitation, while addressing some of the technical and environmental aspects of water and sanitation, is also facing challenges. In its classical form, it may not be acceptable to some people, for example in certain Muslim communities, due to religious and cultural taboos. Choosing a technically innovative and culturally acceptable approach is fundamental in achieving the relevant UN goal. Therefore, solutions to large-scale implementation should be devised by combining technological and socio-cultural, as well as behavioral strategies to improve water-supply distribution and sanitation in the world (Middlestadt et al., 2001).

The issue of water and sanitation is sensitive and diverse. It involves people, cultural and religious values and taboos, formal and informal institutions and technologies. Understanding socio-cultural and institutional aspects linked to water, sanitation and wastewater, as well as integrating them with the available range of technical solutions is important and needs a gamut of efforts. In many cases the best solutions, in the eyes of the experts, are the worst options for the people. The best practice in one region may be rejected in another. So what is the core issue and sustainable solution for the water-supply and sanitation? What solutions will work best? Appropriate water-supply and sanitation methods that are inexpensive, easy to adopt and adapt, and which are culturally acceptable, need to be developed. So what will be the most efficient strategy for introducing innovative technology? How can the actors become involved in its development? What might the role of local institutions be in this process? How do the local men and women view the technical options in light of their economic and socio-cultural environment? Do we understand the attitude, behavior and perception of people with whom we will be working? Do they consider sanitation as a priority problem? Will they appreciate the solutions that will be suggested? Will the supply of safe water and sanitation-infrastructures improve their standards of living if their sanitation practices are not changed? This study attempts to understand and address some of the above-stated questions.

2. GEOGRAPHIC AREA OF THE STUDY

Pakistan has a population of over 160 million, 33% of which is living below the poverty-line, mostly in rural areas (Government of Pakistan 2006). The country has mostly an agro-based economy and 65.9 percent of the country's population live in rural areas, and is directly or indirectly linked with agriculture for their livelihoods. The literacy-rate in the country is estimated at 53% with considerable gaps across genders, provinces and the rural-urban divide.

Pakistan is a federation of four provinces and federally administered tribal areas and Azad Kashmir. Centralized decision-making as inherited by the colonials is still dominant. The distribution of function between the federal and provincial governments is governed by the 1973 constitution of Pakistan, however, most of the power lies with the federal government. The responsibilities of the provincial governments include the provision of services, including education and health; infrastructure, including roads, water-supply and sanitation; and, the maintenance of law and order. In turn, the provincial government has delegated or shared some of their functions with the local government, including provision of basic infrastructure, such as roads, water-supply and sanitation.

The case studies were conducted in North-West Frontier Province (NWFP) of Pakistan, which borders Afghanistan in the west, and is the smallest province of Pakistan in terms of area, covering 101,741 km^2. It has 24 districts and four provincially administered tribal areas. NWFP is one of the poorest provinces of Pakistan with an overall incidence of poverty at 44%, as compared to 33% for Pakistan. The total population of NWFP is about 20 million. Agriculture remains important source of livlihood throughout the province. The farm-area in NWFP is only 11.76% of the total farm-area in Pakistan. It has a high share of small-sized land holdings. Fifty-one percent of the province's total land still remains uncultivated. Wheat is the chief crop; barley, sugarcane, sugar beets, tobacco and fruit trees are also cultivated, as well as livestock is raised. About 17% of the total area of the province consists of forests.

More than 85% of population of NWFP is living in rural areas. The majority of the rural people are facing numerous problems, such as a high population-growth rate, a low level of agricultural productivity, a defective marketing system, illiteracy (particularly among women), and a lack of basic needs and infrastructures, including safe water and sanitation. The socio-cultural contexts within NWFP are diverse. The province, which is regarded as the Western border of the subcontinent, was the traditional trade-route from Central Asia to India. Ethnically, the people belong to different tribes. Numerous languages are spoken throughout the province, as a whole, the predominant language is Pushto and ethnic group is called 'Pashtuns'. The majority of the people in this province have relatively strong religious and cultural values, as well as strong traditional institutions for handling routine matters and conflicts.

In most villages, an elders' assembly governs common resources, including water-supply and sanitation services. The assembly is composed of heads of households or representatives from sub-clans that have been assigned decision-making authority in the village. Rural people in the NWFP consider water as a gift of God and hold the government responsible for the supply of clean water, free of charge, to all inhabitants. They argue that Islam indicates the responsibility of the government to secure basic needs of people, such as water.

The three sites for case studies (i.e. Takht-e-Nasrati, Kot and Machaki), are located in different parts of the NWFP (Figure - 1), have many features in common. For example, people in the selected study-sites are religiously conservative, and the society is male-dominated. Daily life is more driven by tradition, prevailing culture and religion, than by the state law. In the villages, collective decisions are usually made by assembly of the village-elders in the Hujra (large assembly halls) or the Mosque. Disputes are usually settled in the 'Jirga' (court of the community elders) . Hujra, Mosque and Jirga are the three strong institutions in the study-areas, however, all are 'male-institutions' and women are forbidden, both religiously and socially, from participating in them. The male community spends its free time entertaining guests and sharing daily matters with other villagers in the Hujra. Mosques are used for praying and discussing religious and other common matters of the villages. Religious scholars and the Imam (religious leader) of the Mosque are well respected, and people are willing to listen to them. Women's activities are mostly restricted to the boundaries of their homes, where they mostly have a reproductive role, which includes child-nurturing, food preparation and cleanliness-related activities. They have little or indirect say in decision-making in daily matters, outside the home – atleast publicly. However, some women do help the male members of the household with outside activities, like in the collection of fodder and smallholding farming. NGOs are usually not socially accepted, since people are suspicious of their motives and possible hidden agenda. In rural areas, majority of the villages have mud-houses and the rest are either made of bricks or stones. Houses are mostly adjoining each other and in many cases neighbors have shared walls of houses. The villagers are usually disposing their greywater in the common street.

3. RESEARCH APPROACH AND METHODOLOGY

One option for conducting this research-study was to have an in-depth understanding of one aspect of water, sanitation and wastewater-handling. This is the approach that is

Figure – 1: Map Showing the Case Study Villages in N.W.F.P., Pakistan

most common in research on water and sanitation. Another option, however, was to see water-supply and sanitation as an integrated issue and understand it from a different perspective. The latter option was chosen due to two main reasons. First: Pakistan needs the understanding of this problem holistically, rather than having in-depth knowledge of any one aspect. Little research work has been done in this sector, with most of it emphasizing the engineering rather than the socio-cultural aspects of water and sanitation. The country still lacks the necessary primary data and best rural sanitation-practices needed for furthering an in-depth, interdisciplinary analysis of the issue, in order to improve both policy and practice. Second: The personal experience shows that water and sanitation is a sensitive issue involving taboo, beliefs, behavior and personal motivation. These are difficult topics to study, however, unless all these socio-cultural and religious aspects are understood and integrated with technical and institutional measures, the net outcome of any intervention may not be so promising. Thus, it is hoped this interdisciplinary approach will contribute to a better understanding of water and sanitation issues in developing countries like Pakistan.

Both qualitative and quantitative research-approach were used interchangeably. Information about the daily practices of water-supply, sanitation and wastewater-handling were collected from three rural villages (i.e., Takht-e-Nasrati, Kot and Machaki) in NWFP. Local people and the perceptions of others actors were obtained through open-ended interviews, group discussions, surveys and personal observations.

4. WATER-SUPPLY AND SANITATION CHALLENGES

The Constitution of Pakistan in its Article 38, titled "promotion of social and economic well being of the people", ensures the provision of basic necessities of life, including safe-water and sanitation for all citizens. Unfortunately, availability of water in Pakistan continues to become scarce, both in total amount of water, as well as in per capita water-availability. Although the fact remains that lack of access to safe water and improved sanitation is central to all problems. In 1951, when the population stood at 34 million, per capita availability of water was 5,300 cubic meters, which has now decreased to 1,105 cubic meter (Government of Pakistan 2003). The most pressing challenge in Pakistan is, therefore, management of the rapidly increasing population and provision of basic amenities. The increasing population will have a major and serious impact on water and sanitation requirements, as well as food and power, in the future.

Groundwater is the major source of drinking-water in Pakistan. About 53% of the rural population has access to drinking water from public water-supply sources. The remaining population gets their drinking-water supply from streams, canals, ponds or springs, etc, which is untreated and mostly unsafe for human consumption (ibid). Also majority of the government's water-supply are bacteriologically and chemically contaminated, and does not meet the WHO standard (Government of Pakistan 2001).

According to an integrated household-survey, conducted by the government of Pakistan in 2001, some 66% of the rural households do not have any form of sanitation system – means of draining household wastewater. As a whole, 43 percent households do not have any toilet. This varies greatly between urban and rural areas. Only 5% of urban households have no toilet, whereas the percentage in rural area is 59% (Government of Pakistan 2001).

The statistics concerning the size of the population having water-supply and sanitation-coverage also carries a big question-mark. Various government and international agencies claim different water and sanitation-coverage, which blurs the ground situation. For example, the government claims 86% water and 57% sanitation-coverage (ibid), whereas the UN report claim 56% water and 24% sanitation-coverage in Pakistan (United Nations 2002). In many rural areas, poor people rely on ponds and irrigation-channels for domestic water that are also used for waste disposal. The quality of water-supplied to consumers is commonly poor as a result of contamination from leaky water-pipes passing through sewage drains. The combined effect of poor quality water, poor sanitation and lack of wastewater-treatment, brings Pakistan 2nd among 31 Asian countries on account of number of annual diarrhoeal episodes among children. Diarrhea causes 250,000 deaths (Government of Pakistan and UNICEF 1996) and 47.5 million disability-adjusted life-years (DALYs) annually in Pakistan (Government of Pakistan 2003).

Infrastructure for wastewater-disposal, including the few existing sewage treatment facilities, are largely non-operational. Half the wastewater in urban areas of Pakistan is disposed of through underground or covered-drains (Government of Pakistan 2002a). The remaining sewage is disposed of through open drains or directly onto roadsides or waterways. In the informal settlements, (or Katchi Abadies), where people are relatively poor, practically all the wastewater is disposed of through open unlined drains, if any. The total annual quantity of wastewater, produced in Pakistan, is 4,369 million m^3, 70 % of which is municipal and 30 % is industrial waste (Government of Pakistan 2002b). The total wastewater-discharged to the major rivers is 1,782 million m^3, i.e. 1/3rd of all wastewater. A huge amount of wastewater is used for irrigation purposes. Municipal wastewater is normally not treated and none of the cities have any biological-treatment process except Islamabad and Karachi, and even these cities only partially treat a small proportion of their wastewater before disposal. It is estimated that only about 1% of municipal wastewater is treated before disposal.

Disposal of untreated industrial and municipal wastewater has become one of the largest environmental and health-risk problems in Pakistan.

The investigational study conducted by Pakistan Council of Research in Water Resources (PCRWR 2001) indicated that water in many cities of Pakistan is unsafe for human-consumption, due to both bacterial and chemical contamination. Poor microbial quality of drinking-water supplies is by far the dominant water-quality issue for health in Pakistan. Many drinking-water treatment-plants do not observe basic procedures to ensure quality of water. It is estimated that 90% of the country's population is exposed to unsafe drinking water. Poor people are suffering more and the elite depend heavily on the use of costly bottled water. So far the country has not developed a proper drinking-water quality-monitoring system. The institutions responsible for water-quality monitoring, like Public Health Engineering Department and Municipal Corporation, maintain that there is not much point in monitoring the water-quality, when alternative sources of supply simply do not exist.

In NWFP, the accessibility to drinking-water has significantly improved in the past two decades after installation of large number of tube-wells, especially in the dry southern part of the province. The government and civil society are creating awareness to this issue. However, in spite of this progress, only 40% of the housing-units in NWFP have piped-water (urban 65%, rural 38%) and 63% population has access to safe water (Government of NWFP 2002). The government's current delivery-practices are not satisfactory. In some parts of NWFP, the poor have to choose between traveling for several kilometers to fetch water on their heads, on donkeys or camels, or using pond-water, where sometime men and animals take their bath and defecate. Another option is to buy water from the vendor, which costs more to the poor than the rich, who are getting comparatively clean water in the pipes, free of charge.

Hygienic sanitation, defined by WHO as 'the means of collecting and disposing of excreta and community liquid-waste in a hygienic way so as not to endanger the health of individuals or the community as a whole', is rarely observed in any part of the NWFP, be it urban or rural areas. Even Peshawar city, the provincial metropolitan, does not have proper sanitation facilities, since the open drains discharge wastewater into the nearby surface-water. In rural areas, people are presently left with three major options; a) open-field defecation, b) flush the excreta and other household wastewater into the street drain, and, c) dispose human-excreta into pits inside their homes.

Sanitation facilities, compared to drinking water, have gone from bad to worse since the services are not at pace with population growth. However, government's statistics show that 39% of the population lives in households with sanitary means for excreta-disposal, out of which 10% use flush-toilets, connected to sewerage systems, 15% use septic tanks, 10% use pit-latrine with flushing, and 4% use dry-pit latrine, with urban and rural ratio of 75% vs. 33% (Government of NWFP 2002). In the rural areas, what is called 'improved sanitation' is almost non-existent, despite the government's claim of 39% coverage. In practical terms, government's sanitation-coverage means paving the streets and making small open drains in it for household wastewater and rainwater-disposal. Being open, these drains are usually blocked with plastic, sand and solid-waste. Human faeces enter these drains frequently, as residents sometimes discharge their excreta directly to the street drains. Water-supply and sanitation are, thus, not given equal importance; water is the first priority of both government and civil society.

5. WATER-SUPPLY AND SANITATION INSTITUTIONS

Before the devolution process in Pakistan in 2001, rural water-supply and sanitation was the sole responsibility of the Public Health Engineering Department (PHED). The organizational hierarchy was a provincial headoffice, divisional offices (5) and district offices (24). In cities, water-supply and sanitation services were the responsibility of Municipal Corporations (MC). Almost the same organizational set up still exists but now due to the local government ordinance, i.e., devolution of power, the two organizations (PHED and MC) are legally under the control of local government, called Tehsil Municipal Administration (TMA) (Government of Pakistan, 2002). The devolution system closed down the divisional offices and devolved power to the district and tehsil governments. The new system establishes elected local governments at the union council, tehsil, town, district and city district levels. All the service-delivery related government-departments have been placed under the control of the respective district coordination officers. The elected district Nazim (administrator) provides the vision for development and with the assistance of district officers, develops strategies and plans for the development of the district. Tehsil Nazim has a similar corresponding role in the tehsil. The Union Council is mainly responsible for provision of, and improvement in, the delivery of services at the local level. The PHED has been decentralized and placed under the respective district coordination officers. The local governments and rural development department, which also provides water-supply and sanitation services to rural areas, have also been decentralized (see organograme of PHED before and after the devolution i.e., Figure-2).

However, so far the devolution has not been fully and practically implemented. The local institutions are still far from autonomy and are ineffective. They depend upon the provincial governments for the bulk of their finances and other administrative matters, and hardly exercise power to make policies, regulations and its implementation. Therefore, the major constraints in the water and sanitation-sector in Pakistan, particularly in N.W.F.P., are due to weak political, institutional and structural arrangements. The government itself confesses that institutionally, there is lack of

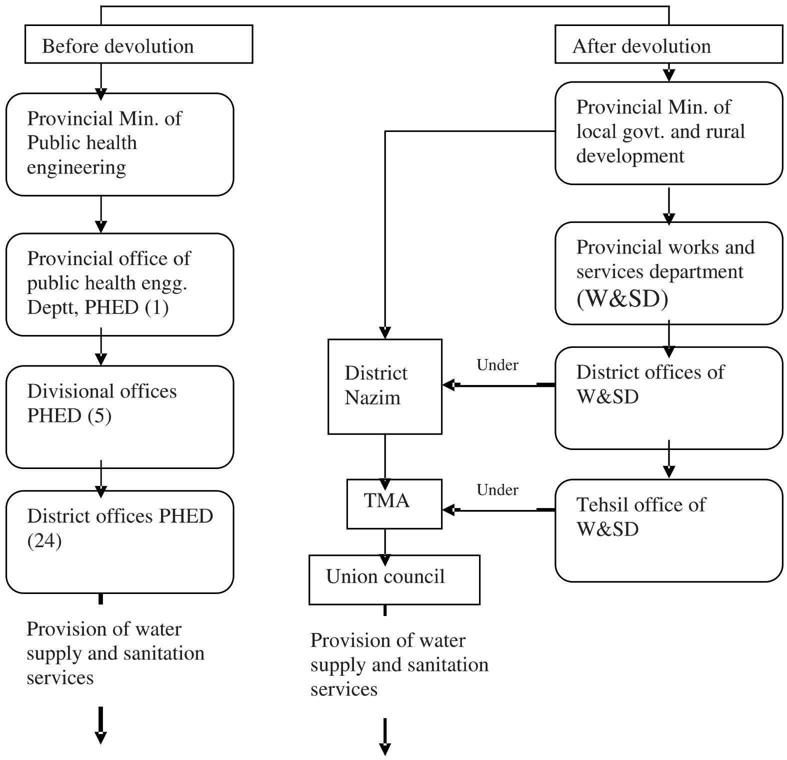


Figure – 2: Organogram of Rural Water-Supply and Sanitation-Services Department (PHED)

clarity regarding functions and responsibilities of national, provincial and local governments, and institutions concerned with water-supply and sanitation-planning, implementation and law-enforcement, as well as ambiguity, regarding roles of the community (Government of Pakistan 2001). At the federal and provincial levels, several ministries and departments deal with water and sanitation with no clear definition of roles, responsibilities and coordination.

6. CURRENT WATER-SUPPLY AND SANITATION INITIATIVES AND FUTURE PLANS

Inspite of all these shortcomings, stated earlier, the government of Pakistan is committed to supply safe-drinking water to the people and many initiatives are underway and planned. The government has drafted drinking-water and sanitation-policies, and proposed the revival of relevant managerial, institutional and legal issues, so as to ensure adequate quantity and quality of water and improved sanitation (Government of Pakistan, 2004). Plans are underway to provide 93 percent of the population with access to clean-drinking water, and 90 percent of the population with access to sanitation by 2015. The challenge, however, lies in keeping pace with the burgeoning population growth. An increase in population, rapid urbanization, and improved socio-economic conditions, will need a much greater quantity of clean water. The demand will increase from the present 6 million to 13 million cubic-meter water by the year 2025, as well as need for improved sanitation and the corresponding increase in wastewater (Government of Pakistan 2002b).

The Government of Pakistan committed “clean drinking water for all” by 2007. This was a three-year federal government programme, costing PKRs 10 billion. Under this programme, 6,035 water-purification plants of different capacities (500/ 1000/ 2000 gallons/ hour) were supposed to be installed, one in each union council of Pakistan (Government of Pakistan 2006). For this purpose the government also ran a big media campaign. The project is still working, but it did not meet the expectations and proved less beneficial to the common man. As against the commitment, water-supply and sanitation is still a big issue in Pakistan.

Similarly inspite of the efforts of Government of NWFP, the conventional, technologically-driven and top-down approaches, towards problem-solving in the water-supply and sanitation-sector, seem ineffective. This is evident from the fact that with an annual investment of around Rs. 800 million, only 63% household in NWFP are claimed to have access to clean water (Government of NWFP 2003). The quality of water, supplied to consumers, is commonly poor as a result of contamination from sewage-drains to a leaky network of water-supply pipes that is frequently non-pressurized. In many rural areas, poor people rely on ponds and irrigation-canals for domestic water that are also used for waste disposal. In water-rich areas, the contamination of groundwater from the commonly practiced drop-and-store sanitation method is another health-risk. Infrastructure for wastewater-disposal and the few existing sewage-treatment facilities are largely non-operational. For example, Peshawar Development Authority designed and constructed a sewage-treatment plant for a newly built Hayatabad township, which did not have enough capacity to provide primary treatment to the municipal wastewater of the planned township. The treatment-plant was a health hazard and a continuous source of odour, and hence was closed due to public pressure. Three other sewage wastewater-treatment plants, funded by the Asian Development Bank and constructed under the Second Urban Development Project (SUDP) in 1997 in Bannu, Kohat, and Peshawar, are only partially functioning, as less than 10% of the total wastewater produced in these cities reaches the treatment-plants. The rest is mostly used for irrigation and/or finds its way to surface and ground-water recipients. The reason for low success-rate of conventional technical solutions is that they are imposed by expert engineers and do not match the prevailing socio-cultural preferences among people.

Apart from the above-mentioned facts, in a country where one-third of the population, or 45 million people, do not have enough to eat (Food Aid Programme 2004), the need for investment in all sectors of society (schools, hospitals, infrastructure, etc.) is immense. Funding of conventional sanitation and high-cost treatment-plants for wastewater is often lost to other pressing social needs. Therefore, along with technical factors, problems like affordability, environmental issues, institutional abilities and community preferences in poor countries, are not in favour of conventional treatment-systems (see Mara 2003; Loetscher and Keller 2002; Berndtsson and Hyvonen 2002; Mara 2001; Venhuizen 1997; Feacham et al., 1983).

Arrangements for technical solutions to water-supply and sanitation will probably not work on their own in NWFP, since water-supply and sanitation institutions are weak. The shortage of staff of institutions is generally inadequate and funding is insufficient for implementing modern technologies. Therefore, the problem has to be looked at from interdisciplinary perspective, by combining technical and socio-cultural approaches.

The government, although having no realistic drinking-water and sanitation-policy, is the sole owner of water-supply and sanitation infrastructure. They decide when, where, to whom and at what cost to supply drinking-water and provide sanitation-facilities. The government has adopted a piecemeal approach of water-supply here; sanitation there and the two are not integrated. People feel that governmental decisions are more bureaucratically and politically influenced rather than need-based. Therefore, the community is often reluctant to participate in the government's water-supply and sanitation-projects. People consider that water is a gift from the God and consider the government responsible for its free provision. They expect all basic services, including water and sanitation to be provided by the government, and usually accept no responsibility to them. The majority of people hate NGOs and feels hesitant to work with them. Due to cultural and religious barriers, women have little voice in the society of NWFP and hence, in the decisions about water-supply and sanitation.

7. CONCLUSIONS

The study was undertaken with the objective to provide knowledge about appropriate technical options, socio-cultural preferences and realistic policy for sanitation and wastewater-treatment, needed to reach the UN Millennium goal, concerning safe water and sanitation in NWFP, Pakistan. The study brings tangible knowledge on rural peoples' water-supply and sanitation-practices, the drawbacks and potential health-risks associated with those practices. Rural peoples' perceptions and needs concerning water-supply and sanitation, their expectations from the government and their own responsibilities were highlighted in this study. The historical, current and proposed policies, approaches and interventions of the government were also presented. The study shows that due to inappropriate management, on the part of service-delivery authorities, as well as, local people, most of the current water-supply and sanitation-facilities have turned into health-risks, without local people sometimes realizing this and its consequences. The government on the other hand, seems less concerned with the quality of services, and most of their policies and approaches are often inappropriate in achieving the targets and goals.

The Government of Pakistan has realised the seriousness of the water-supply and sanitation-situation in the country. The press and electronic media are almost daily highlighting the prevalence of contaminated drinking-water and poor sanitation and the associated health-risk. The government is also facing enormous internal pressure and is a signatory to the UN Millennium Development goals. Therefore, the federal government has formulated separate water-supply and sanitation-policies. The proposed policies are products of national consultants, relevant experts and inputs from series of national and regional workshops and seminars. However, those policies seem good on paper, but they do not contain the opinions and perceptions of the community at grass-root level. The policies do not match with daily life practices, needs, desires and expectations of the local people as it was found in the subject villages and with other concerned actors. Instead, in many ways, these are in conflict with the local practices of water-supply and sanitation. The majority of the local people, have no idea about the concerned policies and plans and mostly they read and listen from media about the government's ambitious plans and mega projects. Therefore, it is most likely that local people will not accept or even may reject the proposed solutions once they find them clashing with their prevailing culture and behaviour. Many policy-implementers and local actors believe that the government is focusing more on framing policy and legislation, but has little resources, motivation and skills for its implementation. Most people in rural areas feel easy with traditional institutions and instead of relying only on regulative instruments; cognitive and normative instruments might be more effective in organizing and motivating local people and taking them on board for joint efforts of improving water-supply and sanitation and reducing health-risk. Therefore, policy and decision-makers need to understand past practices and the reasons for their failure, and make institutional and instrumental changes, in line with the local socio-cultural values and context.

The study indicates that access to safe water and dignified and safe disposal of excreta needs resources, technology, efficient institutions and good intentions of the services-facilitator/provider, as well as community willingness for participation. All these factors, collectively ensure safe and reliable services. Promoting one factor and ignoring another might not only negatively affect efficient service-delivery, but could further complicate the issue. For example considering water-supply and sanitation a mere technical issue ignores the complex social aspects around it. So far, provision of water-supply and sanitation-service in Pakistan has been mostly technology-driven. Innovative water-supply and sanitation-technology can definitely solve much of the problem. However, the study found that unless there are strong and legitimate institutional arrangements for execution and maintenance of technology, and the intervention is according to the needs and expectations of local people and their prevailing culture, the well-intended service could turn into a major mess. The technocratic facilitation of services not in-line with the local culture often becomes less successful and/or sometimes even a failure. This study, therefore, warrants that instead of picking one specific aspect of water-supply and sanitation, planners and policy-makers are required to adopt a holistic approach by focusing on the multifaceted and complex nature of technology, institutions, actors and culture.

REFERENCES

- Appleton, B. & Black, M., 1990. The decade flows on. New Internationalist, p.207.
- Berndtsson, J.C. & Hyvonen, I., 2002. Are there sustainable alternatives to water based sanitation system? Practical illustrations and policy issues. Water policy 4, p.515-530.
- Dillon, P., 1997. Groundwater pollution by sanitation on tropical islands. International hydrological programme, UNESCO, IHP-V project 6-1 Paris.
- Feachem, R.G. Bradley, D.J. Garelick, H. & Mara, D. D., 1983. Sanitation and disease: Health aspect of excreta and wastewater management. World Bank studies on water supply and sanitation. Chichester: John Wiley & Sons.
- Food Aid Programme, 2004. Pakistan country reports, Food Aid Programme
- Gosselin, D.C. Headrick, J. Trembly, R. Chen, X.H. Summerside, S., 1997. Domestic well water quality in rural Nebraska: Focus on nitrate-nitrogen, pesticides, and coliform bacteria, groundwater monit. Rem., 17 (2), p.77-87.
- Government of NWFP, 2002. Multiple indicator cluster survey, jointly conducted by ministry of local government and rural development and UNICEF.
- Government of NWFP, 2003. Provincial budget book 2003-2004, Government of NWFP, Pakistan
- Government of Pakistan, 2001. Ten years perspective development plan (2001-11), Planning division, government of Pakistan.
- Government of Pakistan, 2002a. Pakistan integrated household survey (PIHS), federal bureau of statistics, Government of Pakistan, Islamabad.
- Government of Pakistan, 2002b. Pakistan Water Sector Strategy. Currently available at http://www.waterinfo.net.pk/pwss/vol5c.htm
- Government of Pakistan, 2003. sanitation and hygiene in Pakistan. Pakistan country paper on water and sanitation presented in South Asian Conference on Sanitation, 21st –23rd October, Dhaka.
- Government of Pakistan, 2004. Pakistan water policy, water and power

development authority, Government of Pakistan.

- Government of Pakistan, 2006. Economic survey of Pakistan, Ministry of finance, Government of Pakistan.
- Howard, G., 2002. Healthy villages- a guide for communities and community health workers. Geneva, Switzerland.
- Kinley D., 1993. Running just to stay in place. In Choices (Edited by UNDP), p.25-29, December.
- Langergraber, G. & Muellegger, E., 2005. Ecological Sanitation—a way to solve global sanitation problems? Environment International, 31(3), p.433-444.
- Loetscher, T. & Keller, J., 2002. A decision support system for selecting sanitation systems in developing countries. Socio-economic Planning Sciences 36, p.267-290.
- Mara, D., 2001. Appropriate wastewater collection, treatment and reuse in developing countries. Proc. Inst. Civil Engineers - Municipal Engineer. 145(4): p.299-303.
- Mara, D., 2003. Water, sanitation and hygiene for the health of developing nations. Public health, 117, p.452-456.
- Middlestadt, S. Grieser, M. Herna`ndez, O. Tubaishat, K. Sanchack, J. Southwell, B. & Schwartz, R., 2001. Turning minds on and fucets off: Water conservation education in Jordanian schools. Journal of environmental education, 23, p.37-45
- PCRWR, 2001. Quality analysis of bottled mineral water. Ministry of Science and Technology report, Islamabad, Government of Pakistan.
- Reed, R., 1994. Why pit latrines fail: some environmental factors. Waterlines 13, p.5–7
- Scott, C.A., Faruqui, N.I., Raschid-Sally, L. 2004. Wastewater use in irrigated agriculture: confronting the livelihood and environmental realities. CAB International, Wallingford, UK.
- UN Millennium Project, 2005. Health, dignity, and development: what will it take. UN Millennium Project task Force on Water and Sanitation, Washington D.C.
- UN-habitat, United Nations Human Settlements Programme, 2003. The challenge of slums-Global report on human settlements. Earthscan Publications London.
- United Nations, 2002. United Nations reports on water supply and sanitations in Pakistan.
- Vanderslice, J. Briscoe, J., 1995. Environmental intervention in developing countries: interaction and their implications. Am. J. Epidemiol. 141 (2):p.135-144.
- Venhuizen, D., 1997. The decentralized concept of wastewater management. US EPA National Small Flows, fall 1997. Clearinghouse quarterly publication, USA. Currently available at http://www.geocities.com/RainForest/Vines/5240/Venh_decentralized_WW.htm.
- Wagner, E.G. Lanoix, J.N., 1958. Excreta disposal for rural areas and small communities. World Health Organization, Geneva. Washington, DC.
- WHO, 1996. Water supply and sanitation sector monitoring report 1996 (Sector

Status as of 1994). Water Supply and Sanitation Collaborative Council and the United Nations Children's Fund, UNICEF, New York.

- WHO, 2003. Quantifying selected major risks to health. The World Health Report 2002. World Health Organization, Geneva (Chapter 4).
- WSSCC, 2004. Listening, Water Sanitation Hygiene (WASH), Water supply and sanitation collaborative council (WSSCC), Geneva.

SECTION - D

EPILOGUE AND INDICES

EPILOGUE

Socio-economic development in the poor countries is a complex phenomenon and it becomes more intricate when the country is facing challenges of political instability or of internal and external conflicts. Policies and strategies for any development-plan have a key role in determining its success or failure. The picture becomes further complicated when the concept of sustainable development becomes the part of the equation. World initiatives of socio-economic development, like MDGs, are not yielding the expected results so far due to overambitious and in many ways unworkable policies and strategies. This has created disillusionment among a large number of developing countries who were supposed to be the primary beneficiaries of the MDGs. Is it time to take another look at the policies and strategies being pursued for the last several years? The answer will depend upon the sagacity and vision of the advanced and the developing countries together, bearing in mind that the target date of stock taking is not too far, only seven years away.

The potential contributions of science and technology to the sustainable socio-economic uplift of the developing countries is as important as it is for the developed ones. The developing countries have not yet fully realized the importance of this fact and have suffered a great deal in the past. It will be unfortunate if they remain adherent to this mindset in the future as well. This is the most difficult barrier that the developing countries have to cross, i.e., give adequate place to science and technology in their future policy considerations aimed at sustainable socio-economic development. The present book has provided several encouraging ideas for the policy-makers in the developing countries to cross the aforestated barrier and be fully sensitized to the imperativeness of the inclusion of science and technology in their policy-making processes. Mobilizing science and technology for sustainable development in the developing societies, building-up of a scientific culture and educating the societies on the potentials of information and communication technologies should form the developing society's base, in order to set foot on the road to sustainable socio-economic uplift.

It is usually not easy for the developing countries to formulate appropriate policies and strategies to solve their complex socio-economic problems. The major cause is the lack of capacities and competencies. One cannot imitate the policies and strategies of the successful societies per se, as each developing country has its own specific pattern of socio-economic problems. Sound education and expertise are pre-requisites for transforming the knowledge of other societies to suit the exact requirements of another country. Capacity building and competency enhancement through international cooperation are necessary to achieve such prerequisites.

Policies and strategies must not be intermingled with each other. Policy leads towards objectives or targets which, in turn, are linked to the strategies for their successful achievement. Strategies provide enabling schemes for the fulfillment of a policy and the objectives. Thus the policies and objectives constitute what is called the design of a project, whereas the strategies will be linked to the implementation or execution of that project. As the projects are major tools in the process of achieving socio-economic progress, they must be handled carefully with full clarity of policies, objectives and strategies. The role of expert management-personnel is of crucial significance in the successful handling of the socio-economic developmental projects. Excellent information, based on the practical experience for project collaboration, as provided in one of the relevant Articles in this book, leads to the conclusion that developing countries can indeed learn a lot from the developed countries so as to manage a successful project on socio-economic development carrying a sizeable chunk of science and technology.

As mentioned earlier, the much sought after MDG's are of major concern to a large majority of the developing world. Some important arguments have been built in the present book on the role of biotechnology and genetic engineering to serve the cause of several MDG's. These specific applications of S&T are expected to emerge as major fields of further research during the 21st century. If these segments of science and technology, alongwith some others, are appropriately included in the policies and strategies of the developing countries, they can bring significant change in the poor societies by reducing poverty, hunger, disease and the devastating impacts due to the environmental degradation. Moreover, health and environmental risks from poor water-supply and sanitation are also discussed thoroughly in the overall context of S&T linked parameters, which should constitute an important part of policies and strategies aimed at sustainable socio-economic betterment of the populations of developing countries.

Case studies are always useful to clearly understand the intricacies of any complex project and its execution, and especially for the policies and strategies, which are inherently linked to these projects or programmes. How others have successfully formulated and executed such policies and strategies provides a useful input in the thinking process of other decision-makers. Although it is not advisable for the developing countries to blindly follow the examples of others, it is often useful that lessons learned in such examples are kept in mind while contemplating a country's own set of policies and strategies. In the present discourse a good deal of discussion on three economies at various stages of development, i.e., USA, South Korea and Turkey, has been provided. This conveys clear message that sound S&T policies and innovation does lead to socio-economic development, provided other relevant parameters are well in place. When read side by side, the above three scenarios reveal how various background paradigms and the policies and strategies stemming out of them are defining the destinies of these nations. The developing countries could learn a lot from these three countries' approach to their socio-economic development, their successes and shortcomings, as well as the effect of integrating the crucial component of innovation in the overall framework of their policies and strategies that are led by science and technology.

Today, the future of both rich and poor countries lies in the equitable distribution of wealth and prosperity in the world. To this end they must be willing to show strong political resolve to work coherently on using the world's resources during this century and agree on ways and means to do that successfully. Policies and strategies must be evolved as early as possible by both advanced and developing nations to help each other in scientific and technological development with judicious flow of benefits in both direction. The advanced countries may formulate policies to transfer knowledge, technology and expertise to the developing countries and provide market access to latters' manufactured products, whereas the developing countries should gear up their resource allocation to education, science and technology, industry-university integration for research and innovation, and provide better working environments for educationists, scientists and engineering, ensuring protection of intellectual property rights, etc. Above all, good governance must be ensured at every level. On strategy side, the developed countries should make unbiased assessment of the efficacy of their past and ongoing mechanisms, assistance schemes and socio-economic projects, with a view to make corrections in the previous stereotyped approaches. They should provide generous opportunities for the scientists, engineers, technicians and managers of the developing countries to get high-quality training in their relevant technical and research organizations.

Indigenization of scientific and technological programmes in the developing countries should be encouraged by the rich nations for several spin-off advantages that would accrue to them from the developing economies. Joint industrial ventures in the developing countries should be enhanced considerably and tactically scattered technical workshops for repairs, maintenance, spare parts stock transports, and other logistical facilities for industrial goods as well as the production units, should be built on profitable locations in all the regions of underdeveloped and developing nations. More technical, financial and managerial facilities should be made available to the developing countries by the developed ones in the areas that are going to be of crucial importance in the near future to both, but more so to the poor countries. A few such areas could be: high food-productivity, clean drinking water, energy security, healthcare and environmental protection. It may take half a century of vigorous and concerted efforts by both the rich and poor countries, with their best science and technology inputs and serious cooperation, before any useful results will start to emerge. Daunting causes such as uncontrolled human population and conflicts will have to be stringently controlled at the global level. National and international strategies involving strong political and technical forces will be required to achieve this. Science and technology will certainly play its positive role, the doubt will only be from the political side.

(Hasibullah)
Advisor International Affairs
COMSATS Headquarters, Islamabad, Pakistan

AUTHOR INDEX

SUBJECT INDEX