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Capacity Building for Science and Technology

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Commission on Science and Technology
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Sustainable Development in the South

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Capacity Building for Science and Technology

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Capacity Building for Science and Technology

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PREFACE

COMSATS had organized a three day ‘Meeting on Science and Technology Capacity Building for Sustainable Development’, from the 19 to 21 February, 2003, at Islamabad. The meeting was attended by leading scholars and scientists, heads of various research and scientific institutions, representatives of local and foreign donor and development agencies, and eminent technologists from different fields.

In the five technical sessions, namely Industry and Engineering; Geology & Energy; Human Resource; Information Technology and Agriculture, this meeting addressed some of the most contemporary and popularly debated concepts concerning socio-economic and environmental aspects of S&T Capacity Building of a nation.

This book is a documentation of some of the selected technical papers presented at this meeting. The results are of pivotal importance for the effective building up of science and technology capacity in developing countries, in general, and Pakistan, in particular. Realizing this, COMSATS is publishing the proceedings of this meeting in the form of a book, which will be the first of a series of COMSATS S&T publications, aimed at making an appropriate impact in the S&T arena of Pakistan and other developing countries. I would like to express my sincere gratitude to Dr. Ishfaq Ahmad and Prof. Dr. Atta-ur-Rahman, for their generous guidance and continued support for COMSATS and their awareness of events has always been a source of inspiration for this organization to do better and better every passing year.

The active participation of local and foreign participants and speakers was the essence of the success of this meeting and COMSATS wishes to thank them for their time, effort, interest and the contributions that they graciously made in this event. Acknowledgement is also deservedly due to the COMSATS team, that successfully organized this meeting and tirelessly contributed towards its success. I would particularly like to appreciate the efforts of Prof. Dr. M.M. Qurashi, the Editor of this publication, without whose input and guidance, this meaningful publication would not have been possible. Moreover, I would also like to acknowledge the efforts Mr. Irfan Hayee and Ms. Zainab Hussain Siddiqui for their effective collaboration in the compilation and editing of this document.

Dr. Hameed Ahmed Khan
(Executive Director, COMSATS)

SUPPORT FROM DONOR-AGENCIES: OPTIMAL USE FOR CAPACITY-BUILDING IN DEVELOPING COUNTRIES

Tajammul Hussain and Hameed A. Khan***

ABSTRACT

Despite great efforts and investments to promote development, economic disparity between developed and developing countries has continued to grow. This economic disparity is particularly apparent after the collapse of Soviet Union. Developing countries suffered due to the change induced in the post colonial period, while the countries in transition are yet suffering from the effects of the post communist period. The negative externalities of modern development in all these countries can only be avoided if adequate economic development takes place. However, economic development should not be detrimental to the social and environmental sectors, as has often been the case in the past, unfortunately.

This concern and aspect of development was first denoted by the World Commission on Environment and Development through the term 'Sustainable Development'. In response to this concern, the concept of 'Capacity-Building' emerged in the later part of 1970s. Though nearly after three decades, enormous constraints to achieve effective capacities to promote sustainable development yet remains, however, genuine signs of progress are evident. At present, most countries have strategies for either environmental management or sustainable development, and the global community has a reasonable sense of what needs to be done, with respect to capacity-building for sustainable development.

In this context, the International Donor-Agencies and the Financial Institutions have played a significant role and this paper encapsulates results of several case-studies, screening that the development-assistance has been marked by a series of dramatic successes, and at the same time some disappointing failures. The paper also takes into account the role of COMSATS in detail

Conclusively, in the context of S&T Capacity building, analytical suggestions for both the donor-agencies and the recipient countries have been articulated.

INTRODUCTION

Despite great investment and effort to promote development, economic disparity between developed and developing countries has continued to grow. In fact, the Gross National Product (GNP) of 80% of the world's population has remained low, while the wealth of the affluent 20% has increased. According to UNDP (1999), inequality has become greater at both the global and national levels. In 1997, 20% of the world's population in the richest countries accounted for 86% of global GDP, 82% of exports, 68% of foreign investment, and 93% of internet users. These disparities between North and South were complemented by increasingly apparent disparities between East and West, particularly after the collapse of the Soviet Union. Developing countries were and still are, suffering from change induced in the post-colonial period, while countries in transition were, and still are, suffering the effects of the post-communist period. Thus the curse of modern development in all these countries can only be avoided if adequate economic development takes place. However, economic development should not be detrimental to the social and environmental sectors, as has unfortunately often been the case in the past. As a prerequisite, technological and economic development at the global level should not pose major risks. But even more urgent is the need for technologies and regulatory systems that reduce and eventually remove negative trends. Achieving this goal, however, requires new paradigms and approaches to development. This is true in any sector, including, for example, agriculture, particularly agricultural research.

The above requirements were first defined by the World Commission on Environment and Development in the term "Sustainable Development", and broadly endorsed at the Earth Summit in Rio de Janeiro in 1992. Since then, however, numerous conference, conventions and negotiations at the global level, especially UN conferences, have shown that it is extremely difficult to harmonize development within and between countries. One concern listed in this respect was insufficient research-capacity to tackle

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the paradigm of sustainable development (cf. Shrum, 1996).

The goal of sustainable development is to create and maintain prosperous social, economic, and ecological systems for future generations of humankind. One of the major lessons learned since the 1992 United Nations Conference on Environment and Development (UNCED) is that transition towards sustainable development is inconceivable without science, engineering and technology.

Therefore, promoting the goals of sustainability, addressing immediate human and social needs while preserving the earth's fragile life-support systems, has emerged as an increasing priority for the International Scienctific and Technological Community (IS&TC). The IS&TC in its submissions to the Preparatory Committee Meetings of the Multi-stakeholder Dialogue Sessions, preceding the World Summit on Sustainable Development (WSSD) held in Johannesburg, South Africa in August/September 2002 has urged the nations of the world to accelerate the building of capacity, especially in developing countries, and to form mutually-sustaining, synergistic partnerships to achieve this.

Responding to the above concern, the concept of "Capacity Building" emerged during a relatively late phase of development cooperation, beginning only in the late 1970's; In 1979 at a conference on science and technology for development in Vienna, major donors agreed that their support should be seen as collaboration benefiting both parties, i.e. as a form of partnership rather than assistance. In general, it is possible to speak of a shift from technology-transfer to cooperation in science and technology. In order to achieve this, great emphasis is now being given to training and to the strengthening of institutional capacity in partner countries.

Capacity can be defined as the ability of individuals, organizations, or societies to set and implement developmental objectives on a sustainable basis (Land, 2000). Individual capacities consist of skills and aptitudes, and their translation into organizational capacity. Organizational capacity consists of internal structures, collective staff capacity, and an enabling environment (policy framework and other factors).

Although enormous constraints to the achievement of effective capacities to promote sustainable development remain, genuine signs of progress are evident. At present, most countries have strategies for either environmental management or sustainable development, and the global community has a reasonable sense of what needs to be done, with respect to capacity-building for sustainable development. "Science and Technology" has been identified as the key area for achieving the goals of consistent progress. Therefore, it is also extremely important to develop indigenous capabilities and capacities in those areas of science and technology, which are of relevance to the developing countries.

The new forces of science and technology, however, if harnessed properly, offer immense possibilities for solving many of the complex problems which are currently impeding economic and social development in the South. Recent advances in tissue culture, genetic engineering and biotechnology, for example, can be instrumental in raising agricultural production, reversing land-degradation and conserving biodiversity in the ecologically fragile zones of the South.

Another example is that of information and communication technologies and their networks, which have profoundly revolutionalized the modes of interaction in research, education and business. However, access to these technologies requires investment in telecommunication-systems which are currently beyond the reach of a vast number of poor countries, thereby posing the risk of further enhancing the growing education and information gap between them and the rest of the world.

The challenge, therefore, is for developing countries to master modern science and technology and apply them to their own development-requirements. To meet this challenge, radical measures are needed by the governments in the South. These will include substantially more investment in research and development and full integration of science and technology into national development plans, for building national and regional capacities in science and technology, intensifying regional cooperation and establishing strong national and regional alliances between the private sector and research and development institutions.

ROLE OF DONOR AGENCIES

1. INTERNATIONAL DEVELOPMENT RESEARCH CENTRE, IDRC

Objectives:

- To foster and support the production and application of research results leading to policies and technologies that enhance the lives of people in the developing regions of the world.
- To mobilize and strengthen the indigenous research-capacity for policies and technologies that advance healthy and prosperous societies, food security, biodiversity and access to information.
- To help communities in the developing world find solutions to social, economics, and environmental problems through research.
- To initiate, encourage, support and conduct research into the problems of the developing regions of the world and into the means for applying and adapting knowledge to the economic and social advancement of those regions.
- To empower through knowledge

Main Activities:

- Supporting researchers in the developing world to carry out their work in their own institutions, in particular, supporting research projects and partnerships proposed by developing-country partners. Projects supported relate to three main areas – social and economic equity; environment and natural resource management; and information and communication technologies for development. In addition, IDRC supports research on two cross-cutting issues; gender and knowledge systems.
- Hosting international multi-donor secretariats dedicated to generating and applying knowledge to major development issues in particular topics, eco-regions, or countries.
- Publishing the results of research and communicating them to key audiences around the world.

Activities relating to strengthening Institutional Capacity:

- IDRC's methodology enables local institutions to determine their own needs and to carry out the necessary work.
- IDRC emphasizes a multidisciplinary, participatory approach to research-support and management.
- IDRC supports networking to combat intellectual isolation and realize the synergies that come from the exchange of ideas and experiences. IDRC also helps establish direct links between researchers in the South and the Canadian scientific and development communities, as well as between academic, non-governmental, and private-sector communities.
- IDRC had created and strengthened information and communication systems, services, networks, technologies, and tools in and for the South.
- IDRC programme staff act as a conduit for the best sources of specialist research-information to researchers in poor countries.

Geographic Focus:

- IDRC has agreements with some 130 countries in Africa, Asia, and Latin America and the Caribbean. Its six regional offices serve respectively:
- Africa: Eastern and Southern Africa, Middle East and North Africa, West and Central Africa.
- Asia: Southern and East Asia, South Asia
- Latin America: America and Caribbean

IDRC and the Dnieper River

Summary of the Project and its Principal Outputs

In 1993, Canada wanted to support Ukrainian efforts to rehabilitate the Dnieper River and asked IDRC to apply its techniques to this task. For this purpose, an initial budget of CAD 4 million was transferred to IDRC, to manage a project named Environmental Management Development in Ukraine (EMDU). In 1997, a second phase was approved under CIDA financing; this phase ended in December 2000. During these six years, approximately CSD 12 million were spent in Ukraine for that purpose, along with an additional estimated CAD 1 million in local contributions.

Immediate Results

The various research activities have produced the following immediate results:

- Information about the state of the river was obtained and organized and a network of scientists and mangers is now providing data online for the management of the river.
- A National Programme for Rehabilitating the Dnieper and Improving Water Quality was approved by the Verhovna Rada. Nearly all Ukrainian respondents interviewed stated that among the most important result coming out of EMDU cooperation experiences was the drafting and implementation of this policy.
- Ukraine's Ministry of Environment Protection and Nuclear Safety has taken measures to seek a USD 7 million grant from the Global Environment Facility (GEF) to define a Strategic Action Plan (SAP) for the rehabilitation of the river basin and ameliorating its effects on the Black Sea.
- Environmental auditing and clean-production concepts have been introduced and established. A group of Ukrainian scientists has formed a consortium to provide such national audits.
- Significant improvements in the provision of public utility services in the city of Zaporizhzhia have led to the approval of a loan by EBRD (European Bank for Reconstruction and Development; USD 30 million) to upgrade water and sewer systems. In contrast, an adjacent city was refused a similar loan, because it had not yet learned to provide utility-services in a financially viable manner.
- Ukraine is now participating in an international network for testing and calibrating quality of water, using bio-testing methods.
- Civil society has increasingly become involved in the programme through outreach activities, such as numerous television programmes for local station and a web page.
- The effects of ramial ship wood on soil-fertility is being tested and gradually proving to be a significant alternative to other, less environmen-friendly means of increasing soil-fertility.

Perceived Positive Aspects of the IDRC Programme

There exists an atmosphere of trust, confidence, and real partnership between IDRC and Ukrainian recipients. IDRC's consultants and staff never force their views upon recipients, but are open to discussing and exploring all avenues for solving problems.

All project-managers are local Ukrainians and they feel they have a great deal of independence e.g. hiring necessary specialists, choosing appropriate equipment, approving trips within the project-budget, etc. Using IDRC's approach, more money is spent locally and more money reaches Ukrainian scientists and consultants. No other donor-agency in Ukraine spends 60% of its funds in the recipient country (taking into account the rent for the local IDRC office and salaries of local staff, the percentage is even higher).

Many of the projects carried out under EMDU were very practical, with outcomes that will last beyond the end of EMDU and funding from IDRC. Real tangible results can be seen going beyond the usual reports and publications, whose utility to locals is questionable. Among these are the river-bank protection strip, the remediated landfill in Zaporizhzhia, modernized equipment for several audited enterprises, water-treatment units for hospitals, kindergartens and schools, etc.

A large component of training has allowed many Ukrainian specialists to upgrade their skills and qualifications in Canada and other countries. Many scientists participated in international workshops and conferences, thanks to EMDU grants.

Perceived Negative Aspects of the IDRC Programme

What IDRC understood as benign intrusion, in practicing due diligence and enquiring about administrative and technical issues, was often regarded as severe probing by recipient institutions. IDRC's approval was expected to be forthright and simple. Sometimes recipients have to revise a proposal four or five times before IDRC approves it. This has led to the senior scientific adviser of IDRC being referred to as "Dr. Niet".

Proposal approval, contract preparation, and transfer of funds can take much time. In the current poor economic conditions for many scientists in Ukraine, donor-money is the only means of support, and delays thus cause nervousness.

The list of reports that have to be prepared, along with the final project-outputs, is quite long. Many recipients do not see any real purpose and value with the preparation of some of these reports. Moreover, the list tends to grow over time. For instance, results-base management and time-sheets for workers on the project have recently been added, joining report gender, training and local contributions as a requirement.

From the outset, IDRC has suggested greater involvement of Ukrainian civil society, increased public participation, and NGO involvement. These ideas run counter to seventy years of socialism and were difficult to internalize. In the past, government officials flooded thousands of hectares of arable land and hundreds of villages, without consultations, in order to build a hydroelectric station on the Dnieper. With respect to NGOs, Ukrainian scientists granted them little credit, as they perceived NGOs as lacking professionalism and being driven by emotions and political considerations. They also questioned NGO accountability. A few projects, however, met with strong opposition at the village-level that had to be dealt with in a manner similar to that in any other democracy, through consultation and negotiations at grassroots, thus vindicating IDRC's initial preoccupation.

Analysis: IDRC's Demand-Driven Methodology

As IDRC compared notes with other Western organizations active in the region, the importance of capacity-building methods and approaches became even more apparent. It is useful to remind the readers at this juncture that there are four critical aspects for project-delivery:

i. Complete ownership by recipient countries
ii. Best financial and operational management
iii. Highest scientific and technical standards
iv. Collaborations with other partners

It is essential to assure a good balance among these four complementary goals. However, experience has shown that, in practice, projects are often skewed in favor of one or the other of these goals; generally, priority is put on ensuring that all procurement and accounting procedures will be meticulously adhered to, and pressure is put on foreign experts and consultants to obtain and demonstrate visible results as a result of "supply-driven technical assistance". As a result:

– There is an over-emphasis on immediate, tangible results such as reports;
– Local ownership and capacity building suffer;
– Long-term sustainability is left in doubt.

In contrast, the demand-driven methodology of IDRC is now being heralded by Ukrainian authorities as a unique and effective model. Ukrainian partners have expressed a preference for the management-methods employed in EMDU, bemoaning the fact that many of the other organizations do not operate in this manner, but rather rely on extensive use of expensive foreign consultants.

Changing Mind-Set and Ensuring Sustainability

By building relationships based on trust, carrying out business in an open and transparent fashion, relying on local partners as equals, employing local talent to the greatest possible degree, and choosing to build-up local institutions to function without its help, IDRC has been able to achieve its goals. In the end, the authors believe that important changes in the mind-sets have occurred.

In particular, confidence and self-esteem are a most significant outcome of this programme. Scientists and managers have come to recognize themselves as a part of the world scientific elite and they now feel that their opinions are respected and can have an influence on policies. They feel capable of defending Ukrainian interests within the region and internationally. Second, the capacity to work cooperatively and to take decisions collegially has significantly been improved; this attitude is essential when dealing with protracted and complex environmental problems, such as those that plague the Dnieper River.

2. EUROPEAN COMMISSION, DEVELOPMENT DIRECTORATE-GENERAL, EU

Objectives:

- To offer support for research-activities in developing and transition countries.
- To promote high-quality R&TD in the fields directly affecting developing countries.
- To help maintain and to strengthen research-capacities in developing countries.
- To improve the level of excellence of the EU in major fields concerning developing countries.

Main Activities:

- INCO-Dev
- DG Development

Activities related to Strengthening Institutional Capacity:

- African Virtual University, Statistical Education Facilities, etc. (in ACP countries)

Geographic Focus:

- World-wide

Strategies, Tools and Experiences of the European Commission:

The European Commission has two separate, complementary lines of support for research-activities and capacity-building in the South. Briefly explaining the two, there is also a mention of some of the issues arising from the evaluations and their experiences.

Inco Dev

Within the ambit of the multi-billion research funds available to researchers within the European Commission in the EC Research Framework Programme, a small horizontal programme for development-cooperation is available to partnerships of European and Southern institutions under the name INCO-DEV. The overall priority-setting of the programme is based on a per-region dialogue with partner countries. Moreover, the evaluation of the development relevance of individual proposals is done by experts from the South. Total funds available per year vary between 60 and 80 million Euros.

Independent evaluations of this programme have mostly been highly positive. Its main impact has been on the establishment of long-term relations/ partnerships between research groups in North and South, outlasting in fact the actual contract.

However, there are some limitations. Only a restricted number of ACP countries (ACP: Africa, the Caribbean, and the Pacific) participate in the programme (ca. 30%), with a strong concentration of partners in a few countries (Kenya, Senegal). In general, it seems difficult for the institutions in the developing world to become an equal partner in this kind of programme. Institutions of the South, in particular, have difficulty initiating and formulating proposals. A certain dominance of the partners of the North in the choice of topics and the conception of proposal is therefore to be feared.

DG Development:

Although perhaps less directly visible, like most donors, the EC is a major sponsor of research and research-capacity building, through its bilateral and regional development programmes. These are executed for the ACP countries through specific funds managed by the DG External Relations (DG: Directorate-General).

The most recent comprehensive evaluation of research-related activities was conducted in 1997. From the outcomes of that, we may learn several significant and surprising facts. The effectiveness of individual actions in solving particular problems was not contested. Surprisingly, however, most of the activities (80%) had no local capacity-building component and depended heavily on external scientific expertise. Furthermore, most activities suffered from political profile and a lack of dialogue on sectoral policy upstream of activities. This resulted in the absence of an adequate methodology to enable genuine association of researchers and entrepreneur with R&TD in developing countries. In general, the failure to consider institutional aspects reduced the impact of dispersed actions.

Lessons Learnt:

Since then, following a conference in Leyden, the Commission and the European Parliament have underlined the need of a strategy based on:

- Partnerships;
- A differentiated approach that can be adapted to the specific circumstances in each country;
- Integration of research and technology development.

Two types of studies were done in the past year to help develop the strategy:

At the individual country level, small diagnostic studies were funded to describe the institutional set-up and the main constraints for research. To a certain extent they have confirmed the dispersion of research-efforts as a result of fragmented donor-funding. They also indicate that substantial capacity exists in countries like Ghana. One of the constraints that exist is the lack of conviction on the part of major partners (politics, private sector) that research is an essential investment. The dominance of the donor in agenda-setting is thus partly the result of local indifference. There is a clear challenge to be met there.

A broader study was commissioned to look at issues concerning the creation of a European Foundation for Research for Development (EFRD).

Those consulted with the study consider that the following are the main lessons to be learned:

- International efforts have, for many years, focused on setting up planned high-quality institutes of science and technology. These had little to do with the main concerns of developing countries and left the countries concerned with high maintenance costs.
- Funding has focused on new research-efforts, while the application of completed research has received less support.
- Institutions, rather than individuals, need strengthening.

The following were seen as characteristics of best practices:

- A clearly enunciated goal;
- Long-term commitment;
- Scale and critical mass;
- Patience and Tolerance for errors;
- Follow-through and systematic approaches: support for science without support for technology and innovation has limited the benefits;
- Risk-taking and supporting new approaches;
- Development of Leadership;
- Focused partnerships linked to clear goals;
- Foundations that function as investors.

3. DEPARTMENT FOR INTERNATIONAL DEVELOPMENT, DFID

Unlike several other bilateral donors, DFID does not have a single programme directed specifically at capacity-building. Rather, it has a number of schemes that contribute, more or less directly, to capacity-building in higher education and research.

Objectives:

- Produce new knowledge in and about developing countries/ transition countries that will contribute to sustainable development and the reduction of poverty.

Main Activities:

- DFID funds research-programmes in the following areas:
- Renewable Natural Resources (include, for instance, crops, farming systems, livestock, fisheries, pest management);
- Health and Population (e.g. disease control, safe motherhood, child mortality, health systems);
- Engineering (e.g. energy, water and sanitation, urban development);
- Economic and Social Issues (e.g. economics, social development, governance, enterprise development);
- Education.

Activities related to strengthening institutional capacity:

- Support for research and higher-education institutions (from country-programmes and central programmes)

Geographic Focus:

- Sub-Saharan Africa
- South Asia

DFID's Experience with Research and Capacity Building

Ghana Research Evaluation:

DFID conducted an evaluation of the impact of its health-research projects in Ghana and Tanzania. This reports on one of the case-studies in this evaluation, the Vitamin A Supplementation Trial (VAST) in Ghana. The study was conducted between 1990 and 1992 in the North of Ghana, as a collaboration between the London School of Hygiene and Tropical Medicine (LSHTM) and the Kumasi University of Science and Technology, with the active participation of the Ministry of Health (MOH). The aim was to assess the impact of Vitamin A supplementation on mortality and morbidity amongst children. It consisted of two related randomized controlled trials. The larger involved 21,906 children, receiving Vitamin A and a placebo every four months. The smaller, more intensive trial on 1455 children received a similar regime, but was monitored for illness on a weekly basis. The result of the former trial indicated a 19% reduction of mortality with supplementation. The latter study showed that the incidence of disease did not appear to be affected by supplementation, but the prevalence of severe diseases was reduced, along with attendances at clinics and hospitals.

The study built on, and confirmed, earlier evidence from Indonesia on the impact of supplementation. It also clarified the mechanism by which Vitamin A works (by reducing the severity, rather than the incidence of disease) and it was the first study in Africa to demonstrate this effect.

Impact:

The study had a significant policy-impact in Ghana. It led to the formation of a national Vitamin A Deficiency Control Programme in 1995. Follow-up research studies, one of which was also funded by DFID, helped to clarify the best means of implementing the programmes (e.g. by dietary adjustments or supplementation).

There was also an international impact. The VAST study contributed to an international consensus on the value of interventions to improve Vitamin A intake, and was included in meta-analysis studies that confirmed the findings.

Capacity-Building:

The project had an important impact on Ghanaian capacity in this field. The resources of the project were handed over to the Ministry of Health and formed the basis of the Navrongo Health Research Centre (NHRC). The institution has developed a reputation for excellence, both nationally and internationally. The Ghanaian researchers on VAST subsequently provided a stable nucleus of committed and experienced researchers for the development of this centre. NHRC was able to further develop its research activities and funding from overseas collaborators. The experience gained in VAST, particularly on the managment and implementation of the trials and the collection and analysis of epidemiological data, was invaluable.

What Lessons can be Learned?

The evaluation drew a number of conclusions about the reasons for the impact of the project. These included:

- *Close relationship between researchers and policy makers:* There was an active dialogue between, in this case, the research team and the MOH formalized in a steering committee chaired by the Director of Medical Services. Subsequently, several researchers served as advisors in the implementation of the supplementation programme.

- *An extended operational phase:* While the VAST study indicated the benefits of Vitamin A supplementation, it did not tell policy-makers the best way to implement it. The researchers addressed this need in follow-up operational research, again in close collaboration with policy makers.

- *National Ownership:* This was a study carried out in Ghana, with Ghanaians, which maximized policy-impact, as compared to evidence derived from other countries.

- *High-quality Research:* The impact of the research is related to its quality, reputation and credibility of the researchers. Impact was also increased because the findings were relatively dramatic, conclusive and reinforced those made in other countries.

- *National and International Networking:* Meetings were held locally, nationally, regionally and internationally, to publicize the results of the research and policy implications. The evaluation showed that a West African Conference held in 1993, with high-level participation, was particularly effective in providing impetus for action within Ghana, and regionally. This is perhaps important, as conferences are sometimes thought by donors to be rather frivolous extras.

4. UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP) IS THE UN'S GLOBAL DEVELOPMENT NETWORK

It advocates for change and connects countries to knowledge, experience and resources in order to help people build a better life. They are on the ground in 166 countries, working with them on their own solutions to global and national development challenges. As they develop local capacity, they draw on the people of UNDP and their wide range of partners.

Capacity-Development: Capacity-development is the ability of individuals, organizations and societies to perform functions, solve problems, and set and achieve goals. It entails the sustainable creation, utilization and retention of that capacity, in order to reduce poverty, enhance self-reliance, and improve people's lives. The importance of capacity-development has never been greater, as people all over the world confront the extraordinary challenges of consolidating development gains and creating the conditions for furthering sustainable progress.

The opportunities for capacity-development have also never been greater. The information revolution and the advent of new technologies continue to open up possibilities for individual and collective empowerment, information-exchange and knowledge-accumulation that were previously not imagined. Today, TECHNOLOGY enables countries to enhance certain capacities almost instantaneously, with the wealth of experiences and expertise that can now be shared electronically.

Capacity-development builds on and harnesses, rather than replaces, indigenous capacity. It is about promoting learning, boosting empowerment, building social capital, creating enabling environments, integrating cultures, and orientating personal and societal behavior.

Capacity-Development and UNDP

Capacity-development has always been a strong guiding theme, of the United Nations system activities, and is embodied in UNDP's mission, goals and strategies. UNDP has been very active in capacity-development in trying to ensure that:

- Capacity-development is promoted through UNDP's six practice areas:
  - democratic governance,
  - energy and environment,
  - crisis prevention and recovery,
  - information and communication technology,
  - HIV/AIDS;
- Capacity-development entails the acquisition of both individual skills and institutional capacities and social capital, as well as the development of opportunities to put these skills and networks to productive use in the transformation of society;
- Capacity-development concerns are built into development policies and strategies;
- Technical cooperation, its operational modalities and delivery services, facilitate rather than lead capacity-development efforts;
- Sustainable national capacities are developed, not only within the public sector, but also within other segments of society, particularly amongst civil-society actors and the private sector.

Agenda 21:

Agenda 21 is a statement of willingness by countries to strive for a form of development that recognizes the essential links between economic growth, social equity and environmental protection. 178 countries adopted Agenda 21 at the United Nations Conference on Environment and Development (UNCED, or the “Earth Summit”) held in June, 1992, in Rio de Janeiro, Brazil.

In providing guidelines for sustainable development, Agenda 21 seeks to ensure that development “meets the needs of the present, without compromising the ability of future generations to meet their needs.”

The *Commission on Sustainable Development (CSD)* was created in December 1992 to ensure effective follow-up to the UNCED meeting, and to monitor and implement the agreements at the local, national, regional and international levels.

About Capacity 21:

The UNDP Capacity 21 Trust Fund works with countries in order to build national capacities for the implementation of Agenda 21. Working with governments, civil society and the private sector, Capacity 21 programmes support the development of integrated, participatory and decentralized strategies for sustainable development.

Capacity 21 programmes are country-owned, country-driven processes that support and influence national and local decision-making to build long-term capacities at all levels of society. Three principles lie at the heart of any Agenda 21 process and are the main building blocks for Capacity 21:

– *Participation* of all stakeholders in programme development, implementation, monitoring and learning;
– *Integration* of economic, social and environmental priorities within national and local policies, plans and programmes;
– *Information* about sustainable development, to help people make better decisions.

Capacity 21 is operational in each of UNDP’s 5 regions: Africa, the Arab States, Asia, Europe and the Commonwealth of Independent States, and Latin America and the Caribbean.

Introduction To Approaches to Sustainability Series:

Capacity 21 has piloted the implementation of Agenda 21 principles in more than 75 developing countries and countries in transition, and is strategically placed to draw on an extensive knowledge-base to share good practices and experiences with the global development community.

With the support of Capacity 21, many countries have adopted innovative capacity-building approaches to meet the challenges of environmental degradation, social inequity and economic decline. As you will read, each experience in building and strengthening capacities is unique and aims to meet national priorities. There is no single blueprint for sustainable development.

The Approaches to Sustainability series is Capacity 21’s main tool for the analysis and dissemination of the innovative approaches and lessons emerging from Capacity 21 programmes (and selected other experiences from around the world).

The Approaches to Sustainability series:

– Fosters the *exchange of knowledge and experience* on capacity-building for sustainable development among developing countries, their stakeholders and development partners;
– Facilitates analysis and advocacy of experiences and approaches in capacity-building for sustainable development to *inform (global, regional, national and local level) decision- and policy-making.*

An Analysis & Suggestions:

Development assistance has been marked by a series of dramatic successes and disappointing failures. One of its most pervasive failures has been the inability to build long-lasting capacities in developing countries, with the result that too many remain dependent on development-assistance. Agenda 21, with its emphasis on people defining their own needs and priorities, provides an excellent framework on which to build capacities to develop and implement strategies for sustainable development.

Agenda 21 establishes a set of basic principles for achieving sustainable development, based on the need to manage the economy, the environment and social issues, in a coherent and coordinated fashion. It is recognized that each country needs a clear vision of its own future path of development. Clear vision facilitates sound analysis of what is good and what is bad about a country's current development-strategy, and this information can be used to develop plans of action for a more sustainable future.

The United Nations Development Programme's (UNDP's) Capacity 21 initiative, operational since 1993, has assisted more than 75 countries in putting these principles into practice. A close look at Capacity 21 programmes reveals that different countries have taken different courses of action, but a *number of common approaches* can be found across the range of national initiatives.

In particular, bearing in mind that Agenda 21 calls for co-management of the economic, social and environmental domains, Capacity 21 programmes have striven to promote the integration of economic, social and environmental priorities into national and local development-planning. The participation of all stakeholders (across different social and economic sectors) in programme for development, implementation, monitoring, learning and evaluation has been a common feature and serves as a building-block for every Capacity 21 programme. The huge role of information as a facilitator of development, to help people make better and more informed choices, has also been critical. Monitoring and learning are vital to ensure that programmes adapt fluidly, as conditions change, and as experience builds and contributes to the growing body of practical information on capacity-building for sustainable development — in the various countries and world-wide.

It is clear that there is no single blueprint for sustainable development. Each experience in building and strengthening capacities is unique and aims to meet the national priorities. With the support of Capacity 21, a number of countries have adopted innovative capacity-building approaches to meet the challenges of environmental degradation, social inequity and economic decline.

CONTRIBUTIONS OF GLOBAL FINANCIAL INSTITUTIONS

THE WORLD BANK

The World Bank Group is one of the world's largest sources of development-assistance. In fiscal year 2002, the institution provided more than US$19.5 billion in loans to its client countries. It is now working in more than 100 developing economies, bringing a mix of finance and ideas, to improve living standards and eliminate the worst forms of poverty. For each of its clients, the Bank works with government agencies, nongovernmental organizations, and the private sector, to formulate assistance-strategies. Its country offices, worldwide, deliver the Bank's program in countries, liaise with government and civil society, and work to increase understanding of developmental issues.

The World Bank is owned by more than 184 member countries, whose views and interests are represented by a Board of Governors and a Washington-based Board of Directors. Member countries are shareholders who carry ultimate decision-making power in the World Bank.

The Bank uses its financial resources, its highly trained staff, and its extensive knowledge-base to individually help each developing country onto a path of stable, sustainable, and equitable growth. The main focus is on helping the poorest people and the poorest countries, but for all its clients the Bank emphasizes the need for:

- Investing in people, particularly through basic health and education;
- Focusing on social development, inclusion, governance, and institution-building as key elements of poverty-reduction;
- Strengthening the ability of the governments to deliver quality-services, efficiently and transparently;
- Protecting the environment;
- Supporting and encouraging private-business development;
- Promoting reforms to create a stable macroeconomic environment, conducive to investment and long-term planning.

Through its loans, policy advice and technical assistance, the World Bank supports a broad range of programs aimed at reducing poverty and improving living standards in the developing world.

The Bank is also helping countries to strengthen and sustain the fundamental conditions they need to attract and retain private investment. With Bank support—both lending and advice—governments are reforming their overall economies and strengthening their banking systems. They are investing in human resources, infrastructure, and environmental protection, which enhances the attractiveness and productivity of private investment.

Themes of Bank-assistance in FY 2001 to developing countries in recent years included the following:

- *Accelerated debt relief:* Significant process has been made to provide deeper, broader, and faster debt- relief to some of the world's poorest countries, many of them in Africa, under the enhanced Heavily Indebted Poor Countries (HIPC) Initiative framework. As of June 30, 2002, 26 countries were receiving debt-relief under this framework, expected to amount to $41 billion over time. After HIPC (and combined with traditional) debt- relief, the 26 countries will witness a two-thirds reduction in total debt, increase social expenditures, and reduce spending on debt service.

- *Support of the fight against HIV/AIDS:* The HIV/ AIDS epidemic now poses a paramount threat to Sub-Saharan Africa. In collaboration with partners, the Bank launched in September 2000 the Multi-Country HIV/AIDS Program (MAP) for Africa-the first of its kind. Under the MAP, flexible and rapid funding will be committed, on International Development Association (IDA-the Bank's concessional lending window) terms, to individual HIV/AIDS projects developed by countries.

- *Multidimensional support for poverty- reduction:* The Bank's World Development Report 2000/2001 emphasized opportunity, empowerment, and security as keys to reducing multidimensional poverty. To this end, Bank support for education is emphasizing access, quality, and equity; working toward a cleaner, healthier environment has entailed extensive global consultations to inform its new environment strategy; and a fast-growing area of Bank-support is law and justice, where Bank-focus has evolved from specific law-reform to encompass legal education for the public, anticorruption programs in the judiciary, indigenous dispute-resolution mechanisms, and legal aid for poor women.

- *Improved development effectiveness:* The number of projects considered "at risk" in the Bank's portfolio has been cut in half over the past five years and is now the lowest in many years. The quality of project appraisal and supervision has also improved substantially; a similar trend is emerging with respect to no lending services.

OTHER INSTITUTIONS

In addition to **IDA** and the **International Bank for Reconstruction and Development (IBRD),** which provides loans and development-assistance to middle-income countries and creditworthy poorer countries, the World Bank Group is made up of three other institutions:

- The *International Finance Corporation (IFC)*. IFC promotes private-sector investment, both foreign and domestic, in developing member countries. Its investment and advisory activities are designed to reduce poverty and improve people's lives in an environmentally and socially responsible manner. Its work includes activities in some of the riskiest sectors and countries. IFC serves as an investor and an honest broker, to balance each party's interest in a transaction, reassuring foreign investors, local partners, other creditors, and government authorities. IFC advises businesses entering new markets and governments trying to provide a more hospitable business environment, to create effective and stable financial markets, or to privatize inefficient state- enterprises.

- The *Multilateral Investment Guarantee Agency (MIGA)***.** Foreign direct investment is an important driver of growth in emerging economies. MIGA's mandate is to promote foreign direct-investment by offering political-risk insurance (guarantees) to investors and lenders, and by providing skills and resources to help emerging economies attract and retain this investment. Projects MIGA supports typically convey many direct benefits to host countries, including jobs created for local workers; accompanying and enduring investments in skills and training for employees; and a general impact on the national economy as a whole, as provided by tax- revenues and foreign exchange earnings through exports.

- The *International Centre for Settlement of Investment Disputes (ICSID).* ICSID provides facilities for the settlement—by conciliation or arbitration—of investment-disputes between foreign investors and their host countries.

The World Bank's President is by tradition a national of the largest shareholder, the United States. Elected for a five-year renewable term, the President chairs meetings of the Board of Executive Directors and is responsible for overall management of the World Bank. The World Bank raises money for its development-programs by tapping the world's capital markets, and, in the case of IDA, through contributions from wealthier member-governments.

SUSTAINABLE DEVELOPMENT: LESSONS LEARNED AND CHALLENGES AHEAD

(By Frannie A. Léautier, World Bank Institute)

The World Bank provided more than $17,000 million in loans last year to more than 100 developing countries, with the primary goal of helping to reduce poverty. Believing that knowledge builds capacity, and capacity-building leads to growth, security, and empowerment of the poor, much of the bank's work has focused on promoting learning and the sharing of knowledge and experience. The bank's learning approaches include innovations, such as global electronic knowledge-networks and distance-learning, to extend the reach of knowledge and learning, which lead to an improved quality of life and a reduction in poverty worldwide.

Sustainable development is central to the World Bank's mission of reducing poverty. Progress has been made on poverty-reduction in the last 10 years, and absolute poverty has been reduced by impressive amounts, even as poor populations have grown. During the past generation, life expectancy has increased by 20 years and the number of literate adults has doubled. Nevertheless, nearly 3,000 million people — almost half the world's population — live on less than $2 a day, over 1,500 million people do not have clean drinking water; and in the next 25 years the world's population is expected to increase by an additional 2,000 million people, mostly in poor countries.

The World Bank's poverty-reduction mission and sustainable development efforts mean working across traditional sectoral boundaries in environment, agriculture, health, education, energy, water and sanitation, social development, and infrastructure. Our approach to sustainable development means being committed to building long-term collaborative working relationships with partners in the public and private sectors and with civil society, to build capacity and help our clients achieve their sustainable-development objectives.

The Millennium Development Goals (MDGs) provide a framework for all our poverty-reduction and sustainable-development efforts. These goals, agreed to by over 150 heads of state and government at the UN Millennium Summit in 2000, provide the measurable targets we need to collectively measure global progress in improving living standards. Our lending program and policy-work will directly support achievement of the Millennium Development Goals.

Translating Lessons Learned and Operational Experiences into Policies and Practice:

The World Bank uses its lessons of experience in the implementation of poverty-reduction and sustainable development projects and programs, to enhance support to developing countries. We have increased the effectiveness of our programs through country-assistance programs that are more selective, more participatory, and better coordinated. As one of the world's largest sources of development-assistance, the World Bank provided more than $17,000 million in loans last year to more than 100 developing economies, with the primary goal of helping to reduce poverty. It is only through sustainable development that this assistance can be effective.
The World Bank is the world's largest external provider of funds for health and education programs, and for the global fight against HIV/AIDS. Since 1996, we

have launched more than 600 anti-corruption programs and governance initiatives in almost 100 client countries. Since 1988, the World Bank has become one of the largest providers of international funds for biodiversity projects, and the current portfolio of our projects with clear environmental objectives is $16,000 million.

The World Bank is addressing global environmental concerns, as an implementing agency of the Global Environment Facility (GEF), and works closely with the GEF in supporting projects in biodiversity conservation, as well as projects addressing climate change, the phase-out of ozone-depleting substances, and the protection of international waters. Through our cooperation with the Montreal Protocol's Multilateral Fund, we support programs in 20 countries for the phase-out of ozone depleting substances. Mainstreaming the priorities of the Biodiversity Convention, the Framework Convention on Climate Change, and the Convention on Desertification into our regular investment-lending is underway.

Poverty-Reduction Strategies: Effective poverty reduction strategies and poverty-focused lending are central to achieving development-objectives. Many of the lessons learned by countries about poverty-reduction and sustainable development are being put into action through the Poverty Reduction Strategy Paper (PRSP) development process. James D. Wolfensohn, president of the World Bank, recently described PRSPs as strategies that need to be "based on broad citizen-participation and assent, comprehensive in scope, long-term in perspective, results-oriented in approach, and supported by external partners." (Opening remarks at the International Conference on Poverty-Reduction Strategies, January 14, 2002.) This approach to poverty-reduction recognizes that development is a comprehensive, holistic, and long-term process, and it is an approach that recognizes the multi-dimensionality of poverty.

Country-owned poverty-reduction strategies provide the basis for all World Bank and International Monetary Fund concessional lending, as well as debt-relief under the Highly Indebted Poor Countries Initiative (HIPC). Eight countries have completed their first PRSPs and over 40 have prepared interim PRSPs. In partnership with the donor community and the International Monetary Fund (IMF), while 24 highly indebted poor countries will receive more than $34,000 million in debt service relief.

Learning and Capacity-Building

Agenda 21, the core agreement that emerged from the 1992 Rio Earth Summit, emphasizes the importance of capacity-building for sustainable development. The World Bank is fully committed to learning and capacity-building as essential in the drive for poverty-reduction and sustainable development. Much of our work focuses on promoting learning, sharing of knowledge and experiences, and building the capacity of people and institutions.

Our process of learning has meant benefiting from the lessons of our successes and failures, as well as from the lessons of others. Knowledge builds capacity, and capacity-building leads to growth, security, and empowerment of the poor. We have found that the best way to build capacity is by creating an enabling environment, in which local knowledge is allowed to flourish and contribute to global knowledge; where people learn from one another as they also innovate on their own; and where global and local knowledge inform action and influence change. The ability of a society to solve problems and innovate is the key to sustainable development. That is what a process of learning ensures.

The World Bank Institute (WBI) supports the bank's learning and knowledge agenda, through capacity-building, and by providing learning programs and policy-advice that address issues central to poverty-reduction and sustainable development. WBI currently delivers nearly 600 learning programs and reaches over 48,000 participants in 150 countries, through collaboration with more than 160 partner institutions.

Through these partnerships, which include local institutes, as well as donor countries and the private sector, the World Bank and partner-institutions are using technology to help bring knowledge to the most remote and inaccessible corners of the earth. Our learning-approaches often combine face-to-face and distance learning through new and traditional media, including the Internet and videoconferencing.

We are making strides in closing the digital divide, for example, through the development and wide use of global electronic knowledge-networks and distance-learning initiatives, such as the Global Distance Learning Network (GDLN). These kinds of innovations will greatly extend the reach of knowledge and learning for sustainable development, to improve the quality of life and to reduce poverty worldwide.

Clients use the knowledge and learning opportunities they get from WBI offerings to make real change in their countries. A public official from Chiapas, Mexico, who followed a learning-series in anti-corruption for public officials, implemented a program in his state upon return. The changes he instituted resulted in a 64 percent increase in resources collected in his state.

The World Bank's Participation in WSSD

The World Bank has taken an active role in preparations for the World Summit for Sustainable Development (WSSD), held in Johannesburg in August 2002. As Ian Johnson, the bank's vice-president of the Environmentally and Socially Sustainable Development (ESSD) Network, said during the most recent WSSD PrepCom: "The World Bank approach to sustainable development has changed considerably since the Rio Earth Summit in 1992. We have sharpened the poverty-focus of our work, expanded support for social services, equitable broad-based growth, good governance, and social inclusion, and are integrating gender and environmental considerations into our development efforts." As we move together toward the Johannesburg Summit, the World Bank:

- Supports the U.N. process and is participating fully in regional and global preparatory meetings in preparation for the summit;
- Supports the poverty reduction focus of the sustainable development agenda;
- Strongly supports the alignment of the summit objectives and the Millennium Development Goals;
- Hopes to see increases in overseas development-assistance, domestic resource-mobilization, and market access;
- Urges the adoption of "accounting for sustainable development" in national accounts.

The World Bank is preparing a number of contributions to the Johannesburg Summit. The 2002/2003 World Development Report, entitled "Sustainable Development with a Dynamic Economy: Growth, Poverty, Social Cohesion, and the Environment," will help establish an integrated view of sustainable development. We are also carrying out analytical work on a number of key thematic issues, including innovative financing for sustainable development, poverty and environment linkages, "green" accounting, and a stock-taking of our implementation of Agenda 21.

Future Challenges

We face enormous challenges in reducing global poverty and improving the quality of life for people, worldwide. We need to continue in our efforts to scale up successful development-efforts based on lessons learned. We also need to share knowledge and experiences about what has worked, in ways that will have a greater impact on a much larger scale. The nature and magnitude of the challenges will vary, depending on the regional, country, and local context. Much of our impact comes from work carried out at the local level. Partner-institutions in client countries play increasingly more important roles in making sure that programs are grounded in the local culture and social conditions. Our working relationships with partners also help to build long-term local capacity.

At the global level, the World Bank will continue to work with governments, civil society, multilateral organizations, and the private sector. As Ian Johnson has said, "In moving forward, we have to aim to increase our impact in terms of outcomes, working on a scale that is commensurate with the development-challenge. And to be truly effective, we need to work together."

COMSATS CONTRIBUTIONS AS A FACILITATOR

The Commission on Science and Technology for Sustainable Development in the South (COMSATS) is an international inter-governmental organization, with its headquarters located in Pakistan. The main aim of COMSATS is to access, organize, develop and share human and technological resources among the developing countries, for their socioeconomic uplift. In 1994, COMSATS was established as the highest forum, being represented by the heads of states or governments, to sensitize the developing countries to the centrality of science and technology in the process of development. The idea was to put forth an organized effort towards utilizing the south's own resources for their developmental needs. COMSATS, right from inception, has been supporting the programmes for development of science and technology in the developing countries. It has undertaken a number of programmes in different areas, which have benefited the member countries.

The COMSATS has selected Centers of Science & Technology in the member countries and is using these centers to provide the lead-role in their respective areas of specialization. The COMSATS has been promoting the formation of networks around these centers and promoting close collaboration within their respective specialties.

PROGRAMMES IN PAKISTAN

COMSATS has taken up quite a few projects in Pakistan. Launched Internet project in 1996: it started originally offering services in three cities, namely Islamabad, Karachi and Lahore. Now it is offering services in ten cities of Pakistan.

COMSATS has also helped Pakistan in getting the Numerical Weather Prediction Model developed, tested and applied. With the application of this model, the weather forecasts have become more reliable & optimally accurate. COMSATS is also working on alternate sources of energy, like solar and bio-gas, in Pakistan.

Capacity Building in Education & Professional Training

COMSATS Institute of Information Technology

To promote the application and utilization of information-technology in Pakistan, COMSATS laid the foundation and established the COMSATS Institute of Information Technology (CIIT). That has been an initiative to build capacity in the education sector, and to further extend the same idea for the development of the member countries.

The main aim of the CIIT is to impart high-level education, so as to produce quality-manpower matching the requirements of the international IT industry. Besides teaching, CIIT is also involved in software-development, web-application, multimedia development and development of e-commerce tools, which reflects efforts put in by CIIT in building capacity for itself and also to support the member countries from that basic establishment. CIIT is fully equipped to handle the needs of the fast-paced IT industry and flexible enough to anticipate and meet the challenges of future technologies. CIIT has a mission to deliver new ideas and products, through research, development and education, in strategic partnership with IT industry and organizations. Offering quality-education within the country, maintaining such excellent levels of training and seeking the trained personnel's services for internal capacity-building means that we may also stop brain-drain, which has been a serious issue for most of the developing countries. To promote the same concept, COMSATS also offers facilities of Students Exchange programme, Research grants, and Scholarships to nationals from the member countries.

SYRIAN – COMSATS – COMSTECH IT Centre, Syria

To take it further to promote the idea of capacity building in the field of education internationally and in a spirit to benefit the member countries, COMSATS put in their offerings to establish a replica of CIIT in Syria jointly with COMSTECH. This IT centre at Damascus Syria is a result of mutual efforts by COMSATS, COMSTECH and the Ministry of Higher Education, Arab Republic of Syria. The working scope of this centre includes training in software, hardware and networking; software development, Internet applications and electronic-commerce, which certainly leads to building strengths internally, instead of sending our students abroad to get quality education.

Distance Learning

COMSATS initiative of distance- education is a useful means of introducing quality-education & training-opportunities, in a range of subjects, to remote areas that are disadvantaged in terms of access to advanced learning or quality-instructors, which eventually contributes to building strong educational network.
Banking on its superior expertise of Information and Communication Technologies (ICTs), COMSATS has done a pilot-scale distance-learning project with

Alliance Francaise, the French Linguistic Centre, Islamabad. The project aimed to initiate web-based French-language training-services in otherwise inaccessible areas of Pakistan. It seeks to open doors to higher education and the French programmes for Pakistani youth.

Workshops & Seminars

Professional workshops and technical training, arranged on the COMSATS platform, provide the scientists and institutions of the member states an opportunity to learn, share and upgrade their skills and facilities in key-fields of science and technology in order to help the developing countries of the South to build up on their internal capacities for a sustainable future. Under the umbrella of COMSATS, these programmes are supported through sponsorships, to attain one common objective of self-sufficiency and optimizing potentials.

Capcity Building in Science & Technology

COMSATS Internet Services

Introduction and promotion of the latest internet technologies in the member countries, for exchange of information and development, is one of the important programmes of COMSATS. The first project in this area was launched in Pakistan in 1995. The purpose was to make this facility a regional hub, to generate resources in this critically important field and ultimately to share the expertise and related technology for the benefit of member states.

COMSATS-CERN-NCP Project for Data-Grid Applications & Physics Data-Analysis

COMSATS-CERN-NCP project is based on the basic concept of grid, which enables distribution of workload and basic data-sharing through networks and clusters. Compared to the web, the grid is much more intelligent. It harnesses the power of PC clusters and acts as a distributed network. Industries, such as pharmaceutical, bioscience, aerospace, and academic research institutes, have to deal with the complex calculations and permutations, which need heavy processing and computing powers. The grid makes the required computing power available in a more cost-effective way, such that disparate research centers/ entities can access and share the remote computing resources.

Renewable Energy Programme

The rapid depletion of traditional sources of energy (coal, oil, and natural gas) in the face of an ever-growing demand for the same has turned the world's attention towards development of alternate energy resources. Renewable-energy systems are resources that are replenished by nature and usually have less impact on the environment. COMSATS areas of interest include energy derived from biomass, solar and micro-hydel technologies. Various projects had been undertaken by COMSATS, in collaboration or assistance with UNESCO and Pakistan Council of renewable Energy Technology (PCRET). Pakistan within its own capacity of resources has also offered Sudan, one of the member countries, facilities for similar projects which may benefit them in the development of their energy resources.

Bio-Technology Programme

Among the broad range of technologies with the potential to reach the goal of sustainability, bio-technology could take an important place, especially in the fields of food-production, renewable raw-materials and energy, pollution-prevention and bio-remediation. COMSATS initial focus remains on applications of biotechnology in agriculture, environment and health. Its plans in the field of biotechnology include building appropriate infrastructures and an enabling environment in the member countries, to help them acquire, develop and systematically manage local competence. The newly established Biotechnology Cell at COMSATS headquarters is set to undertake this task in the long run. It aims to establish effective linkages and collaboration for meaningful research in the Third-World.

Capcity Building in Health Facilities

COMSATS Tele-Health Programme

Access to health-care facilities is dismally limited in most of the developing countries, Whereas our large urban centers face scarcity of quality medical-facilities, our rural population is completely ignored and left vulnerable to almost all kinds of diseases. Scarcity of resources puts the governments in the South at a disadvantage and they find themselves unable to extend health-facilities to remote or rural areas.

COMSATS, in collaboration with Byte 2000, a subsidiary of PAKMT, USA, has launched a tele-health project in Pakistan. The project involves linking small clinics in rural areas, where paramedical staff is available, to the hospitals in major cities. Tele-medicines equipped with all necessary equipment would be set up, to provide online professional advice to be given to patients in the remote clinics or dispensaries. It has been estimated that the cost incurred by a person on such consultation is far less than what one spends on getting a treatment from a major city. Not only can this idea build internal capacity and internal links, but also a network can be established for all member countries to share the medical researches, discoveries and knowledge among themselves, to support each other on their way to development.

Capcity Building in Business Industry

Development of Small & Medium Enterprises

Small and medium enterprises are considered the backbone of an economy and are directly relevant to social empowerment and poverty-alleviation in a country. COMSATS Network of Centers of Excellence carries a mandate to develop strong links with the production-sector, for undertaking collaborative research and transferring relevant technology for the development of the latter. COMSATS, in general, encourages utilization of latest technologies, to strengthen the industrial economy of the member states.

COMSATS PERSPECTIVE

Although COMSATS role has not been as a donor-agency but more like a facilitator, in executing and supporting all these development programmes, it is worthy of mention that, in this specific character, COMSATS has always been better able to analyze needs & aid from both the donor agency's and the recipient country's perspective.

Suggestions for the Donor Agencies

Partnership Approach

Support given to the developing or the transition countries should be seen as collaboration, benefiting both parties, i.e. as a form of partnership rather than assistance;

– In general, it is possible to speak of a shift from technology-transfer to cooperation in science and technology;
– In order to achieve that, great emphasis should be given on training and to strengthening institutional capacity in partner countries.

Multi-dimensional Support

In particular, capacity-building requires investment and attention in all the different fields, like infrastructure, higher education, research and development, economy build-up, medical facilities, poverty alleviation, institutional strengthening, science & technology advancement, etc, so these donor agencies along with working on single focus approach should also offer a multi-dimensional support.

Duplication of Efforts

All these various donor-agencies should operate in a coordinated fashion, which could help them share their identified focus for a common region/ country, to avoid any duplication of efforts, thus letting every agency to be pursuing a different objectives from the others. In this way, a number of fields would be covered where the recipient country needs help.

Evaluation Systems

All these support-organizations should have a standardized evaluation-system, so that at the accomplishment of every project they should be able to assess their performance both in terms of efficiency and effectiveness. This would surely be helpful for their future operations; lessons learnt from one project should be taken as basis for the next one.

Differentiated Strategies

Donor agencies can't be using unified strategies to operate in different countries, especially the countries of the North and the South. Due to the divergence of knowledge-basis, experiences and capacities, there have been growing disparities between the countries of the Southern and Northern parts of the world, thus compelling these agencies to come up with differentiated strategies to be applied in various countries.

Multiplicity of Actors

While some of the donor-agencies occupy a very specific niche, it is not unique on the scene to find several institutions contributing in the same field in the developing world. As a result, it is sometime difficult to distinguish the impact of assistance from one agency to the others.

Suggestions for the Recepient Countries

Building Research-Capacities

Scientific advancement and modern development are obviously intimately linked. Most progress comes from scientific achievements that result from basic research approaches, usually within single disciplines or in mono-disciplinary teams. The traditional role of research has thus been to contribute to the "blessings" of modern development, by generating knowledge with technical applications, such as new information-technologies. So far, that type of research had been mostly supported, yet the demand of interdisciplinary and integrated research is more recent. This approach was a consequence of the emergence of the multiple problems of the ecological and social realms. Whatever the type of research may be, but the need of the recipient countries is to emphasize most on research-studies to find out what the real problems are and what possible solutions could be. That is what can lead us to capacity-building in the true sense, when eventually there would come a time when we would not need any external help or, at least, we would be able to optimize the foreign aid.

True Management

Real manner management is a major lack of the developing countries, who are always in a need of external assistance. One of the dilemmas of these recipient countries is that even when they are given some sort of help by the donor agencies, we fail to utilize this help and manage the development programmes. Proper planning, working out best possible strategies, organizing resources and accurate implementation can help us move in the right direction and maximize the benefits coming from any developmental programmes and ultimately enable us to build internal capacities.

Problem Identification

Problem identification is one area, where the donor agencies can make wrong judgments; of course from a foreign agent one cannot expect to correctly identify problems when they are not truly familiar with the environment, system and living in a region. Developing countries, while receiving any sort of help from these donor agencies, should most of all help them identify the problem. Instead of the agency taking the recipient country through an odd development programme, it should be the other way round: to accurately point out the problem and use the right strategy as a way forward. Most importantly, until and unless the recipient countries learn "problem analysis" the external support coming would be of no use.

Institutional Development

Advancement in scientific research and capacity building needs an appropriately developed institutional framework, in which to carry out the research: equipped laboratories with regular supplies, communication facilities, a minimum essential number of scientists, and an adequate operational budget, which are not always available in the South. Training and institutional development is what donor agencies should be working on in these developing countries, instead of only building structures and empty buildings to make them permanent dependants on that external aid. Recipient countries should also emphasize most on building institutional strengths, to make the foreign support dispensable for them in the coming future.

Stable Policy-Structure

While receiving aid to eliminate problems, the recipient countries should make appropriate policies for a consistent application of the strategy-network they together come up with. Those firm policies and rules surely can provide a balance and organization of development-programmes and would optimize the use of external help. Then, with affect of the support received, development can take place which shall last long by adhering to policies and working for capacity building.

Work in Collaboration with Private Sector

Increase the sense of corporate-identity, by emphasizing the value of exchange and sharing. Bring in realization of mutual benefits, possibly to be derived out of development. Invite the private sector, as the business industry organization or other institutions, to contribute to local development programmes, which indirectly will create an environment of their prosperity. These associations work best for building internal capacities.

CONCLUSIONS & RECOMMENDATIONS: THE WAY FORWARD

A Developmental Approach to Capacity- Building in Civil-Society

There is a need to explore the question: 'What are the specific characteristics and challenges of undertaking capacity-building at the level of civil society as a sector (rather than at other levels of intervention, such as that of the organization or individual)?' In assessing the critical factors, it could be proposed that there is a need for a more developmental approach to capacity-building at civil-society level. In particular, interventions aiming to build the capacity of civil-society need to move beyond short-term, compartmentalized and donor-driven approaches. Instead, such interventions need to be based on a deep contextual analysis of the state of civil-society development in a given country combined with an understanding of the nature of organizational processes, both internally and in terms of external relations between organizations.

In this context, civil society is defined as organizational forms that exist outside the state and the market. It broadly incorporates informal expressions of civic association that may not fall within a legalistic definition of civil-society 'organizations' per se. Furthermore, this definition is informed by power analysis; civil society is not seen as homogeneous and concensual, but rather interpreted as an arena where actors play out their different interests, both in competition as well as in collaboration.

The term 'capacity building' is defined here as an ongoing process of helping people, organizations and societies to improve and to adapt to the changes around them. The distinctive characteristic of capacity-building is that it is based on a conscious intervention. Emphasizing, in particular, the interventions that explicitly set out to develop the capacities of civil-society organizations (CSOs), either as a specific programme or as a component of a broader programme.

Approaches and Methodologies

The critical question in the capacity-building of civil society is: 'capacity-building for what purpose', and in turn 'who defines the answer?'. In practice, this depends on the power-balance between resource-providers (that is Northern donors, whether official or non-governmental) and the subjects of the intervention. Capacity-building programmes are often shaped by the donor's own requirements for effective project-implementation and reporting, and based on the donor's sectoral priorities (such as poverty-reduction, democratization, environmental change or conflict-reduction) and regional focus. This results in a tendency for civil society capacity-building interventions to be compartmentalized and short-term, failing adequately to assess the totality of the environment in which civil-society organizations exist and function.

An alternative approach sees the strengthening of civil society as an end in itself: the end is for CSOs to strengthen their ability to achieve their purpose. In other words, there is an element of empowerment in capacity-building, enabling civil society to fully develop its role of being a counterbalance to the state and to market forces (Clayton 1996).

Thus, donor strategies towards capacity-building at the level of civil society are shaped by their own conceptual approach, in particular, how they view civil-society and whether they adopt an approach based on consensus or conflict-analysis. Their conceptual approach, in turn, influences the methodologies they use for capacity-building interventions. Some critical issues to be highlighted include:

- the degree to which the design of the intervention is truly reflective of the context and civil society in question, rather than a pre-determined agenda or set of donor interests;
- the strong influence on the intervention, as to whether the donor sees strengthening CSOs as a means to an end or an end in itself;
- the absence of appropriate capacity-assessment methods at the civil society level;
- the extent to which design and planning methods are open and flexible.

Core Principles in a Developmental Approach

By applying core-principles from the field of organization development, an overall developmental approach is proposed for civil-society strengthening initiatives, rooted in an integrated understanding of CSOs and how they develop within a particular context. This is based on the following key factors:

- a clear contextual analysis of the nature of civil society and its stage of development in the country or region in question;
- a contextualized understanding of organizational-life cycles and how these influence the capacity of CSOs to engage in proposed interventions;
- an integrated analysis of linkages at all stages during the capacity-building intervention, recognizing and working with vertical and horizontal linkages between society and the individual;
- addressing issues of behavioral and organizational change. This involves not merely accepting cultural norms, such as attitudes to authority, decision-making and gender relations, but also changing them;
- clarity concerning how the intervention will incorporate mangement of learning and knowledge throughout its time span;
- openness on the part of resource-providers to articulate their own agenda and make themselves part of the capacity-building process; in other words, a willingness to change. Donors need to adapt very different tools and timeframes in strengthening civil-society compared to those used in the more familiar output-oriented projects and programmes.

It may therefore be possible to suggest an organization-development approach to civil-society capacity-development, based on these core principles from organization-development experience. Furthermore, the essential ingredient for a truly developmental approach to civil-society capacity building must be for the subjects, themselves, to be the principal protagonists.

Striking a Balance

A Guide to Enhancing the Effectiveness of NGOs in International Development

At a time of rapid global change, developmental NGOs are to scale-up their impact, diversify their activities, respond to long-term crises and improve their performance on all fronts. The concept offers both analysis and a practical guide on how NGOs can fulfill these demanding expectations. The objectives of sustainable people-centered development, and the processes required to achieve it, focuses on the five factors which determine effectiveness: suitable organizational design; competent leadership and human resources; appropriate external relationships; mobilisation of high-quality finance; and the measurement of performance coupled to 'learning for leverage'.

NGOs, Aid and Conflict

The book of the above title is based upon extensive field-research in the Former Soviet Union, South Asia and West Africa, conducted in collaboration with international and local NGOs and multi-lateral and bi-lateral donor-agencies. Through an examination of case-study material and the emerging literature on contemporary conflict, it aims to provide a conceptual framework and practical guidelines for policy-makers and NGO practitioners working 'in' and 'on' conflict.

People and Change: Exploring Capacity- Building in African NGOs

People and Change in relation to improving the impact of capacity-building is an another subject of high importance. Based on many years of practical experiences with NGOs, largely in Africa, it is suggested that for capacity-building programmes to be more effective, we must:

– better appreciate the complex and highly personal dimensions to organizational change. Capacity-building cannot occur unless people change;
– understand the culture and context within which the capacity-building takes place and adjust the programmes accordingly;
– consciously learn from our capacity-building work, by taking the monitoring and evaluation of our work much more seriously.

Knowledge, Power and Development Agendas:

Development NGOs in the North and the South interact in a global web of relationships. Ideas may be drawn from the South, but the way in which they are taken up, changed and then re-disseminated is dominated by Northern institutions and agendas, and by global waves of development fashion. Based on field research in Ghana, India, Mexico and Europe, we need to explore how Southern NGOs can have more of a voice in determining the work they actually do, and how they can get more of their ideas on to the international development-agenda.

Power and Partner

From the 1999 conference, 'NGOs in a Global Future', at the University of Birmingham, a panel was set up to focus on NGO capacity-building. Individuals were invited to present papers describing their actual experiences of NGO capacity-building, to better understand how capacity-building is implemented in practice, what actually happens, what works and why. The term 'capacity-building' has become almost synonymous with 'development' in many aid circles. The World Bank, bilateral and multi- lateral donors, international NGOs (INGOs) and some local NGOs are prioritizing capacity-building. A recent survey of Northern NGOs revealed that an overwhelming majority, over 91%, claimed to be involved in capacity-building. It is therefore critical to analyze carefully the practice of capacity-building, to ensure that we learn from others' experience and avoid the danger that the term 'capacity-building' becomes merely a cosmetic and meaningless addition to all proposals and policies. Capacity-building is a conscious approach to change which, if taken seriously, has very radical and far-reaching implications, not only for skills and behaviors, but also power-dynamics within and between organizations. To get a better understanding of capacity-building, we may analyze a number of specific capacity-building interventions, drawing out the issues and insights from practice.

Demystifying Organisational Development

Practical Capacity-Building Experiences from African NGOs

Organizational Development consultancy is being prioritized by many Northern NGOs as a key-strategy for building the capacity for NGOs in the South. Few NGO decision-makers, however, are sure of what OD consultancy looks like in practice; whether it does really strengthen NGOs; and on what factors its success is contingent. Based on research undertaken in 1997, we may examine the theory and practice of OD consultancy with NGOs, by analyzing the actual experiences of some of the NGOs. The specific issues, which should be given particular importance include: the nature of NGO consultancy; OD consultancy; OD consultancy tools and processes; the roles, styles and characteristics of good OD consultants; OD and cross-cultural issues; the impact and evaluation of OD consultancy; key success factors in OD interventions; effective Northern support for OD and its implications.

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LOCAL RESEARCH-CAPACITY DEVELOPMENT IN UGANDA:CHALLENGES AND PROSPECTS

*Rugumire-Makuza Emmanuel**

ABSTRACT

In a fast changing world, the South continues to face overwhelming challenges of sustainable development. These challenges take on a strategic importance for both developing and developed countries, with respect to finite world resources, continued marginalisation of developing countries and globalisation. A time and context focused S & T is fundamental if these challenges are to be addressed. This calls for concerted efforts in Research-Capacity Development, the foundation of any science and technology. Focusing on Uganda, the twentieth poorest nation (UNDP Report 2002), this article examines the issues, challenges and prospects of local Research Development. Four aspects of Research Capacity Development are presented; the Human resources base, the institutions and the research environment. Crosscutting issues such as cooperation/competition, ownership/partnerships in research are discussed. Finally, the article proposes some solutions.

INTRODUCTION

From the time Man started living in communities, societies with an edge in science and technology have controlled nature as well as those communities that had inferior S&T. Thus, societies from the North with superior S&T have continually(ab)used resources from the South, to accumulate a wealth and power-base, used in controlling planetary affairs. A fast changing world-environment, of unpredictable political, economic and environmental dynamics, with spillovers from systems both in the North and South, requires us to reflect more on the 'One World' concept. These same dynamics have worsened the devastating challenges that the Third World faces. Science and Technology has a fundamental role in the judicious use of the limited world resources for any sustainable Development. We here examine the foundation of S&T; Research Capacity Development, notably the prospects, challenges and issues of research in Uganda.

CONTEXT

Uganda is sandwiched between Kenya, Sudan, Tanzania, Rwanda and the DRC. Straddling the Equator in East Africa, Uganda, the 20th poorest nation (UNDP Report, 2002), is predominantly an agricultural country (involving 80% of the Population). 60years of British colonisation that ended in 1962, have left their mark and continue to shape the country's destiny.

Uganda has a chequered post-independence history of political and economic mismanagement; beginning with President Obote to Idi Amin who left a legacy of violence that is still present. It is only in the last decade, that a semblance of economic and political order has been re-established. Even then, the region is still faced with political turbulences in Sudan, Democratic Republic of Congo, Rwanda, etc., the effects of which spill over into Uganda. The country is beset with serious developmental challenges; Poverty, HIV-AIDS, Malaria, and other diseases, ecological and environmental degradation, food insecurity and the fastest population growth-rate in Africa. Fervent efforts to deal with these challenges have been initiated in the last decade; the results however remain modest. Inherited colonial policies and priorities still dominate the way of doing things, including Research.

THE INSTITUTIONS

Pioneer research institutions in Uganda date to the early 1920s and were largely concerned with increasing agricultural output of cash-crops of particular interest to Great Britain, the colonial master then. It was only in the late 1960s that the post-independence Uganda government made an attempt to regularise research activities, forming the National Research Council (NRC) in 1969, to oversee financing of research in Uganda. (Opio-Odongo 1993). Under-funded and generally ineffectual, the National Research Council (NRC) was a fig-leaf for the government's general apathy to research. Subsequent years (1970-90) removed doubts about governmental position on research-development; little research was done during this period.

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An economic revolution in the 1990s and the prior increased interest in developmental issues as a result of several landmark advocacy efforts (Brundtland Commission, the Lagos plan of Action, the Bali declaration etc), as well as the end of the cold war, led to increased funding towards development issues. Action for development called for policy-research; thus a lot of research during this period in Uganda was related to policy-research in social development, and many research institutions have consequently sprung up during the 1990s.

The last inventory of Research and S&T related institutions in Uganda revealed a considerable increase in the number of institutions (123) (Bennett, J.G. 2000). The increased number of research institutions and interest in research led to efforts to streamline the research activities. The indolent National Research Council metamorphosed into the Uganda National Council for Science and Technology (UNCST) in 1990, underlining a reawakening to the importance of S&T in development. The UNCST was formed by an act of parliament, Statute 1 of 1990, which also spells out the mandate of UNCST; this statute.

Empowers the UNCST to provide a central mechanism for rationalising the integration of Science and Technology into the national socio-economic development process, by advising government on all matters relating to Science and Technology for development of National Economy.
(Mugoya, 2000; 145)

The recognition of the role of S&T in development is further underscored by the Vision 2025, Uganda's blue-print for long-term development; "S&T has been recognised in national development-strategy as a clear avenue for Uganda to leap forward from an agrarian to an industrial economy" (Mugoya 2000; 143). However the encouragement of this interest, and the increased inventoried research institutions should not engender a false euphoria! Beleaguered by organisational problems, under-funded and understaffed with less skilled personnel, most of the research institutions are weak, proof of which is the derisory research output. In a period of ten years, for the whole of Uganda, the number of research publications was less than two hundred! During the same period the number of patents applied for were forty (and we are not even talking of breakthrough inventions). The liberalisation of education, as a result of structural adjustment, has seen the emergence of 11 universities in the last eight years. These are budding institutions and are yet to contribute substantially to research. The two national universities; Makerere University Kampala (MUK), and Mbarara University of Science and Technology (MUST) have seen government-funding slashed drastically reflecting a shift of donor-support to primary education.

Universities have always been bastions of Research in S&T, but Uganda's universities have often been accused of an ivory-tower mentality, of doing research that was disarticulated from the realities of their society. They have further been accused of being more concerned with international accreditation than with responding to local needs (Opio F 1998, Opio-Odongo 1995). University-based researchers have consequently been regarded as being too theoretical for policy-research and this has led to difficult working-relations with other policy-makers. University output in terms of graduates has increased by 30% (1990 to 2000), however single digit PhDs (less than 8 annually) and double digit M.Sc./M.A are still too low to create a critical mass of researchers. Moreover, most of these graduates are quickly absorbed in mainstream employment. The practice of pegging university career-advancement on scholarly (Research) output seems to have been largely ignored in Uganda: partly because there are few regular journals and other publication-media, partly because of the overload that lecturers face (despite increased under-graduate numbers, there is still a ban on recruitment of staff, as a result of structural adjustment policies since 1996). The reluctance to do research and publish is further encouraged by an attitude that once one gets his/her doctorate, then there is little else to prove. It is not therefore surprising to find Doctors, whose last publication was their thesis, heading research institutions.

Slightly divorced from the world of academia, and generally better funded, are the sector-based "mission" research institutions: the National Agricultural Research Organisation (NARO) comprising seven agro-specialised research institutes, the Uganda Investment Authority (UIA), the National Environmental Management Authority (NEMA), the Uganda National Health Research Organisation (UNHRO) and the Uganda National Bureau of Standards (UNBOS).

These research organisations are legally constituted and form the backbone of government research-policy. These institutions are run, and funded by the ministries to which they belong, as well as donors 'interested' in the work they do. The knowledge that has been generated by these research organisations has not really trickled down to the grassroots communities, mainly because of knowledge-sharing and management weakness in the research-system and a lack of multidisciplinary approach. Better- yielding seeds are, for instance, developed, and it is simply assumed that grassroot communities will adopt them; which they do not, because of social norms and other aspects that would better be understood by a social scientist: Thus the need for the natural- science researchers to work with the social scientists. Efforts to diffuse research-knowledge to grassroots, through joint outreach and partnership initiatives by 'mission' research institutions and social research institutions, have been initiated. It is still early to assess their success.

Private-sector involvement in research has been limited. The other research-institutions are independent and struggling, grappling with a system that has not yet fully realised the importance of research. These NGO-like research institutions depend on donor-funding for commissioned research, which unfortunately is reducing in importance. In an effort to strengthen themselves and hence to have a better bargaining power, thirty-two research institutions formed a coalition of researchers: NURRU the Network of Ugandan Researchers and Research Users. NURRU had early serious organisational problems of mismanagement that led to donors withdraw funding (Rugumire-Makuza 2001). After restructuring, NURRU has re-launched an open call for research-proposals, mostly in the social sciences. In the social science arena, notable institutions are the Centre for Basic Research (CBR), Makerere Institute for Social Research (MISR) and the Economic Policy Research Centre (EPRC).

Perhaps the most important institutions in research, in Uganda, are the funding agencies: by their capacity to influence the research-agenda and the rules of the game. Uganda has benefited from donor-funding, especially on poverty-eradication research, from the OECD countries. Of particular note are Sida-SAREC, DANIDA-ENRECA, UNDP, IDRC, IFAD, GTZ-DAAD, Rockefeller Foundation, RAWOO and the Dutch Ministry of Foreign Affairs, DFID/ESCOR, USAID and

Box - 1: Institutional Profile of S&T System of Uganda

Function	**Institutions**			
F1	Office of the President	Parliament	Cabinet	Ministries
F2	Uganda National council of S&T UNCST	Mission Agencies NEMA, NARO, UNHRO	International Organisations UNESCO ASARECA	
F3	**Public R&D** Institutions; Universities, Polytechnics…	**Semi-public R&D** Uganda Management Institue	**International R&D** IIATA, CIAT	**Private R&D** NGOs, Private Universities
F4	**University Based Institutions;** MISR, EPRC		**Others** USSIA, Central Materials	
F5	**International Donor Agencies:** IDRC, IFS, Rockefeller..		**Ministry of Finance**	
F6	Regulatory and Standards Bodies UNBOS, UIA, URA			

many others. These institutions have not only determined what research to do, but also who does it, the way it is done, and the policies that emanate from the researches. This has not always been good for Uganda. The nefarious effects of this will be discussed in the issues. What we cannot ignore is that research institutions can only be as good as the people that are involved: because organisations only learn through individuals who learn.

RESEARCHERS

"The active force in any organisation is people. All the other resources are only tools" affirms management guru, Peter Senge, in his book 'The fifth Discipline'". Research Networks, research infrastructure and research environment can only deliver 'good' research, as good as the researchers involved. The UNDP Human Development Report on S&T (2002) places Uganda at the 150th mark in S&T out of 173 countries. For every million Ugandans, only 25 scientists and engineers are available. Opio-Odongo (1995) laments the quality of researchers; the junior researchers lack creativity and are not well tooled in methodology, while the senior ones have poor understanding of policy-issues.

The lack of researchers and the poor quality are a result of a colonial educational system that created elitist tertiary-education institutions that were used as a 'pivot centre of separating the underdogs from the elite' (Opio F 1998). Consequently, the number of undergraduates has been deliberately low. For a long time, a Bachelors degree was enough to gain employment, consequently thus seemed little need for postgraduate studies. It is only recently, with the liberalisation of the education sector, that there has been an increase in output at undergraduate level as a result of new universities opening up. Doctoral output from Makerere University confirms this; less than 8 PhDs per annum for the last ten years. Those who find their way into research are even less: a comparative study of S&T capacity in East Africa found that 9% of the researchers had doctorates, 15% M.Sc./M.A and the rest had B.A/B.Sc. 75% of the researchers were male! Yet Olsson (2001; 250) reminds us of the importance of doctoral studies in research: "doctoral [students] are important for the implementation of research as well as for the capacity of the institution to reproduce 'its own capacity'".

The lack of a critical mass of researchers and scientists poses a serious challenge for local research capacity development, and by the look of things, this trend is likely to continue until research commands its due respect. For most researchers, research is not a job or a vocation. It is a stopgap, as they look for 'better things to do'. For others yet, especially from government institutions and academia, it is simply another means of supplementing their incomes. A Ministry of Finance, Planning and Development survey (MFPED 1999) found out that researchers were;

- Underpaid, overworked and appeared to have low social status,
- Isolated from international research and,
- That there was little or no research training for personnel and supporting cadres.

Demonstrably the research conditions are far from being encouraging in Uganda. What makes this picture bleaker, is the distribution of researchers…Poverty challenges and social research are better funded and hence have more researchers, often at the expense of vital areas to science. Enos. J (1995) on Makerere University clarifies:

"Particularly deprived is the Mathematics Department. With an 'establishment' of 13*, the mathematics faculty (sic) has been able to attract and retain only* 4 *mathematicians, of whom two are former graduate students, who have not progressed beyond the level of M.Sc. Two professional mathematicians, trained abroad, and two local ex-graduate students are a dreadfully inadequate body to teach a subject which is the basis for all the scientific and technical fields…."*

"…without the supplement of their salaries […] the mathematicians must seek part-time employment outside the university…as accountants".

(Enos J. 1995; 144)

Additionally most of the research institutions we visited had no research-training component in their activities. "Unless that component is explicitly included in the terms of reference of the research project, we can not afford to train" confessed one research institution Director.

ISSUES AND CHALLENGES

Uganda is at the crossroads of its Development destiny. Policy-research is crucial if Development issues are to be addressed. "Lack of sufficient analytical capacity in the South has often been cited as the cause for Development policy failure" Ng'ong'ola & Suresh (1994). Susana Moorehead, the Head of ESCOR of the Department For International Development of Great Britain, puts it more succinctly: *New ideas and sound evidence are essential tools in reducing poverty. Good research, targeted at the right audience in a timely manner underpins successful changes, policies and behaviour. At a time of transition, knowledge is the vital ingredient that will affect the impact of globalisation on people living in poverty. The impact of government funding for research on poverty is crucial*.

(Moorehead 2001).

The case for supporting research is clear, its funding unfortunately is not. Neither the donor community, nor the private sector nor government is contributing enough towards R&D. Uganda has only increased its spending on R&D to a paltry 0.8% of its GNP.

Related to the poor funding of research, is undue influence by donors in priority-setting. This becomes critical where a researcher from the north is involved and his country has contributed substantially to the research. The power relations in such a case are that, in deference to the researcher or more important to the money involved, the results of the research become policy.

Any research, however 'good', will always have its limitations. If research is going to inform policy whose potential impact may go beyond generations, then it is wise to have multiple views. In Uganda we have had cases where a single research became policy, and the limitations are beginning to show in the implementation of the policies. This raises the question of 'ownership' vs. 'partnership' in setting research agenda. Research 'ownership' has often been cited as the way to increase participation and ensure long-term benefits to the local communities. The case for partnerships is also strong, as far as knowledge- management and sharing of scarce resources are concerned. Striking the right balance is a challenge that Ugandan research faces but which at the same time represents an opportunity of growth.

Table - 1: University Enrolment for Undergraduate Courses 1995/96

University	Male	Female	Total	%
MUK	1830	957	2787	82.2
MUST	77	18	95	2.8
Islamic Univ.	136	57	195	5.8
Ndejje	12	1	13	0.3
Uganda Martyrs	29	39	68	2.0
Bugema	30	16	46	1.4
Nkumba	76	76	152	4.5
Namasagali	18	16	34	1.0
Total	**2210**	**1180**	**3390**	**100.0**

Table - 2: University Education: Full-Time Academic Staff in MUK

Position/Gender	males	Females	Total
Professors	48	3	51
Associate Professors	60	6	66
Senior Lecturers	179	28	207
Lecturers	233	85	318
Assistant lecturers	91	22	113
Total	**611**	**144**	**755**
%age	80.9	19.1	100.0

Research in Uganda, especially in the social sciences, has been the 'quick and dirty' short-term kind; baseline surveys, rapid rural appraisals…etc. Certainly, this kind has its merits, but there is need to take a long-term perspective on R&D. Unfortunately, research-funding has often been averse to supporting long-term research. Connected to this, is the concentration of research-resources on limited research-themes, at the expense of other equally vital areas. It can be argued that resources are limited and, therefore, not every research can be funded, but experience is such that in research, there is wasteful duplication of efforts, multiple donors-funding the same type of research. This has often been the result of research following Development fads.

In Uganda there are inherent constraints in the R&D system. Mugoya (2000) pointed out some of these constraints:

- poor management-skills, as a result of political appointments, where the skills do not fit the job;
- poor remuneration, leading to survival-mechanisms such as economic rent-seeking, corruption and poor accountability.
- poor work-culture that promotes nepotism as a way of protecting mediocrity.

Bennet J (2000) points out lack of the necessary legal framework for S&T to be effective. Additionally, he says 'Uganda's S&T policies are too ambiguous and one fails to see how the 'plethora of S&T, R&D issues can be operationalised'. This can be explained by a weak UNCST. Although the Uganda National Council for Science and Technology (UNCST) is slightly better than its predecessor, the National Research Council, it still lacks both the intellectual and political clout to be really effective. For an organisation that pretends to "advise government on all matters relating to S&T, R&D for Development', its budget and personnel are painfully inadequate.

Another issue in Uganda, is how to deal with research-output: most often it has been left to gather dust on shelves of the research institutions that are involved. Dissemination is perhaps the weakest point in research practice in Uganda. Scarce funds to publish, arrange exhibitions, seminars and workshops, as well as lack of journals in which to publish, have affected scholarship. For many junior researchers, the opportunity to see their names in print would be enough motivation to stay in research. Recent developments in ICT, with the help of donors, have however enabled researchers to access online journals.

Another challenge has been the poor remuneration and lack of incentive systems in research. This has led to the massive brain-drain from research to less challenging but well-remunerated jobs. The main culprits have often been international NGOs. It is common to find a highly qualified scientist working as a data clerk for an NGO, because the pay is good and he/she has to put bread on the family table.

Notwithstanding these challenges, research in Uganda has evolved remarkably well in the last decade. Increased support, through increased funding, development of research networks and support of institutions as well as researchers, would concretise efforts. S&T is the motor that will lift Uganda out of poverty and thus ensure Sustainable Development.

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EMERGING DIRECTIONS OF R&D COMMERCIALIZATION IN PCSIR

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ABSTRACT

Development of commercializable technologies in Pakistan is a formidable task. Reduced public-sector funding for routine R&D has necessitated the emergence of participative investment by the end-user industrialists and entrepreneurs. ISO regulations on industrial quality-assurance and the competition threats posed by WTO to the national industrial base are conducive for investment in R&D on commercializable technologies. Under such a scenario, our national industrial base is faced with stiff challenges from international competition for their survival. Innovation is widely recognized as a key-element for national industrial competitiveness. Traditionally, the amount of R&D carried out by the private sector in Pakistan has remained negligible on the scale of international standards. Within this background, PCSIR provides the necessary base for encouraging SMEs to invest in the development of technologies that are suited to indigenous materials and local conditions. Linkages for such type of arrangements are possible through institutional clusters of cooperative business technologies and through business mode of technology-incubators. Such arrangements have been successfully operated in several developing countries. Venture-capital investment by SMEs is suggested for incubation of technologies at the pilot-plant facilities of PCSIR and their eventual graduation into the industrial sector. A mechanism of implementation based on the so-called Third-Generation R&D is proposed for extending a variety of technical services by PCSIR.

INTRODUCTION TO PCSIR

Pakistan Council of Scientific & Industrial Research (PCSIR) had its beginning in 1949, immediately after the inception of Pakistan in 1947, as the Department of Industrial Research. The Department was given its present name in 1953. Despite numerous constraints, however, PCSIR continued to contribute to the realization of objectives of its charter. A major policy decision was again taken in 1973 when around PCSIR was created the Ministry of Science & Technology (MoST). PCSIR, at present, is the largest applied/ industrial R&D organization in the country. Starting with PCSIR as its only R&D council, MoST now has under its folds more than a dozen autonomous councils, institutes and a science foundation, covering a wide spectrum of S&T disciplines. PCSIR, nevertheless, continues to be the ministry's largest R&D body receiving the largest chunk of its budget and employing almost the same proportion of technical manpower.

PCSIR has four multifunctional research laboratories in Karachi, Lahore, Peshawar and Quetta; Karachi and Lahore are by far the larger and therefore set-up in the structures of "laboratories complexes". A wide-range of S&T disciplines are organized into quasi-independent Centres/Divisions, such as Applied Chemistry, Minerals & Metallurgy, Glass & Ceramics, Food & Biotechnology, Environment Protection, Medicinal Botanics, Fine Chemicals & Pharmaceuticals, Rural Technologies, Instrumentation & Electronics, Research Industrialization, Polymers & Plastics, Marine & Applied Biology. The monofunctional units include National Physical Standards Laboratory at Islamabad, Fuel Research Centre at Karachi, Leather Research Centre at Karachi, Solar Energy Center at Hyderabad, and Fruit Processing-cum-Demonstration Unit at Skardu. Also, there is a Scientific Information Centre at Karachi; the Centre, in addition to other information-related matters, puts out, now in its 46th volume of publication, the Pakistan Journal of Scientific & Industrial Research which publishes articles from national and international contributors after international refereeing. The trained-manpower needs of the industrial sector are met through two centers in Karachi, viz., Pak-Swiss Technical Centre for middle-level technicians, and the National Institute of Industrial Electronics Engineering producing graduate engineers. The administrative headquarters are located at Karachi, with the Chairman's Secretariat at Islamabad.

The charter of PCSIR activities, in general terms, relates to providing a broad base to the industrial

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sector, through better utilization of indigenous resources. These may be categorized as:

- Optimum utilization of indigenous raw-material resources for the development of industrial processes.
- Development of technologies around local resources, from bench to pilot-plant stages, and leasing them out for industrial exploitation, leading to import substitution and export-enhancement.
- To conduct R&D work on problems faced by the industrial sector and maintain linkages with the industry through advisory services.
- Dissemination of technological knowledge through seminars, workshops, publications and provision of services to academic institutions.
- To undertake cooperative research, with local and foreign R&D organizations, on projects of mutual interest.
- Training and grooming of manpower for industry and research centres to create a sound S&T base in the country.

Over the years, the primary target of PCSIR scientists has remained the development of low-cost technologies attracting the attention of small and medium-level entrepreneurs (SMEs), since this class of investors is internationally recognized to be the backbone of economies in developing countries. The number of technical processes developed for such SMEs is well over a thousand. A survey carried out in the 1990s indicated that out of 84 technical processes developed until 1990, 367 were leased out to SMEs. These were estimated to turn over Rs. 612 million to the national economy, which in terms of foreign exchange savings amounted to Rs. 7 billion. The spin-offs, such as job creation and down-stream industries, remained unaccounted for within the scope of this survey. In addition to these technical processes, the organization's scientists have obtained about 350 patents and contributed more than 5000 research publications in national and international journals. In the domain of human-resource development, the number of Ph.D. and M. Sc. research theses supervision is well over a hundred and a thousand. PCSIR is also running its own degree- awarding Institute of Industrial Electronics & Engineering, and a diploma-level Technical Training Centre. The number of graduates and trainees from these institutions runs into thousands. As the principal national R&D facility, PCSIR is extending advisory and technical services to various ministries and public- sector organizations. It is also playing its due role in enhancing the national self-reliance capability in the production of much needed defence-related supplies.

Analytical and technical reports issued by the PCSIR scientists have gained international credibility and acceptance. Among the specific recognitions accorded to PCSIR are by Saudi Arabian Standards Organization, Japanese Ministry of Health, ISO- 9001 and ISO-17025. This facility is being used by importers and exporters for the quality-certification of products in large numbers, which on a daily basis ranges between 80-100, collectively at the various PCSIR laboratories located in different parts of the country. This activity is particularly relevant, since Pakistan is a signatory to the General Agreement on Tariff and Trade (GATT), and to the rules and regulations of World Trade Organization (WTO). With the likely implementation of WTO by the year 2005, PCSIR is destined to play a very vital role in quality-certification of Pakistani products of export.

FIRST GENERATION R&D

The mechanism of technology-development in PCSIR has remained, what is typically dubbed as "First Generation R&D". Researchers in this system operate in isolation, having little or no linkage with end-users. Budget provisions are made for the total project-framework. The research operator receives little or no guidance from the top management in the defining, development and conduct of projects. The researcher is not pushed for a time-frame. The finance allocators view the activity as a generally wasteful input. The non-scientists industry outfit vs. the research scientist are locked in a continuous debate to under-rate each other's perceptions and contributions. The business community believes that researchers lack appreciation of the technology-needs of the industry, that they are strong-headed and not prepared to communicate, and that they lack confidence in putting their research-findings to a test. Researchers, on the other hand, believe that any industry-targetted research-objective kills in them the motivation to explore new frontiers of knowledge, that administrative and management disciplining hits at their creativity potential, and that predicting a time-frame for completion of projects is not possible. With a few exceptions, indeed, the psyche of researchers and the managers in the industries/commerce in developing countries, including Pakistan, is a typical reflection of the fundamentals of first generation R&D.

Whereas significance of creativity, intuition and spatial reasoning, as the basic elements of the first-generation R&D management, are un-questionable, yet there are serious concerns when these are followed unbridled. Difficulties, for example, may arise when R&D is pursued, without the nod or commitment of an end-user, since, on completion thereof, the linkage with the one prepared to take it up and commercialize may be difficult to establish. The developed technology may then have to wait on the shelves for unspecified periods, or may be traded off haphazardly, or sold to the industry at throwaway fees. From the management point of view, another difficulty relates to measuring the results; in simple words the R&D progress-evaluation tends to be ritualistic. This is experienced, owing to vaguely defined objectives, such as: “the project, on completion, will render the process cost-effective”, “process-innovation will increase output”, “use of indigenous raw-materials will reduce the import bill”, “it will help augment exports”, and so on. All these claims are insufficiently defined output, against which the progress of the R&D project may be realistically weighed. The review ultimately can, at best, relate the output to technical achievements, usually in the shape of research papers and reports. But this, for the end-user in the industry, means little or nothing at all.

EVOLUTION OF THIRD-GENERATION R&D

Internationally, the First Generation has evolved since long, via the Second Generation, to the commonly known Third Generation R&D. This has been mainly due to the continued stripping of R&D funding from the public sector budgetary provisions. Finance planners all over the world, when considering resource mobilization for S&T, are now invariably raising the issue: how will the society benefit from investments made in R&D? This in fact reflects their gut-feeling of fear that the technology outflow may not be commensurate with the allocations made. From their perspective, the concern has a merit in the void of a defined benchmark to measure the often invisible and indirect but benign contributions that accrue from S&T research. An acceptable tangible, now recognized, is the level of real money or in-kind participation in R&D efforts that flows-in from various players in the game. A manifestation thereof in the technologically developed countries is evidenced in the corporatized R&D, having a holistic strategic framework.

The concept, generally dubbed as the “third generation R&D management”, is based on the philosophy of partnership that breaks isolation of researchers from the user and integrates R&D with business strategies. The operating principles in such a scenario are:

a. *Technology Selection*: depends upon national priorities, maturity status, competitive advantage and absorption capacity.
b. *Funding*: based on expected financial impact, balance of risk and reward.
c. *Target*: all R&D to be well defined and consistent with business, output and technological objectives.
d. *Priorities*: affordable on cost-benefits balance-sheet and contributive to strategic objectives.
e. *Output Measurement*: quantifiable realization of objectives, relevant with benefits to the society, and the commercial output measured against technological expectations.
f. *Progress Evaluation*: regularly, according to milestone setting, schedules and dictates of external and internal indicators.

The emerging direction evidently alienates the hitherto held view on the convertibility of wealth into knowledge through government patronage at the expense of tax-payer’s money. The very idea of selling knowledge was then generally viewed as anathematic. This encouraged ad hocism in project selection centered around ego-satisfaction of scientists, generally with little regard for the stakeholders and end-users. However, the changing economic patterns, political realities and greater awareness on spendings led to submission of such directionless pursuit of knowledge to valuation of the worth it will generate on measurables. This has influenced the change in S&T orientation. The culture thus evolved has introduced elements of sensitivity to client-needs, significance of time-constraints on the resolution of problems, judgment on the interpretation of observations and a commercial awareness of revenue and costs. The spawning of R&D corporatization was the evident corollary, which has a scope, with special reference to Pakistan, as the future direction of R&D commercialization.

To summarize, the third generation R&D is typically characterized by the following. The latest stage in the evolving concept of R&D management seeks to create a balanced portfolio, jointly conceived, developed and executed, in a spirit of partnership between the business-manager, administrative managers, and the technical managers. The theme of management is strategic and purposeful, with a corporatized outlook. Fundamentals of the approach reflect the following characteristics:

- Responsive to the existing technology-needs of the business.
- Exploitation of the existing technology-opportunities.
- Identification of new commerce-oriented technologies.
- Strategic and operational partnership between technology-developers and users.

The concept of third-generation R&D management, having evolved from the first, through the second generation, is an improvement in the following aspects:

- The spirit of cooperation between different operators of the project jointly explores, assesses and decides on the management of the project, leading to the creation of mutual trust among them, and so the partners are willing to share gains and losses.
- Partners remain motivated and involved, as key-players in their respective areas of responsibility, resulting in better-quality decisions during implementation phases.
- Execution in a horizontal sliding-matrix provides holistic view on the entire range of segmental R&D activities, enabling recognition of the ongoing strategic dynamics and the risk-component, on account of different uncertainty elements.
- Isolation of the researcher is broken, through interaction within the group, with other groups working in the R&D portfolio-range of the organization, and in general with all other managers somehow connected with the project.
- Integration of the operatives of plan-execution, sharing of collective experience, and access to information is helpful in exploiting the technological synergies that may emerge, thus providing a suitable base for continuity of achievements.

It is significant that the third-generation R&D still views academic research as the forerunner of industrial research. Whereas the approach provides sufficient motivation for creativity to researchers, it also introduces a sense of purpose in their pursuits, through the introduction of short-term business-oriented targets, rather than mere ramblings in the dark in the quest for knowledge. The following mechanisms introduce the requisite constraints for the maintenance of vision and mission in place.

- Relevance and importance of the predominantly fundamental research-objectives to the R&D financing partner within a defined period, say in 5 or 10 years.
- Availability of the technical manpower-threshold necessary to convert research-findings into a commercial technology.
- Resource-mobilization potential and availability of cash-flow for commercialization.
- The priority domain of the technology likely to develop from the academic research.

STRENGTHS OF PCSIR FOR ADOPTING THIRD-GENERATION R&D MODE

PCSIR is particularly strong to attract industrial linkages through “Third Generation R&D”, as evident from what it can do in the following areas.

- Expertise to develop small to medium-scale processes, procedures and technologies.
- Facilities to evaluate and test raw-materials and finished products.
- Competence to undertake quality-control and standardization of industrial products and unit operations.
- Experience of extending trouble-shooting services to industry.
- Experience of repair and maintenance of instruments.
- Expertise to extend consultancy-services and undertake feasibility studies.
- Excellent track-record of technical training for human-resources development.

- Availability of pilot-plants for testing of technologies.

VENTURE AND RISK CAPITAL

The above-stated strengths are sufficient indicators for PCSIR to embark upon various innovative approaches of technology commercialization. Among these are the mobilization of venture and risk-capital by SMEs. This initiative is being taken, in consideration of the following current impediments to commercialize PCSIR technologies.

- SMEs are reluctant to invest in untested technologies.
- Venture-capital is not available.
- Risk-factors are too high for SMEs.
- Service mark-up on loans is high and not manageable.
- Capital costs for development of industrial operations is prohibitive for SMEs.
- Importation of black-box technologies is easy.

The following stages are particularly relevant for start-up ventures by SMEs. As the technology-market grows, new ideas normally come from research and development scientists and engineers, who try to solve technical problems. As technical problems are being solved, new ideas are generated for the development of new products. All ideas internal to an industrial outfit go through a close examination and scrutiny, in order to make sure that they match with the commercialization strategy of the industry. As the industry grows, its operations diversify and its needs for R&D expand as well. It may happen that certain category of R&D is outside the scope of a certain SME company’s strategy. Frequently, such technologies will be scrapped or ignored by the SMEs administration. The R&D team will then start to look for another SME or modify the technology to suit the product-portfolio of the company. In most of the cases, new ventures are started up by a group of engineers or technologists.

The following are the steps that a new venture goes through to develop, or continue to develop, the product that has been conceived. Marketing will then become a critical activity that needs to be managed. For a new venture at this stage, a marketing executive is needed to manage marketing-programme. As soon as marketing-programme is formed and activity is started, then there is a need for capital to support the operation. A detailed and well thought of plan is therefore needed in order to raise funds to finance the operation. At this moment, a financial consultant is needed to help structure the company in such a way that supportive investors get attracted. Because an entrepreneur normally lacks financial experience, he or she would be put in an inferior position in negotiation with investors. This is the stage when the need for a well organized technology business-incubator becomes critical.

TECHNOLOGY-BUSINESS INCUBATORS

There is increasing emphasis around the world now on strategies and instruments for promoting innovation and creating entrepreneurial ventures. In this context, technology-business incubators are showing evidence of effectiveness in creating growth-potential enterprises, employment incomes, technology commercialization and other benefits. These managed workspaces are growing rapidly in the industrializing countries as well as those in transition to open markets. A recent phenomenon is the sharp increase in internet incubators, based on the concept of venture and risk capital. Technology incubators are longer-term, capital intensive, real-estate driven investments, which take advantage of proximity to sources of intellectual capital and conducive infrastructure, to promote scientific research and its utilization. In many Asian countries, the trend is towards the convergence of services for holistic support.

In recent years, both governments and donors are scrutinizing business-development services for small enterprises, in order to enhance their performance and raise cost-recoveries for different types of support-facilities that are provided in these incubators. An emerging view is that governments should develop supportive policies and business-infrastructure, while private agencies provide the actual training, counseling, information, networking and related services in a business-like manner. It has to be appreciated that the start-up and early-stage businesses in difficult environments require access to good support for management-related activities, technology and infrastructure, all within the context of their very limited financial resources. In most countries, both rich and poor, initial governmental support is needed for management, technical and infrastructure-support for early-stage businesses, but it must always be with the objective of moving towards a sound level of self-sustainability after three to five years.

The rationale for the incubator as an economic-development tool is generally as follows.

- Facilitating transition from command to market economy.
- Mechanism to promote technology-commercialization.
- Promoting synergy within and among businesses.
- Reducing costs and consequences of business failures.
- Modifying the cultures of risk-taking, teamwork, networking, information sharing.
- Helping reduce market failure, e.g., the lack of affordable, divisible work-space, facilities, services, access to finance, information and other resources.
- It must be realized, nevertheless, that government support makes sense in specific conditions, such as listed below:

– When it helps overcome market constraints, improves access to information not freely available, reduces proportion of failed firms.

– Becomes a visible symbol of the state's commitment to SMEs.

– Is limited to initiate the incubator-establishment process:
  not new building construction but a renovated or rented space,
  not a continual subsidy but till operations are stabilized.

– When an incubator is an extension of the state's role in providing public goods: knowledge, research, technology transfer, infrastructure.

– Incubators have helped address some of these problems.

It is also appropriate to indicate the justification for public investment, which is as follows:

- Creation of jobs (direct & indirect) per unit public subsidy.
- Taxes paid by corporations and workers per unit subsidy.
- Income, sales and exports generated for community and country.
- Disadvantaged groups empowered.
- Client (incubator tenant) satisfaction at services received, common costs saved, faster time to market.
- Public satisfaction at demonstration of commitment.
- Partner (private) satisfaction at return on investment.
- Promote innovation and entrepreneurship as prime forces in new economy.

VARIANT VERSION OF TECHNOLOGY-BUSINESS INCUBATOR PROPOSED BY PCSIR

There is a great deal of interest in many countries in the contribution made to the economy by the small and medium-sized enterprises. These enterprises not only contribute towards employment but also a sizable proportion can grow to become future large corporations, which form the mainstay of any economy. Because of this, business incubation is now recognized as a very important part in any economy. Business incubators are the institutions that help newly starting enterprises to overcome the difficulties encountered during their vital early stages.

There are many difficulties that start-up SMEs frequently face. The most common among these are: financing, marketing and working out proper business-plans. Many entrepreneurs, owing to lack of experience in business-management and operations, lack of technological skills, and of the ways of marketing and financing their products have caused their businesses to fail. A lot of studies indicate that if such enterprises had access to proper technical and financial assistance, the failures could have been avoided or at least minimized. Business incubators are the organizations that help small enterprises to overcome the factors that cause failure in most start-ups.

There are quite a few definitions given to business incubators; the following is a general definition: "a business incubator is a systematic work-space where new SMEs cluster and share service items necessary for their growth; an ideal technology-business incubator has all the needed facilities within one work-place". The systematic space includes tenant enterprises, management and service institutions, R&D matching for the development of compatible technologies, and business-operation environment. The tenant enterprises are the objects that a business incubator supports. They are the sources of job-creation, technological innovation and technology-commercialization. The management and technological service institutions are operated by and holdings of the business incubator. They provide various services necessary to the growth of the tenant enterprises. The business operation environment refers to the physical space and shared services required for the R&D and business activities of the enterprises.

Among the most important futuristic initiatives for the commercialization of technologies, PCSIR is planning to take a bold decision of setting up a variant version of Technology Business Incubators (TBIs). Through these TBIs, PCSIR is aiming at popularization of its technologies in an innovative approach. These TBIs will function as pilot plants for the demonstration of technological processes developed by its scientists. These are anticipated to attract venture-capital from SMEs in the environment of a science and technology cooperative mode. The approach is being designed to attract such SMEs who are either shy of investing in untested technologies or do not have sufficient venture-capital resources of their own. On successful completion of this endeavor, PCSIR hopes to spearhead a new wave of small and cottage-scale industrial entrepreneurship in the country. This will create a large volume of job-opportunities, generate several spin-off industries, and make a worthwhile contribution to the growth of national economy. PCSIR has decided to opt for this kind of operation, since:

- Several hundred small technologies/processes have been developed by PCSIR.
- Many PCSIR technologies are sitting on laboratory- shelves waiting to be commercialized.
- PCSIR plans to extend these technologies through “technology business incubators”.

The proposed mechanism of commercialization of technologies through business-incubators will have the following salient features.

- PCSIR will demonstrate viability of the developed technologies on pilot plants to prospective SMEs.
- After successful demonstration, SMEs will be encouraged to develop a partnership with PCSIR:
  - at the technical facilities of PCSIR;
  - under the supervision of PCSIR experts;
  - cost of raw materials to be paid by SMEs;
  - cost of utilities to be paid by SMEs;
  - marketing potential to be explored by SMEs.
- Graduating technologies to be industrialized by SMEs.
- PCSIR to continue providing technical support for quality-control of products.
- Products to be marketed with logo/trade marks of PCSIR/SMEs.

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S&T CAPACITY-BUILDING FOR SUSTAINABLE DEVELOPMENT IN THE ENGINEERING AND INDUSTRIAL SECTORS

*Zahid Aziz**

ABSTRACT

The major stimulus to the economic growth and development of rich countries has been their reliance on engineering to produce plant & equipment. This, in turn, provided them with a sustainable base for creating employment-opportunities and raising their standards of living. In the wake of WTO, we need to identify our tangible standing vis-a-vis the competitors and the world around us. The world trade competition is posing a serious threat to our local industry. It is in this perspective that we have to fall back on the engineering and manufacturing sector to chalk out a road-map towards sustainable development.

The key ingredients for capacity-building are Human-Resource Development enabled with technological upgradation, keeping in view the environment-saving elements. LDCs have shown an increasing preference to adopt the proved Euro-American Model of broad-spectrum industrialization as a panacea for expeditiously solving the problems that arise out of poverty, illiteracy, rapidly expanding populations, with diminishing food / energy-resources.

Keeping in view the above scenario, an evaluation needs to be done on our part as to what has been done so far by the Ministry of Industries & Production to Address this issue and how successful have we been in our efforts through using instruments like tariff rationalization, technical education, quality standards, regulation and deletion programs.

SUSTAINABLE DEVELOPMENT

Sustainable industrial development can be defined as a pattern or patterns of development that balance a country's concerns for competitiveness, for social development and for environmental soundness[1]. Sustainable development is based on the principles of participation and partnership between international organizations and governments; between central and local government; between government, private enterprise and non-governmental organizations; between communities and women and men in households. It requires a clear understanding of the different capacities and potentials of each stakeholder and their needs for support and incentives that will enable them to play a full and progressive role in the planning and management of development.

Economic development is crucially dependent on industrial development[2], both with respect to the industrial sector's pivotal contribution to economic growth, as well as the structural transformation of an economy. Also, social development is strongly impacted by industrial development. Often, industrialization is seen as a motor behind many of the processes usually termed "social transformation" and "modernization". More specifically, there are at least three ways in which industry helps to achieve the goals of social development:

- Industry's substantial contribution to economic growth helps to create a large portion of the resources needed to fund social-development programs;
- Creation of employment and hence generation of income take place in the industrial sector directly, and are indirectly fostered in other sectors — like agriculture or services — through their linkages to industry;
- Industry promotes various aspects of social integration, through its general thrust towards modernization, and makes a specific contribution to the integration of women by way of productive employment.

Industry provides a typical example of a sectoral aspect of sustainable development: industrial issues — cutting across the environmental, economic and social dimensions — figure prominently in the sustainability debate.

Environmental constraints to development are acutely felt in the industrial sector, in relation to both production and consumption of manufactured goods. Here the key to solving many of the problems lies in technology. Remedial policy-measures are needed to reduce or eliminate such effects. The response of industry to such policies is, in almost all cases, of a technological nature. Hence industrial technology and

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its continuous innovative change, if properly shaped by market and policy incentives, make an important contribution to solving the environmental sustainability problem.

Development managers and planners must recognize the fundamental need for the integration of economic, social and environmental planning.

THE GLOBAL PERSPECTIVE

Humans are conducting an uncontrolled experiment, unprecedented in scope and scale, that represents the reversal of natural evolution which produced clean air and water and increasingly complex and diverse ecosystems - systems that made human evolution possible. These changes, a result of unsustainable and inequitable patterns of production and consumption, are likely to accelerate with the addition of 81 million people to the planet each year. We are a society living off its natural capital, not its income. We are acting like a planet in liquidation.

Current strategies to meet human needs are not sustainable. Around 1.5 billion of the world's population is below poverty line. Eighty percent of the world's resources are being consumed by 20 percent of the world's population. The world's poorest 20 percent earn 1.4 percent of the world's income. The world will need an unprecedented 2 billion jobs in the next 20 to 30 years in order to employ the current 800 million underemployed and unemployed people and the new job seekers who will enter the market[3].

While it is necessary to build and enhance strong scientific and technological capacity in all regions of the world, this need is particularly pressing in developing countries. The responsibility for building and maintaining this capacity lies squarely on the shoulders of national governments, but requires significantly enhanced collaboration and partnerships with the private sector, the global development assistance community and the science & technology community.

WHERE DO WE STAND?

The Pakistan Government has committed itself to sustainable development, aimed at economic growth in harmony with the environmental preservation and, at the same time, improving social conditions such as health and education. Initiatives have been taken to implement a long-term capacity-building program, especially concerning the WTO issues. The objective is to ensure a meaningful and constant dialogue between the government, private sector and other non-government stakeholders, on trade policy and the WTO obligations of Pakistan. There is still great room, as the current steps are not substantial enough to sustain in the post-WTO scenario.

Certainly, there are great contributions from the private sector; specifically, the organizations like SDPI (Sustainable Development Policy Institute) and IUCN-Pakistan (International Union for Conservation of Nature and Natural Resources) has done a remarkable job till now in identifying and underlining the matter. They have also convened dialogues at different levels to address the issues. This trend needs to be encouraged. At present, Pakistan is in a far from satisfactory position to accept and face challenges of the non-compliance to Global agenda for Sustainable Development. The engineering industry, particularly, is weak and its share in manufacturing as well as in exports is very low, as compared to our competitors 2-3 decades back. Pakistan engineering exports are 0.009% of the total world-market. High technology exports are only 0.3 % of the total exports; average steel consumption is 20KG/per head, as compared to the world average of 200KG/per head. There are only 249 PhDs in engineering and related sciences at present in the public-sector universities. This is itself a clear indication that a much-awaited national strategy has to be developed and executed before time writes us off. In the past, Pakistan has signed various international protocols, without fully realizing its implications.

Ministry of Industries & Production positively realizes the seriousness of the matter and has therefore focused its policy-thrust on engineering industry, specifically, to help prepare a sustainable environment essential for the other industries to compete economically and efficiently. A number of steps have been taken/initiated, emphasizing the underlying seriousness of the matter. These steps include the launching of Textile Vision, Engineering Vision, Leather policy, Fertilizer policy; all aiming at building a sound technological base, with industrial-support departments and R&D institutes. Tariff rationalization, reforms in regulatory, legal and policy environment are being introduced to remove barriers to growth and make our industry, specifically engineering industry, internationally, competitive. Also the investment-plan 2003-2010 for technology support centers and strengthening engineering-units being launched. The ISO standards have already been adopted.

The future plans are: to increase share of manufacturing goods in GDP from current 17.2% to 25 % by 2010, and gradually move to 30% in the future; especially, the share of engineering-goods to grow to 30% of the manufacturing goods in ten years. Also it is likely to increase per capita income to $1000 by year 2010. These plans might not look realistic but, we have got to be that ambitious, we have got to strengthen our engineering base, we have got to upgrade the current technologies and adopt the new over, we have got to furnish technical manpower. As a matter of fact, this is all possible, but a definite will is required on our part, domestically. To achieve sustainable development in today's context of market and private-sector-driven development, the developing countries require support from the industrialized countries, to build up basic capacities. Still, we need to indigenize our production-processes. Although the North has a crucial role to play over here, but let us not forget our own strength. We can very well initiate and rely on south-south partnerships. There is an immense need to address the impact of the so-called "brain-drain" on science capacity building. Mobilization of expatriate third-world scientists, living and working in the industrialized countries, to examine critical problems in developing countries could prove instrumental in turning the brain drain into a brain gain.

But the industrialized countries must not forget their imperative role. Their focus should be on the exchange of ideas, communication of scientific information and development of scientific industrial standards and networks in the developing countries.

IDENTIFICATION OF THE PROBLEM

We need a paradigm-shift in the relationship of humans to the environment and each other, in which humans live in harmony with both natural systems and each other. We cannot achieve these results with our current thinking.

A psychologist once remarked that a definition of insanity is doing the same thing over and over again and expecting a different result. As Einstein observed, "the significant problems we face cannot be solved at the same level of thinking we were at when we created them."

Therefore it is high time that we give deep thought to the matter. After all, it's a question of our own self! Our life … Our future … Our children …

VISION FOR A JUST AND SUSTAINABLE FUTURE

A first step in the transition to a sustainable path is to shift from problem-solving to creative action.

The foremost object should be to alleviate poverty from the developing countries, the fact is contrary to the commitment as said by United Nations secretary-general, *Kofi Annan, at the 32nd meeting of World Economic Forum, in which he had stated that "business leaders of the world were not sharing enough to eradicate poverty."* This itself is crucial for the very sustenance of the business leaders as well. As a hard fact which even they cannot deny.

A growth of $ 500 in per capita GDP in the developed world would not make any significant increase in the level of obtaining prosperity. But a similar growth in economies like ours would make a significant impact. Future scientists, engineers, and business people must design technology and economic activities that sustain rather than degrade the natural environment, enhance human health and well-being, and live within the limits of natural systems. The desire for a continuing "cheap" supply of fossil fuels has had enormous military and economic costs to keep the oil and gas flowing around the world, especially from the Middle East. Moreover, this fossil fuel dependence is economically unsustainable for more than a few decades - it takes 10,000 days for nature to create the fossil fuels that society consumes in one day!

The vision of a sustainable future is one in which:

- The population is stabilized at a level that is within the short and long-term carrying capacity of our finite resources;
- The toxic wastes are dumped properly in such a manner that they do not pose a threat to the

environment and human themselves. Humans are the only species on earth that produce waste which is not a raw material or nutrient for another species;

- The renewable resources are used at a rate less than or equal to the natural environment's ability to regenerate the resource; this means living off the income, not the capital;
- The production of durable, repairable goods and eliminate persistent, toxic and bio-accumulative substances is increased; at the same time, disposable goods as much as possible are eliminated;
- Products are designed for disassembly, so that the materials could be utilized in making new products;
- The reliance on the energy extracted from non-fossil fuels is increased, as the use of energy from the fossil fuels causes major environmental and health problems, such as black lung disease, air pollution, acid rain, oil spills and global climate-change, to name a few. The desire for a continuing "cheap" supply of fossil-fuels has had enormous military and economic cost to keep the oil and gas flowing around the world, especially from the Middle East. Moreover, this dependence on fossil-fuel is economically unsustainable for more than a few decades - it takes 10,000 days for nature to create the fossil-fuelds that society consumes in one day![4]
- It might be apparently over-ambitious but, at some later stage, reliance on direct solar energy is essential for our economic system;
- Timely economic and social signals that encourage environmentally and socially sustainable behavior.

The economic measures of success we use today, such as the GNP and consumer price-index, discourage conservation and encourage waste, consumption, and the substitution of capital for jobs. The price of goods and services reflects all the profits to the producers, but does not include all the social, environmental and health costs to society. This needs recosting.

WHAT IS TO BE DONE?

The challenge ahead is to foster the sustainable development of competitive industries, create employment, generate income and thus contribute to the alleviation of poverty, illiteracy and all kinds of social hardship. The focus needs to be on the creation of employment, on higher value-added products and increase of competitiveness in export markets, as well as the improvement of institutional capacities and capabilities for environmental, energy and product-quality management. The following steps need to be taken in order to achieve the stated targets:

- Implement international agreements, primarily the Montreal Protocol, the UN Framework Convention on Climate Change and the Basel Convention;
- Develop ISO 14000 environmental management systems certification scheme;
- Create awareness of national and international best-practices in the fields of technology, management-systems, and policy;
- Improve the understanding of sustainable development and, in particular, the business opportunities that sustainable development presents in Pakistan;
- Encourage industry, government and community-organizations to adopt initiatives that result in the improved use of eco-efficiency and cleaner production among their constituencies;
- Build common demonstration effluent-treatment plants for the textile and leather industry;
- Implement industrial policies that provide an enabling framework, within which the private industrial sector can operate with full efficiency and competitiveness;
- Raise awareness of potential foreign investors and technology-suppliers of investment opportunities
- Develop strategies and related institutional framework to enhance the development of more efficient and competitive small- and medium-scale industries;
- Encourage the formation of industrial clusters that provide cost-effective access to highly specialized economic inputs;
- Industrial Information Network, providing information and value-added support for SMEs.
- Increase the output of agro-based industries (food, textile and leather processing industries) by modernization and build support of the development of such industries;
- Identify the managerial and technical skills needed to expand specific industrial sub sectors.

- Formulate an environmental strategy that sets risk- based pollution-reduction targets and realistic time-frames for compliance;
- Build national capabilities for development of energy-management systems; promote renewable energy by introducing clean and new technologies;
- Develop human resource in the field of industrial energy efficiency;
- Develop and implement energy-saving, co-generation and recovery systems in selected industries and demonstration plants;
- Promote technologies for generation of "renewable" energy in order to reduce environmental pollution;
- Assist development of environmental regulations and transfer of advanced environmental practices for management of large cities;
- Assist development of environmental monitoring and pollution-control systems in the private sector.
- Advise industry on the best combination of pollution-prevention and abatement options that would mitigate environmental problems;
- Offer training programs that expand the availability of technical, managerial and entrepreneurial skills.
- Create a cadre of highly qualified professionals, so that they can perform functions related to technology-promotion;
- Encourage women entrepreneurs in industry, with a combination of training and consultancy services;
- Promote innovative and appropriate technologies for commercial applications in specific manufacturing branches.

This whole system needs to be executed in a precise and appropriate manner. This would require continuous monitoring and feedback, which is crucial for any mid-course correcting action. For such purposes, UNIDO has identified certain industry-specific indicators that cover all three dimensions of sustainable development.

CONCLUSIONS

Many of the problems that Pakistan is facing, viz. self-inflicted: poverty, food security, shelter, illiteracy, are central social problems. The country needs to set its house in order. There is also a need to develop the capacity to deal with the external problems. The hard fact, however, is that the latter is impossible without the former. A fundamental change in the policy-implementation is required.

Unless current attitudes are changed, we will continue to experience economic nightmares and socio-political disorder. The goals for sustainable development must not be treated as a tool in the hands of the industrialized world, to exploit the much lagged developing country's industry; rather they should be taken as a collective global aspiration for a better planet for our children.

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CAUSES OF INDUSTRIAL FAILURE AND ITS IMPLICATIONS IN NWFP

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ABSTRACT

The North West Frontier Province is the smallest province in terms of area, amongst the four provinces, and the third largest in terms of population. The contribution of industrial sector towards the socio-economic development of the province is not significant. It is horrifying to note that about 1145 industrial units have been closed, which has given birth to many social vices like phenomenal increase in smuggling, narco- trade and indulgence of jobless youth in illegal commercial ventures The main reasons attributed to these closures are inconvenient locations, (away from the seaport), non availability of skilled labor, inconsistent government policies, dearth of local capital, lack of proper infra - structure and comparatively poor law & order situation, due to Afghan War, etc. This paper will cover the aforesaid areas in detail and suggest the possible remedial measures.

INTRODUCTION

The North West Frontier Province (NWFP) of Pakistan extends from latitude 31° 4'to 37 8' north and longitude 69° 16 to 74 7 east. The approximate area of NWFP is 74,521 sq. km, with population above 17 million. Density of population is 236 people per square kilometer. The province is shut off from Diamer District of Northern Areas in northeast, Federal Administered Tribal Areas in west, Punjab in southeast and Azad Jammu and Kashmir in northeast.

The province is bestowed with rich natural resources, a hardworking population and immense opportunities for investment. However, industrially the province is backward and its share in the total installed industrial units is just 7.5 percent. Industries in NWFP could not contribute significantly to the economic development of the country. Majority of the industrial units are not working, for one or the other reasons. As economic development without industrialization is a dream, accelerated industrialization is considered by most developing countries as the key to rapid economic development and social prosperity.

This paper presents briefly the status of sick & closed industrial units in NWFP, their causes and remedial measures.

STATUS OF SICK / CLOSED INDUSTRIAL UNITS IN NWFP

According to Directorate of Industries Department, NWFP, total number of registered installed Industrial units in the province is 1848 , out of which 1145 units are closed. The overall percentage of closed units in the province is thus 62%.

Table-1 shows status of medium and large-scale industries in the Industrial Estate administered by the Sarhad Development Authority NWFP. Total installed units are 646, out of which 415 units are closed, rendering 19896 workers jobless. The percentage of closed units in these Industrial Estates is thus 64% (Table-1).

Table-2 shows status of small-scale industries administrated by Small Industrial Development Board. Total installed units in these Industrial Estates are 449, out of which 247 units are closed. The percentage of closed units is thus 55%, rendering 5292 workers jobless.

Total constructed units in the above Industrial Estates of the Province are 1095, while 753 units are scattered and are situated outside the Industrial Estates. Table-3, indicates the overall distribution of industries in each district, along with cost and employment-level. Total investment in this sector is Rs. 60805.45 million, employing 57,290 workers.

The worst-hit industrial sectors of the province are: industries based on imported raw materials, biscuits/ confectionary, flour mills, engineering tobacco and textile mills. These industries were once considered profitable ventures and attracted a bulk of investment from other parts of the country in the past. Colony Sarhad Textile Mill, Janan Da Maloocho Mills, Premier sugar Mill, were previously known as well established industrial units. These units not only provided jobs to thousands of workers, but also played a pivotal role in Industrial Development of the Province. Tobacco industry in the NWFP is also at the verge of the collapse, because majority of the cigarette manufacturing units are closed, which has not only rendered thousands of employees jobless, but also added to the woes of tobacco growers, who are facing many difficulties in selling their crop.

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Table - 1: Details of Medium/Large Scale Industries in the Industrial Estates of NWFP, Administrated by SDA

Name of Industrial Estate	Installed /units	Operational Units	Present employment	Closed units	Retrenched workers
Hayatabad Peshawar	212	132	17865	80	3564
Gadoon Amazai	228	30	650	198	15750
Hattar	192	58	8392	134	418
Nowshewra	14	11	479	3	164
Total	**646**	**231**	**27,386**	**415**	**19,896**
Percentage of closed industries in the Industrial Estates: 64%					

Fourteen industrial units were established in the Federally Administered Tribal Areas during Bhutto's era. These are also non-functioning and their ill-effects are clearly visible in the present scenario. The early revival of industrial units in FATA can improve the situation to a larger extent because opportunities of jobs will automatically check smuggling, narco-trade and other illegal activities in the tribal belt.

Apart from that, 50% of marble is being taken from the NWFP but primitive usage of blasting in the excavation process is causing more damage than the profit, and so there is urgent need to educate all those involved in the business to employ modem scientific techniques. Moreover, raw materials from the marble-sector goes out of the province because the industrial units for cutting the marble stone are located outside of the province and thus the major chunk of the profit from this sector also goes out of the province, thus depriving NWFP of the much required economic growth.

MAJOR CAUSES OF FAILURE / SICK UNITS IN NWFP

The following are the major causes of this sick / close and slow pace of industrialization in the province:

a. Inconsistent policies of the Government.
b. Locational Disadvantage, distance from the Seaport.
c. Law and order situation.
d. Non-availability of skilled labor.
e. Lack of entrepreneurial skill.
f. Dearth of local capital.
g. Lack of proper infrastructure.
h. Location of Head offices of DFI / Banks at Karachi.
i. Smuggling of foreign goods.
j. Abolishment of NOC for industrial units.
k. Improper selection of the product. (50% success of the industries depend on the proper selection of products, proper evaluation of the market).
l. Mushroom-growth of one type of industry members (e.g. flour mills).
m. Industries based on imported raw materials.
n. Industries based on less value-added products.
o. Too many govt. agenices/dept. imposing different types of taxes, etc., have also discouraged the industrial growth.

There is a cost differential of about 23% for the industrial units established at Peshawar vis-à-vis those established in Karachi. To offset the above disadvantage and to minimize the cost-differential, the Federal Government in 1988 provided the following incentives for encouraging industrial investment in NWFP:

i. Income Tax holiday for 8 years
ii. Exemption from sales-tax for 5 years
iii. Exemption from custom duty on imported machinery.

The following additional incentives were also provided by the Federal Government for Gadoon Industrial Estate, which was set up to eliminate poppy-cultivation in the area, by providing alternative job-opportunities to the locals:

i. Duty-free import of raw materials
ii. 50% concession in electricity tariff
iii. Provision of loan at 3% mark up.

The above incentives stimulated the pace of Industrial Development in the province, resulting in establishment of 192 industrial units in Hatter Estate, with a total

Table - 2: Details of Small-Scale Industries in Industrial Estates of NWFP administrated by SIDB

Name of the Industrial Estate	Total Constructed Units	Total Operational Unit	Total Closed Units	Total no.of Retrenched Workers
Kohat Industrial Estate Peshawar	124	71	53	1452
Small Industrial Estate Hayatabad	70	27	43	1000
Mardan Industrial Estate	87	39	48	800
Abottabad Industrial Estate	38	25	13	320
Manshera Industrial Estate	51	21	30	500
Kalabat Industrial Estate	11	1	10	300
Kohat Industrial Estate	7	2	5	120
D.I.Khan Industrial Estate	38	9	29	300
Bannu Industrial Estate	23	7	16	500
Total	**449**	**202**	**247**	**5,292**
Percentage of closed units is 55%				

Table - 3: District-Wise Total Number of Units, Investment and Employment in NWFP

S#	District	Total Nos of Units	Cost (Rs. In Million)	Employment
1.	Peshawar	375	3319.261	10391
2.	Nowshera	108	9423.076	6180
3.	Charsadda	40	676.169	640
4.	Kohat	35	2093.736	2839
5.	Karak	5	35.615	51
6.	Bannu	28	208.796	783
7.	Laki	21	4301.491	2103
8.	D.I.Khan	86	919.014	1909
9.	Tank	1	11.00	15
10.	Mardan	133	1004.076	4288
11.	Swabi	265	9649.181	3985
12.	Malakand	44	229.359	438
13.	Swat	267	792.808	2916
14.	Dir	37	393.613	624
15.	Bunir	73	128.869	789
16.	Chitral	10	10.625	91
17.	Haripur	229	27029.148	14249
18.	Abbottabad	52	339.182	513
19.	Mansehra	35	220.12	445
20.	Kohistan	1	4.00	10
21.	Battagram	3	16.311	31
	Total	**1848**	**60,805.450**	**57,290**

Table - 4: Sector-Wise Total Number of Industrial Units

S#	District	Total No. of Units	Remarks
1	Food, Beverages, Tobacco	567	Included Flour mill 208, Biscuits Conf. 63
2	Textile, Wearing Apparel Carpet, Leather and Footwear	265	Included Silk mill/Looms 158
3	Wood, Wood Products and Cork	85	Furniture 65
4	Paper, Paper Products, and Printing press	54	Included Packaging 44,
5	Chemical, Petroleum, Rubber, and Plastic Products	335	Plastic 140, Soap 43, Medicines 40,
6	Mineral Products	312	Marble etc. 285
7	Metal & Metal Products, Electric/Electric goods	207	Engineering 53
8.	Other Manufacturing Industries	23	
	Total	**1848**	

investment of Rs. 18.798 billion and employment-opportunities for about 17522 workers. Similarly, 228 units were established in Gadoon Amazai Industrial Estate, with a total investment of Rs. 9.123 billion and employment provided to about 16762 workers.

The process of industrialization in the province suffered a set back when the above incentives either stood expired, or were pre-maturely withdrawn by the Government during the period 1991-95. As a result, industrial units started closing down and, presently, 1145 units out of 1848 are lying closed.

Past experience shows that, as and when the incentive were provided by the Government, the pace of industrialization accelerated, of which Industrial Estate Gadoon and Industrial Estate Hattar are the examples. When the Government withdrew the incentives or these expired, the industrial units started closing down in the above industrial estates.

The other major factor responsible for bringing the sector to the present crippling situation is the locational disadvantage of the province. In order to offset the locational disadvantage and thereby to minimize cost differential of 23%, the Federal Government may grant some sort of incentives to restore the industrial activities and accelerate the pace of industrialization in the province.

Due to Afghan war, the NWFP particularly suffered greatly in terms of law and order and smuggling of foreign goods. This has badly shaken the Investors confidence and so they are reluctant to invest in the province. Besides this, the Federal Government has abolished the requirement of NOC for establishment of Industrial units, except for a few categories. Taking advantage of the situation most of the investors set up Flour Mills in the Province, without keeping in view the supply and demand forces. Resultantly, due to lifting of ban on the movement of wheat and flour by the Federal Government almost all the Flour Mills have closed down. The closure of these industrial units in the province has given birth to many social vices, like phenomenal increase in smuggling, narco-trade and indulgence of jobless youth in illegal commercial ventures to earn their livelihood.

CONCLUSIONS

A comprehensive strategy and concerted efforts could improve the situation, in long run, and would pay dividends to the poor residents of the province, who are voyaging round the globe to earn livelihood for their families. The Federal Government should consider the provision of some sorts of incentives in the form of reduction in the price of electricity, permission for the export of goods from EPZ Risalpur, transportation subsidy (23%) and establishment of stock exchange, etc., for the development of industrial sector in this backward region.

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GROWTH-STRATEGY FOR THE ENGINEERING INDUSTRY TO ACHIEVE RAPID INDUSTRIALIZATION AND ECONOMIC GROWTH

*Javed Akhtar Paracha**

ABSTRACT

The paper focuses on the importance of the engineering sector in economic development with an overall global perspective, compared to the position of Pakistan's engineering sector. Main feature of the paper is that the engineering data of Newly industrialized countries has been compiled which depicts a progression of their development in the engineering sector. This provides realistic correspondence with Pakistan's scenario of engineering industry's development, which is a close follower of the Newly Industrialized Countries (NICs).

In the end, existing and future plans for the government alongwith recommendation are provided. These provide policy guidelines for government institutions in formulating future approaches to engineering sector development.

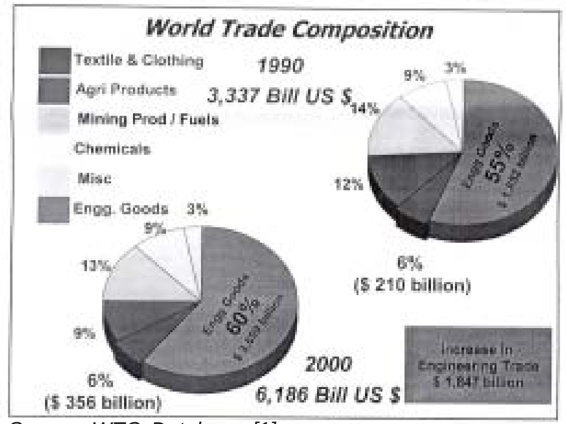
SIGNIFICANCE OF THE ENGINEERING INDUSTRY

The Economic Power-Houses in the contemporary world do not just appear; they are manufactured through engineering industry. Evidence suggests that, the highly developed Engineering base of developed countries directly relates to the high standard of living of its people. It is therefore considered as the engine of economic growth.

Countries dependent on natural resources, such as oil, agriculture produce, etc., may find the reserves depleting fast, resulting in ultimate recession. On the other hand, engineering sector being high value-added breeds brisk economic activity; thus self-reliance in this sector is sustainable.

The Newly Industrialized Countries (NICs), Taiwan, Singapore, Korea, Malaysia had accorded the highest priority to the engineering sector and are developing fast. It is noteworthy that Engineering sector is more capital-intensive, requires higly qualified manpower and a diverse industrial infrastructure.

Figure - 1 suggests that Engineering Goods account for around 60% of the world's trade, which is higher than all other commodities put together.



Source: WTO Database [1]

Figure - 1: World Trade Composition

Figure - 2 Shows a consistent increase for the past decade in the world merchandise exports concerning t

Source: WTO Database [2]

Figure - 2: World Merdhandise Exports % share

Table-1 Suggest a major share of engineering goods in the production of developed countries. This indicates a direct relationship of the engineering sector to the development of the world economy.

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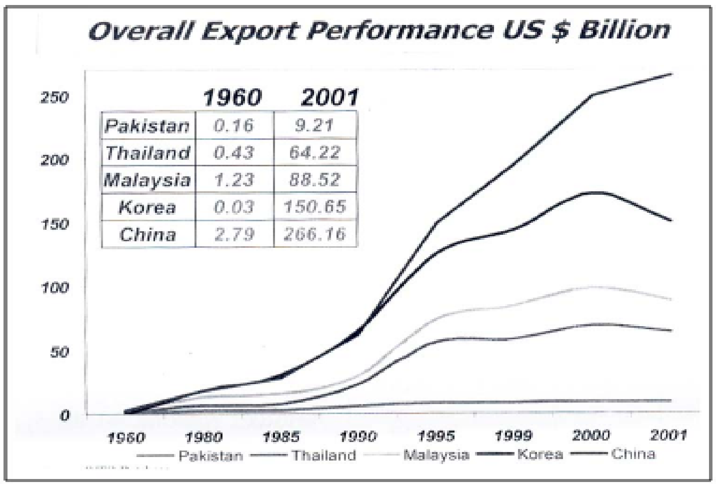
Table - 1: World Split of Production: Major Products (%)

	Industrialized Countries	Newly Industrialized Countries	Others
No. of Countries	**48**	**7**	**129**
Steel	76.1	17.7	6.2
Mech. Goods	94.7	4.1	1.2
Elect. Goods	89.3	8.3	2.4
Transport Equip	83.5	13.2	3.3
Distribution of MVA	76.6	19.9	3.4

Source: UNIDO 1990 [3]



Source: WTO Database [4]

Figure - 3: Overall Export Performance US $ Billion

Figure - 3 gives a graphical comparison of Pakistan's export performance with those countries which shifted their maximum emphasis to the Engineering Goods industry.

These were few examples that clearly manifest a strong link between the economic growth and the development of the engineering sector.

Considering the share of manufacturing in GDP of the Industrialized Countries (ICs) and the Newly Industrialized Countries (NICs) from Tables 2 & 3, a direct inference can be drawn to suggest that the infrastructure for the engineering sector plays the most important role in sustained economic growth.

SITUATION ANALYSIS

Although the policy-pattern as indicated in Table 4 & 5 although reflects some emphasis by respective governments on the importance of investment in the engineering sector, yet the investment priorities had been irrational on one hand and policies had not been consistent and at times conflicting, on the other hand.

As a direct consequence of the above policies, the implementation aspect clearly shows a dis-proportionate trend, in respect of technical manpower development. The ratio of Institutions to the respective enrolments in Technical Universities and Vocational Institutes has been in a state of imbalance, see Figure-4, whereas the total allocation to development of technical education is also out of proportion (Figure-5).

Table - 2: Share of Manufacturing in GDP (%)

	1960	1965	1970	1977	1980	1985	1990	2000
	Selected Asian Countries							
Pakistan	12	14	16	16	16	18	17	17
Indonesia	8	8	10	9	13	24	21	26
Malaysia	9	9	12	18	21	29	24	28
Korea	12	18	21	25	28	30	29	32
	Developed Countries							
Sweden	27	28	-	24	-	-	-	26
Germany	40	-	38	38	-	-	26	28
UK	32	30	33	25	-	-	-	25
Japan	33	32	36	33	29	-	28	24

Source: World Bank - World Development Report [5]

Table - 3: Comparison of Key Indicators

	Malaysia	Korea	Pakistan
GDP US$ Billion	90	457	62
Manufacturing Value Added (% of GDP)	29	32	17
Population (Million)	23	48	137
GDP per capita (US $)	3,849	9,520	446
Exports Per Capita (US $)	4,206	3,650	67
Engineering Exports per Capita (US $)	2,679	2,600	2
High Technology Exports (% of Manufacturing)	54	27	0.04

Source: World Bank - World Development Report - World Bank 2000 [6]

Ultimately, the industrial sector has therefore, not been able to take-off, as is evident from Figure 6 & 7. It is evident that, despite the geographical size and the abundance of manpower resource, Pakistan is far behind its much smaller regional companions.

EFFECTS OF INDIGENIZATION

Despite certain constraints and hesitation due to variation of emphasis on the engineering-goods sector during various regimes over the past decades, which could not lead to successful marriage of the policies and the implementation process, Pakistan's indigenization policies are ultimately proving a success story. Within the past 4 to 5 years, the local content i.e. the deletion achieved in the Automobile sector alone has increased from 7 to 27% in various categories of vehicles, with a marked increase in sales-volume and market volume. The effect of indigenization has been appreciably instrumental in foreign-exchange saving. Since 1995, saving of **US$ 401,205,762 per year** has been made on this account with a continuously upward trend. Similar pattern is observed in other industrial sectors.

Overall, siginificant investment has also come in the engineering goods area, as is evident from Figure 8. The Engineering Development Board is now playing a pivotal role in rationalizing the policies, in order to affect synergy for sustainable development.

STRATEGIC FOCUS

Ministry of Industries & Production and the Engineering Development Board, in a presentation on 22 August, 2002 to the President of Pakistan, on "*Growth Strategy for the Engineering Industry to Acheive Rapid Industrialization & Economic Growth*" achieved a major

Table - 4: Industrial Development Paradigm in Pakistan

Year	Shifting Paradigm
1950-1960	Import Susbstitution - Industrial Development via Direct Control
1960-1970	Development of Consumer & Capital Goods Industry - with some Export Incentives
1970-1977	Nationalization - Emphasis on Heavy Engineering
1978-1992	Liberalization & Privatization
1992-2002	Privatization, infra-structural development, employment-creation and export-led growth

Source: Economic Survey 2002 [7]

Table - 5: Past Investment Priorities

Types of Industries	Fixed Assets	Value added	Val-Add. as % of Fixed Assets	Past Tariff Protection %
Basic Metal	43.2	6.1	14%	60-100%
Metal Products	5.8	1	17%	Upto 45%
Mech. Machinery & Equip.	4.5	2.8	62%*	Upto 45%
Elect. & Electronic Equip.	8.4	4.6	55%*	Upto 45%
Transport Equipment	12.2	2.9	24%	Upto 250%

** Future value addition/Investment target: 100%*
Source: Economic Survey 2002 [8]

milestone towards prioritiizng the engineering sector. The presentation was highly regarded equally in the government as well as the private sectors.

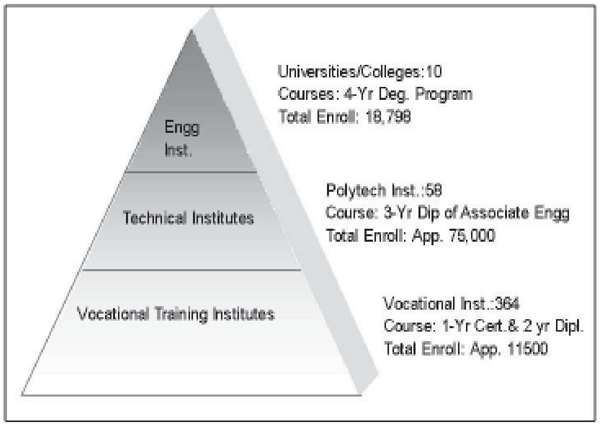
The recommendations made in the presentation are already being implemented through the forum of the Engineering Development Board. Salient features are as under:-

a. Policy Thrust

- Govt. should build Pakistan's image as a professional producer of quality-products, as per international standards.
- Govt. policies should be driven by national interest, supporting local industry without seriously infringing on WTO and other intl. commitment.
- Govt. should avoid fragmented decision-making and follow an integrated approach, with various policies complimenting and not contradicting each other.

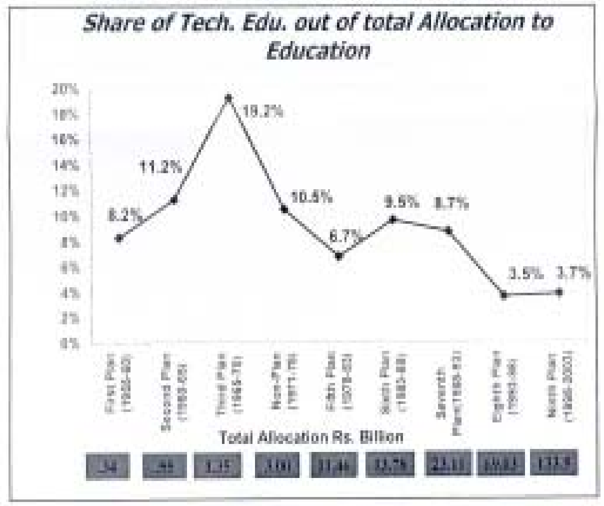
b. Human Resources Development

- Replicating the excellent decision taken to increase the allocation for higher education, the decision needs to be extended for Technical Manpower Training through Allocation of at least 1% of the total annual outlay to technical education and skill-devleopment for the next five years.
- Allocation for higher education to be extended for Technical Manpower Training, through allocation of at least 1% of the total annual outlay to technical education and skill-development for the next five years.
- The success stories in the nuclear and defense fields need to be extended to other sectors of economy, through dependence on the local enigneers, technologists and the Domestic Engineering Industry.
- The Whole Government machinery should support, procurement of Engineering Products and award of contracts to local companies.



Source: Ministry of Education, Provincial Education Departments [9]

Figure - 4: Technical Manpower



Source: 9th Five Year Plans - Planning Commission [10]

Figure - 5: Share of Tech. Education out of total Allocation to Education

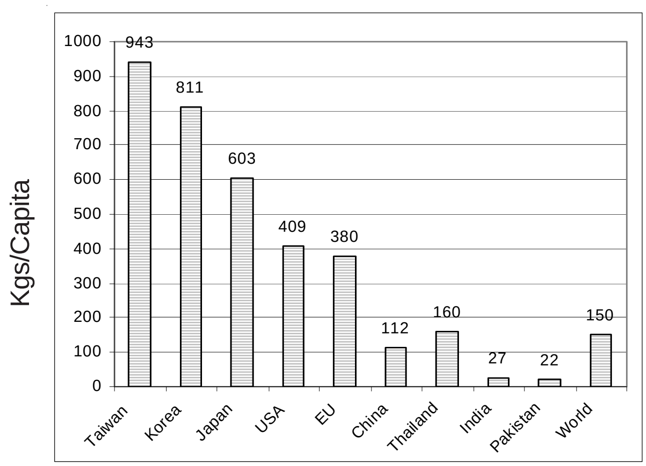
- Provide limited additional resources in the areas of tech. development fund, common facilities, technology centres and technical manpower development.

c. Globalization of Industry

- Aggressive promotion, to attract relocation of industries from industrialized countries.
- Government should intervene to make Pakistan a member of global supply-chain, particularly in auto mobile sector.

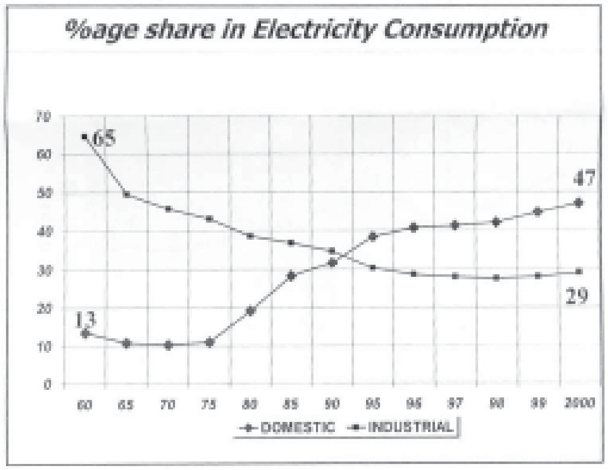
d. Encourage Rapid Growth through market enhancement

- Government has recently announced Consumer Financing Scheme for market enhancement. This scheme needs to be further extended by Employers, including Government/Public Sector, through secured guarantees against gratuity/ provident fund to the suppliers for leasing transport and domestic appliances to their employees.
- Expedite enactment of effective repossession laws



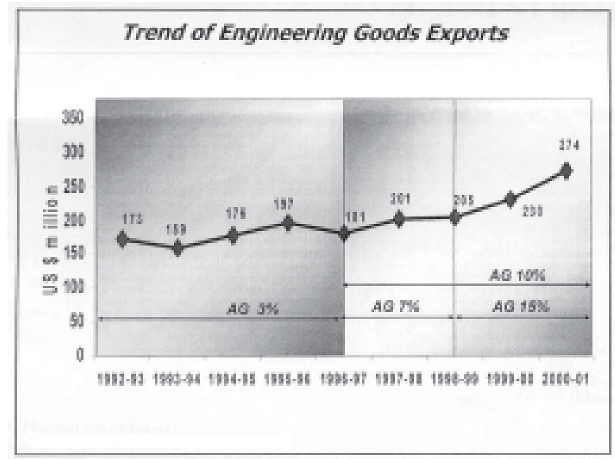
Source: Website: World Steel 2000 [11]

Figure - 6: Per Capita Steel Consumption



Source: Economic Survey of Pakistan 2000 [12]

Figure - 7: %age share in Electricity Consumption



Source: State Bank of Pakistan, Annual Reports and FBS [13]

Figure - 8: Trend of Exports of Engineering Goods

to further encourage leasing.

- Offer State-Credit for exports of capital goods.
- As a matter of Government Policy, stake-holders should renegotiate existing agreements with foreign partners, to permit exports (tractors, cars, etc) from Pakistan.

e. Institutional & Regulatory Framework

- Rationalization of tax and tariff regimes carried out in the last two budgets should be continued for two more years, to provide protection and level playing-field, including withdrawal of exemptions detrimental to the local industry.
- During the President/Chief Executive's visit to Japan, a major achievement was the financial & technical support provided by Japan for upgrading three (PITAC Lahore, PTC & AT&TC Karachi) common facility and technology-support centres.A total number of about 25 such centres are required to be established throughout the country.
- Strengthen Pakistan Standards & Quality Control Authority.

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PROSPECTS OF UTILIZING ADVANCED TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT IN DEVELOPING COUNTRIES

Shahzad Alam, Shinya Sasaki** and A.ul Haq****

ABSTRACT

Rapid industrialization, export enhancement, self-reliance and minimizing the import could be the basic targets of the developing countries in order to strengthen the economy. However, the engineering industries (automobile, textile, chemical, machine-tools, etc.) have failed to achieve the targets set for deletion of imported parts. The reason for this state of affairs can be attributed to the inability of the local industry to manufacture good-quality products, due to use of out-dated techniques and lack of technical know-how. The situation can be rectified by restoring the production of those engineering-based parts locally. To achieve these targets, capacity-building in science and technology is vital, especially in the developing countries.

This paper describes the imperative technologies in the field of Materials-Science and explains their promising features and optimum utilization for the enhancement of imports-substitution and export of values-added products in the engineering sector.

IDENTIFICATION OF LOW AND HIGH-TECH PROJECTS FOR MATERIALS AND PROCESSES

Industry in the present-day world is the backbone of a country's economy and prosperity. In Pakistan, concerted efforts are being made to develop a self-reliant economy. What it means, in actual terms, is that the agro-based economic system should be changed to an industrial-based system, i.e. we must attain autarky in the field of industrial production.

This simple realization of the ground-reality requires action in certain areas. In fact, we have been exploring ways and means to overcome our technology-problem. But nothing seems to have succeeded so far. The present government has taken steps to strengthen the infrastructure and has set the ball rolling; Industrialization should now be a matter of time only. However, the Government alone cannot succeed in its great leap forward, unless all sections of the society engaged in this process can perform their individual, specific roles properly. We, as scientist, must be able to identify the usefulness and relevance of the technologies that should be adopted or materials to be developed. This is most essential in order to avoid wastage of time, resource and the materials.

Having made this observation, let us proceed on to recognize the fact that, so far, we have not succeeded in building a sound technological set-up based on low-technology. This is not to say that first priority must be given to low-tech. In fact this is not entirely necessary. Now is the time to develop high-technology as quickly as possible. We have to live in the contemporary world and compete with contemporary reality, which is now defined by new and emerging technologies and materials.

The high-technology basically aims at developing materials which are lighter, stronger, more resistant to effects of aggressions of environment; they are longer lasting, they are appealing to the eye and maintain their appeal for longer time. High technology also aims at miniaturization, automation, precision and enhanced productivity.

New and emerging technologies have revolutionized, transport, automation, industrial production, communication, bio-medics, diagnostics of every kind, avionics and space travel, etc. It is really now high time to create these facilities in the developing countries, so that capacity-building in science and technology can be enriched in many ways.

AREAS OF NEW AND EMERGING TECHNOLOGIES

The specific areas of the new and emerging technology that need our immediate attention pertain to the following specific fields.

i Powder Metallurgy And Metal Matrix Composites
ii Composite Materials And Engineering Ceramics

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iii Shape Memory Alloys
iv Single Crystals
v Materials For Defence
vi Special Alloys For Surgical And Biomedical Use
vii High-Temperature Alloys
viii Plastics, Composite Plastics And Ceramic Polymers
ix Materials For Sports Industry
x New Magnetic Materials & Ceramic Magnets
xi Surface Modification By Plasma, CVD And PVD Techniques
xii Nano-Technology, With Special Emphasis On Nano-Materials And Their Characterization For Engineering Industrial Applications.

In the light of the abvoe list, projects/schemes of short and long-term duration in the following fields are recommended to be undertaken.

Powder Metallurgy And Metal Matrix Composites

The techniques utilize compaction of powder mixtures, composite powders and/or pre-alloyed powders, followed by sintering and coining for the production of complex shapes, such as gears, pistons and bush bearings. The technique is now being employed for the production of new magnets, ceramics magnets, engineering ceramics, hard metals, refractory metals, etc. The materials are intensively being used in the automobile industry, electronics, avionics and space-research.

Similarly, Metal matrix composites have achieved considerable attention in the developed countries, due to high strength, high specific modulus, high-temperature properties and lower expansion-coefficient. MMCs have wide industrial applications in aerospace, auto and defence industry.

In Pakistan, powder metallurgy and Metal matrix composite posses great potential for industrial applications.

Composite Materials And Engineering Ceramics

Composite materials can be classified into metal-matrix composites and ceramic-matrix composites. These materials, due to light weight and high strength along with ability to withstand high temperatures, have properties that render them highly useful in a variety of applications i.e. electronics, automobiles, space craft, biomedical and tribological applications.

Glass-reinforced thermosetting plastics are presently competing with both steel-sheet and zinc die-casting. The use of low-cost composites in the automotive industry has already reached impressive performance.

Carbon fibers have emerged as the main reinforcement-fibre for high-performance composite materials. The development of strong and stiff carbon-fibres for a wide range of industrial applications and their use in lightweight structural parts are among the principal technological achievements of this period. High strength and stiffness, light weight, improved fatigue-resistance, corrosion-resistance, good friction and wear-qualities are promising features of this material. Moreover, low thermal expansion and thermal and electrical conductivity combine to make these composites an attractive substitute for various metals, special alloys and other materials [1].

In recent years, there has been a marked improvement and growth in the engineering materials. This is manifest in the development of various high-performance smart engineering materials. These advanced engineering composites, because of their unique and promising features, are replacing the traditional materials.

Keeping in view these factors, advanced composites materials possess a great potential for a wide range of industrial applications in auto, textile, and chemical and petrochemical, dentistry fields.

Shape-Memory Alloys

[So called because they return to original shape after the constraint (heat or stress) has been removed].

Those alloys, which exhibit thermo-elastic martensitic transformation properties, are called shape-memory alloys. These alloys can be divided into ferrous and non-ferrous categories. These alloys are useful in a variety of applications like pipe-coupling, electrical connectors and thermo-elastic switches for automations of industrial plants, communications, avionics and space crafts applications. These alloys are also employed for medical applications (bone plates, catheter bends etc.)

Single-Crystal Alloys

Single-crystal alloys have assumed enormous importance for research and technology, especially in the fields of electronics, electro-optics, metal corrosion, semi-conductors and magnetic bubbles materials.

Materials For Defence

For defence we need a wide range of materials, which includes the following:

- Special alloy steel
- SG Iron
- Precision casting alloys
- LM, 2000, 6000 and 7000 Aluminum series, cast and wrought alloys.
- Advanced engineering composites. i.e. carbon fiber, metal matrix and MMC composites.
- Engineering Polymers
- Plasma coatings of ferrous, non-ferrous, cermits, ceramics coatings.
- Thermal barrier coatings [TBC]. (Zirconia with additives) for high-temperature application.
- CVD and PVD surface-coatings techniques.
- Heat-treatment salts and chemicals
- Transfer of high-tech technologies
- Engineering ceramics etc.

Special Alloys For Surgical And Biomedical Uses

Surgical instruments are one of the major source of export-oriented products in the country. Major part of these alloys is being imported from different countries like Japan, France and Germany; however, about thirty thousand ton of stainless steel of surgical grades, along with twenty-five to thirty tons per day of stainless steel, is being locally re-melted/produced by different small units, especially in Gujranwala and vicinity areas [2]. The re-melting units in these industrial areas are producing generally disposable type of cheap stainless-steel products. However, the castings required for various grades of surgical stainless steel must conform to the standard specifications requiring high quality. The local industry, without possessing relevant abilities, can't produce these grades of high quality. Therefore, local efforts to produce these grades of stainless steel are vital to get a major share of export. We really have to create facilities to produce these materials, along with human-resource development in these fields, to meet the future requirements.

Orthopaedic Implants

In Pakistan, every year the Government spends million of dollars for the imports of various orthopedic implants. However, in the country there are a few companies in Gujranwala who are manufacturing (remelting) these implants locally. It has been practically observed that the quality of these implants is so inferior that if subsequently caused severe damage and even loss of life. These implants of proper quality can be locally manufactured in developing countries by employing standard techniques and the surface can be modified by plasma sprayed with titanium, which not only improves wear-resistance and life but also their bio-compatibility with human body.

High-Temperature Alloys

High-temperature alloys can withstand high temperatures without any physical and mechanical change in materials. Therefore due to these characteristics, these possess large number of applications in aerospace, refineries, high-temp. furnaces and kilns, turbines, high-temp. Creep and fatigue-resistant materials.

Polymers (New And Super)

The term polymer – polymer composites refers to a materials in which rigid, rod-like polymer molecules are dispersed at molecular level in a flexible coil-like polymer of similar chemical composition. With dispersion at this level, the materials are sometimes also known as molecular composites. Polymer composites offers three advantages over polymer-fiber reinforced polymers. Firstly, because of flaws and imperfect alignment of chains with in fibers, the strength of an isolated polymer molecule exceeds, by an order of magnitude or more, the strength of fibers produced from the same polymers. Secondly, fiber-reinforced composites can present adhesion problems at fiber–matrix interface, leading to loss of strength. Thirdly, due to the stress-transfer region at fiber ends, it is only when the axial ratio is high enough that the full reinforcement of the fiber is realized.

These new materials possess great industrial potential in the industry, especially in developing countries.

Materials For Sports Industry

More advanced composite materials are being used in sports industry due to high strength, high stiffness and low weight. When we see the comparative stiffness of steel wire, glass and pitch-based carbon fibers, it shows the carbon-fibers as the stiffest one; this anisotropy of the properties of advanced fiber-composites represents a completely new feature.

The utilization of carbon-fiber reinforced plastics for sports goods has a wide range of application, like fishing rods, golf-club skillets, bicycles and structural members of racing kayaks and yachts. High strength and stiff, light weight with improved fatigue resistance, corrosion resistance, good friction and wear, combine to make carbon-fiber an attractive substitute for various metals, special alloys and wood [1].

Consumers now prefer to buy light-weight, high-strength, better stiffness and fatigue-strength materials as compared to the conventional wooden items. This trend has shown an adverse effect on the export of sports items from Pakistan. Therefore, it is important that to enhance our export, we must focus our attention for the development of carbon-fiber sports items, along with other composites for wide variety of its applications in Pakistan.

Magnetic Materials *(Permanent And Non-Permanent)*

New emerging magnetic materials, like Nd-Fe-B, could be utilized as magnetic materials due to their better magnetic properties. These materials are being extensively used in electronic, communications and avionics industries.

Surface-Modification of Engineering-Based Materials By Plasma Spraying

The Surface modification is a valuable technique that makes it possible to add new properties, only on the top of the surface, irrespective of its internal characteristics; this is most commonly done by coating. Generally, the following techniques are in practice in order to produce various kinds of coatings on industrial scale: evaporation, plasma spray, sputtering, chemical vapour deposition and PVD etc. [3].

Plasma spraying is emerging as an excellent technique to produce a wide variety of coatings on an industrial scale [4]. These coatings are quite useful for corrosion or erosion resistance, thermal barrier for high temperature or for dimensional-accuracy industrial and high-tech applications [5].

Pakistan is one of the major exporters of various textile items in the world. Our economy is mainly based on the export of these textile products. There is no proper scientific research and development for the development of textile parts, its repair and local deletion. These textile industries spend billions of rupees for the import of various textile parts, causing a staggering effect on the economy. The situation can be rectified considerably by restoring to production and repair of these parts locally. Same situation exists for automobile, chemical, petrochemical, defence, power-generation, and fertilizers industries. So plasma spraying is an answer to produce and reclaim worn out parts for a wide variety of industrial coatings.

Future R&D Programme

These techniques possess a wide range of industrial and R&D applications in the industry. Therefore, a wide range of long and short-term projects can be prepared according to industrial demands for high wear- resistance, corrosion and erosion resistance, production of high-temperature coatings and reclamation of worn-out industrial parts. A huge amount of foreign exchange can be saved for textile, chemical, petrochemical, auto industries in developing countries.

Nano-Technology With Special Emphasis On Nano-Materials And Their Characterization For Engineering Industrial Applications

Nano-scale science and technology enables controlled component design and fabrication, on atomic and molecular scales. Nano-related R&D units, findings and processes from biotechnology and genetic engineering, with chemistry, Physics, electronics and Materials science, with the aim of manufacturing cost-effective innovative products are now coming up, as below:[6].

Industrial Applications

- Biomedical
- Nano tribology
- Nano-mechanical system
- Nano-machining
- Nano thin films
- Nano-scale technologies to produce miniaturized and inexpensive electronic, sensing and actuator system.
- Chemical, biological and drug sensors
- Nano-scale powders for specific industrial application

Development Of Nano-Powder In Pakistan

These powders have got considerable industrial potential and applications can be summarized as follows:

- Conductive coating and paste
- Electrode for MLCC (multi-layer chip condenser)
- EMI shielding coatings
- Dielectric and piezoelectric
- Hi-Tech microwave filter
- Transducer
- Anti-static coatings on plastic sheets

Nano-structured Materials

The world-market for materials is estimated almost $10 billion per annum and this demand is growing rapidly. More recently, with the advent of the tools of Nano-technology, materials-science has been transformed to a point that the relationship between the structure of a material and its properties can now be controlled.

Materials possess very promising and different properties when nanostructured. The much finer grain-size can be used to produce denser materials, with greatly improved mechanical properties. Aerospace and defence will also benefit from the new lightweight, high-strength nano-composite materials and even ceramics, as well biomedicine in stronger hip-prostheses.

CONCLUSIONS

The current import-bill for auto, textile and orthopedic implants and engineering goods in the developing countries is running into hundreds of billions p.a., causing a staggering effect on the economy. This situation can be rectified by resorting to production of these engineering based parts locally; which requires:

a. Up-gradation and improvement of technological set up
b. Enhancement of technical skill and manpower
c. Improvement of product-quality, through R&D inputs.
d. Export enhancement of value-added products

These measures are key-factors to more rapid industrialization, export enhancement, self-reliance and minimize the import in the developing countries. However, local efforts, especially R&D input pertaining to material technology, are necessary for the sake of production and development of these advanced materials locally, to meet the challenge of 21st century's demand for low-cost and efficient materials.

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CAPACITY-BUILDING IN BIO-MEDICAL RESEARCH IN PAKISTAN

*Shahzad A. Mufti**

ABSTRACT

The edifice of any research, may it be scientific or social, stands on 3 basic pillars:

1. *Appropriate manpower (trained experts, competent personnel);*
2. *Adequate Infrastructure (space, physical environment, equipment, library, etc);*
3. *Incentives (well defined goals, reward and punishment.*

Based on this principle, it is no wonder that very little research is carried out in this country. There are no more than 3,000 science PhDs in the country, with an addition of hardly 30-50 per year. Only 90 persons are engaged in R&D per million of population, as compared to 4100 in Japan. Less than 0.4% of our GDP is spent on R&D, whereas a minimum of 1-2% is essential. Thus, Pakistan contributes less than 0.04% towards the world's research publications, out of which there is a negligible amount in the field of health-sciences.

On the other hand, even a cursory look at the health-indicators presents a highly discouraging picture. Infant mortality of around 86 per 1,000 live births is the highest in Southeast Asia; even Nepal has 73/1,000; so is childhood-mortality (at 110/1000). More than 50% of pregnant women suffer from anemia. Tuberculosis still accounts for 18% of mortality in the communicable disease category, while hepatitis and AIDS are increasing alarmingly.

Pakistani scientists, especially biomedical scientists cannot remain indifferent to this situation. However, the basic problem with biomedical research is that there are only a few trained scientists in this field. Medical professionals, by definition, have no formal training in research. There has also been a lack of collaboration between clinicians and basic scientists to carry out biomedical research. There is, thus, an urgent need for such scientists to work together, as is universal in technologically advanced countries. Basic scientists in the fields of biology, biochemistry, biotechnology, biophysics and bioinformatics, etc, need to work together with clinicians in trying to understand health and diseased conditions of the human body. A concerted research effort is required to arrive at an accurate diagnosis of the disease and to adopt an appropriate therapeutic regime. Such research has become all the more relevant in this post-genomics era, as well as, with the advances made in stem-cell research arena. These recent developments in biomedical technologies have the potential to change the face of control and management of disease. It is imperative that Pakistani basic-scientists and clinicians are provided an institutional platform, where they can work together, to evolve a state health-care arid management plan. COMSATS Biomedical Research Center is being established as a step in this direction. Details of the capacity-building and research plans of the Center will now be discussed...

INTRODUCTION

At the beginning of this century, with the completion of human genome project, many mysteries and puzzles were being unfolded and many more are waiting to be explored in the field of human health care. The last century has witnessed the zenith of Physics and nuclear technology but this century undoubtedly can be called the century of Biotechnology and its derivative sciences, such as Biomedical sciences.

Like the rest of the third-world countries, Pakistan also suffers from a primitive and quite dysfunctional, health-care system. What can be said about the general health-conditions of a population, 60% of which does not have access even to clean drinking water. Even a cursory look at the health statistics in Pakistan reveals a depressing scenario.

According to the latest statistics available (for the year 2001-2002), Infant mortality in Pakistan is 83.3 per 1000, which is the HIGHEST among many South Asian and far eastern countries; it is even higher than Nepal (with 73.6 per 1000) and compares pathetically with a country such as Malaysia (with only 7.9 per 1000). Even childhood mortality (under the age of 5

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years) per 1000 persons is the highest in Pakistan at 110.3, as compared to that of Nepal (104.7) and India (87.7).

Almost 35% of children remain undernourished, while 50% of pregnant women in our country suffer from anemia. This is inspite of a major effort of children-immunization program, being carried out during the last several years in the country. Many dreaded communicable diseases, such as Malaria, Acute Diarrhea, Dysentery (Both amoebic and bacillary) and Tuberculosis, are quite rampant and the current scenario shows that their percentage is very high among the world population. Acute Diarrhea has been the biggest killer and contributes almost a quarter of the total mortality. Even respiratory tuberculosis, which has been eliminated from many parts of the world, causes almost 18% of the mortality among the communicable diseases category. In 1998-99, there were as many as 105,000 cases of Malaria reported, indoors in various hospitals of Pakistan: a disease which has been eliminated from many parts of the world. More recently, cases of Hepatitis and AIDS are also increasing at an alarming rate; more than 13,000 cases of Hepatitis were reported indoors in Pakistan during 1998-99, while it has been estimated that there may be as many as 70,000 to 80,000 HIV positive cases in this country by now. These figures become more frustrating when one considers the fact that all these communicable disease are “avoidable” through better education, personal and environmental hygiene and through research.

Pakistan has been struggling due to some basic problems to provide basic medical care and health-facilities to its citizens during the last 50 or so years of its existence. Very briefly, these problems are:

- i Over population
- ii Lack of Education
- iii Lack of Resources, both human and financial
- iv Poor Research and Planning

These are discussed below:-

i Overpopulation

Pakistan’s population has increased from 30 million in 1947 to about 146 million. The population growth-rate of 2.4% (for the year 2000) and projection of 2.1% for the year 2002, is the second highest among several of its neighboring countries (only Bhutan, with 2.9% has higher). This is an alarming situation, which needs to be tackled urgently. The family planning program has been able to cover only about 50% of the population and is expected to cover 70% of population by the end of 2003. Unfortunately, however, this program has not been able to achieve its goals so far, due to a large number of reasons, including our social and religious norms. It can be easily speculated that if such a trend in population-growth continues, then many of the public-health and welfare programs will continue to remain inadequate, despite substantial inputs, both monetary and human.

ii Lack of Education

It has been well established that education is the key to socio-economic growth and development of a country. It not only enlightens but also prepares people to take part in the opportunities available in the labor market, thus enabling them to escape poverty.

There has been a gradual increase in our literacy-rate over the past decade and it has now reached almost 45-50%. There has also been an increase in the number of Primary, Middle, Secondary, Higher Secondary institutions, Colleges and even Universities in the country but their number is still far less than what is required for universal education. In many of our rural areas, the literacy rate is still below the 30% mark. The overall rate of less than 50% is still among the lowest in the region and needs to be improved dramatically if we are to compete with the rest of the world and, more specifically, in the context of the present discussion, we need to educate our masses about the potentially deadly diseases and the importance of their timely reporting. With the beginning of the post genomic era, it is also important to orientate our public and policy-makers in the right direction so as to set the stage for getting the maximum use of available genome data, to resolve our indigenous as well as global health problems.

iii Lack of Resources

There is a pathetically low financial investment in the health-sector in this country. Pakistan spends about 0.7% of its GNP on health in public sector, as compared to 6-15% which the industrialized countries spend, or even 2-5% of GNP spent by many developing countries. No wonder we have a ratio of one doctor for more than 500 persons and one nurse for more than 3600 population, while there is only one dentist for more than 31,000 people. There is only one hospital bed for more than 1400 persons! It is quite obvious that in order to improve these conditions, infrastructural facilities need to be increased substantially, both physical and human.

iv Poor Research & Planning

For a sound health-delivery system in a society, a well established Health Research System is essential. Without sounding dramatic about it, it can be stated fairly accurately that health research has never been more than rudimentary in this country. Not only are there very few researchers in this field, but there is almost a complete lack of organizational and financial support for the researchers in the areas of health and nutrition. Pakistan Medical Research Council (PMRC) is the only organization that has been trying to set up a viable Health Research System in Pakistan, with relatively very little resources at its disposal. In fact, very little research has been conducted so far in the country in the field of medical sciences. What can be expected in a country where there are no more than 3000 Ph.Ds in all Science disciplines, with an input of 30-50 PhD's a year! Then, not all of these "experts" are engaged in research. According to a recent estimate, there are only 90 persons engaged in R&D in Pakistan per one million population (compared with 4100 such persons in Japan!). To make matters worse, Pakistan spends less than 0.4% of its GDP on R&D (as compared to at least 1-2% recommended for a meaningful R&D). No wonder, Pakistani scientists contribute less than 0.04% to research publications of the world (as compared to more than 2% by India). It is quite apparent that a major endeavor is needed in this area if Pakistan is to set up a decent Health Research and Delivery System for its people.

REVIEW OF CURRENT HEALTH-RESEARCH IN PAKISTAN

As stated previously, very little biomedical and clinical research is being carried out in Pakistan. Recently, PMRC has prepared a guideline for action i.e. an operational plan for the period 2001-2006, for the development and strengthening of Health Research System in Pakistan. How successfully PMRC will be able to achieve the objectives of this plan will have to be seen after the completion of the program. In the meantime, PMRC has been able to set up 18 Research Centers so far in 90% of the public-sector undergraduate and all postgraduate medical institutions of the country. However, the present arrangement has not worked satisfactorily till now.

Apparently, trained manpower, financial resources as well as logistics are all lacking, presently, to achieve the desired results. Thus, PMRC is revamping the whole strategy. An in-depth analysis of i) priority areas of medical research ii) identification of capable institutions iii) technical, financial and material sources availability, and iv) incorporation of the results of the research into policy-making, is planned to be carried out in the next few years. That too, with expected national and international fiscal assistance. The following main parameters to be studied during the proposed 5 years (2001-2006).

- Magnitude of the disease/condition burden
- Current interventions, in place of those conditions
- Potential impact of research on policies and interventions

PMRC is also planning to bring about its restructuring, in order to achieve its goals in a more effective manner, including a significant decrease in the number of its Research Centers; from 18 to 5 in total, but located at major institutions with well established communication-mechanisms.

WHY LACK OF MEDICAL RESEARCH IN PAKISTAN

There are a number of reasons for an almost complete absence of research in the medical field in this country. Interestingly enough, the research which is carried out is that of a survey type or statistical in nature. For example, the Annual Report of Director-General (Health) for 1998-99 lists 6 publications by Health Services Academy (HSA), Islamabad. The titles of these publications are:

- "Occupational safety and Health in Pakistan"
- "Perceptions of obesity and diabetes in societies in transition"
- "Environmental considerations in nutrition"

- "Role of economic and social development on nutritional status of women with reference to South Asia: An agenda for public policy"
- "Privatization of public hospitals in Pakistan; issues of quality, cost and quality"

It is quite apparent that there was no experimental or clinical research carried out and published during the year under review.

As pointed out earlier, there are a number of reasons for this state of affairs, in terms of basic medical research, in Pakistan.

Firstly, as pointed out earlier, there is a lack of research persons in all sectors of science. There has been a little effort to develop what is referred to as "Science Culture" in our society. Scientific research has had little incentive or reward till very recently. Only this year, a few scientists in the country have been given financial rewards, based on the "Impact Factor" and "Citation" record of their publications. (It is, however, entirely a different matter that these publications were mostly based on research work carried out in foreign countries!!!). It is quite disheartening to note that there were a total of only 669 publications in the year 2000 emanating from Pakistan, which was about 0.04% of the total publications. This number was even less than Nigeria (933) or Morocco (1110)! Such was the output from various disciplines of science, such as Chemistry, Physics, Agriculture and Biology, etc., in which there are well trained scientists (with Ph.D degree) in the country. What can be expected from medical (clinical) graduates, who, by and large, have no formal training in conducting research. Only recently, a few of the medical graduates have enrolled into M.Phil or Ph.D programs within or outside the country. Such research-trained clinical scientists have not yet made a tangible mark on the overall medical research arena in Pakistan.

The second most important reason for lack of interest in research is financial. Due to an acute shortage of physicians in the country, most of them are extremely busy in direct patient care, both at hospitals, as well as in their private practice. It follows that this becomes financially very rewarding. These clinicians would, naturally, spend time in this lucrative activity, rather than spend time in research, which is highly time-consuming and does not carry even a fraction of the rewards.

Thirdly, there is an almost total lack of interaction between basic scientists and clinicians in our country. It is a norm in the scientifically advanced countries that clinicians interact very closely with basic scientists in carrying out their research. It is quite obvious that the generation of new knowledge in any aspect of human existence follows extensive experimentation on the closely related species of experimental animals, such as mice, rats, guinea pigs, cats, dogs and monkeys. The genetic make up of such animals is very closely related to humans and so are, therefore, all life processes going on in them. The bio-scientists, may these be anatomists, physiologists, biochemists, cell biologists, geneticists or developmental biologists, are all involved in the study of the human body, through the use of other life-forms, including micro-organisms. A lot of information (data) is thus generated by basic scientists, in terms of all life-processes, as these occur in animals, which is then taken up, studied, analyzed, and used by clinicians in the understanding of what goes on in humans. In fact, a survey carried out by American Medical Association in 1989 found that 99%, of more than 500,000 physicians believed that animal- research had been essential for medical progress. These were the studies on mice, which led to the progress in gene-therapy as a cure for Cystic Fibrosis in children and young adults. Similarly, dogs were used to develop angioplasty techniques, and a lot of research on Alzheimer's disease was carried out on monkeys. Animal studies are required by law to be carried out on all medical drugs and procedures, before these can be allowed to be tested on human subjects.

Unfortunately, this relatively simple concept has not yet been comprehended by our scientists. Till today, our medical colleges tend to compartmentalize basic and clinical sciences and treat them as separate entities, instead of two parts of a whole. This has resulted in these scientists working in isolation, with very little extrapolation and application of basic biological research onto human health and welfare. No wonder, clinical scientists have not been able to carry out any meaningful research in various fields of health. It is therefore, about time that our basic scientists and clinical scientists get together (as is done in the developed world) to carry out research for the betterment of human health. The major draw-back in this regard is that our policy-makers were not focused to plan the health-policy to address the real as well as potential health threats. Temporary and short-term measures have been adopted in the past to tackle health-problems and real research, according to the ever changing needs of the country, is non-existent. This aspect of medical or clinical research has attained significant importance, in the light of many recent scientific advances in both preventive and therapeutic practices.

One particular scientific achievement, which has potential to give new out look to the whole health-care system in the coming years, pertains to “functional genomics” i.e. the science dealing with the functional characterization of genes belonging to complex human genome and disease-causing pathogens.

It was visualized well before the completion of human genome project (2001) that the explosion of information will bring a revolution in medical research and patient-care. With the completion of genome sequencing of the deadly human pathogens, and with the human genome being sequenced already, it would be possible to understand how genes associated with particular functions are controlled, regulated and interact with each other, in particular environment, to control the complex biochemical functions of the living organisms during the disease process.

Thus, this research will have major benefits for the prevention, diagnosis and management of many diseases, including both communicable and non-communicable diseases. Research in genomics will help us to understand the host-pathogen interaction and the strategies deployed by the pathogen to avoid the host-defense mechanisms. This information, in turn, will help us in better diagnosis and development of new vaccines and drugs.

BIO-INFORMATICS

Bioinformatics is one of the most exciting areas in biomedical sciences during the transition to the 21st century. By definition, science of Bioinformatics has to be multidisciplinary in nature, involving biology, medicine, mathematics and computer sciences. In simplest terms, Bio-informatics concerns the creation, maintenance and analyzing of databases of biological information.

The objectives of this newly emerging science are to enable researchers to access efficient tools for managing and interpreting the ever-increasing quantities of genome data and for making it available to the research-community in an accessible and usable form. Its main focus is on Molecular Biology i.e. computational modeling of regulatory and metabolic pathways, protein structure and design and characterization of the genomes of organisms, including human genome. The focus of the project is to move from the “wet lab” with its gels, sequences and PCR machines to the “dry lab” of hardware, software and algorithms. A researcher equipped with an internet-connected computer, a working knowledge of the sequence-analysis techniques can provide a surprising insight into the macromolecular architecture of a completed genome.

Genome sequences are of little value without the powerful tools of bioinformatics and functional genomics. The vast amount of the new data will provide us not only with information on bacterial diversity and evolution, but also with the ability to probe the inner depths of some of mankind’s oldest enemies (and some of the newer ones).

Pakistan, already trying to catch up with other countries in acquiring new technologies, such as Biotechnology and Information technology, cannot afford to lag behind in this endeavor. The research will focus on developing bioinformatic tools and resources for data-storage, mining and processing; developing special computational biology approaches for *in silico* prediction of gene-function and for the simulation of complex regulatory networks. Considering all these facts, and to materialize them, we need to set up an infrastructure for genomic research supported by a well-established bioinformatic laboratory.

DIAGNOSTICS

The complete sequencing of the human genome, announced in 2001, marked the culmination of unprecedented advances in the science of genomics, the study of genome and its functions. The availability of genome-sequences for many living organisms clearly has important implications for improvement of health, and it has been widely predicted that elucidation of the sequences will lead to a revolution in medical research and patient care.

Any benefits that result from the latest advances in genomics research, in clinical applications in many diseases, will be irrelevant to countries that do not have functioning health-care systems. However, conventional, tried and effective approaches to medical research and practice must not be neglected while the medical potential of genomics is being explored. DNA diagnostics prove to be a valuable tool to identify the pathological agents which are otherwise difficult to identify by conventional methods, such as culture, and also for assessing the level of activity of chronic viral infections, such as Hepatitis C infections. This will give us accurate information for future drug design or vaccine-formulation according to our indigenous needs, keeping in mind the target gene-sequence of the pathogenic organism.

Molecular biology techniques, such as Polymerase Chain Reaction (PCR) and Enzyme-linked immunosorbant assays (ELISA), have proved to be rapid, cost-effective and highly sensitive tools in modern diagnostics. For instance, beta thalasaemia is an autosomal recessive genetic abnormality resulting from the reduced/absent synthesis of beta-chains of the globin part of the haemoglobin molecule, which in most cases is due to point mutations in globin gene on chromosome 11. Pre-natal genetic counseling/diagnosis will prevent this social, emotional and economic trauma, which is also prevalent in Pakistan. Similarly the strong molecular biology technique of multiplex PCR has been successfully used to diagnose various diseases like Cholera. The unexpected and explosive entry of the O139 serogroup of Cholera has complicated the diagnosis of the disease, whereas current rapid tests are all focused on the O1 serogroup. Multiplex PCR method is capable of providing multiple information directly from stool-specimens in approximately 5 hours. The potential for using genes themselves to treat disease, known as gene-therapy, is the most exciting application of DNA science. "DNA chips" is another fascinating idea in modern science, which can be used to screen enormous number of potential target DNA-sequences and is therefore ideal for examining clinical samples for microbial pathogens. However, the time-scale for this diagnostic tool to be operational is difficult to predict. These routine diagnostics can also act as a bridge in linking the clinicians and basic scientists and also give financial boost to the biomedical faculty in conducting meaningful research in parallel.

CONCLUSIONS

This brings us to the final point of the present discussion, which is how we can proceed to carry out research in this direction. Although it is obviously a difficult proposition, especially in the context of our political, economic and social milieu but, sooner or later, we have to realize the importance of "genomics" in transforming the status of health-care in our country. Therefore, this is the time to get ourselves organized and plan for the genomics era, in order to ensure that the advances of the genomics revolution are effectively and efficiently applied to improve the health of our population. We should also be conscious of the reality that much of the genomics research and development is performed, and owned, by private-sector interests in the developed world and hence is market-driven and therefore, instead of looking to some other developed nations to come and rescue us from our indigenous health-related issues, we better move in the direction of self-sufficiency in Biomedical sciences with the changing interests of big pharmaceutical industries in the post-genomic era. This can be done either by strengthening the existing or establishing new centers and institutions engaged in genomics research, with a view to strengthen national capacity and accelerating applications of the advances in genomics relevant to the country's health-problems.

Lastly, one needs to re-emphasize the three well known basic ingredients for carrying out any meaningful research. These factors are:

- Trained manpower
- Adequate infrastructure
- Appropriate incentives

Unfortunately, even these basic factors are lacking in our country. However, let this meeting / workshop be the first step in the planning and action in the direction of sufficiency in this regard. The first and foremost thing with reference to building our capacity in Biomedical research is to train scientists/researchers so that they can acquire the necessary expertise in various aspects of biomedical research, such as functional genomics and bioinformatics as explained already. This would obviously involve clinical scientists, basic scientists, paramedical experts and technicians. The need for all health-professionals to have competency in various fields of biology and medicine is therefore essential. A vast majority of existing clinicians, who have practically no training in carrying out scientific research, need to be given short and long-term training courses to familiarize them with modern research-techniques and their applications.

Similarly, many of the basic scientists in the fields of biology, chemistry, physics, mathematics and engineering will need to be trained in health-related problems. Auxiliary paramedical/technical staff needs to be educated and trained to carry out routine clinical practices and so on. This can only be achieved if necessary infrastructure is in place, in the form of laboratory facilities and equipment---a giant effort in itself. Thirdly, realistic incentives, both professional and economic, need to be provided to all these personnel, if we are serious in our efforts to provide better health care to our people.

COMSATS Institute of Information Technology does plan to embark upon this effort, by setting up their Center for Biomedical Research (CBR). It is hoped that this initial endeavor would lead to the setting up of many more biomedical research centers in the country, so that better health-care system can evolve in Pakistan.

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BUILDING OF S&T INSTITUTIONS FOR SUSTAINABLE DEVELOPMENT

*Nelofar Arshad**

ABSTRACT

Building S&T capacity for sustainable Development is a more formidable challenge than just building S & T capacity. It implies building a capacity for integrated, problem-driven research on highly complex situations, at the same time as providing the basic general S&T capacity in different fields.

In order for science and Technology to effectively contribute to sustainable development, countries do require scientific capacity. The sustained and enduring investments that developed countries have made in building their educational and science and technological capacity largely explain their success. However, national investments need to be accompanied by responsible and mutually beneficial international partnerships. Experience shows that international scientific cooperation through efforts such as the creation of institutional networks, scientific exchanges and mobility, and the establishment of scientific centers of excellence among nations with weak scientific infrastructures, are excellent strategies for building scientific capacities.

Building and maintaining the qualities of key institutions of learning—especially universities—is critical to long-term capacity-building in S&T. In addition, the establishment of regional sustainable development centers/networks in representative locations, in poverty-stricken areas of the world, are a high priority. Such centers/networks could be linked by effective communication-networks with senior scientists and engineers, serving as advisors and mentors in critical fields. The centers could serve as focal points for capacity-building for students from developing countries and as training centers for visiting volunteer engineers and scientist.

BASIC CONCEPTS

Institution-building is defined as a process of creating capacity within and among organizational sets, to redefine the operating culture, formal and informal rules, conventions and norms of individual and collective work, in response to environmental change. The capacity-building efforts in developing countries must be perceived in the framework of the enormous disparities between the North and the poorly developed South, where 80% of the humanity lives & where only 10% of total outlays for scientific research are spent and only 2% of world patents are registered.

Sustainable development, with faster growth and higher productivity, requires much strong institutions. This is not only true for science and technology, but for all other sectors. The World Development Report, 2002 states;

> *"Without[2] effective institutions, poor people and poor countries are excluded from the benefits of market. The report elaborates that institutions are not immutable. Be prepared to experiment with new institutional arrangements and to modify or abandon those that fail. Learning from the success and failures of other country's experiences in institution-building can provide valuable guidance. But copying institutional models, without considering whether those they are supposed to serve need them, can waste scarce resources"*.

Coming now to components of institution-building, it is necessary to discuss briefly each component, which makes an institution strong. The framework of institutional building consists of six major components[1], which have further sub divisions described below:

1. STRATEGIC LEADERSHIP

Strategic leadership is associated with vision**,** ideas and timely action. It involves developing ways of procuring essential resources, inspiring organization-members and stakeholders to perform in ways that attain the mission, and adapting to or buffering external forces. A strategically led institution will be continuously engaged in the process of changing, adapting and following a path that leads to fulfilling the organizational objectives. The more broadly that constructive leadership is available to the organization, the more vibrant and creative the organization will be.

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2. COMPETENT HUMAN RESOURCES

Human resources of any institution are the most valuable asset. *Professional development* of researchers is necessary for building institutions. Mobilization of expatriate third-world scientists, living and working in the North, to examine critical problems in developing countries together with their colleagues in the South and to assist in building the capacity and excellence of scientific institutions in the developed world that could prove instrumental in transforming the brain-drain into a brain-gain. *Exchange* of scientists & engineers is a proven method of capacity- enhancement. Such exchanges must include a South-North-South dimension.

A *new generation* of scientists is needed, particularly for sustainability needs, with a holistic approach and transdisciplinary resources. Input and work coming from diasporas, or repatriating scientists can be a solution, but nothing replaces the need of developing a home-based scientific capacity. The programmes for Ph.D training must take into accounts the special need for sustainable development, as well as competitive research grants.

3. ADEQUATE CORE-RESOURCES

These resources include infrastructure, technological resources and finance. These are a barometer for an organization's health. As a part of understanding institution-building one has to consider the extent to which inadequate infrastructure interferes with the functioning or the potential functioning of specific S&T institutions. Achieving the critical mass in human resources must be complimented by adequate infrastructure, including modern, well equipped and maintained laboratories, libraries, independent research-funding mechanisms and especially peer-review mechanisms, access to basic communications, including internet, and adequate salaries and career recognition. There is a need to build capacity for carrying out long-term observations and research.

4. GOOD PROGRAMME-MANAGEMENT

The ongoing programs of S &T institutions are its central endeavor and, indeed, its main product. Research-support services and ongoing training should be vital programs within the organization. Program- management is the ability to develop and administer these programs in ways that support the mission. Good program-management sees to it that proper weight is given to each facet of mission-fulfillment. For instance, if producing research and conducting ongoing training are both stated priorities, each should receive commensurate resources. The main effort should be to:

- Identify and assess research needs — their relevance to national plans and priorities and any gaps in existing programs
- Set goals and strategies; identify focus areas and activities
- Develop plans that
  - are consistent with needs, strategies, and areas of focus
  - address constraints and opportunities, and
  - take into account technical and organizational capabilities
- Account for technological, economic, social, and environmental aspects, to ensure applicability of research outputs
- Find/create opportunities for funding that is secure, diversified, and sustainable
- Review, revise, and approve plans/budgets
- Generate and review research proposals; submit to and negotiate with funding agencies, sponsors, and clients
- Assimilate reviewers' comments; approve proposals, activities; allocate resources

a **Research-Program Implementation:** Research- program implementation should entails the following tasks:

- Implement research-objectives.
- Provide technical, administrative, and logistic support to projects.
- Identify and meet training needs.
- Disseminate/use research results, as appropriate.
- Maintain linkages with policy makers, research disseminators, and other users.

b **Research Program-Monitoring and Evaluation:** Monitoring and evaluating are necessary components in the planning cycle. These activities involve:

- Establishing performance-measurement indicators and processes.
- Monitoring technical quality and scientific progress and providing feedback to researchers.
- Administrative and financial monitoring and reporting.
- Reviewing/revising procedures and resources, taking corrective measures or terminating.
- At project completion, evaluating:
  - Objectives — their overall relevance, adequacy, appropriateness, and degree of achievement
  - cost-effectiveness of activities
  - quality of outputs produced (relevance, adequacy, and appropriateness vis-à-vis objectives)
  - activities required to maximize utilization of outputs
  - lessons learned
- Based on the assessment, identifying follow-up courses of action.

c Research-Support Services: Research-supporting services in the organization that must be planned for, implemented, and monitored include:

- External linkages with relevant actors, decision-makers, and policymakers
- Management of Information and materials
- Financial and administrative services
- Field-testing and disseminating research-outputs (farm, community, and commercial trials, patents, marketing)

5. ACCELERATED PROCESS-MANAGEMENT

Taking a vision and making it a reality, through smooth-flowing, daily work in an organization, is largely dependent on the ongoing "processes." These are the internal management systems — the many mechanisms that guide interactions among people, to ensure that ongoing work is accomplished rather than hindered or blocked. They include planning, communication, decision-making, problem-solving, monitoring, and evaluation. If all are working in harmony, the outcome is that the organization is learning and accomplishing a great deal and it is the indicator of a healthy institution. If they are deficient, the organizational direction is often hampered.

Problem solving and *decision-making* are two interacting and mutually reinforcing processes that must function well at every level of an institution. These processes entail the ability to define important problems, gather the data to frame the issues, create a set of alternatives to deal with the problem, decide on solutions, create the conditions to carry out decisions, and monitor these decisions and the problem's progress. Timeliness is a key element in this process: Organizations must be able to identify important issues and act in a timely fashion.

6. EFFECTIVE INTER AND INTRA-INSTITUTIONAL LINKAGE

For S&T institutions engaged in creating and utilizing knowledge, it is vital to cultivate contacts with other institutions and groups of strategic importance to the work. These may be potential collaborators and collegial bodies, potential funders, or key institutions. Formal links with others can result in a healthy exchange of approaches and resources (including knowledge and expertise) and can serve as an important reality check. Keeping up with advances in pertinent fields of research is of crucial importance to S & T institutions. This means having access to wide-ranging sources of up-to-date information within each discipline. New information and technology of importance in the field bear directly on the organization's program-management, from the choice of research topics (to pursue) to the types of training and services the institute will provide. The nature of linkage is as follows:

a. Networks: Networks of scientists or organizations are one of the most important ways of institution- building according to international standards. They provide sharing of produced scientific knowledge, identification of common interests, understanding of impacts, dissemination and gathering of information and support through sharing of facilities. The "Educational Model Network for a global Seminar on Environment(3)" organized as a global network of universities (Cornell University as the center and many others from the United States, Netherlands, Sweden, Melbourne, India & Costa Rica) is a new paradigm of education for sustainable development. It consists in videoconferencing, multiconferencing and satellite-communication systems that focus on problems, with the objective of transforming institutions and empowering global citizens cooperatively to sustain human, environmental and food systems. The global learning concept and theory is constructive, experiential learning, "learning to learn " and uses cognitive psychology

b. Centers of Excellence: These are catalysts of research, they provide capacity-building opportunities and peer revision. Such centers could be linked by effective communication-networks with senior scientists and engineers serving as advisors and mentors in critical fields. The centers could serve as focal points for capacity-building for students from developing countries and as training centers for visiting volunteer engineers and scientists.

c. Collaboration & Cooperation: The "Trieste mode(3)" an idea put forward by Abdus Salam, supported by IAEA and UNESCO, is related to the work of the international Center of Theoretical Physics, the International Center for Genetic Engineering and Biotechnology and the Third World Academy of Sciences. It constitutes a model of international capacity-building. They provide for capacity-building in the biggest sense, contribution to the return of scientists to their countries, and transferring know-how and technologies. It is a perfect example of North/ South and South/ South cooperation.

PAKISTAN'S PERSPECTIVE IN THE BUILDING OF S&T INSTITUTIONS

Keeping in view the importance of institution-building in science and technology, the Government of Pakistan has taken serious action during the last 3 years. During the 2nd meeting of National Commission for Science and Technology in the year 2000 with the Chief Executive, the overall state of S&T institutions had been discussed and it was agreed to critically assess their strengths, weakness, opportunities and threats(4). Peer Review Committees comprising relevant experts, constituted in each S&T discipline/ subject, have been assigned the task to evaluate R&D organizations and S&T departments of universities. The reviewers had visited physically each of 528 R&D organizations, subordinate institutions, stations, unit, S&T departments of universities, etc. The common observations of the peer review committees are as follows:

i The institutions are disjointed, scattered and, in some cases, duplicating each other's efforts.
ii The institutions are under-funded, under-staffed, poorly equipped, poorly managed and non-productive.
iii Almost 95% of their budgetary allocation meets only the establishment charges.
iv The equipment has become obsolete and has no repair and maintenance facilities.
v The libraries have no modern information-facilities and institutions have poor inter and intra-institutional linkages.
vi Numbers of institution do not have well defined targets and goals and the high-quality but limited manpower working there is under-utilized.
vii Much of the failure is attributed to lack of leadership and R&D managers, who lack the knowledge of whole process of innovation and development.
viii The organization has not been able to build confidence of even local industries to resolve their problems.

a. R&D Organizations

Out of 228 R&D organizations, stations and subordinate institutions, etc, the peer review committees suggested the merger of 33 institutions, closure of 6, re-organization/restructuring of 11,up-gradation of 141 and internal administrative reforms for 22, see Fig-2.

b. S&T Departments of Universitites

As for as 300 S&T departments of universities are concerned, it was noted by the Peer Review Committees that almost 90% are below standard, in respect of input and output. It is not possible, due to limitation of time and space, to discuss in this paper each department individually selectively three main S&T subjects classified under three major disciplines are discussed, viz.

- Mathematics in Basic Sciences
- Veterinary Sciences & Animal Production in Agricultural Sciences
- Electrical Engg/ Electronics in Engineering Sciences

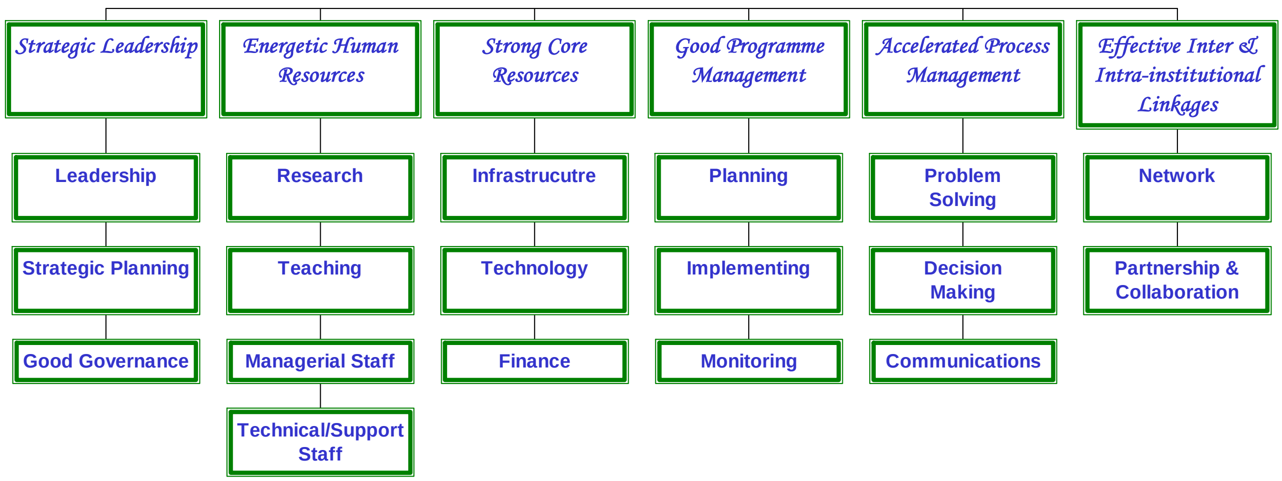


Figure - 1: Component of Institutional Building

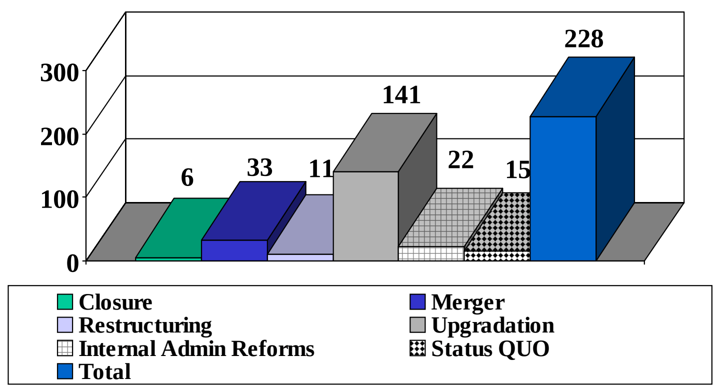
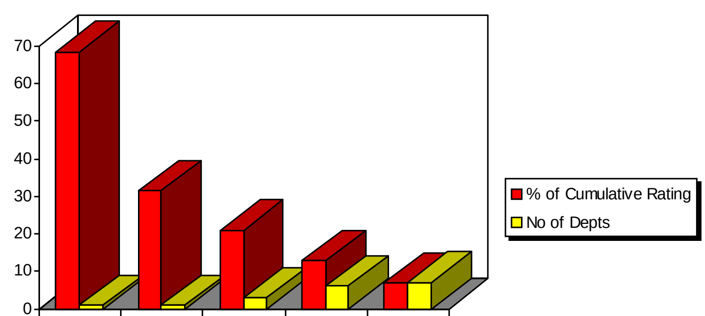
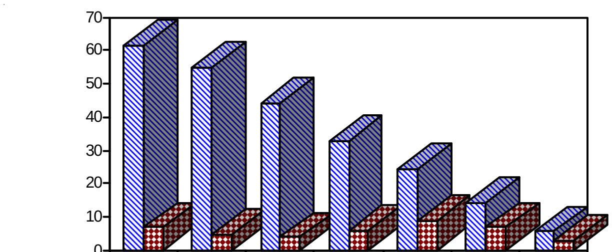


Figure - 2: Recommendations for R&D Institutional Building in Pakistan (2002)



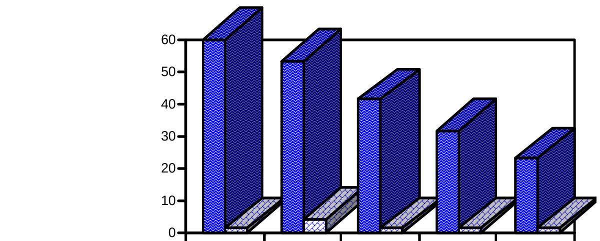
	B	E	F	G	H
% of Cumulative Rating	68.5	31.4	20.9	12.8	6.9
No of Depts	1	1	3	6	7

Figure - 3: Categorization of Mathematical Departments on the basis of cumulative rating



	B	C	D	E	F	G	H
% of Rating	61.6	55.1	44.2	32.8	24.6	14.4	5.7
No of Depts	7	5	4	6	9	7	3

Figure - 4: Categorization of departments of veterinary sciences and animal production on the basis of cumulative rating



	B	C	D	E	F
%of Cumulative Rating	60	53.5	41.4	31.4	22.8
No of Depts	1	4	1	1	1

Figure - 5: Categorization of departments of electrical engineering/electronics on the basis of cumulative rating

The situation of Mathematics is appalling. There is no worthwhile programme in all universities except one. Out of 18 departments, only 1 has been classified in category "B" (see Fig-3) in respect of input and output (scientific and technical merit, contribution towards M.Phil/Ph.D level training, quality of research, linkage/collaboration, ability to win grants & development projects and economic impact of research). There is no more than 90 Ph.D in the nation of 140 million people. There have only been about 35 Ph.Ds produced by the country so far. About 66% of the human resources are non-Ph.D; most of the remaining 33% are likely to retire by the year 2007. It was observed that there is no institutional linkage at national and international level. The libraries have no funds for subscribing journals.

The situation in the Agro-Sciences is summarized below:

1.NWFP Agricultural University, Peshawar	1
2.University of Agriculture, Faisalabad	83
3.University of Veterinary & Animal Sciences, Lahore	8
4.Sindh Agriculture University, Tandojam	2

Only 7 are placed in category "B", see Fig.4

Problem faced by these departments are multifarious, these problems can mainly be grouped into lack of operational funds, the quality of faculty, availability of infrastructure. Some of the departments have the potential to work with local industries, but the mechanism & procedure for joint appointment & research are not fully developed. Thus this interaction is never institutionalized..[2]

The Electrical Engineering/Electronics departments of eight universities are facing the same difficulties as departments of other subjects. It is noted (see Fig-5) that out of 8 departments only one could attain grade B i.e. satisfactory while rest of 7 are below standard in respect of all those components which make an institution strong.

Let us do something before it is too late. History will not forgive us---the policy makers, science administrators & the managers.

The basic questions relate to the adequacy, effectiveness & relevance of the scientific & technical system in the context of indigenous needs: (i) Whether the growth of the science & technology institutions has been haphazard, or has been linked to the felt needs of the country, (ii) Whether requisite attention has been given to critical elements of institution-building, leadership, doctrine, programmes, resources, internal structure & linkages;(iii) Whether the system is balanced and has all the necessary structures for S&T policy, planning, coordination, education, research, extension & evaluation, and(iv) whether the system has been productive & has contributed to socio-economic development.

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THE ROLE OF UNIVERSITIES IN S&T CAPACITY-BUILDING FOR SUSTAINABLE DEVELOPMENT

*Khalid Farooq Akbar**

ABSTRACT

The basic characteristic of developing countries is poverty. What is needed is a new, people-based, sustainable development, with a focus on broad-based rural development and resource-conservation. It can prove to be the most effective way of tackling poverty in the South.

Finding a sustainable way of life, socially, economically and environmentally, is one of the greatest challenges facing humanity today. Science and technology are important components of aggregate national strength and one of the fundamental bases for sustainable development. Without the support of advanced science and technology, the objective of sustainable development cannot be realized. The thesis that science and technology constitute a fundamental productive force has been universally accepted. Education is critical for improving a country's capacity in science and technology and to address issues related to sustainable development. It is just as important for Education to arrive at sustainability, as for the economy, legislation, science and technology, and furthermore, is a prerequisite for all the aforesaid.

Universities, being the fountainheads of knowledge, should play a leading role in developing a multi-disciplinary form of scientific education, in order to devise solutions linked to sustainable development. The universities should, therefore, commit themselves to an on-going process of educating, training and mobilising all the stakeholders of society linked to sustainable development so as to ensure a sustainable and just world.

To achieve this, the universities should plan and implement their academic activities on the basis of the following principles:

- *i. The universities should incorporate a sustainable-development perspective in all teaching and research activities, including science education and develop the necessary teaching materials.*
- *ii. The universities should organise and co-ordinate comprehensive, multi-disciplinary and collaborative academic programs in science-education in order to develop and adopt appropriate environmental and resource-management policies to achieve sustainable development.*
- *iii. Develop effective guidelines and policies to attract and encourage large numbers of talented people to engage in science and technology for sustainable development and to build up a well-organized and able contingent of scientific researchers.*
- *iv. To prepare motivated and trained manpower that is able to implement policies for sustainable development: the universities should make efforts to develop capacity-building programs for scientific, political, economic and other decision-makers.*
- *v. To meet the needs of education and training in an ever-changing scientific world, the courses and programs providing traditional campus-based education need to be suitably modified for their incorporation into a continuing education and training system.*

INTRODUCTION

The basic characteristic of developing countries being poverty, what is needed is a new, people-based sustainable development, with a focus on broad rural development and resources-conservation. It can prove to be the most effective way of tackling poverty in the South.

Finding a sustainable way of life, socially, economically and environmentally, is one of the greatest challenges facing humanity today. Science and technology are important components of aggregate national strength and one of the fundamental bases for sustainable development. One of the biggest hurdles in achieving sustainable development in the developing countries is the need to generate the capacity to apply science and technology to this goal. While it is necessary to build and enhance strong scientific and technological capacity in all regions of the world, this need is particularly pressing in developing countries. The Organization for Economic Cooperation and Development (OECD) countries spend annually more on research and development than the economic output of the world's 61 least developed countries. Developing countries must address this problem and make capacity-building in science and technology, a prime priority area in their struggle to achieve the goal of sustainable development.

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Continuous advances in science and technology can effectively help in:

1. Formulation of policies for sustainable development;
2. Promoting the upgrading of the management for sustainable development;
3. Deepening humankind's understanding of the relationships between man and nature;
4. Expanding the supply and availability of natural resources;
5. Enhancing the utilization and economic benefits of resources; and
6. Providing guidance for the protection of the environment and natural resources.

These capacities are critical if we are to alleviate the contradictions among the South's population and economic growth and limited resources, while attempting to increase the environment's capacity for sustainability and to improve the quality of life, thereby realizing the main objectives of sustainable development.

EDUCATION AND CAPACITY-BUILDING

The capacity-building in science and technology encompasses a multiplicity of resources, actors and organizational and institutional components, interacting in a long-term systemic process. Among these, education is the critical component for improving a country's capacity in science and technology and to address issues related to sustainable development. Education is just as important to arrive at sustainability as the economy, legislation, science and technology and furthermore, is a prerequisite for all the aforesaid.

UNIVERSITIES AND CAPACITY-BUILDING IN S&T

Universities, being the fountainhead of knowledge, should play a leading role in developing a multi-disciplinary form of scientific education, in order to devise solutions linked to sustainable development. Universities and other institutions of higher education are, in fact, a necessary component-the crucial node-in a healthy system of development of science and technology for sustainable development.

The main function of universities is to train the future generation of citizens and develop capacity in all fields of knowledge, both in technology as well as in the natural, human and social sciences. For this purpose, universities should strive to fulfill the following aims:

1. To prepare a solid basis for more efficient, coherent and responsible development of economic, financial, human and natural resources;
2. To strengthen national capacities, particularly in scientific education and training so as to enable governments, employees, and workers to meet their developmental and environmental objectives and to facilitate the transfer and assimilation of new, environmentally-sound, socially acceptable and appropriate technology and know-how.
3. To prepare adequately trained and adaptive workforce of various ages, equipped to meet the growing environmental and developmental problems and changes arising from the transition to a sustainable society.

To achieve these objectives, our universities should plan their academic activities and emphasize the following features:

– **Institutional Commitment**

Universities should demonstrate real commitment to the capacity building in science and technology within their academic milieu. For this purpose, a policy for sustainable development should be incorporated, as basic criteria, in the medium and long-range planning of all academic activities. All the faculties, including S&T faculties, should include courses on sustainable development in their educational and research programs.

Universities should develop a well-structured scientific and technological system for basic research, applied research and engineering design and should strengthen new and high-tech research for sustainable development.

– **Interdisciplinary Approach**

The challenges faced by the present world are so complex and multifaceted that research and education have extended beyond the traditional faculties, and so activities in scientific research require huge investments and a concerted effort by large groups, to combine their knowledge and ensure continuity.

At present, in our universities, most of the students receive a mono-disciplinary training of high specialization or oriented to specific topics, and their efforts are geared towards individual performance rather than collective work. The present landscape of scientific education and research is similar to a deep tunnel instead of wide horizons. The tradition of dividing knowledge into separate subjects and encouraging competition between different scientific disciplines has become outdated.

To improve this, universities should encourage inter-disciplinary and collaborative education and research activities for sustainable development. The universities should open themselves up to new trends, in order to break through disciplinary boundaries and to join forces with other institutions and professions. The universities should create mechanisms in their organisation that foster and legitimise interdisciplinary work, in particular, financing research projects that bring together multidisciplinary teams for addressing real problems. The university administrators should promote extensive exchange and cooperation among scientific researchers in all fields and from all parts of the country, and enhance exchange and collaboration in the fields of scientific research, teaching and production.

– Cooperation with other Sections of Society

Universities should take initiatives in developing partnerships with other concerned sections of society, in order to design and implement coordinated approaches, strategies and action-plans to increase their capacity-building activities. Universities should launch programs involving coordinated participation of other institutions, provincial and federal governments, business community and NGOs. University students need to be trained in working with communities, while at the same time other sections of society should be induced to recognize the value of capacity-building in science and technology for sustainable development.

To ease the financial problems, universities should develop schemes, in partnership with other organisations, to relieve pressure on university budgets. The help of voluntary organisations and private enterprises can play a positive role in implementing R&D plans of universities.

– Priority Areas for Capacity-Building in S&T for Sustainable Development

For universities to take a lead in the changes required for science to respond to the challenges of sustainable development, they must revise their curricula, as well as the organisation and assessment of research. They should emphasize efforts on the following areas:

- Agriculture is the largest sector in most countries of the South and universities should devise plans to adopt a gradual shift towards sustainable agriculture.
- Modernizing the energy sector is necessary for sustainable development, and our universities should take measures to increase energy- production and efficiency of energy-use.
- Conservation of biodiversity, including fauna, flora, other habitats and landscapes, and preservation of cultural heritage of developing countries.
- Integration of environmental considerations into business, industry, transport and urban planning.

– Continuing Education and Training

In the present world, the pace of development of scientific knowledge is so fast that initial education and a single degree can not provide a sufficient basis for a life-long career. There is a growing demand for a new type of educational and training system that should provide facilities for mid-career or supplementary training. Our universities should gear up to fulfil this need, by revamping the present system of curriculum development, methods of examination, etc., and increase the facilities for continuing education. To achieve this, the courses and programs providing initial education need to be modified for their incorporation into a system for continuing education and training.

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ENERGY OPTIONS FOR PAKISTAN IN A GEOLOGICAL PERSPECTIVE

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ABSTRACT

The modern industrial civilization which has principally developed during the last century differs from all pervious civilizations in the amounts of energy it uses in sustaining its rate of growth. The most critical aspect of the present-day development scenario is that the rate of increase in energy-consumption is not simply arithmetical; it is geometrical and increases exponentially due to population increase coupled with a rising standard of living.

For a country like Pakistan, dependable and affordable supply of energy is of critical importance in order to industrialize the economy and to alleviate poverty. Although the energy related problems of Pakistan are formidable, but fortunately they are not entirely insurmountable, and geology holds the key to provide hope, options and solutions. The paper discusses the available energy-options for Pakistan in a geological context, and recommends measures which can hopefully ensure a better energy scene and thus a brighter future for Pakistan.

INTRODUCTION

Endowed with enormous potential for energy resources, Pakistan still remains an energy-deficient country. This is despite the fact that more than 70 per cent of the national territory is constituted by sedimentary rocks of various ages, which further extend into a large prospective off-shore region, through a 700km long coast in Sindh and Balochistan. The growth of the economy, combined with a high demographic rate and rising urbanization, has put the present energy-resources under pressure. It is, therefore, urgently needed that the rising energy-demand is met in consonance with the overall developmental goals and achievement of self-reliance through better supply position.

With an estimated population of 150 million people, growing at an alarming rate of 2.6 percent per annum, and an economy of US$ 70.0 billion growing on an average of about 5-6 percent per annum, the country needs ever-increasing supplies of energy for its developmental and socio-economic needs. Although since inception, Pakistan's per capita energy-consumption has increased 12 times from 0.22 to 2.6 barrels of oil equivalent, this level is still one-half of the average of the developing countries and 1/30th of that of USA. With continuing increase in population alongside an expansion in economic activities, the per capita consumption of energy is bound to rise substantially with severe demands of environmental sustainability.

**ENERGY RESOURCES:
POTENTIAL AND PROSPECTS**

Pakistan's proven energy-resources are not commensurate with the prognosticated geological potential.

The remaining resources of crude oil in known areas are estimated at over 310 million barrels while the production is only about 60,000 barrels per day, of which 33 per cent comes from the Potohar region and the other 67 percent is from Badin and adjoining areas in Sindh. Similarly, exploitation potential of natural gas is estimated at over 26 trillion cubic feet, against which the obtained production is about 2,600 million cubic feet per day. Likewise, the exploitation-potential of coal in the country is about 176 billion tonnes (175 billion tonnes in Thar coalfield in Sindh alone), but the annual production is confined to a meagre 4 million tonnes.

The hydroelectric potential is variously estimated, ranging from 20,000 to 45,000 MW, but the installed hydel capacity is 5,000 MW, which is expected to increase to about 6,200 MW by the end of 2000. The two operating nuclear- power plants have an installed capacity of 462 MW. The total thermal base power-capacity in the country is around 12,000 MW based either on the natural gas or the imported furnace oil.

It is clear from the foregoing description that the known energy potential of the country is much larger than the present level of exploitation. If carefully planned and efficiently implemented and managed than this potential is sufficient enough to provide

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immediate relief to the national economy in short to medium term, i.e. from 5 to 10 years. During this breathing period, long-term policies ensuring sustainable energy-supplies can be drawn and implemented. These long-term policies should also take into account the new developments taking place in the realm of renewable energy resources, like solar; hydrogen/fuel-cell; wind & tidal; biomass; geothermal and the nuclear involving the new breed of safer and better performing reactors.

Presently, Pakistan consumes 45.7 million tonnes of oil equivalent (TOE) as primary commercial energy. This comprises 41 percent oil, 43 per cent gas, 10 per cent hydro, 5 percent coal and 1 per cent nuclear. Nearly 83 per cent of oil is imported at a cost of over US $ 3.0 billion per annum. The import bill is likely to touch the 5 billion dollars mark within the next 3 to 5 years. It is, therefore, vitally important for Pakistan to further explore and develop its own resources of oil & gas; and also at the same time bring coal into major focus through coal-based power-generation; underground gasification; washing and briquetting; and as replacement-fuel in cement, sugar and other industries.

In the complex and interdependent world of today, the development-policies in a country cannot be drawn in isolation. It is, therefore, imperative for Pakistan to plan its energy-policies by taking a realistic account of what is happening all around the world, particularly in terms of new energy sources. It is almost certain that the era of fossil fuels, spanning over two centuries, is about to come to an end within the next 3-5 decades, not because of the depletion of resources but primarily because of cost factors and environmental considerations. Oil production in the world is likely to peak between 2007 and 2012. Thereafter, natural gas will start assuming the role of major source of commercial energy and this will be a transitional period, which will eventually give way to an altogether new 'era' of cleaner, safer and perhaps cheaper energy resources. This era is likely to be dominated ultimately by 'hydrogen' as the major player and with solar, wind, tidal and nuclear as the junior players. This R&D scenario is relevant to Pakistan, in the context that it provides some space to Pakistan to increase and expand its gas production and distribution network, with lesser worries now as to what will happen after 20 years or so.

When the energy scene of the world is viewed objectively and analyzed in its true scientific perspective, keeping in mind the human ingenuity factor, than it becomes clear that at least on a global scale the energy crisis is not really of resources but of perception. Nature is still bountiful (e.g. newly identified resources of gas hydrates), but the humankind has to be more compassionate and should exercise its options more carefully in an environmentally benign manner. Another critical aspect is that politicians and decision-makers, all over the world, should make a clear distinction between nuclear proliferation for weapon-use and the nuclear-power for meeting the energy-needs. If these aspects are taken into account and R&D efforts for harnessing new sources of energy and improving the use of existing resources are pursued vigorously, then the perceived energy- crisis can be resolved into *'an energy for all'* scenario. The alternative is a tense and divided world full of unpredictable and uncontrollable crises.

CONCLUSIONS AND RECOMMENDATIONS

Considered in a geological perspective, the overall picture of energy resources of Pakistan is not dismal, as is often projected. However, the country is confronted with the formidable task to explore and develop, as quickly as possible, all the available resources by readjusting priorities and making right choices for their rational use, both in power-generation, as well as, for other commercial purposes.

For the next 20 to 30 years, the transition of world's energy from the traditional mix of resources to a new blend of sources, the policy makers in Pakistan may consider the following suggestions with a view to augment energy supplies in the most economical and environment-friendly manners:-

1. Notwithstanding the policy and financial incentives and other concessions for foreign investment in oil & gas sector; concerted efforts should be made to develop a national pool of truly competent professionals to oversee and undertake all aspects of exploration and development of energy resources.
2. While R&D efforts may continue and be further accelerated on renewable energy resources, particularly solar, wind and tidal, the main thrust and focus of attention for immediate future should

continue to be on oil, gas and coal. In this connection, the *Indus off-shore* region in Sindh and the sedimentary troughs between Ras Koh and the Makran hills; and in Kakar-Khorasan area in Balochistan should be given high priority for exploration.

3. The use of CNG should be further encouraged and at least 50 percent of the road transport be switched on to CNG by 2007.
4. A re-assessment of hydel exploitation-potential should be made on proper scientific lines, particularly in view of the phenomena of global warming and the consequent shrinking of glaciers in the *Himalaya-Karakoram* region, which according to some computer modelling and climatological predictions are likely to melt in the next 40 to 50 years. The Indus river system depends heavily on glaical melt for its water flows. All this needs to be urgently and very carefully researched.
5. In view of the huge coal exploitation-potential established at Thar in Sindh, and additional resources of coal identified elsewhere in the country, a comprehensive *National Energy Policy* should be formulated, in which coal should occupy a pivotal position for power generation as well as for in-situ gasification (UCG: underground coal gasification), briquetting and washing. All the production-plants of cement & sugar and other small to medium industries should be made coal-based, instead of using imported fuel.
6. The setting up of small coal-based power-plants (5 to 25MW) in the country should be encouraged to provide locally available job-opportunities and a dependable source of power. This will also help strengthen the engineering industry in the country.
7. Use of LPG and coal-briquettes should be introduced / encouraged in the mountainous regions of the country, with a view to save the precious wealth of forests.

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CAPACITY-BUILDING FOR SUSTAINED PROMOTION AND DISSEMINATION OF BIOGAS TECHNOLOGY(BT)

*Majid ul Hassan**

COUNTRY BACKGROUND

In Pakistan, the household sector consumes about 20.7 million TOE as fuel, which accounts for 54% (approx) of total (commercial and renewable) energy consumption. Bio-fuel (fire-wood, dung and crop-residue) accounts for 86% of total household energy consumption, while fire-wood alone accounts for 54% of the total.

About 70% of the population resides in rural areas and meet 95% of their domestic fuel needs by burning bio-fuels, but in urban areas the bio-fuel consumption drops to 56%, because they use Kerosene oil, LPG and gases, etc., in addition to fuel wood to meet their domestic fuel needs.

The forest areas in Pakistan comprise about 5% of the land, which can hardly serve as a carbon sink. Besides, due to increase in population and domestic energy needs, the fuelwood cutting-rate could surpass the growth rate. Similarly, we are not yet sufficiently self reliant in fossil-fuel production. During the year 1998-99, 0.5 million tons of kerosene oil was consumed to meet domestic fuel needs, out of which 30% (0.114 million tons) was imported at a cost of US$ 14.5 million.

Since sufficient fossil-fuel reserves are not available to replace fuel-wood consumption at domestic level, so there is no alternative to check the cutting of trees, which, in turn, is leading to deforestation, and degradation of eco-system and environment. Urgent measures are needed to reduce fossil-fuel consumption, which is the main source of anthropogenic green-house gases. Therefore, there is a need to take holistic approach to enhance endowment and management of natural resources.

On the average, the daily dung dropping of a medium size animal is estimated at 10Kg per day, capable of producing 0.5M^3 biogas through an aerobic digestion/ bio-gasification. As per livestock census 2000, there are 46.69 million animals (Buffaloes, Cows, Bullocks) in Pakistan. This would yield 466.9 million Kg dung per day. Assuming 50% collectability the availability of fresh dung comes to be 233.45 million Kg/ per day. Thus, 11.67 Million M^3 per biogas day can be produced through bio-gasification. Since 0.4 M^3 gas could suffice the cooking needs of a person per day, therefore 11.67 million M^3 of biogas could meet the cooking needs of 29.2 million people. The total population of Pakistan is about 140 million, out of which, 70% reside in the rural areas, whihc comes to be 98 million. Therefore, we can meet about 30% cooking requirements of the rural masses from this source of energy (biogas) alone. Besides, producing 33.62 million Kg of bio-fertilizer per day or 12.3 million tons of bio-fertilizer per year, which is an essential requrement for sustaining the fertility of agricultural lands.

Thus, in view of the prevailing situation, promotion of the biogas technology (BT) seems to be one of the best options which could not only partially offset the fossil-fuel and fuel-wood consumption, but also could facilitate recycling of agro-animal residues as a bio-fertilizer. Moreover, being clean and renewable, it would also contribute towards environmental protection, sustenance of eco-system and conservation of bio-diversity.

There is a tremendous need to promote public awareness, in particular, among youth and women, of the use of bio-energy (biogas) and bio-fertilizer, and also to create awareness and know-how in eco-system management, conservation of bio-diversity and sustainable use of natural resources.

1. INTRODUCTION

Energy needs and the related consumption, the world over, are increasing at a fast pace, causing atmospheric concentration of greenhouse gases, which if not checked could result in dangerous anthropogenic (human-induced) interference with the climate system. It must be understood that atmospheric CO_2 from biotic source (e.g. burning wood) is a part of the closed biogeochemical cycle, and can be sequestered by, say, growing trees

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whereas fossil-sourced CO_2 is addition to biogeochemical sourced CO_2, which is not a part of closed cycle and, therefore, can not be validly compensated for by carbon sequestration.

Pakistan is in a difficult situation, because it is neither self-sufficient in fossil resources nor in forest reserves. The immediate problem, which we are facing, is the indiscriminate cutting of trees, for meeting domestic fuel-needs, which if not checked, could create deforestation, resulting in degradation of environment and the eco-system. There is thus a need to launch projects, which may integrate the varied dimensions to create a balance between supplies and consumptions of energy, and also aim at environmental protection.

In view of the prevailing situation, promotion of the biogas technology (BT) is an option, which could not only offset, albeit partially, the fossil-fuel and fuel-wood consumption, but also facilitate recycling of agro-animal residues as a bio-fertilizer. Moreover, being clean and renewable, it would also contribute towards environment protection, sustenance of eco-system and conservation of bio-diversity. The success of B.T., however, depends on its acceptance by the common man. Large-scale adoption of the technology demands conscious efforts for making it acceptable to the population, at large.

2. WHAT IS BIOGAS?

It is a combustible mixture of gases, produced by the anaerobic fermentation of organic materials achieved in a biogas plant (described below). The composition of biogas produced from a normal functioning biogas-plant is as follows:

Methane	CH_4	60-70%
Carbon dioxide	CO_2	30-35%
Nitrogen	N_2	Upto 1%
Hydrogen	H_2	0.1-0.5%
Carbon monoxide	CO	Upto 0.1%
Hydrogen sulphide	H_2S	Traces

It is the presence of methane that makes this gaseous mixture combustible. The general properties of biogas are:

- It is non-poisonous in nature;
- It has no offensive smell;
- It burns with a clean blue soot-less flame:
- Its critical pressure and temperature are 42 atmospheres and 82°C respectively.
- Its caloric value is 4700-6000 kcal/m^3 (20-24MJ/m^3);
- Air required for complete combustion = 8 ft^3/ft^3
- Its thermal efficiency in a standard burner is 60%.

3. PRINCIPLES OF BIOGAS PRODUCTION

Biogas is generated by the anaerobic fermentation of various organic materials like livestock wastes, agricultural crop-residues, industrial processing-wastes, etc. During the last few decades, worldwide, there have been substantial research-efforts to understand the microbiology and chemistry of biogas-production. The process of anaerobic fermentation involves a series of biochemical reactions. The specific nature and type of some of these reactions are yet to be understood. As regards developments in the microbiology of biogas production, several strains of bacteria contributing to these reactions have recently been isolated and identified.

3.1 Chemical Process

The series of complex reactions involved in the digestion of organic wastes into biogas can be broadly divided into two main phases: an acidogenic phase, in which the organic wastes are converted mainly to acetate, and the methanogenic phase, in which methane and carbon dioxide are formed.

3.2 Acidogenic Phase

Acid-phase fermentation is a key step in biogas production, since it results in the generation of acetate, which is the primary substrate for methane-formation. The terminal end products of acid-phase fermentation are acetate, higher fatty acids, CO_2 and H_2. The formation of these products is mediated by a complicated network of enzymatic reaction chains. The polymeric carbohydrates contained in the complex organic wastes are hydrolyzed by enzymes to simple soluble sugars and short-chain organic acids, like acetic acid, propionic acid, lactic acid, etc., and to alcohols like methanol, ethanol, propanol, etc. The celluloses and starches of the complex organic wastes are hydrolyzed to simple sugars, while proteins are hydrolyzed to amino acids. Fatty acids are the only compounds that are not acted upon by the extra-cellular enzymes.

The primary breakdown of sugars in fermentation is to pyruvic acid, with liberation of hydrogen in the form of a hydrogen-carrier complex. This hydrogen could then be used to reduce pyruvic acid to propionic acid. Pyruvic acid can also be reduced to ethanol by a different pathway:

3.3 Methane Phase

This involves the conversion of the intermediary products of the acid phase to form methane. The main substrates for methanogenesis are acetic acid and hydrogen, with some carbon dioxide. Acetic acid is usually regarded as the most important substrate.

The overall reactions occurring in the second phase of anaerobic fermentation are known; but complete details of the biochemical mechanisms involved are yet to be brought to light. The overall reactions involved in the production of methane can be due to the cleavage and reduction, respectively, of acetic acid and carbon dioxide. The cleavage of acetic acid results in the conversion of methyl carbon to methane and carbon dioxide. Carbon dioxide is further reduced to methane:

$$2C_2H_4O_2 \longrightarrow 2CH_4 + 2CO_2$$
$$4H_2 + CO_2 \longrightarrow CH_4 + 2H_2O$$

If the methanogenic bacteria are growing alongwith the sugar-fermenting bacteria, the removal of hydrogen will induce the bacteria to form more hydrogen, thus instead of a mixture of acetic and propionic acids; acetic acid would be produced: -

$$C_6H_{12}O_6+2H_2 \longrightarrow 2C_2H_4O_2 + 2CO_2 + 4H_2$$

Hydrogen formed in the initial split of glucose to pyruvic acid would be released as hydrogen gas. Additional hydrogen would be released during the formation of acetic acid. The H_2 would then be combined with CO_2 to form methane. In a similar way, the production of

Table - 1: Methanogenic Bacteria: Morphology and Growth Characteristics

S. No.	Organism	Morphology	Optimum Temps. °C	Dimension Length (µm)	pH Optimal	Electron Donor (Energy Source)	Sulfur Source
1.	Methanobacterium formicium	Rods, single pairs or chains	37-45	2-15	6.6-7.8	Hydrogen and format	Cysteine
2.	M. Strain MOH	-do-	37-39	2-4	6.9-7.2	Hydrogen	Cysteine or H_2S
3.	M. arborphilicum	-do-	37-39	2-3.5	7.5-8.0	Hydrogen	Cysteine or H_2S
4.	M. Strain AZ	-do-	-do-	2-3	6.8-7.2	-do-	Cysteine
5.	Methanosarcina barkeri	sarcina	35-40	1.5-5.0	7.0(6.7-7.2)	Methanol and Hydrogen	-
6.	Methanobacterium ruminantium	Coccus chains	37-39	1-2	6.0-8.0	Hydrogen and format	H_2S
7.	Methanococcus vanniellic	Coccus	36-40	0.5-4.0 (diameter)	7.4-9.2	Format	-
8.	Methanobacterium mobile	Rod	40	-	6.1-6.9	Hydrogen or format	-
9.	Methanobacterium thermoautotrophicum	Rod	65-70	5-10	7.2-7.6	Hydrogen	H_2S
10.	Methanospirillium hungatic	Spiral rods	30-40	50	6.8-7.5	Hydrogen or format	-

ethanol, lactic acid and the other reactions, would be displaced in favor of acetic acid and hydrogen production.

In the formation of methane from carbohydrates, 66% of the methane is estimated to have come from acetic acid while 33% is from hydrogen.

3.4 Microbiological Process

Effective digestion of organic wastes into methane requires the combined and coordinated metabolism of different kinds of carbon-catabolizing anaerobic bacteria. At least four different trophic types of bacteria have been isolated, which can be distinctly recognized on the basis of substrates fermented and metabolic end products formed. The different types of bacteria identified are:

a. **The hydrolytic bacteria:** These ferment a variety of complex organic molecules (i.e. polysaccharides, lipids and protein) into a broad spectrum of end products (i.e. acetic acid, H_2, CO_2, one-carbon compounds, and organic acids larger than acetic acid, neutral compounds larger than methanol);
b. The hydrogen-producing **acetogenic bacteria,** which include both obligate and facultative species that can convert organic acids larger than acetic acid (e.g. butyrate, propionate) and neutral compounds larger than methanol (e.g. ethanol, propanol) to hydrogen and acetate;
c. The **homoacetogenic bacteria,** which can ferment a very wide spectrum of multi-or one-carbon compounds to acetic acid; and
d. The **methanogenic bacteria**, which ferment H_2, CO_2, one-carbon compounds (i.e. methanol, CO, methylamine) and acetate into methane. The methanogenic bacteria perform a pivotal role in anaerobic digestion, because their unique metabolism controls the rate of organic degradation and directs the flow of carbon and electrons by removing toxic intermediary metabolics and by increasing the thermodynamic efficiency of interspecies intermediary metabolism (i.e. those of the other stages).

Methanogens are a very morphologically and macro-molecularly (i.e. cell wall, lipid and DNA-GC composition) diverse bacteria having a unique property to produce methane in the absence of oxygen. So far the following species of methanogenic bacteria have been identified: (i) Methanococcus, (ii) Methanobacterium, (ii) Methanosarcina, (iv) Methanospirillium, and (v) Methanobacilus. All the known species of methanogens can use hydrogen and produce methane. Table-1 gives morphological and growth characteristics of some methanogens.

4. WHAT IS A BIOGAS PLANT?

Biogas plant is a device for converting fermentable organic matter, in particular cattle dung, into combustible gas (Biogas) and fully matured and enriched organic fertilizer.

A typical biogas plant consists of a digester, where the anaerobic fermentation takes place, a gasholder for collecting the biogas, the input-output units for feeding the influent and storing the effluent, respectively, and a gas-distribution system.

Biogas plant could be broadly classified into two types:

4.1 Plants with moveable gasholder

The improved Indian type of biogas plant is a typical example of this plant. The metallic gasholder floats on the digester slurry. (See Figure-1)

Advantages

- Gas pressure is regulated by the weight of the gasholder.
- Scum-breaker could be attached to the gasholder.
- Easy to construct.

Disadvantages

- Metallic gasholder is exposed to the atmosphere and causes heat losses.
- As it dips in the slurry, anti-corrosion treatment is required.
- Gasholder is expensive.

4.2 Plants with built-in (fixed dome) gasholder

In this type of design, a masonry dome-type structure, forming the upper part of the digester, acts as gasholder. (See Figure - 2)

Advantage

- Since it is underground, the plant space can be utilized.
- Fairly steady temperature can be maintained inside the digester.
- Construction cost is low.

Disadvantages

- Construction needs special skills.
- Stirring and scum-breaking is generally difficult.
- Gas pressure control is difficult.

Both the movable gasholder type of biogas plant and fixed dome type of biogas plant have their advantages and disadvantages. A pre-feasibility study should, therefore, be done for selection of a suitable model for the respective site/ area.

4.3 Selection of a Model

Selection of a model depends on the geographical, economic and other conditions prevailing in different areas of the country. Given below are some of the parameters for selection:

a. *Technical:* It is better to select a model, which does not necessitate high construction skills. The flexible gasholder-type plants can generally be constructed with moderate skill. Construction of the fixed domes, on the other hand, involves great skill and care.

   Another factor is the provision for breaking the scum formed on the slurry. The scum might prove a critical factor in the long run. Generally, attaching a stirrer in the flexible gasholder type plants is easy, while in the fixed-dome type a rod will have to be inserted, through the outlet pipe, and the slurry stirred. This may not be effective. Equally important is the mechanism for removing the sludge, especially if it is a continuous-feed model. In the majority of the flexible gasholder models, the sludge collection is by automatic gravity-flow whereas in the fixed dome Chinese (Sichuan) model the sludge has to be periodically pumped out or removed manually.

b. *Economics:* The plant selected should be cheap. One way of ensuring this is to use locally available materials for construction. Cost of maintenance also should be as low as possible. Steel gasholders generally require painting frequently (say every couple of years) thereby increasing the maintenance cost.

   In developing countries, the plant parts will have to be taken to rural areas with very poor transportation-facilities. Carrying the steel gasholder to these areas or fabricating it locally may be difficult. Under these conditions, portable bag-type plants may be a viable option. The Chinese design also offers possibilities of application, since it can be constructed with locally available materials.

c. *Geographical:* Generally, all models are suited to places where the digester pit can be excavated to more than 3M.

   The Indian horizontal plant and the Nepalese tapering model are, however, designed for locations marked with the presence of hard rock and high water-table.

d. *Climatic:* The rate of biogas-production tends to decrease during winter. In the underground fixed-dome plants, the temperature will be comparatively steady and optimum due to the natural coating of earth on top. During summer, however, the rate of biogas-production from the moveable gasholder biogas plant is almost double than the fixed-dome plant.

   In actual practice, one may have to select a model offering the maximum possibilities and modify it suitably, keeping in view the techno-economic and geo-climatic conditions of the respective site/area

5. FERMENTATION PARAMETERS

Anaerobic fermentation is governed by a number of parameters like temperature, pH, and Carbon to Nitrogen (C/N) ratio, etc. These are discussed below:

5.1 Air tightness: Microorganisms can either be facultative or obligate. Facultative anaerobes are capable of shifting from a metabolism that uses free oxygen to one that does not. Several of the hydrolytic and acetogenic bacteria are facultative ones. However, the methanogens are strictly obligate and hence can survive only in the absence of free oxygen. As a result, the digester for biogas-production has to be made airtight.

5.2 Temperature: The temperature for fermentation will greatly affect the rate of biogas-production. There are two ranges of temperatures over which the anaerobic bacteria grow: mesophilic range of 21-45°C and the thermophilic range of 55-70°C. Most of the anaerobes have an optimum activity at 35°C-40°C. Certain, recently- identified strains of thermophilic methanogens, like M. thermoacetotrophicum and methanothermus grow between 63°C-97°C. All bacteria in general are found to be highly sensitive to temperature fluctuations. For instance, sudden changes in temperature, exceeding 3°C, are found to affect the microorganisms adversely.

One disadvantage of thermophilic digestion is that the biogas generated will have more H_2S content. This increased H_2S production would give the biogas an offensive smell, which might create problems in the use of biogas for certain purposes.

5.3 pH: The anaerobic microorganisms require a neutral environment for optimum functioning. The hydrolytic and acetogenic bacteria can survive in as low a pH as 5.5; the optimum pH for the methanogens is, however, 6.8 to 8.5 and the slurry in the digester usually has a buffer-system to balance the pH level. During the start-up of a biogas plant, the new slurry, which has not yet developed the buffer system, can be helped by the addition of chemicals or by the addition of sludge from plants already in operation.

5.4 C/N Ratio: Both the acid-forming and methane-forming bacteria require a C/N ratio ranging from 25 to 30 for optimum functioning. Since, the various organic wastes used for biogas production differ unduly in their C/N ratio, hence an optimum mix of the input materials is necessary to get the optimum C/N of 30.

5.5 Solid Content: The organic wastes, during anaerobic digestion, are decomposed into their constituent elements like carbon, oxygen, hydrogen, nitrogen, etc. The quantity and quality of biogas generated from an organic waste is decided by its total solids content, volatile and fixed solids.

The weight of the organic material left after an hour of drying, or the weight that is unchanged after several dryings, is called its dry weight, dry matter or Total Solids (TS). Total solids comprise Total Volatile Solids and Ash. Volatile Solids (VS) represent the organic matter present and, hence, are available for biological decomposition. The volatile solids are constituted of carbon, nitrogen, hydrogen, oxygen, etc., and are determined by burning the material at 600°C, when elements like C, O, N, H get evaporated. The leftover ashes or the Fixed Solids are inorganic and hence not available for biological decomposition.

Volatile Solids content is, however, is not a very good measure of the biologically available material for the microorganisms. This is because the lignin content of the organic waste gives a high percentage of VS, and lignin hardly contributes to biogas production.

5.6 Water Content: The optimum water-content of the input material would be about 90% of the weight of the total contents. If the water content is too high, the rate of biogas production per unit volume in the diegester will fall, whereas with too little water-content, acetic acid accumulates, inhibiitng the fermentation process.

However, studies on the role of water in anaerobic fermentation at the New York State College of Agriculture and life Sciences of the Cornell University, U.S.A., have shown that relatively dry mixtures of organic materials would be efficiently converted to methane when fermented. It was found that both the rate and efficiency of anaerobic fermentation was relatively unaffected at a moisture level as low as 68% of the total weight. (Decreasing the water content from 68 to 60% of the total weight resulted in the accumulation of volatile acids and the inhibition of biogas production).

This process of using input materials of a lower water-content (up to 68% of the total weight) is called dry fermentation and appears to simplify the process and

5M^3 BIOGAS PLANT

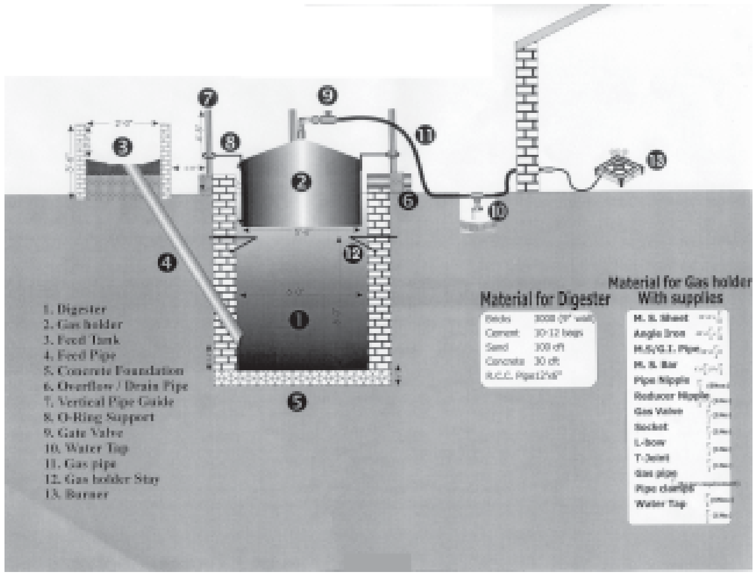

Figure - 1: Biogas plant with moveable gasholder design-PCRET (Model)

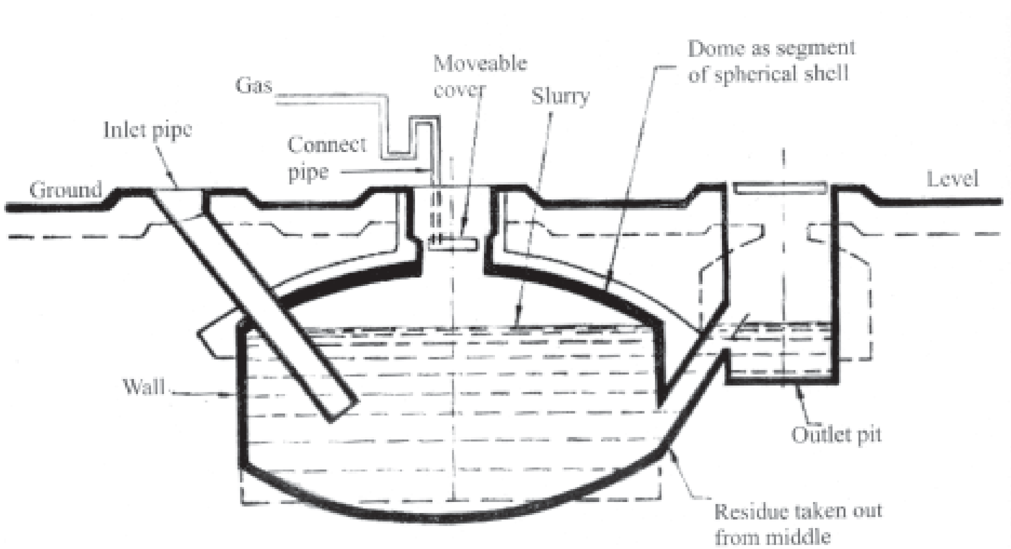

Figure - 2: Fixed Dome Type Biogas - Chinese Model

enhance the possibilities of using agricultural crop-residues for biogas production.

5.7 Toxic Substrates: High concentrations of ammonia, antibiotics, pesticides, detergents, heavy metals like chromium, copper, nickel, zinc, etc., are toxic to the microorganisms involved in biogas-production. A low C/N ratio of the slurry leads to a high concentration of ammonia. Antibiotics used in animal feed or injected into the animals can cause difficulties in production of biogas in plants using manure as the input. Heavy metals are mostly present in industrial wastes.

Nickel is considered inessential for bacterial growth, and is generally detrimental for the growth of plants and animals. Contrary to this, however, nickel is actually beneficial for the growth of methane-producing bacteria, if present in minute amounts. The slightest excess of this heavy metal can however have a negative effect, hindering rather than helping the production of methane. Great care is, therefore, required in using this metal as a catalyst, and certain adjustments have to be made in the experiment.

Research work conducted at the Tata Energy Research Institute (TERI) New Delhi; established that rice husk can be used for bio-methanation. Addition of nickel chloride in traces boosted the production of biogas and improved the quality and quantity of the gas produced. See Table-2.

The maximum allowable concentration of some of the harmful materials is given below:

Sulphate (SO_4-)	5,000 mg/litre
Sodium chloride (NaCl)	40,000 mg/litre
Copper (Cu)	100 mg/Litre
Chromium (Cr)	200 mg/Litre
Nickel (Ni)	200-500 mg/Litre
Cyanide (CN)	below 25 mg/Litre
ABS (detergent compound)	40 part per million
Ammonia (NH_3)	3,000 mg/Litre
Sodium (Na)	5,500 mg/Litre
Potassium (K)	4,500 mg/Litre
Calcium (Ca)	4,500 mg/Litre
Magnesium (Mg)	1,500 mg/Litre

5.8 Hydraulic Retention Time (HRT): HRT is the average number of days a unit volume of slurry stays in the digester. Under optimum conditions, 80-90% of the total production of biogas is obtained within a period of 3-4 weeks. Hence for small-scale, semi-continuous plants, the HRT will generally be 30 days or more. The HRT is in fact a design-parameter and can be changed according to the size of the plant, temperature of fermentation, washout time, etc. If the HRT is too low, the bacteria are washed out of the digester as fast as they can multiply; resulting is an unstable bacterial population. The lower limit of HRT is the washout time or the time required for the methanogenic bacteria to replenish their numbers at a certain temperature. The upper limit is a question of economics of plant-construction.

5.9 Organic Loading Rate: Loading rate is the weight of volatile solids loaded each day in the digester, divided by the volume of the digester. Loading rate is an important parameter especially in continuous-feed plants, since a high loading-rate may affect the pH of the slurry. Even though the volatile solids fed into the plant are converted to volatile acids by acidogens, the pH is affected if the rate of action of methanogens on the volatile acids is not compatible with its rate of production.

Table - 2: Production of biogas from one kilogram of dry rice-straw

	Control (No nickel)	**Single dose nickel**	**Double dose nickel**	**Tetra dose nickel**
Total biogas produced (Liter)	16.50	**25.72**	17.76	13.01
Total methane produced (Liter)	9.87	**16.77**	10.91	7.80
Period for Good biogas production (days)	16-26	**17-40**	18-27	17-26

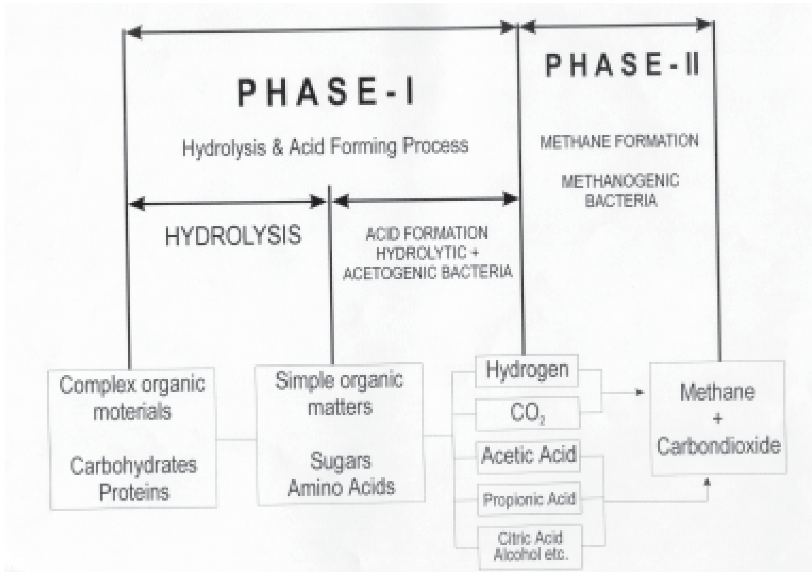

Figure - 3: Disphasic Digestion

5.10 Diphasic Digestion: The above parameters become critical in the case of conventional anaerobic fermentation system where both the acid and methane production stages take place in the same physical unit. This is because different strains of physiologically and micro molecularly different bacteria operate in the same unit. Consequently, there is likely to be insufficient growth of anaerobes and the subsequent washout.

Diphasic digestion, in which the acid and methane production stages are separated, has been found to be effective in providing the optimum parameters for the respective bacteria. Separation of the phases is effected by controlling the hydraulic retention time, since the minimum generation-time of facultative microbes is found to be shorter than that of the obligate microbes. (See Figure-3)

6. ADVANTAGES OF BIOGAS TECHNOLOGY

The major advantages of the biogas technology are given below:

i. Availability of cheap and clean (soot-free) and environment-friendly fuel.
ii. Availability of enriched organic fertilizer, which is direly needed for the improvement and sustenance of fertility of agricultural lands.
iii. No need of collecting fuel-wood, hence the time saved can be used in other productive tasks.
iv. Check on deforestation, land erosion and flooding, which occurs due to cutting of trees for meeting fuel needs.
v. Smokeless fuel saves the environment. The danger of eye cataract in women also decreases considerably, which otherwise is caused by using smoky fuels like agro-residue, fuel-wood and cow-dung cakes.
vi. No need of blowing into the fire; a flick of matchstick lights up the fire.
vii. Utensils do not get stains of smoke and can be easily washed.
viii. No odor or insects near the plant, which infact, is a test of proper working of a biogas plant.

The biogas plant/ bio-gasification technology is an environment-friendly technology. It contributes towards sustenance of the eco-system management, bio-diversity conservation and improvement of fertility of agricultural lands.

6.1 Uses of Biogas

The various biogas uses and its requirement for different applications are as given in Table-3.

6.2 Exhaust Slurry

The exhaust slurry of the biogas plant is an enriched organic fertilizer. Since all pathogens are killed, due to an-aerobic condition in the biogas digester, the effluent slurry does not emit odor and / or attract flies and other insects.

7. USES OF EXHAUST SLURRY

a. As Fertilizer

The slurry can be used as an organic fertilizer. Generally, it is applied either as it comes out from the digester, or after dilution with irrigation-water. If the sludge is to be stored, it can be run into shallow pits and allowed to dry partially or fully in the sun. It is then dug out and stored in piles, until it is time to spread it on the fields. The number of pits, dug for drying and storing the sludge can be more than one, so that by the time one pit is full, the sludge in the other is dry enough for carting. During the rainy season, protective roofing will have to be provided over the pits.

In an alternate method, a channel leads the sludge to a filter bed, with an opening at the opposite end of the sloping bottom. A compact layer of green or dry leaves is made up in the filter bed. Water from the sludge filters down and flows out of the opening into the pit. This water can be reused for preparing fresh slurry. The semi-solid residue left at the top of the bed has the consistency of dung and can be transported and stored in a pit for use when required.

b. As Enriched Organic Manure

The sludge, as it comes out of the plant, contains about 90% moisture and takes a long time to dry in the sun. Experiments conducted on this aspect have shown that the sludge could be absorbed in materials like dry broken leaves, sawdust, charcoal dust, etc.,

Table - 3: Biogas Requirements for Typical Applications

PURPOSES	SPECIFICATIONS	GAS REQUIRED, (M^3)	COUNTRY
Cooking	Per person	0.5/day	China
	Per person	0.34-0.43/day	India
	Per person	0.425/day	Nepal
Gas Stove	5 cm dia.	0.33/h	
Gas Stove	10 cm dia	0.47/h	
Boiling Water	15cm dia	0.64/h	
Boiling Water	Per gallon	0.28/h	
Lighting	200-candle power	0.1/h	China
	40-watt bulb	0.13/h	India
	1-mantle	0.07-0.08/h	
	2-mantle	0.14/h	
	3-mantle	0.17/h	
Gasoline engine	Per hp	0.45/h	India (Engine efficiency 25%).
	Per hp	0.41/h	Pakistan (Engine efficiency 28%)
	Per hp	0.43/h	Philippines
Diesel engine	Per hp	0.45/h	Pakistan (Compression ratio 20)
Generating Electricity	Per kWh	0.616/h	
Refrigerator	Per m^3	1.2/h	U.K
Incubator	Per m^3	0.5-0.7/h	Nepal
Table fan	30 cm dia.	0.17/h	
Space heater	30 cm dia.	0.16/h	

and then spread out to dry. The operation of soaking and drying can be repeated to yield twice the quantity of manure obtainable by drying the sludge alone. The nitrogen content of the manure will depend on the original composition of the materials used, but this can always be corrected to make the manures fit for use by enrichment.

The sludge by itself, or dried by the above process, may be enriched with chemical fertilizer containing nitrogen and, in addition, with phosphorous, if required, to obtain concentrated organo-mineral manures that could be applied in comparatively small quantities, to act as a good plant-growth stimulant. The enrichment can be carried out by taking 11Kg of urea, 31Kg of super phosphate and dissolving these in about 15 liters of water. This solution is then absorbed in 48Kg of dry low-grade manure, mixed thoroughly and spread out in the sun to dry. The enriched manure would then contain at least 5% nitrogen and 5% phosphoric acid, in addition to its original quantities of organo-mineral nutrients.

8. FACTORS HINDERING MASS ACCEPTANCE OF BIOGAS TECHNOLOGY (BT)

There are certain factors limiting the acceptance of this technology among the people. These can be broadly categorized as technical, economic, and social problems, which are experienced more at the individual or the actual beneficiary level. These problems can be solved, or their intensity can be reduced, by a concerted effort on the part of the local, regional and national authorities concerned with the biogas technology.

8.1 Technical Problems In Operation of Plant

- Hydraulic pressure of ground-water on the plant,
- Soil characteristics, corrosion of gas-holder,
- Scum-formation in the slurry,
- Clogging,
- Breakdown of pipes,
- Deterioration of gas mains, etc.
- Lack of sufficient quantity of bacteria.
- Fluctuations in slurry consistency.
- Lack / excess of conditions like pH, temperature etc. for fermentation.
- Seasonality of gas production.
- Storage in liquid form not possible.
- Storage in gaseous form needs containers, which need special manufacturing skills.
- Storage and transportation beyond 20m not economical.
- Special devices are necessary for using biogas.

Studying the local situations carefully, and planning accordingly, can solve many of these problems. If neglected, these would affect the promotion of BT considerably.

8.2 Economic Problems

- High initial capital investment and low economic return.
- High opportunity cost.
- Scarcity of input materials.
- Limitation imposed by the traditional energy system. (Depriving the poor people of their fuels source, i.e. cattle dung).

The problems can be resolved by:

- evolving cheaper design and construction techniques
- providing partial financial support from the Federal Government
- developing integrated cattle farm-cum biogas system with emphasis on producing enriched organic fertilizer on commercial basis

8.3 Social Problems

Often the beliefs, prejudices, habits etc. prevailing in the society pose problems for promotion of the technology. Educational background, income of the beneficiaries' etc. may also affect the speed of BT adoption.

The success of BT depends on its acceptability by the common man. Acceptability studies should consider cultural level of people, social customs and habits, beliefs, prejudices, educational status etc.

This has to be tackled in 2 ways – (1) Try to introduce the plant models most suited for the area and (2) Devise suitable training of extension workers to enable them to take the message of BT to the people.

CONCLUSIONS

Biogas Technology (B.T.) has reached the stage of technological maturity. The technological uncertainty has now been erased to a certain level. There is, however, a need for continued R&D input, to further achieve advances in the technology.

For mass propagation of B.T., an effective promotional & dissemination strategy is required, which should cater for the capacity-building to enhance the skill-level; create awareness, in particular, among youth and women for the use of B.T.; create awareness and know-how in eco-system management; conservation of biodiversity and sustainable use of natural resources.

Successful implementation of B.T. is fundamentally a process of reducing the uncertainty and creating acceptability in the end-users, considering their culture, society, customs, habits, beliefs, prejudices, educational status, etc.

Services of the social scientists, in addition to engineers, scientists / technologist, are therefore, essentially required to remove the skepticism and socio-cultural barriers hampering mass propagation and acceptance of B.T. among the rural masses.

RECOMMENDATIONS

- Establish Biogas Research Center at PCRET, Head Office Islamabad, for research, development & diffusion of B.T. in the country.
- Design new low-cost and sustainable plant-models.
- Study anaerobic photosynthetic technology, efficient microbe (E.M) technology & its application for enhancing the efficiency of biogas plants.
- Design and develop commercial / industrial biogas plants, based on sanitary waste-water, distillery waste, sugar industrial wastes & other agro-industrial wastes; and optimize operating conditions on laboratory/ pilot-scale for developing design-criteria for a full-scale commercial plant.
- Develop methodology for pre-casting the digester and dome-structure of biogas plants to enhance speed of construction & ensure proofing of gas leak.
- Fabricate biogas digester by cast-in-situ method
- Manufacture Ferro-cement gasholder to replace metallic (M.S) gasholder, which is corroded, particularly in the coastal & saline areas.
- Accelerate production-rate of gas, through studies on: the methanogenic bacteria, their isolation, cultivation, physiology, biochemistry, ecology, etc.; additive selection; digester types and implementation of fermentation technology.
- Systematic training of professional masons, extension-managers & technicians
- Build capacities to enhance capability at grass-root level for propagating B.T on mass-scale.
- Develop technical, educational and promotional materials for construction and post-installation, operation, maintenance and troubleshooting of biogas plants

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DEVELOPMENT OF MINERAL-BASED INDUSTRIES

*Izhar ul Haque Khan**

ABSTRACT

Prospects of rich mineral-resources in Pakistan are evident from the occurrence of major mineralized zones and associated mineral depositions. However, the country is importing substantial amount of ores and minerals, and mineral-based products and chemicals from abroad, despite the fact that a number of public and private organizations have been engaged in mineral-development work. The role of mineral sector, in terms of GNP, in Pakistan is also quite insignificant.

Technologies based on setting up of mineral industries are required to harness the available and potential mineral-resources of the country for national economic development. Scientific and technological research in mineral development, for utilizing the potential of mineral resources, are requirement of mineral-based chemicals and products. To meet the challenge of WTO, cheap local technologies need to be developed, based on indigenous, abundantly available raw materials.

INTRODUCTION

Table 1 to 3 show that several billions of rupees of mineral- based chemicals and products are imported in the country, despite the fact that important types of minerals are present in the country. It contains sedimentary minerals, including evaporates, in the salt range; basement rocks; ultramafic mineralization containing chromite, magnesite with potential of Pt, Ni, Co; diorite-granodiorite related rocks of Dir, Chitral and Swat, with potential of copper, lead-zinc, manganese, uranium, lead, gold, silver, etc; andesite and intrusive rocks of Chilghazi containing copper, gold, silver and magnetite; the granites and metagranite with potential of U, Th, Rare earths; the silica deficient syenite containing K, Al, Gallium, etc.

From mining and reserve point of view, these available and potential deposits are classified as:

- Huge to large deposits, such as carbonates, evaporites, oxides gypsum anhydride, halite, silica sand, quartzite, coals, olivine, serpentine.
- deposits requiring mid-term investment, such as chromite, magnesite, copper, gold, gemstones.
- Deposits for long-term investment, such as coal, ferrous and non-ferrous (base metals), platinum, gold, gallium, rare earths, etc.

Feasibilities for utilization of the mineral occurrence in the country were completed at PCSIR for the following:

Minerals for Iron & Steel
Iron Ores, Manganese, Fluorite, Chromite, Manganese

Base Metals
Copper, Lead, Zinc

Minerals for Ceramics Industries
Bauxite and Laterite, Rare Earths

Precious and Economic Minerals
Gold & Silver, Gemstones , Tin, Tungsten, Nickel, Antimony

Industrial Minerals & Advanced Engineering-Materials
Asbestos, Graphite, Fluorite, Baryte, Gypsum, Building and Structural Stones, Quartz Glass Sand, Feldspar, Garnet, Magnesite, Calcite, Limestone and Dolomite, Sulphur, Soapstone, Ochres, Phosphate, Celestite, Coal, Nepheline Syenite, Halite

GEOCHEMICAL, MINERALOGICAL AND PROCESSING PROJECTS

To harness the reserves of mineral resources and grade with respect to process feasibilities, the mineral-reserves estimation is required to be investigated by geochemical and mineralogical modeling, to find their economic potential by undertaking R&D projects involving geochemistry, ore petrography, process-mineralogy, mineral processing and product development, as follows:

i. **Short-term projects:** Development of available reserves, geochemical sampling for feasibility

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Table - 1: Import Data of Chemicals (1996 - 2000)

Chemicals	1996-97		1997-98		1998-99		1999-2000	
	Qty (Tons)	Rs. (mil)	Qty (Tons)	Rs. (mil)	Qty (Tons)	Rs. (mil)	Qty (Tons)	Rs. (mil)
Aluminium hydroxide	4,912	57	4,788	81	4,910	80	3,748	66
Aluminum Oxide	1,596	28	1,479	27	1,242	23	1,937	38
Barium Carbonate	2,708	32	3,014	30	1,448	24	3,422	34
Barium Sulphate	40	1	131	1	284	4	304	3
Calcium Carbide	8,222	142	6,459	123	5,804	111	3,677	69
Calcium Carbonate	2,645	40	1,987	30	2,463	46	2,605	50
Calcium Chloride	333	4	701	10	924	16	283	6
Carbon black	5,340	127	5,479	151	5,867	170	5,216	144
Carbonate-other	507	32	215	13	469	21	217	8
Chemical prepared graphite	43	15	115	3	159	11	83	9
Chromate salt	227	8	367	18				
Chromium oxides	187	15	215	17	221	21	257	24
Coal-tar products	4,975	30	1,387	40	841	42	2,763	66
Cobalt oxides	4	4	12	11	19	23	58	11
Corudum	400	12	260	6	227	9	452	13
Inorganic – other	570	14	105	25	877	33	1,497	35
Inorganic Phosphates	4,520	139	5,472	142	5,534	185	6,359	255
Inorganic Sulphates	10,482	125	8,918	128	12,784	162	13,544	1,192
Iodine	21	5	28	10	19	18	31	13
Iron compounds	2,386	48	2,311	59	3,107	97	4,987	215
Lab. Chemicals	77	25	39	5	73	13	8	10
Lead compounds	182	8	58	3	163	8	138	6
Maganese compounds	105	4	105	4	265	13	300	14
Magnesium Oxide	427	11	256	110	188	10	177	10
Mercury	68	13	60	12	121	25	80	18
Nickle catalyst	192	54	684	264	80	28	156	52
Nitric Acid	1,006	13	1,283	18	1,692	24	1,732	25
Phosphorous	108	9	154	14	158	16	161	14
Pigment – Leather	196	28	249	29	159	27	170	33
Pigment base chrome	456	35	404	39	540	59	900	94
Pigment base TiO_2	6,570	391	8,329	683	7,545	725	8,173	849
Pigment prepared	191	15	227	17	146	15	143	15
Inorg Pigments	2,679	656	3,085	770	2,920	866	3,159	873

Continue…

								...*Continued*
Potasium Carbonate	517	13	557	20	700	19	1,094	31
Potasium Chloride	1,528	15	851	9	1	14	2	21
Potasium Cholorate	2,319	65	2,001	62	2,946	98	2,538	78
Potasium Compound	2,663	24	228	11	336	12	354	16
Potasium Sulphate							23	194
Silica	1,287	67	1,183	65	1,467	82	1,543	92
Silicates	1,213	101	426	20	619	33	307	17
Silicon carbide	735	27	477	25	707	31	423	19
Silicon polymers	1,048	159	1,168	176	1,276	217	1,757	267
Soda Ash	3,700	26	3,033	22	5,746	43	25,631	177
Sodium bicarbonates	931	9	2,429	22	1,899	19	10,123	86
Sodium dichromate	82	4	1,054	49	1,375	70	761	34
Sodium Hyd. Sulphite	302	10	243	8	360	14	621	26
Sodium Hydroxide	4,373	50	1,307	26	4,415	69	8,854	126
Sodium Nitrate	1,458	18	770	11	814	12	1,182	15
Sodium Nitrate	101	1	270	4	1	11	1	12
Sodium Sulphides	12,859	146	6,213	66	1,193	38	873	25
Titanium oxides	1,605	135	1,505	135	915	84	2,140	218
Zinc Oxide	467	20	609	35	563	35	522	34
Mineral Based Chemicals	99,563	3,030	82,700	3,659	86,582	3,826	125,486	5,752
All Other Chemicals		46,000		54,000		58,200		71,300
Ores / Concentrates								7,200
Metals and Alloys								
(excluding Machines)								3,800
Mineral Based Products/Chemicals								16,752
TOTAL								**88.052**

studies, process-mineralogy for mineral beneficiation.

ii. **Mid term projects:** Geochemical surveys of economic minerals, such as base metals, precious metals (such as gold and platinum) mineralizations, rare earths in acidic and silica-deficient syenite rocks.

iii. **Long term projects:** Exploration for potential minerals, such as gold, silver, platinum group of metals, rare earths, nickel, magnetite, tungsten, molybdenum, lead- zinc.

MINERAL PROCESSING

Most of the ores, as mined, are not suitable for industrial utilization till undesirable impurities are removed. Suitable industrial processes were to be developed at PCSIR for upgrading every ore, first at the laboratory- scale and then at pilot-scale trials in order to establish its industrial viability.

PRIORITY AREAS FOR S&T PROJECTS

Some of the priority areas for S&T projects on the development and utilization of minerals, highlighted

Table - 2: Import of Mineral-Based Chemicals

Commodity	Ton (000)	Rs. (Mil)	Ton (000)	Rs. (Mil)	Ton (000)	Rs. (Mil)	Ton (000)	Rs. (Mil)	Ton (000)	Rs. (Mil)
Zinc oxide	1.1	16.7	0.9	15.1	1.1	17.3	0.6	10.7	0.6	13.6
Manganese dioxide	0.8	9.5	0.3	3.4	0.2	3.6	0.4	6.5	0.3	6.4
Iron oxide & hydroxide	3.4	24.5	2.0	24.1	3.4	38.5	3.4	30.7	2.5	40.0
Titanium dioxide	3.6	139.4	1.8	88.8	0.1	76.3	1.2	64.0	1.1	61.4
Litharge		0.5		0.2		0.1		0.4		0.2
Lead dioxide	-		-		0.1	1.4	0.1	2.2	0.1	2.0
Red lead	0.5	9.8	0.2	4.7	0.2	4.7	0.3	6.7	0.5	10.5
NaOH (Caustic soda)	4.6	49.8	2.9	33.0	11.6	133.8	17.2	175.7	20.9	162.4
NaOH (aqueous soln.)	-	-	0.1	0.1	-	-	0.5	0.5		2.0
Potassium hydroxide	0.2	3.4	0.3	5.1	0.1	2.6	0.4	7.3	0.3	6.2
Mag. Hydroxide	0.1	3.0	0.1	1.7	0.1	3.5	0.1	3.1	0.1	2.1
Al. hydroxide	1.8	21.9	2.4	29.4	3.0	30.7	2.8	30.1	4.5	43.5
Artificial corrundum	0.1	1.6	0.1	2.5	0.2	4.2	0.1	2.5	0.1	3.2
Hydrogen peroxide	8.4	94.3	8.7	98.5	9.6	117.2	12.3	154.9	13.6	189.1
Sod. Dichromate	1.7	20.8	0.7	14.3	0.8	20.2	1.3	28.9	0.8	19.6
Pot. Dichromate	0.1	0.8		0.5	0.1	1.1	0.2	2.4	0.1	1.1
Calcium carbonate	3.3	21.1	3.0	20.8	5.2	35.0	3.1	24.1	2.3	23.7
Sodium sulphide	9.1	47.1	9.4	61.9	9.3	62.2	11.9	77.4	9.9	61.6
Total		**464.1**		**404.0**		**552.3**		**627.9**		**648.4**

by various mineral-development agencies, are as follows:

i. *Coal washing:* Total estimated production of coal in ten years is 50 million tons. The cost of coal will increase from Rs. 750 - 7000 to 1500 - 2000 after washing. Ten percent of the total cost of production is taken as its economic worth, i.e. Rs. 50 billions.

ii. *Documented export of Gemstones* is Rs. 360 million, while actual export may be 4 billion per annum. The projected total output in 10 years would be about 40 billion, 20 percent of which is calculated as economic worth.

iii. *100 million tons of mine waste* cut-off and low-grade ores are generated. The cost at the rate of Rs. 10 per ton would be 1 billion/year, amounting to Rs. 10 billion 20% of which is Rs. 2 billion.

iv. *Rs. 35 billions of inorganic chemicals* are imported; 20% substitution from local resources in 10 years would amount to Rs. 7 billion as economic worth.

v. *Project cost put of Granite & Marbles* is expected to be 12 m/tons, worth 650 billion of finished products. The ceramic may be worth 20% of the cost i.e., Rs. 12 billion.

vi. *Bentonite clay* production in ten years period amounts to Rs. 5.0 billion rupees, 20% of which is calculated as economic worth.

vii. *Rs. 50 billion worth of iron ore* is required in the country in ten years; 20 percent substitution by this project makes economic worth as 10 billion.

viii. *On the basis of Rs. 5.0 billion Gypsum production* the economic worth is calculated at 20% i.e., Rs. 1 billion.

ix. *Magnesite chromite refractories worth Rs. 25 billion* are imported for cement, steel and other high-temperature furnaces. The projected fire-clay refractory demand is 250,000 tons/year, amounting to Rs. 5 billion in ten years. The economic worth is taken as 50% of the project i.e., approximately Rs.

12 billion.

x. The social, cultural, tourism, education and sale amounts to Rs. 10 billion as a rough estimate.

xi. Several small unexplored minerals exist in the country, which would also be developed.

UTILIZATION OF ECONOMIC AND INDUSTRIAL MINERALS FOR THE DEVELOPMENT OF CHEMICALS AND PRODUCTS

The focus can be placed on the following areas, needing immediate development:

- Mineral-based chemicals & products
- Value-addition of minerals by chemical/product
- Directly reduced iron-ore pellets for iron and steel
- Development of new materials and synthetic-mineral products
- The production of industrial chemicals, such as phosphoric acid; dicalcium phosphate and sodium acid pyrophosphate, from rock phosphate.
- Studies on the economic production of strategic chemicals/salts from indigenous ores of strontium, barium and magnesium.
- Preparation of industrial salts from indigenous raw material
- Materials-utilization of gypsum for production of sulphuric acid and salts
- Characterization of economic minerals, precious metals and gemstones of the country
- Beneficiation of graphite ore for the production of foundry-grade graphite concentrate.
- Development for toxicity-control of industrial products and waste managements
- Rare earths
- New building-material development, special materials for dams, saline and underwater application, processed sand with low alkalies, recycling waste in building-materials, such as cements, by using fly-ash, steel slag, etc.
- New materials, involving organic powder coatings, fillers, catalysts using cheap and natural environment-friendly materials.
- Development of Ferrite, cermets, ceramics from indigenous sources, such as beach sand containing zirconia, titania, monazite.
- Utilization of economic minerals and ores
- Value-added products from industrial minerals
- Clays as catalysts and environment-friendly materials.
- Coal utilization
- Mineral-based strategic chemicals

Table - 3: Import of Ores, Minerals and Mineral-Concentrates

Commodity	1989 - 90		1990 - 91		1991 - 92		1992 - 93		1993 - 94	
	Ton (000)	Rs. (Mil)	Ton (000)	Rs. (Mil)	Ton (000)	Rs. (Mil)	Ton (000)	Rs. (Mil)	Ton (000)	Rs. (Mil)
Sulphur	27.2	66.6	23.5	62.8	24.6	81.4	43.7	58.0	30.3	47.6
Graphite Natural	2.6	11.9	6.0	19.3	2.8	13.5	5.1	22.2	1.9	11.4
Fluoraspar		0.2	5.1	15.0		0.1	2.2	5.5	3.2	18.2
Iron ore agglomerates	1,308	825	1,418.2	1,037	1,587	1,379	1,572	1,219	2,071	1,645
Alumina	0.5	6.5	0.7	8.1	1.3	20.6	0.6	10.4	0.6	1
Lead ore and concent.	0.3	7.0	0.3	5.7	0.3	6.7	0.4	9.5	0.2	6.2
Zinc ore and conc.										
Manganese ore / conc.	0.6	1.6	29.0	52.4		!	0.1	0.3		0.7
Titanium ore and conc.	0.1	0.8	0.2	3.0	0.3	3.0	0.2	2.3	0.2	2.5
Zinrconium ore /conc.		1.8	0.3	8.7	0.1	2.8	0.2	3.2	0.2	2.8
Rutile sand	0.3	4.2	0.3	5.0	0.2	3.0	0.2	3.9	0.3	4.9
Chromium ore / conc.	0.2	0.5				0.4		0.5		0.2
Coal	764.4	956	973.1	1,387	1,069	1,652	1,030	1,625	1,093	1,949
Total		**1,883**		**2,604**		**3,163**		**2,960**		**3,699**

Table - 4: Priority Areas for S&T Projects:
Estimates of Cost of Project and Economic Worth duirng ten-year period

(in million Rs.)

S#	Description	Cost of Projects	Economic Worth	Projected Total Output in Ten Yrs.
1	Establishment of Model Mines concept, regarding Coal washry, Coal beneficiation and Coal Banks in each province	0.435	50	500
2	Gemstone Training Institute: demonstration of Technology practices by inviting the foreign experts	0.18	8	40
3	Utilization of Mine-wastes e.g. Shale, Marble, Chromites, Coal etc. Regarding R&D work and extraction of valuables	0.435	10	10
4	R&D activities on products-development on industrial-based mineral, with special reference to Chromites, Nephelene, Syenite, etc.	0.495	7	350
5	Acquisition of technology for value-addition for Granite, Marble, etc., and R&D work on Building stones for local demand and export.	0.480	12	650
6	Investigation of Clay, including Bentonite Clay, and development of Barite closer to Karachi for mostly export.	0.460	1	5
7	Development of indigenous technology on Utilization of Iron Ores.	0.496	10	50
8	R&D Activities Gypsum and Anhydrite for commercial exploitation	0.075	1	5
9	Technology for refractory minerals, like Fireclay, Magnesite and Chromite.	0.425	12	25
10	Establishment of Museum of 1st Historical Geology for International Tourists of Quetta (Discovery of 1st Dinosaur Fossils, evaluation of whale, Human Evolution Fossils, Samples of Meteorites in Pakistan) & Strategraphic Museum of the world at Khewra George.	0.455	1	5
11	Up gradation / Strengthening of existing laboratories and human-resource development in the mineral sector.	0.3	1	5
12	R&D activities on mineral-based chemicals/ products .	0.5	1.6	15
13	Establishment of Geo-data centers. Geochemical studies for mineral Identification, resource and geological evaluation of base-metals as well as gold, copper, and platinum.	0.3		
14	Miscellaneous Projects Mineral Dep.	0.360	1	5
	TOTAL	**5.496**	**116**	**1620**

MINERAL-BASED CHEMICALS & PRODUCTS

The country needs large amounts of laboratory chemicals, which falls under the category of commercial, reagent, pure and analar-grade reagents. The pure and analytical grades of reagents marketed are not reliable, and the facilities available are sufficient to produce certified and standards chemicals, metals, materials and products.

In view of the increasing importance of environmental aspects, due to urban and industrial growth, new methods are required for recycling of waste, rivers and coastal-water preservation, safer and environment-friendly technologies, waste treatment, non-toxic catalysts and chemicals for industrial products, etc.

A number of strategic chemicals were being developed by the PCSIR, such as graphite, lead oxide, antimony metal, heat treatment salts, mould powders from Nepheline syenite, sodium phosphate. Other products of great industrial value have been produced on laboratory-scale, such as sodium cyanide, coated industrial minerals, electroplating salts, titania and alumina.

Huge deposits of all kinds of industrial minerals exist in the country, such as graphite, barite, calcite, magnesite, orpiment, celestite, trona, bauxite, talc, quartz, salt, vermiculite, phosphate. The value-addition of these minerals can easily be of great economic benefit to Pakistan, as it does not involve very sophisticated technology.

Although large deposits of economic minerals are not proven for their reserves, a number of small workings of lead, zinc, copper, alumina, titania, iron, antimony, Arsenic, Silver, Gold, Platinum, etc., showed the feasibility and good potential of these ore deposits. It was felt that a comprehensive project on the development of mineral products is a prerequisite for ultimate utilization of these deposits for local and export purposes.

It is estimated that about 100 crores rupees worth of Alumina, Iron and Titanium Industrial minerals are imported in the country, despite the fact that their reserves are abundantly available and the technology can be developed within low cost; some are developed at PCSIR at bench scale. The projects completed by geochemistry are Ziarat laterite, Bauxite from Khushab, red oxide, pigments and Nepheline syenite. There is wide application and demand for such products for use as refractories, abrasives, paints, pigmensts, catalysts, fuller in industries.Huge deposits of alumina and iron are available in the country, with varying grades and tonnage. A few of them can directly be employed for their particular purpose, while the others need specific processes/ methods for its upgradation to be made suitable for the particular industries. By developing the local technology, huge amount of foreign exchange can be saved at the same time, developing the indigenous mineral reserves of the country. Extensive reserves of a number of economic and industrial minerals and coal deposits are currently mined in Sind, Punjab, NWFP and Baluchistan provinces. Building-stones, granites, marble, seal salts, trona, china clay, bentonite, fullers earth, silica sand, celastite, calcite, marble, chromite, magnesite, manganese, copper, bauxite, zirconia, ilmenite, etc., are being mined in the provinces. As the GNP and per capita figures for minerals-sector is very small, application of the indigenous minerals in the development of conventional and New materials is required, through use of coordinated and systematic scientific method

VALUE-ADDITION OF MINERALS

Huge Deposits of Industrial minerals occur in the country, which can be exploited as basic materials for chemical Industry. New building-material for dams, saline and underwater application, processed sand with low alkalies, recycling waste in building materials; new materials involving organic powder coatings, fillers, catalysts, using cheap and natural environment-friendly materials. Indigenous materials for Ferrite, Cermets, Ceramics-development from indigenous sources, such as beach-sand containing zirconia, titania, monazite, etc. Heavy media preparation for drilling pigments.

DIRECTLY REDUCED IRON-ORE PELLETS FOR PRODUCTION OF IRON AND STEEL IN PAKISTAN

Pakistan is spending, on the average, Rs.2500 million every year on the import of iron and steel scrap to keep its remelting furnaces in operation. At the same time, the Pakistan Steel Mills is not meeting the per-capita requirements of iron and steel, which necessitates the creation of additional capacity. The installation of Direct Reduction plants (200,000 to 400,000 tonnes per annum) seems to be a solution of both the problems i.e. huge foreign-exchange spendings on import of iron and steel scarp and the creation of additional capacity. This can be made possible by utilizing the small iron-ore deposits, which otherwise cannot be used for the conventional blast-furnace steel making.

DEVELOPMENT OF NEW MATERIALS/PRODUCTS

A large variety of minerals exist in the country, which can be modified for this specialised use. The R&D work in this regard will consist of evaluation, pyro-metallogenesis studies on the behaviour of natural materials for SO_2 pollution control. The manufacturing of mineral-based products, e.g. heat and wear resistant parts; fine ceramics, with their outstanding wear-resistant quality, textile parts made of zirconia materials and yarn guides from Al_2O_3.

STUDIES ON THE PRODUCTION OF PHOSPHATE CHEMICALS, SUCH AS PHOSPHORIC ACID, DICALCIUM PHOSPHATE AND SODIUM ACID PYROPHOSPHATE, FROM ROCK PHOSPHATE.

Pakistan inherits huge deposits of phosphate rock of good quality having P_2O_5 contents in the range of 24% to 29%. Thus, no dependence on foreign investment is involved at all. So far, no project for production of industrial chemicals has been undertaken and it is an entirely new attempt. The chemicals aimed at for production are in great demand in Food, Pharmaceutical, Beverage, Fertilizer, Metallurgical, Cosmetics, and Detergent industries.

STUDIES ON THE ECONOMIC PRODUCTION OF STRATEGIC CHEMICALS/ SALTS FROM INDIGENOUS ORES OF STRONTIUM, BARIUM AND MAGNESIUM

Utilization of indigenous ores of barium, magnesium and strontium, which have more than 90% of barium, magnesium and strontium contents. These rich ores, which are abundantly available in Balochistan, NWFP and Sind, would not only save foreign exchange but also create a nucleus for developing a chemical industry within the country. The main objective, however, is self-reliance in this specific domain.

PREPARATION OF INDUSTRIAL SALTS FROM INDIGENOUS RAW MATERIALS

Production of chemicals and industrial salts is a heavy industry that involves huge investment. The recovery of this investment is slow and this is the main reason that the investors are reluctant to invest in this domain. The economical and worthwhile route for the production is the resort to the use of minerals and ores that are locally available. However, the raw material for preparation of these salts is abundantly available in the market. Some major salts include sodium acetate, sodium citrate, table salt, iodized salt, potassium dihydrogen phosphate & sodium dihydrogen phosphate.

UTILIZATION OF GYPSUM FOR PRODUCTION OF SULPHURIC ACID AND SALTS

Gypsum of extremely good quality is abundantly available in Pakistan. Bulk is used as a material of construction, fertilizer and as filler. It can be used for the manufacture of useful heavy chemicals and industrial salts. Among heavy chemicals, sulphuric acid has special importance. At present, its production is based upon imported sulphur, involving huge amounts of foreign exchange. This important basic chemical, viz. sulphuric acid, can be produced directly from gypsum, which has a sulphur content in the vicinity of 25%. This sulphuric acid can be used for production of a large number of industrial salts.

PRODUCTION OF FOUNDRY-GRADE GRAPHITE CONCENTRATE.

This product finds application in making graphite crucibles, carbon brushes, lead pencils, lubricants, etc., and also in nuclear technology. Presently all the domestic requirement of this material (about 5000-6000 t/annum) is met through imports. Extensive deposits of graphite ore have been reported in the Malakand area of NWFP and Azad Kashmir. In ores of low grade and average, graphite content ranges from 10 to 20%. This can not be used, as such, without its beneficiation or concentration to make it usable as commercial market-commodity. The ore, after being crushed, ground and sizing, would be processed by the method of froth-flotation. Mineralogical studies shall also be carried out to choose the mesh of grind and for selection of flotation reagents.

Graphite and graphite-based products are imported to the tune of Rs.30-40 mil-lions/annum. Since the raw material is abundantly available in the country, its prdouction in the country would definitely save the foreign exchange spendings.

DEVELOPMENT OF MINERAL-BASED MATERIAL FOR TOXICITY-CONTROL OF INDUSTRIAL PRODUCTS AND WASTE MANAGEMENT

Mineral-Based materials have wide application in innumerable products of daily life, being easily available and cheap. On one hand, they have high priority for emerging industries while, on the other hand, they can

Box - 1: The Beneficiation Processes for Commercialization

1. Iron and Steel
   - i) Processing of Chichali Iron Ore
   - ii) Processing of Nokkundi Iron re
   - iii) Processing of Chilghazi and Chittral Iron Ore
2. Copper
   - i) Processing of Saindak copper ore
   - ii) Processing & leaching of Dir and Chitral copper
   - iii) Evaluation of Waziristan copper ore
3. Chromite
   - i) Processing of Malakand chromites
   - ii) Processing of Muslimbagh chromites
4. Lead/Zinc
   - i) Processing of Besham Lead/Zinc ore
   - ii) Processing of Dudder ore
   - iii) Processing of Azad Kashmir ore
5. Antimony
   - i) Processing & Recovery of antimony sulphide and metal from Chitral stibnite ore-
6. Laterite
   - i) Processing & Recovery of Iron, Alumina and Titania from Ziarat Laterie
7. Gold and Silver
   - i) Processing of Chilghazi Iron Ore for the recovery of gold and silver
8. Graphite
   - i) Processing of Azad Kashmir Graphite ores
   - ii) Processing of Malakand Graphite ore
   - iii) Production Foundry Grade & Pure graphite
9. Sulphur
   - i) Processing of Kohi Sultan sulphur ore
10. Nephylene Syenite
    - i) Processing of Koga ore for glass industry
    - ii) Processing for mould powder
11. Magnesite
    - i) Processing & Evaluation of Kumhar magnesite
12. Baryte
    - i) Processing & Production of Barium Chemicals
13. Manganese
    - i) Processing & Production of Manganese carbonate
14. Bentonite & Clays
    - i) Processing of Azad Kashmir Clays

Box - 2: Major R&D Projects of PCSIR for Commercial Development

- Mineralogical studies and beneficiation of Nokkundi iron ores
- Survey report on the mineral potential of Kohistan area
- Feasibility of the utilization of Pachinkoh Iron Ore
- Mining Feasibility and Processing of Nepheline syenite.
- Feasibility report on Chitral iron ore
- Feasibility of the utilization of Chigendik iron ore
- Mineralogical studies and beneficiation of Nokkundi iron ores
- Mining Feasibility and Processing of Nepheline syenite.
- Mineralogical Feasibility Report on Nepheline syenite for use in glass and ceramics raw material
- Metallogenic prospection for copper in Dir and Chitral Area.
- Mineralogical contribution in Pre-Investment Feasibility of Kel Graphite Deposit
- Feasibility of the utilization of Pachinkoh Iron ore
- Feasibility report on Chitral iron ore
- Feasibility of the utilization of Chigendik Iron ore
- Processing of Chromite on Industrial Scale. ADP Project
- Mining feasibility of Hazara Phosphate
- Production of flow sheet and pilot plant studies on Saindak Copper Ore
- Production of Quartzite Powders
- Magnesite for refractory
- Technical help in mine development for marble deposit
- Production of iron pigments Mineral based pigments were developed in the laboratory leased to party.
- Production of Red lead and litharge.
- Production of high purity graphite
- Recovery of talc from emerald bearing debris
- Antimony metal production
- Production of Rare earths, Radioactive minerals, phosphates and vermiculite from Carbonate
- Magnesite for refractory
- Utilization of chromite ore
- Mine development for Marble Deposits
- Decorative stone and marble requirement for export purposes are enhanced through R&D support
- Development of construction Engineering Mineral Based Materials
- Feasibility studies of the materials to be used for the construction of Dams
- Development of Sodium Hypochlorite
- Evaluation of antimony and tungsten deposits of NWFP in connection with the extraction of antimony metal. project.
- Washability studies of Coals of Punjab, Baluchistan, Sindh and Azad Kashmir
- Evaluation of gold-silver samples from Kaldam Gol area Chitral Processing studies were conducted on the Schelite ore from NWFP for the extraction of tungsten metal.
- Processing of carbonatite from Silai Patti area NWFP for rare earths and other elements.
- Processing of emerald bearing rocks of Swat area.
- Processing of precious metal bearing ores of Chilghazi, Baluchistan.
- Processing of Koh-i-Sultan sulphur deposit for the extraction of sulphur from the samples.
- Activation studies on the clay samples from various areas of the Punjab in connection with their utilization in ghee industries.
- Production of lead monoxide on pilot plant

Continue…

... Box - 2 Continued

- Development of strategic chemicals such as:
- Barium nitrate, Lead acetate, Lead nitrate, Potassium nitrate, Potassium chlorate, Lead Mono-Oxide, Cobaltous oxide
- Production of lead peroxide
- Research and development work on indigenous iron ores
- Research and development work on indigenous copper ores
- Processing of low grade chromite ores resources of Pakistan
- Separation of sphalerite and galena from lead zinc ore
- Processing of sulphur, magnesite, nepheline syenite, barite and antimony
- Indigenous gemstone valuation and processing for jewellery industry and precious metal winning and metallurgy required for Export increase programme of the GOP.
- Production of intermediate materials for chemicals, paints, paper, cosmetic & rubber industries from industrial minerals such as carbonates and silicates.
- Pilot plant studies for the production of disodium hydrogen phosphate and monosodium hydrogen phosphate from indigenous raw material.
- Development of electro-refining of copper on pilot plant.
- Studies on the economic production of strategic chemicals/ salts from indigenous ores of strontium, barium and magnesium.
- Extraction of strategic metals from indigenous resources.
- Processing of industrial minerals like fluorite and barite ore for commercial exploitation.
- Utilization of indigenous low quality cost and smokeless briquettes for industrial use.

play a vital role to control the demanding future problem of industrial and urban pollution.

Catalytic activity of Pakistani clay-minerals for friedel-crafts akylation: The majority of the catalysts used by organic chemists are based on naturally occurring clays and minerals. The catalysts marketed by various chemical companies prepared from the clays and minerals available in their country. The natural clays or minerals also find use as a catalyst-support and also suitable catalyst for the conversion of larger molecules. The clay-supported reagents are known as pillared clays.

It has been observed that montmorillonites exchanged with the Fe(III) ions is effective for a variety of Diels Alder reactions and for chlorination. The transition metal atom present in natural clays is thought to be the seat of impressive and varied catalytic activity. Recently, the activity of natural clays as catalysts for Friedel Craft alkylation has been investigated. The clay composition and structure changes with the change of source and no two clays are identical in all respects.

The use of alumino-silicate as catalyst in various organic synthesis is most environmentally sound because of ease of handling, work up, non-corrosiveness and low cost.

RECOMMENDATIONS

In view of the requirement of mineral-based industries, the sustainable development in mineral utilization is promising on account of the occurrence of mineral-resources and availability of basic exploration and R&D work conducted by different organizations. However, serious constraints in HR, developmental capital, paucity of funds, lack of commercial ventures, international competition, lack of integrated approach in mineral-development between experts, coordination of earth scientists, technologists, business and management all need attention.

Identification of priority areas and strategies of development from different perspectives are required through relevant specialists. (An example is highlighted in this paper).

Integration of efforts in mineral development is hitherto missing. The projects should not merely result in generation of a report or creation of infrastructure, but should result in business-generation and commercialization.

Technology business incubation may be practiced as a mechanism to promote the commercialization, to reduce cost of investment, increase the success-rate by pilot-scale production through risk coverage, integration, networking, sharing of information.

To overcome the scarcity of qualified and experienced professionals, pools of mineral scientists, technologists and engineers may be created for planning and developmental work, involving all the disciplines.

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ICTs FOR DEVELOPMENT: MOVING OUT OF THE PAKISTANI PARADOX

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ABSTRACT

Having an enthusiastic support from the government —at least for more than three years now—which declared IT as one of its four focus areas and has made substantial investment to put in place the infrastructure of Information and Communication Technologies (ICTs), with the result that Pakistan has the most extensive Internet-coverage in South Asia, and arguably has the cheapest rates for the provision of Internet. However, this has failed to initiate an effective process, which could make a significant impact on the lives of overwhelming majority of its citizens, especially those living in the rural areas of Pakistan. In terms of grass-root projects of ICTs, Pakistan has yet to present a good example, and in this respect lags behind other regional countries like Bangladesh, Sri Lanka and Nepal, not to say India, which can boast of hundreds of such initiatives. We look at some of the root-causes of this situation and come up with practical suggestions for leveraging the power of ICTs for development and alleviating poverty in the country.

1- THE TWO 'WAVES'

Two easily discernable 'waves' have been sweeping across the current of human history, during recent times. They have set in motion a train of changes that have already transformed the human-society, in ways that are nothing short of revolutionary. They are: (i) transition towards information-society, and (ii) revolution in ICTs.

1.1 Transition Towards Information-Society

According to observers of human-society, after passing through the ages of agriculture and industry, it is undergoing yet another change. The industrial revolution of the eighteenth century, in Europe, set in motion processes and mechanisms that changed it from a mainly agrarian mode of organization, to that dictated by the needs of large-scale manufacturing. Recently, however, this industrial age is giving way to what could be termed as the '*age of information*'.

Information is fast becoming the key resource in the increasingly globalized world, we are living in, it is required at every level for making sound decisions. While *right information at the right time* has always been of strategic importance; more recently, in the late 20th century, information has acquired two basic utilitarian connotations. On one hand, it is considered to be an *economic resource*, almost at par with other tangible resources like labour, capital, and material. This view stems from evidence that the possession, manipulation, and use of information can increase the cost-effectiveness of both physical and cognitive processes. The second perception of information is that it is an *economic commodity* which helps to stimulate the worldwide growth of a new segment of national economies – '*the information service-sector*'. The rise in information- processing activities in manufacturing, as well as, in all other transactions and problem-solving activities by humankind has been phenomenal, giving rise to the so-called *information-society* and its concomitant *information-economy*. (see figure- 1).

Developing countries must also adjust to, or suffer exclusion from, the global economy and severe disadvantage in the competitiveness of their goods and services. According to Mahathir Mohammed, the Prime Minister of Malaysia, *"It can be no accident that today there is no wealthy developed country that is information-poor, and no information-rich country that is poor and undeveloped"*[2]. Countries that fail to establish an effective information- infrastructure with a broad range of applications are doomed in the new emerging information-economy.

In this paper, we have tried not to make a distinction between *information* and *knowledge,* and the two have been used interchangeably. There is a growing consensus not only among academics, but also among the more practically oriented management-experts, that knowledge is fast becoming the most important strategic factor for competitive advantage. In a pronouncement that has almost become emblematic for our times, Peter Drucker, alongwith that dozen of management-gurus, say*,"Knowledge has become the key economic resource and the dominant*

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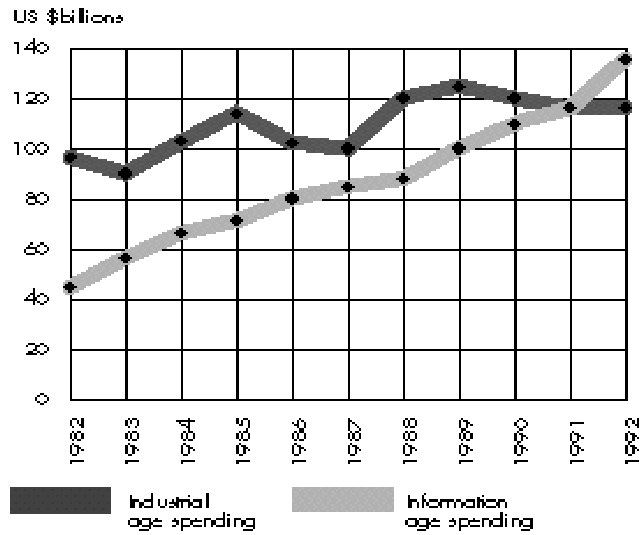

Figure-1: **Rise of the Information-Economy**. Capital spending (in 1987 dollars) by US companies for the industrial age (equipment, machinery for services, mining, oil fields, agriculture, construction) versus capital spending for the information age(computers and communications equipment). In 1991, for the first time, information age spending overtakes industrial age spending.[1]

– perhaps the only – source of competitive advantage".[3]

1.2 Revolution in ICTs

During the last two decades, we have seen a veritable revolution in Information and Communications Technologies (ICTs) that has the potential to profoundly affect all facets of our life. It has already transformed the way we communicate and do business in the *more developed world*.

Because of the empowering nature of these technologies, the world is now faced with a stark *digital divide*[4], in addition to the already yawning income-divide between the *haves, and have-nots*. However, this revolution, like all-revolutions in the past, has also rekindled hopes, especially among growing group of development-practitioners. They aver that the technology-divide doesn't have to follow the income-divide and that the ICTs can become a powerful tool for human development and poverty-reduction[5]. They are fast becoming a cross-cutting theme for development-projects and programmes of diverse nature and scope.

In the case of Pakistan too, there has been a growing realization among the policy-makers about the great potential of these technologies, to the extent that the military government, at the time of its inception, declared Information-Technology to be one of its main focus-areas. The current civilian government is following suite in terms of encouraging the use of ICTs at all levels, with significant planned investment, in both infrastructure and application of these technologies.

2- ICTs AND 'CONVERGENCE'

While Information-Technology (IT) is a marriage of computers and telecommunications, with Internet as its prime global application, ICTs cover a whole array of technologies from computer in its various forms – large mainframes to tiny PDAs (Personal Digital Assistants) - and its peripheral devices (for example, printer, CD ROM, smart-card, etc.) to more conventional electronic communication media, like radio and television. Telecommunication-devices, from ordinary telephone to the increasing versatile mobile cellular-phone, also fall under this category. What ties together these distinct and apparently disparate tools and technologies is the *digitalization* of information that has given rise to what is called *convergence.*

According to this unifying principle, once information is converted into the digital form, it could be recorded, manipulated and communicated, using the same techniques and devices. To elaborate it further: there is no difference in processing a text-message, a voice-recording, a graphic image or a video-clipping, once they are digitized. Whatever apparent differences in form they represent, each of them ultimately consists of a series of *zeroes* and *ones* that characterizes digital information. This unity of diverse forms of information, coupled with the ease with which it could be processed through computing devices and communicated across the globe (especially with the help of Internet) has far reaching implications for managing information and knowledge.

3- UNIQUE CHARACTERISTICS OF ICTs

The principle of convergence and its application to the global Internet, especially the World Wide Web (WWW), gives rise to many unique characteristics of ICTs that dramatically improve communication and exchange of information. The most important of these, to make ICTs a strong enabler of development goals, are[6]:

- ICTs are *pervasive* and *cross-cutting*. They could be applied to a whole range of human activity, from personal use to business, education and government.
- ICTs are a *key enabler in creation of networks* and thus, allow those with access, to benefit from *exponentially increasing returns* as usage increases.
- ICTs foster the *dissemination of information and knowledge,* by separating content from its physical location. This flow of information becomes independent of where it is actually stored, transcends geographical boundaries and in theory could be accessed by anyone.
- The digital and "virtual" nature of many ICT products and services allows for *almost zero or negligible marginal costs*. Replication of content is virtually free, regardless of its volume, and marginal costs for distribution and communication are nearly zero.
- The power of ICTs to seamlessly store, retrieve, sort, filter, distribute and share information can lead to substantial *efficiency-gains* in production, distribution and marketing. They are thus, both the catalysts – towards an information-society as well as, facilitative tools, for it to function effectively.
- The increasing efficiency and reduction in cost engendered by the ICTs is leading to *wholly new products, services and distribution-channels*. They also foster models of *innovative business,* putting the greatest premium on knowledge and ingenuity of humankind.
- ICTs facilitate *disintermediation*, as it allows users to directly acquire products and services from the original provider, cutting out the notoriously profiteering middlemen.

Some of these features can be illustrated by WWW, launched initially as an application of Internet, but which has become synonymous with the Internet itself. During the last few years, it has been transformed into a virtual repository of the whole of human knowledge, information and enterprise. Organized like a vast multi-media global library, it is available to anyone who has access to Internet. The great advantage of putting information on WWW is that one can arrange it in intuitive, user-friendly formats; and with the help of powerful search engines, one can get to the desired information in a matter of seconds. Another benefit that accrues from putting information on WWW is that it becomes an essentially inexhaustible resource. One can make any number of copies of the documents that are placed on the Web. While it is generally true for any information in the electronic form, which resides on the Web, truly presents this possibility with global accessibility and easy-to-search mechanisms.

4- REAL ACCESS

When we talk of providing *real* access to the ICTs for optimal benefit to people and communities, it goes beyond computers and connections. The goal of such meaningful access to ICTs is to provide *right information to the right people at the time they need it, in forms they can understand.* And this shouldn't be just a one-way communication with people being passive recipients, but they should also be enabled to *express* themselves in forms they are comfortable with. This requires a combination of *connectivity, content* and *capacity,* taking into account all the enabling socio-cultural factors.

Bridges.org is an international *not-for-profit* organization, with a mission to help people in developing-countries use ICTs to improve their lives. It promotes *real access* to ICTs by researching, testing, and promoting best practices for sustainable, empowering use of technology. It has come up with a set of dozen factors and determinants of what it terms as *real access*[7]. They are:

i. *Physical Access:* Is technology available and physically accessible?
ii. *Appropriate Technology:* What is the appropriate technology according to local conditions, and how people need and want to make use of technology?
iii. *Affordability:* Is access to technology affordable for people to use?
iv. *Capacity:* Do people understand how to use technology and its potential uses?
v. *Relevant Content:* Is the content locally relevant, especially in terms of language?
vi. *Integration:* Does the technology further burden people's lives or does it integrate into daily routines?
vii. *Socio-Cultural Factors:* Are people limited in their use of technology, based on gender, race, or other socio-cultural factors?
viii. *Trust:* Do people have confidence in, and understand the implications of, the technology they use, for instance in terms of privacy, security, or cybercrime?
ix. *Legal and Regulatory Framework:* How do laws and regulations affect use of technology and what changes are needed to create an environment that fosters its use?
x. *Local Economic Environment:* Is there a local economy that can and will sustain the use of technology?
xi. *Macro-Economic Environment:* Is national economic-policy conducive to widespread use of technology, for example, in terms of transparency, deregulation, investment, and labour issues?
xii. *Political Will:* Is there political will in government to do what is needed, to enable the integration of technology throughout society?

5- ACCESS: THE PAKISTANI PARADOX

Having touched upon the definition of 'real access' and what it requires, we come back to the original paradox of Pakistan in the lop-sided diffusion of ICTs. The military government, during its inception period in 1999, declared IT as one of its four focus- areas and since then made a substantive investment to put in place infrastructure for ICTs and support projects. The present political government has followed suite. This has resulted in some remarkable developments:

- From a mere 29 cities in August 2000, Internet is now available in nearly a thousand cities and towns, almost every town, in the country. To boot, one can access it from all these places with a local call that is not metered. No doubt, there still are major problems in connectivity and quality of service, but this marks by far the most extensive Internet-coverage in South Asia. This is also borne by the data given in the Table-1, which is somewhat dated. If anything, Pakistan's pre-eminence in Internet-connectivity, among the countries of South Asia, would be more pronounced now.

- The rates for Internet-bandwidth has been slashed down, by about 15 times, during the last few years, making them the cheapest in the region. This has promoted a thriving ISP-market, though it has not grown according to the earlier projections for some of the reasons that we discuss later.

In short, *Pakistan has the most extensive Internet-coverage in South Asia, and arguably the cheapest rates for the provision of Internet Service.* However, from the standpoint of *real access*, based on need and innovative applications that could make a difference to the lives of common people, especially those in the rural areas, there is hardly anything to show for. In terms of grass-root ICT-projects, generally referred to as ICTs-for-development (ICT4D) projects, Pakistan has yet to present a good example that could be replicated, on a larger scale, in the country and elsewhere in the developing world. While it may come as a surprise, but in this respect, Pakistan even lags behind Bangladesh and Sri Lanka, not to say India, which can boast of dozens, if not hundreds, of such initiatives.

Table - 1: Diffusion of Telecom, Computer and Internet in South Asia

Per 1000 People

Countries	Telephone Mainlines	Cellular Phones	Personal Computers	Internet Users
Bangladesh	3.4	1.2	1	0.2
India	26.6	1.9	3.3	4.5
Nepal	10.6	--	2.6	1.4
Pakistan	22.2	2.1	4.3	8.5
Sri Lanka	36.4	12.2	5.6	3.4

Source: International Telecommunication Union (2000), Nua Internet Surveys (2000), ADBI working paper (Jan, 2001)

6- SOME EXAMPLES OF ICT4D PROJECTS

Based on the criteria of real access, we look at some representative examples of ICT4D projects, all barring one from the South Asian Region.

6.1 Radio Browsing in Kothmale, Sri Lanka

One of the most innovative projects of its kind, it combines the grass-root outreach of a community-radio with the great knowledge-potential of the global Internet[8]. People in the communities with access to the FM community-radio – incidentally the first of its kind in South Asia – send their queries to the radio-station, through ordinary post, on different issues, such as, health, agriculture, crop-production, pesticides, legal problems. The answers to these queries are generated by programme-hosts or volunteers, through Internet searches. They translate this information in the local language before broadcasting it on the radio. Internet is also utilised by the radio-announcers who often incorporate information, news, weather reports and music into their broadcasts.

It is a joint project of UNESCO and the Government of Sri Lanka. UNESCO basically caters for the cost of Internet-connectivity – a 64 kbps line – to the three Internet Centres, in addition to the initial grant for computers. Apart from one in the radio-station, the other two are located in the Public Library and Town Hall. The Internet-Centres also provides the local community with direct computer and Internet-access – there were no Internet access points in the area previously. With this facility now available, many people in the community now contribute to the Internet-Broadcasts, by researching and translating, and by directly participating in radio-programs. The three access-centers keep in touch via email and share information, which is then posted on boards for all of the community. The services have now been extended to a database of all the information and programmes that have been broadcast, and have become quite popular in the community.

6.2 CorDECT WLL

Pioneered by Professor Ashok Jhunjhunwala, a researcher at IIT, Madras, the corDECT WLL (Wireless in Local Loop) provides a complete wireless-access solution for new and expanding telecommunication-networks with seamless integration of both voice and Internet-services. It is the only cost-effective WLL system in the world today that provides simultaneous toll-quality voice and 35/70 kbps Internet-access.

At the same time, under the banner of N-Logue Communications, the creators of this product have come up with an innovative franchise-based business-model to enable rural connectivity. *N-Logue Communications* offers in the rural areas and small towns a kiosk with corDECT Wireless terminal, telephone instrument, 100 MHz Pentium PC (with colour monitor, local language word processor, browsing and e-mail software) with a 16 hour power back-up for telephone and 4 hour back-up for PC. In addition to this, an STD PCO meter is provided in public kiosks.

N-Logue was incubated by the Telecommunications and Computer Network (TeNet) Group of the Indian Institute of Technology in Madras as part of the institute's strategy for developing and disseminating innovative, affordable communication technologies to the rural poor of the developing countries. The initial results of both the technology as well as the business model have been quite encouraging[9].

6.3 Wind-up radios for communities

Much of the developed world drowns in data from the Information Superhighway. Yet in developing countries, most have never made a phone call and few have ever switched on a computer. Radio remains the world's lifeline. The Freeplay Foundation, UK,[10] has a mission to enable sustained delivery of radio-based information and education to the most vulnerable population-segment, via self-powered radios (*'Lifeline' radios*). Working mostly in Africa, where affordable energy is scarce or non-existent, the Freeplay Foundation collaborates with professionals in education, health, agriculture, peacemaking, and voter education – all sectors where radio can play a vital or even life-saving role. The three main components of this initiative are: appropriate content, hardware (Lifeline radios) and structured distribution of these radios. An additional component that has crucially contributed to success of the project has been an extremely effective system for monitoring and evaluation.

This example of an ICT4D project is particularly relevant for a country like Pakistan, for it not only takes care of the issue of local content, but also solves the problem of electrical power.

6.4 Simputer

Simputer, a short form for *simple computer,* is a low-cost portable alternative to PCs, designed in India for affordable computing needs of the poor[11]. It is yet to be tested out on a mass-scale, but holds great promise for bringing the benefits of ICTs to the common-man.

It has a special role in the Third World because it ensures that illiteracy is no longer a barrier to handling a computer. The key to bridging the digital divide is to have shared-devices that permit truly-simple and natural user-interfaces, based on sight, touch and audio. The *Simputer* meets these demands through a browser for the *Information Markup Language* (IML). IML has been created to provide a uniform experience to users, and to allow rapid development of solutions on any platform.

The projected cost of production of the Simputer is about Rs. 9,000 produced, at large volumes. While this may still be beyond the means of most citizens, in countries like India, the *Smart-Card* feature that the Simputer provides, enables it to be shared by a community. A local community such as, the *village-panchayat*, the village school, a kiosk, a village postman, or even a shopkeeper could be able to loan the device to individuals, for some length of time and then pass it on to others in the community. The Simputer, through its Smart-Card feature, allows for personal information-management, at the individual-level for an unlimited number of users.

The impact of this feature, coupled with the rich connectivity that the Simputer provides, could be dramatic. Applications in diverse sectors, such as, micro banking, large data collection, agricultural information and as a school laboratory, can be made possible at an affordable price.

6.5 Other Examples

In addition to these examples, we could cite a number of others that have contributed to the betterment of the life of a common man in South Asia.

One of the most participatory and thoughtful initiatives in the field of ICTs has been the *M. S. Swaminathan Research Foundation Rural Tele-Centers* in Southern India[12]. One of their tele-centers, for example, downloads weather-reports and other information and translates those into the local language, to be broadcast through a loudspeaker, where fishermen embark for the sea. This has reportedly saved a number of lives by providing advance warning, to the fishermen about storms in the sea.

Gyandoot[13], an award-winning project in the Dhar district of Central India, connects 39 information-centers, set up in different villages, through which information on crop prices, welfare services, domicile certificates, land ownership certificates, etc., are made available.

The *Bhoomi* Project, in Karnataka[14], is one of the brightest e-governance projects, with regard to financial sustainability and it is now being replicated in other states of India. It has computerized more than 20 million records of land of the Karnataka farming community, and can provides that records of: Rights, Tenancy and Crops; and mutation certificates within a few days, for only 15 rupees each. About 400,000 records have been issued every month since its inception, and the state is earning something like 7 to 7.5 million rupees each month.

The Grameen Bank's *Village-Pay-Phone Project,* in Bangladesh[15], is another good example of sustainable ICT-solutions that can be used for the poor. Through this project a selected number of village-women are granted a revolving loan in a Village-Phone- Package and the women are encouraged to run phone-centres, at their respective villages, where other forms of communication are unavailable or costly. Customers are charged both for sending and receiving calls and the phone-set being a cellular, mobile phone, so light to carry - can be used by the whole community. Apart from providing a useful service to the community, this has resulted in earning a decent income for the '*phone-ladies*', thereby, also enhancing their social status.

7- BASIC FACTORS INHIBITING THE GROWTH OF ICTs IN PAKISTAN

The reasons for Pakistan's lack of success in adopting ICTs, to bring about a meaningful change in the lives of common people of the country, are not too difficult to fathom. When we consider ICTs, and especially Internet as a development tool, we are up against some very fundamental barriers. Briefly listed, they are:

- *Poor Literacy Rates:* Pakistan's literacy-rates are among the lowest in the region. And when it comes to the ability to read and write English, hardly a few per cent of the population is able to do so. Internet is still predominantly a text-based medium, most of which is in English. It requires someone, with at least an elementary knowledge of English, to benefit from it. That leaves out an overwhelming majority of Pakistanis, especially in the rural areas, from the ambit of this revolutionary medium.

- *Poverty:* With grinding poverty that has further exacerbated during the decade of the nineties, very few Pakistanis can afford the luxury of owning a computer with an Internet connection. Compared to radio, and even television, computer is significantly more expensive. While cyber-cafes mitigate this limitation to a certain extent, they exist only in urban areas and are still beyond the affordability of the poor.

- *Low Tele-density:* Pakistan's tele-density is abysmally low, at around 3%, which is yet another impediment in the mass diffusion of ICTs. While the latest surge in mobile-telephony has improved the situation to a certain degree, it is yet to make a significant difference.

- *Unreliable Electrical Supply:* Even though the rural electrification schemes have brought most of the country under the power grid, the electrical supply is at best intermittent. There are long unscheduled outages, and in many places, the electricity is available for only a few hours. Such a situation is patently discouraging in building an ICT-infrastructure that reaches out to the general populace. If nothing else, it hikes up the cost of such facilities, which for poor rural areas become all the more unaffordable.

In the face of such formidable barriers and basic problems, it is unrealistic to expect an easy or speedy solution. It would require a consistent effort and investment over a long period of time, to alleviate the situation. However, ICTs can themselves be employed in a thoughtful and innovative fashion, to accelerate this process of change. We now have good examples from around the world – some of which have been discussed above – to have a greater confidence in achieving this goal.

8- WHAT IS TO BE DONE?

Before we go on to recommend specific measures for moving out of the Pakistani paradox, we need to have a better understanding of its causes. While we have already discussed the fundamental structural problems in the diffusion of ICTs in the country, we now take a brief look at the issues impeding ICT4D initiatives in the country, and how they could possibly be tackled.

- *Lack of Awareness:* There is not enough focus on ICT4D among the policy-makers. To be able to launch such initiatives, there should be a greater awareness about the potential of ICTs as a development-tool, at least among the development- practitioners. Ideally, those in the field should have the skills to set up basic applications of ICTs, but if that were not possible, they should have a good understanding about where these technologies could be employed, their scope and limitations.

- *The Challenge of ICT4D:* The challenge of using ICTs, as a development tool, is enormous and goes much beyond the thinking and efforts required for setting up telecom-infrastructure, or using off-the-shelf hardware and software. Such initiatives have to be need-based and require participatory and innovative approaches. An unthinking technology-input, often based on the hype created by technology-vendors, can't be expected to cater for development-needs that are generally specific to a particular community.

- *Language and Cultural Barriers:* While it's easier to understand the language barrier – no matter how useful the content, if one can't understand the language in which it is presented, it has no value – the cultural barriers are sometimes more subtle. However, they are equally important and could at times present a greater barrier than trying to learn a new language. A good example, of which we are all too familiar in Pakistan, is the strong inhibition among women to visit cyber-cafes, frequented by young men often for activities that our society has zero tolerance for women to be associated with.

- *Not Commercially Attractive:* Unlike laying vast infrastructure or the *computerization* of government-agencies, or setting up large networks in universities, ICT4D projects, by their very nature, are generally not found to be attractive from a commercial point of view, even if they can be designed to be sustainable. The main reason for this state of affairs is that the technology-vendors are mostly selling foreign technologies – alien to the needs of the common people of Pakistan – without the necessary indigenization required to work in a different milieu with its paramount needs. So at times, it is more a manifestation of a lack of technological capacity than a lack of commercial potential in the project. The examples of both *corDECT WLL* and *Simputer* listed above, reinforce this point.

Once we have a good basic understanding of these inhibiting factors, we can come up with appropriate solutions. Given the cross-cutting nature of these technologies, we would need to work simultaneously in many areas to get the desired effect. For example, let's take the case of e-commerce. Policy-reforms to promote e-commerce should be accompanied by necessary legislation and regulatory framework, to carry out such transactions, accompanied by appropriate research and development, to create user-friendly software and necessary capacity-building to use these tools.

This would also require a *holistic approach* that entails looking at the larger picture with deeper understanding of the use of ICTs by different sections of the society, taking into account socio-cultural factors, like literacy and gender to encourage inclusive and partnership oriented initiatives. Government, civil society – especially in the form of social entrepreneurship – along with business and local philanthropy should come together to form partnerships, to explore ICT4D initiatives that could be appropriately scaled up.

In a nutshell, for an effective use of ICTs, *connectivity, content and capacity* are all equally important. This requires not only infrastructure, but development of locally relevant content - preferably in national and local languages – the skills to access this content and the ability to contribute towards it.

In remote areas, where the supply of electricity is especially problematic, greater use should be made of battery-operated ICT-equipment (such as: laptop computers and palm-style computing devices) and alternative electrical systems (e.g., solar powered and bicycle powered systems).[16]

Making use of this forum, we would like to make a couple of proposals that are eminently doable and can go a long way in providing a kick start to the ICT4D enterprises in Pakistan.

- *ICT4D Academy:* This is not being proposed as a brick-and-mortar institution, but as a mechanism for bringing together development-practitioners and ICT-experts, to try to come up with need-based, innovative applications of the technologies for the common man, especially in the rural areas. The members of this 'academy' could meet once or twice a year, with smaller select-groups, working on joint projects, meeting more frequently. Since face to face meetings between geographically distant people are difficult to arrange, the discussions could be continued through email, Internet-based discussion-forum, online-chat or voice-communication if required. Apart from this research and development work, the members of the academy can also be asked to conduct awareness raising seminars or training in various aspects of ICT4D.

- *Basic Urdu software-tools in the public domain:* The current situation with regard to basic Urdu software – word processing, email, html editing and database-management – is not conducive to its use on a mass-scale. While these tools are available, they are quite costly for a common man. More importantly, despite a standard being promulgated by the government, with regard to Urdu informatics, it is yet to be followed by commercial software houses developing Urdu-software. As a result Urdu-software tools created by different vendors are mutually incompatible. What is required is to have these basic tools – conforming to the standards – made available in the public domain. Since some of these tools, developed by students and amateurs, already exist, what is needed is to review them for suitability, plug the gaps in their functionality and place them on Internet for downloading. Apart from the technical input, this project would require a good deal of coordination and communication, to reach out to all potential users of tools of Urdu-software.

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CORRELATION BETWEEN BUSINESS AND DOMESTIC INFORMATION-TECHNOLOGY — NEED OF THE HOUR

*Ahsan Mumtaz**

ABSTRACT

The ability to sustain ourselves, i.e. sustainability, requires some basic change. It calls for understanding the mechanism of finding means to meet the end. This pivotal concept has its applications in all spheres of life, as well as Information Technology.

The 20th Century witnessed several new landmarks in human history. Among them, one key break-through has been how we, as human beings, have learned to use information to optimize our processes & procedures. The domain of Information Technology is serving mankind with provision of the right information, at the right place and at the right time. The operational forms & technologies have evolved over time moving from primacy to advancement. But to understand how people in the I.T sector operate, one needs to understand the mechanics of this dynamic field. The main focus is provision of quality-solutions with clear understanding of customer-needs. The international & domestic I.T market is governed by the same principle. The new millennium has brought Pakistan to the forefront of the global I.T industry. Countless consumer-goods, financial, insurance and technology firms have partnered with Pakistani companies. They have enjoyed the wide range of low cost and high-quality products and services that we have to offer. Pakistani Software companies cover every major field of technology, in terms of software, hardware and services.

PSEB (Pakistan Software Export Board) is a commercial, independently operated organization, set up by the government of Pakistan. It was established in 1995 to help bring world-attention to the new information-age of Pakistan. Today, through many support programs, PSEB aims to help over 700 member I.T companies and an estimated 15,000 I.T professionals. Specific measures to ensure I.T capacity-building in the local market are as follows:

- *Representation of Domestic software houses in local & International market,*
- *Provision of Infrastructure & logistic support, including bandwidth, under one roof in software-technology parks,*
- *Automation of Domestic Manufacturing Industry, there by interfacing local software-houses with domestic business-sector and bring their expertise to world-class solution-provider level,*
- *Assistance in implementation of quality-standards like ISO / CMM for Software-sector, to provide products using state-of-the-art quality-assurance techniques,*
- *Provision of quality I.T graduates to Software houses as interns.*

The need of the hour is to understand & develop long-term ties among domestic software-companies and business sector. The post 9/11 world has hit hard at the software-scene in Pakistan. In the previous scenario, the software companies were primarily looking forward to North American market for business-generation. The current outlook requires exploring alternative options for sustainability of business. New international markets in Europe, Far East & Asia are the new leads, which require working up by local software houses. On the Domestic front, strong cohesion between business and I.T industry is the key to success.

INTRODUCTION

The ability to sustain ourselves, i.e. sustainability, requires some basic change. It calls for understanding the mechanism of finding means to meet the ends. The pivotal concept has its applications in all spheres of life, as well as Information Technology. Sustainability is primarily the sum of techniques by which individuals, families, markets and organizations explore avenues for their survival and growth. The purpose of this paper is to evaluate the challenges faced by the Information-Technology industry, in terms of sustainability and then examine Pakistan Software Export Board's (PSEB) role in helping the Pakistani I.T companies in their capacity-building. (For further details check *www.pseb.org.pk).*

The 20th Century witnessed several new landmarks in human history. Among them, one of the key break-through has been how we as human beings have learned to use information to optimize our processes

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& procedures. The domain of Information Technology is serving mankind through provision of the right information, at the right place and at the right time. The operational forms & technologies have evolved over time moving from primacy to advancement. But to understand how people in the I.T sector operate, one needs to understand the workings of this dynamic field. The main focus is provision of quality-solutions, with clear understanding of customer-needs. The international & domestic I.T market is governed by the same principle.

SUSTAINABILITY IN INFORMATION-TECHNOLOGY

Similar to traditional markets, the information-technology market is dependent upon some critical elements for its survival. The salient features of these factors are as follows:

a. Business Opportunities: The fundamental sustainability feature is generation of business-development avenues, to provide “bread & butter” to the software companies. The work-potential can be explored, locally as well as in international market.

b. Quality Solutions: unless & until quality is installed in the products offered by I.T companies, their chances of survival are minimal. Quality in terms of post-sales support & maintenance, as well as bug-free product-code, is the hall-mark of the companies which have progressed over the years.

c. Human-Resource Training & Development: To provide I.T services, a software company’s biggest asset is its human-resource strength. Trained & skilled personnel mark the difference between the progressing companies and companies on the initial stage of the growth-curve.

d. Entrepreneurship Grooming: Like other industries, the leadership-vision & business-sense is critical for the future of a software company. Bright ideas are required to be nurtured into business-models, to be implemented successfully.

e. Infrastructure & Support: To bind the trained people, take advantage of business environment and offer quality-solutions, suitable infrastructure is necessary. Infrastructure in the form of buildings, machines & material, as well as reciprocal industrial setup, including telecommunication and information-technology setup, is mandatory.

f. Domestic & International Representation: To exploit the opportunities locally, as well as in international market, I.T companies must maintain a strong presence in the chosen business-areas for lead-generation to excel and enhance further.

g. Business Counseling & Guidance: Last, but not the least, from time to time the I.T companies require guidance and counseling, to make the most out of available resources. This counseling can be on technical issues, as well as on matters relating to the operational elements of business.

THE LOCAL I.T PRESPECTIVE

The new millennium has brought Pakistan to the forefront of the global I.T industry. Countless consumer- goods, financial, insurance and technology-firms have partnered with Pakistani companies. They have enjoyed the wide range of low-cost and high-quality products and services that we have to offer. Pakistani Software companies cover every major field of technology, in terms of software, hardware and services.

Pakistan is an emerging country at the Information-Technology horizon of the world. With lowest cost of

Table - 1: Cost of Labour: Annual Wages for IT Professionals

Country	Average Annual Wages
United Kingdom	$100,000 +
China	$ 6,000 to $8,000
India	$5,000 to $8,000
Pakistan	$ 3,600 to $6,120

Source: Forbes, 2001, and Computer Weekly Magazine, 2002 development among the Asian countries, English as one of the prime languages spoken & understood in the country, the domestic market offers lots of opportunities. The country is producing nearly 55,000 I.T & computer-related professionals annually, getting training at around 3000 – 4000 I.T institutes & universities nationwide. These graduates& technical professionals comprise the university students, as well as I.T / computer-course diploma-holders. 39% of I.T students already have 3 years of practical experience in their field of work.

This shows the availability of trained human resource, one of the basic requisites for the sustainability of an industry. There are over 700 I.T companies registered with PSEB, with total software companies estimated to be 1000 approximately. Out of this organizational strength, nearly 300 – 350 are engaged in software exports world wide. There are 2 million computer-literate people in Pakistan; 10 out of every 1,000 people use the Internet in Pakistan, compared with just 3 out of every 1,000 people in the neighboring country: 74% of Internet users have been using internet for over a year. There is a huge Pakistani Information Technology workforce overseas, working with international companies to international standards. Much larger numbers of individuals of the same caliber are working in Pakistan, for local I.T companies. This means that international investors & local business-companies can enjoy their excellent skills through domestic I.T companies at just a fraction of the cost. For comparison purposes, see Table-1 which shows Pakistan as having lowest overhead cost of I.T professionals.

At the same time, the Government of Pakistan is aggressively pursuing Information Technology at high-priority in its development agenda. There is 7-year tax-holiday for venture-capital I.T funds. Tax holiday on software exports is available till 2016; for the establishment of software houses, hardware imports are duty-free. Foreign investors are permitted to own up to 100% equity in local software houses/software companies. Imports of software-products are Tax free.

PSEB & THE DOMESTIC MARKET

Pakistan Software Export Board (PSEB) is a commercial, independently operated organization, set up by the Government of Pakistan. It was established in 1995 to help bring world-attention to the new information-age of Pakistan. Initially it was established under Ministry of Communication. In 1999 it was moved to Ministry of Science & Technology. Today it is functioning under the patronage of Ministry of Information Technology & Telecommunication since 2002.

From a humble beginning with staff of a few people to the present-day elaborate set up of professionals & state-of-the-art infrastructure, PSEB has played a vital role in capacity-building for domestic Information-Technology market. The prime objective of this apex software promotion-body is clear & simple. PSEB act as facilitators & mediators i.e. matching the requirements of stake-holders to the huge-resources that Pakistan has to offer. Presently, through many support programs, PSEB aims to help over 700 member I.T companies and an estimated 15,000 I.T professionals. Specific measures to ensure I.T capacity-building in local market are as follows:

- **Business Opportunities**

  The project of Automation of Domestic Manufacturing Industry is helping the local I.T industry to explore the business-options in the domestic business sector. The aim of the project is to computerize 100 Small & Medium Enterprise (SME) business manufacturing units and to introduce the automation-culture in SMEs. Under the project, SMEs from domestic manufacturing industries (Textile, Engineering, Pharmaceuticals, etc.) have been automated in Management, Reporting, Finance, Admin/Work Flow and E-Commerce matters, Quality Solutions, etc. In phase–I of the project, 44 industrial units have been automated. PSEB is offering financial & technical assistance for the development of such solutions.

- **Quality Solutions**

  The project of Standardization of Software Industry is initiated to cope with requirements of international market and to build up trust in I.T product of software-industry of Pakistan. Under this project, the I.T companies are given financial & technical assistance for implementation of quality-standard, such as International standard Organization (ISO) series in phase-I. In phase –II the I.T companies are encouraged to adopt the Capability Maturity Model (CMM) stages in their quest for software excellence. The aim is to bring

80 I.T companies to ISO/9001 level, by providing them financial assistance, up to 75%, along with the technical support. In phase-I, 70 Contracts have been signed

- **Human-Resource Training & Development**

  The Groom (Internships) project is launched with the aim to establish linkages between the software industry and educational institutes. This will help in getting I.T students exposed to the working of software-houses and will facilitate educational institutes to update their curriculum in the light of technologies required in the field. The aim is to deploy 1000 students into the local software-industry, bearing the internship cost of the students up to Rs. 3000/ month for three months. As part of phase–I, 425 students from 116 Institutions (from all parts of Pakistan) have been placed in 96 different software-houses.

- **Entrepreneurship Grooming**

  In order to give an opportunity to young & bright talent of Pakistan, the initiative has been taken to establish 20 new software-companies, consisting of 5 personnel each, concentrating on development of software products from international business- plans and provide them the project-management facilities and office-infrastructure & other logistic facilities at Software Technology Park (STP) Lahore. The construction of incubators has been completed and teams have been selected.

- **Infrastructure & Support**

  PSEB, via its project of Software Technology Park (STP) and Data Node Networks, is fundamental in provision of logistic & bandwidth facilities under one roof. Five towering Information-Technology Parks embellish the four main cities of Pakistan. There are two Technology Parks in the capital city of Islamabad and one each in Lahore, Karachi and Peshawar. Due to their immense popularity, the development of many more in public & private sector is on the horizon. These STP's enable I.T companies to start business immediately with saving of time for instant deliveries. These STP's have subsidized tariff, with high-speed data-connectivity.

- **Domestic & International Representation**

  One of the key services of PSEB is representation of domestic I.T companies at international marketing avenues & domestic exhibitions. The purpose of taking software-companies to international exhibitions is to facilitate the industry to participate in the leading international expos, to show their prowess to the world. Some of the major exhibitions in which Pakistani companies were represented were Gitex Riyadh 2002, Gitex Dubai 2002, Outsource World London 2002, Soft China 2002,Second Vision & Technology Expo Bahrain 2002, ITCN Asia 2002 (Dammam Expo Center Saudi Arabia), ITCN Asia 2002 (Karachi Expo Center).

- **Business Counseling & Guidance**

  The project has been started to develop libraries and Business councils at Lahore, Karachi, Islamabad and Peshawar, for the guidance & support of local I.T industry. Libraries at Lahore and Islamabad have started operations with almost 500 books and about 40 magazines. Member's advisory council is on board to help the software-industry. The exhibition pavilion at PSEB, Islamabad, has been established to facilitate effective introduction by I.T companies of their products and services to their respective clients, using PSEB platform.

CONCLUSIONS

The main need of the hour is to understand & develop long-term ties among domestic software-companies and business sector. The post 9/11 world has hit hard at the software scene in Pakistan. In the Previous scenario, the software companies were primarily looking forward to North American market for business-generation. The current outlook requires exploring alternative options for business-sustainability. New international markets in Europe, Far East and Asia are the new leads, which require working by local software houses. On the Domestic front, strong cohesion among business & I.T industry is the key to success. By understating the needs of the industrial units, software companies will be able to develop tailor-made solutions, as per requirements of the local industry and, subsequently, leading to world-class level.

CAPACITY-CONSTRAINTS ON E-COMMERCE IN PAKISTAN

Naeem Ahmad*

ABSTRACT

There is little doubt that electronic commerce has penetrated many people's—and particularly business'—lives in one way or another, during the past few years. But how many businesses really use the Internet? How do they use it? And how are they planning to use it? When it comes to a precise evaluation of the importance of e-commerce, including its dimensions, growth-rate and role in economic growth and development, uncertainty prevails. The IT sector has shown appreciable progress over the past three years in Pakistan. The Ministry of Science and Technology took a leading role in bringing the IT sector into the center of government policy. The National IT Policy and Plan of Action (August, 2000) was the driving force to strengthen the IT Sector in Pakistan. The government encouraged import of IT equipment, by significantly reducing custom duties; there were tax-incentives for income generated through IT business, bandwidth costs were brought down manifold and Internet-access was provided to more than 800 cities/towns/villages.

On the supply side of the equation, this is an enviable progress. However, there are challenges on the demand side. The number of businesses using e-commerce is negligible. There is a cumulative effect of human-resource capacity-constraints, old business processes, a high proportion of informal economy, lack of trust in electronic-payment culture, insufficiency of legal systems to enforce contracts, etc. E-commerce capacity-constraint can be overcome through ensuring the value of their resources, both for the businesses and customers. If a technology cannot provide value for their resources, its use cannot be sustainable in the long-term. The sustainability is directly proportional to the value provided by the technology and its demand and spread.

INTRODUCTION

There is little doubt that electronic commerce has penetrated many people's lives (particularly business) in one way or another during the past few years. But how many businesses really use the Internet? How do they use it? And how are they planning to use it? When it comes to a precise evaluation of the importance of e-commerce, including its dimensions, growth-rate and role in economic growth and development, uncertainty prevails. The IT sector has shown appreciable progress over the past three years in Pakistan. The Ministry of Science and Technology took a leading role in bringing the IT sector in the center of government policy. The National IT Policy and Plan of Action (August, 2000) was the driving force to strengthen the IT Sector in Pakistan. The government encouraged import of IT equipment, by significantly reducing custom duties; there were tax incentives for income generated through IT business, bandwidth costs were brought down manifold and internet access was provided to more than 800 cities/towns/villages. On the supply side of the equation, this is an enviable progress. However, there are challenges on the demand side.

E-READY STATUS OF PAKISTAN

The number of businesses using e-commerce are negligible. There is a cumulative effect of human-resource capacity- constraints, old business-processes, a high proportion of informal economy, lack of trust in electronic- payment culture, insufficiency of legal systems to enforce contracts, etc. E-commerce capacity-constraint can be overcome through ensuring the value of their resources both for the businesses and customers. If a technology cannot provide value for their resources, its use cannot be sustainable in the long term. The sustainability is directly proportional to the value and its spread that a technology generates.

International perceptions of Pakistan's e-readiness status are poor

i. Respected rating-agencies all place Pakistan very low in terms of e-readiness. The Economist Intelligence Unit's 2002 ratings place Pakistan 57th out of 60 of the world's largest markets, lower than Iran, Nigeria, Indonesia and Vietnam. It has however improved by three places since 2001 (60th). Business culture is determined to be decisive in the scoring. Pakistan does not shape well in this area.

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ii. No e-commerce policy is currently in place and no national strategy to e-enable Pakistan is apparent. The Ministry of Science and Technology have taken ownership of the e-commerce drive, as part of its Information Technology Policy. The Policy does devote a small section to e-commerce, but mainly at the technical level. The lack of a clear national strategy, and a lack of co-ordination between ministries is a potential weakness in the drive to develop e-commerce in Pakistan.

iii. Due to an aggressive IT policy, the telecommunications infrastructure has improved dramatically over the past 18 months. More than 850 cities were now connected to the Internet, of which 240 were connected by optical fibre. There has been a dramatic increase in cellular subscribers from 225,000 (January 2001) to 1150,000 (August 2002). Liberalisation has freed the wireless frequency; VSAT licenses are not required. Pakistan is about to license additional fixed-line telecommunications-providers, thereby ending the current monopoly of the state telecommunications company, PTCL - *www.ptcl.com.pk*. The terms of the licenses are still being debated.

iv. The Internet infrastructure has experienced similar improvements. Availability of Bandwidth was increased from 32 mb/s (August 2000) to 410 mb/s (October 2002). Bandwidth-costs have dropped from USD 70,000.00 per month for a 2 Mb link to around USD 3,500.00 per month. This however is still costly when compared with developed countries.

v. There are still problems with "last mile connectivity". The quality of connections between users and ISPs needed upgrading. The number of Internet subscribers grew from 130,000 (June 2000) to 1180,000 (August 2002). It was estimated that there were more than 4 million actual users (sharing subscriptions, business, Internet cafes, etc).

vi. Broadband-wireless solutions are in process of being rolled out in four cities. Paknet.com (a subsidiary of PTCL) are behind the roll-out and claim that they will offer connectivity between 64k and 128k lines for around Rs 45,000 to Rs 65,000 per month. Plans are afoot to install these solutions in educational institutions. It is believed that this solution will fast-track connectivity, enabling companies to connect to their remote subsidiaries without having to lease or build a wired infrastructure.

Specific to E-commerce

vii. Progress made by banks in developing an e-payment infrastructure over the last three years was important. Of the 4881 branch offices, 570 (8%) have been connected using Internet technology and 2036 are computerized. There are two national switches. To encourage further developments in the e-enablement of banks, the Ministry proposed the publication of the e-readiness status and rankings of Banks. The problem is that the National Bank, which has the most branches and provides services to smaller cities and towns, is a long way off full automation and connection. The e-payment infrastructure under its current development-approach is, therefore, not addressing the needs of the majority of Pakistanis.

viii. In the report of the State Bank of Pakistan, it was noted that no financial network was deployed to cater for the need of the national inter-banking financial traffic. No Real-Time Gross Settlement payment system (RTGS) was in place. Budget has been earmarked for significant investment in the national electronic-payment infrastructure, so this situation is expected to improve dramatically over the next 12 months.

ix. The promulgation of the Electronic Transaction Ordinance is a first and important step in creating the required regulatory environment, in which e-commerce can flourish. This ordinance provides various stakeholders, such as banks, Customs and others, to implement their applications. The ordinance mainly deals with the legality of electronic contracting and non-repudiation. The next areas of concern that need to be addressed are data and privacy protection and consumer protection.

x. E-government initiatives (actually implemented) are few and far between. There have been some recent developments allowing people to make utility payments from ATMs. Utility companies, such as the power supply and telecommunications monopolies, have entered into agreements with some of the banks to allow these payments to be made from various pay-points.

xi. E-education is beginning to show some interesting developments. Applications for university entrance can now be done online. Virtual University has recently been launched and is expected to be fully operational by next year. UNIDO has partnered with Virtual University to promote e-learning via internet-based short-courses for upgrading skills of human resources, as well as for women-development. There is a positive attitude to e-learning, which bodes well for this option to be utilized.

xii. E-Trade facilitation is in its infancy. PRAL is embarking on a pilot with Port Qasim, to allow electronic submissions of declarations. There has been work on simplifying trade-procedures, which will assist in bringing about e-trade. Obstacles such as impeding trade regulations (i.e. exchange controls), could stand in the way of fully fledged e-trade facilitation.

xiii. E-commerce-promotion initiatives and surveys are only recently beginning to surface. An ITU sponsored training-programme on E-commerce was run during April 2002. The ITCN Asia 2002 conference “Emerging IT Trends and Business Opportunities” was held in Karachi during August 2002. The conference focused mainly on ICT, with a section on e-commerce. The Industrial Information Network (IIN) has conducted a survey on levels of use of ICT among small companies. A net-readiness survey of SMEs is currently being conducted by UNIDO. UNIDO is starting working-groups in areas of e-commerce and ICT, and for usage and adoption of e-commerce and ICT for industry, as well as for marginalized poor and women.

xiv. General e-commerce activity is virtually non-existent. It is estimated that there are less than one hundred companies engaged in some form of e-commerce in Pakistan. The reasons range from limitations on the physical infrastructure to a lack of user-interest. Most small-company systems are not automated, hence not in a position to benefit from the various e-commerce applications such as CRM, etc.

In summary, the e-readiness of Pakistan can be described as reasonable in terms of Internet infrastructure, promising in terms of e-payment infrastructure and a regulatory environment, and very weak in terms of e-commerce applications and general user demand.

GENERAL IMPRESSIONS

(UNCTAD/UNDP Study on E-commerce in Pakistan, September 2002)

i. Most agree that there have been impressive strides in the development of the Internet infrastructure over the past year. However there is still a great deal of skepticism about the quality of this connectivity. Certain key-towns, which host textile mills, still have very poor connectivity, making it difficult for textile companies to e-enable their systems (Textiles is the largest export oriented sector).

ii. There was a note of disillusionment among some of the people interviewed about previous e-commerce initiatives. There were a few that had been launched about two years ago, which had lost their momentum. Project-proposals were approved, funds allocated, but implementation was halted due to key-people in the responsible departments not understanding these projects. Money allocated was therefore returned to the treasury. It appears that the Ministry of Commerce was the responsible party in this case.

iii. There is a sufficient level of intellectual capacity within Pakistan to mobilize an e-commerce drive. IT specialists abound and key government and business people have already invested a great deal of time in the question of e-commerce. These people need to be included in the initiatives proposed by UNCTAD.

VIEWS ON INTERNET INFRASTRUCTURE

i. The quality of most of the Internet Service-Providers (ISPs) is still in question. Significant investment in their infrastructure is lacking. This is understandable due to relatively low subscriber-numbers. Large disparities in Internet access-speeds and reliability therefore exist.

ii. The quality of the Internet-access does pose concerns for applications. Economic viability of applications depends on a critical mass of users. It this user-base is affected by quality of access, negative psychological barriers will develop, making it more difficult to achieve assimilation.

VIEWS ON PARTICIPATION OF ENTERPRISES IN E-COMMERCE

i. Most parties agreed that the main challenge to developing e-commerce lay at the level of enterprise and government department. Most players in this area where oblivious of what e-commerce is, and subsequently feel no imperative to move in this direction.

ii. A major obstacle is the virtual non-existence of automation in most enterprises. Many entrepreneurs run their businesses from a book, no records or data are in electronic form. Many do not even have computers, and relatively few use email or the Internet.

iii. A possible objection to automation and e-enablement is the fear of transparency that such a process will bring. Automation will increase the reporting-capability and highlight information about every aspect of the business. One of the basic requirements of electronic business is that the business holds a bank account and transacts through that account. There is a perception that this economic activity will be auditable, providing a tool for the taxation and other authorities.

iv. There have been government-subsidized programmes to support small enterprises to automate and to undergo ISO certification. These programmes have had limited effect so far. Many of the people interviewed felt that the ISO certification was just window-dressing and a way for consultants to extract government funds. Many SMEs are willing to play along with these consultants, as they just want the certification to satisfy their customers and are not interested in installing proper quality-management systems.

v. Various B2B portals have been set up, but none have had economic success to-date, due to low usage. This is possibly because of the lack of focus of these portals, which is not unique to Pakistan. These type of portals have not had great success in other countries either.

vi. Exporters in certain sectors are beginning to feel pressure from international buyers to provide data. The main challenge facing these enterprises is a lack of managerial and, hence, business-culture to comply with the demands of the 21st century.

vii. Certain sectors of the exporting industry have already begun to feel the demands of e-enablement from their foreign buyers. Exporters in the sports and surgical-goods sectors have been the first to feel this. Large buyers in the USA are placing reporting demands, as well as wanting to process and track their orders via the Internet. Those companies that have not automated the internal business-processes will find this demand impossible to satisfy. Some buyers, such as Waltons, have already started to disqualify suppliers unable to comply.

viii. The State Bank has been proactive in e-enablement initiatives. They have a task-force in place involved key-people from the banking industry. As a result, the National payments infrastructure is taking shape. This task-team seems to have had an impact on the e-payment status of banks. This is a good indication that a well managed task-team can achieve its objectives and have national impact.

E-COMMERCE FOR CIVIL SOCIETY

People have not yet felt the positive impact of e-commerce. The majority of the population is oblivious of discussions and developments in this area. There are, however, positive signs of increasing use of e-mail and the Internet. Some estimates put general usage of email and Internet at around 4 million people (about 3.5% of the population).

INSTITUTIONAL CAPACITY

i. Capacity to implement e-commerce related projects already exists in Pakistan. This capacity ranges from a group of key people, a few task-teams to business-associations and business-development-agencies. The banking industry has an active task-force on e-commerce. As part of the UNCTAD Trade Facilitation Action Programme, a National Trade Facilitation Committee has been formed.

ii. UNIDO held an ICT conference in May 2002, with the Federal Ministry of Science and Technology, Federal Secretary IT & Telecom, MD PSEB, and private sector IT SME leaders. The conference served as a launch-pad for Government, private sector, and international organization joint-collaboration in ICT. Subsequently, UNIDO is now forming alliances and partnerships with overseas Pakistani networks, universities, Government, and private-sector leaders that are users or providers of e-commerce and ICT.

iii. SMEDA (Small and Medium Enterprise Development Authority - *www.smeda.org.pk*) is of particular interest. They are an organization focused on developing business-capacity in small-business in Pakistan. They have good infrastructure in Karachi and Lahore, employing over 100 MBAs. They have impressive training-programmes throughout Pakistan. Courses include training on international competitiveness. Management has expressed strong interest in supporting e-commerce initiatives. They have had success in mobilizing their membership to use the Internet for research.

iv. The Industrial Information Network (IIN – *www.iin.org.pk* – a joint developmental project of SMEDA, SME Bank, COMSATS & UNIDO) has been active in both promotion and research in e-commerce initiatives. They produced a needs-assessment on e-commerce, in cooperation with UNIDO, of small enterprises in the textile and leather sectors.

PRO-POOR E-COMMERCE

Officials from the UNDP expressed concern that the focus was on modernization and hence most efforts were aimed at bringing mainstream-businesses into the e-commerce arena. More had to be done in identifying how e-commerce can make a difference to the lives of the poor, and in particular, how e-commerce can be used to empower rural woman.

CONCLUSIONS

Conclusions are summarized below.

a. There is a very strong sense that the Pakistan leadership is fully behind the development of ICT applications in Pakistan. The current IT policy is extensive and has number elements that provide a positive environment to the development of e-commerce. Their speedy action in promulgating the Electronic Transactions Ordinance indicates a willingness to make the required legislative adjustments.

b. The determination of the Ministry of Science and Technology to put in place an e-commerce strategy and policy is a very important development, on which the optimism of this report is based. The fact that it is a local initiative and that a task-force has been put in place provides a ready-made vehicle to which technical assistance can be applied.

c. There is a positive movement toward developing a physical e-commerce infrastructure. The Government have earmarked significant funding in this direction. There are signs of private-sector investment and there is a movement toward the liberalization of the telecommunications provision. This bodes well for more competition and a broader range of services.

d. The banks are showing commitment toward offering e-payment applications for enterprises and for civil society in general. E-government and E-business applications are now possible in main cities.

The fact that certain institutions and individuals have already initiated activities to develop applications of e-commerce indicates that there is a local base from which to launch the project. Organisations such as SMEDA and UNIDO provide a capacity to implement enterprise e-enablement programmes. It is expected that the various sector-associations will be receptive to e-commerce initiatives.

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CAPACITY-BUILDING FOR SUSTAINABLE AGRICULTURAL DEVELOPMENT IN PAKISTAN

Muhammad Afzal*

ABSTRACT

Agriculture continues to be mainstay of economy in the developing countries. In Pakistan it contributes 25% to the national GDP and more than 44% of the labor-force is engaged in this sector. It is a major source of export-earnings and also provides raw materials for the local industries. There are wide differences in agricultural productivity of developing and developed countries: on an average, it is almost double in the developed countries. To reduce the gap, there is a need for a proper R&D infrastructure and enabling policies that can improve production with technologies that are easily adaptable by the farmers and are environment- friendly. In this competitive world, only science-based agriculture will flourish. The focus of research should be to improve genetic potential of crops and animals, for both yield and quality and to enhance efficiency in resource-usage.

National Agricultural Research System (NARS) in Pakistan, like the other developing countries is limited in size, funding level and quality of scientific and professional staff, to tackle the issues. Thus, capacity-building of these scientists, professional staff and, most importantly, the farmers should greatly support agricultural development in the country. Several training-program initiatives have proven to be very successful in the past, and the current models are even more advanced, being based on Information-Technology. In the strategy for capacity-building, universities are key players, by being the knowledge-engines and providing quality-graduates to NARS, extension system and the industry.

INTRODUCTION

Agriculture is the mainstay of Pakistan's economy. It contributes 25 percent to the national GDP and employs over 44% of the labour force. Pakistan's foreign- exchange earnings are also dependent upon agriculture. Agricultural commodities account for 15% of export, while agro-based industries contribute 65% to the export (Government of Pakistan, 2002). Major industries in Pakistan are also dependent on agriculture for the raw materials. Review of the ups and downs of Pakistan's economy in the last 53 years clearly indicates its heavy dependence on agriculture. Agriculture will continue to be the corner stone of Pakistan's economy for the next decade (Afzal, 2001).

Although currently rated as a food-secure country by FAO, Pakistan requires major improvement in agricultural productivity to satisfy the growing population with higher income in the coming years. Current production-levels, as well as future projections of major agricultural commodities, are shown in Table-1.

Pakistan's agricultural system is highly complex. This ranges from high mountainous areas, in the north, to very hot deserts and Indus delta, in the south. Thus several distinct agro-ecological zones and sub-zones exist, with wide diversity in climate, soil and natural vegetation. Furthermore, attitudes, problems and competence of large, medium, small and landless farmers in each region, and even in a village, vary drastically in the management of their resources. This means that, for improved agricultural production, there is a need for a large number of technology-packages if a visible impact has to be demonstrated (Afzal, 2001). These challenges can only be met through a vibrant and well-organized agricultural research system in the country. Without full backing of such a research system, agricultural productivity soon becomes static and will not be able to satisfy the rapid increase in population and rising income-levels.

AGRICULTURAL DEVELOPMENT IN PAKISTAN

Pakistan has made tremendous progress in agricultural development since its independence. The country used to import its main staple food i.e. wheat in large quantities. It has not only attained self-sufficiency but is exporting wheat for the last three years. Significant progress has been achieved in improving yield of all major agricultural commodities. Off-season vegetables-growing technology provides fresh vegetables around the year. Yields and quality of fruits and vegetables have been improved and new vegetables and fruits have been introduced in the

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Table - 1: Projections for Agricultural Commodities in Pakistan

(000 tonnes)

Commodity	Current Production (2001-2002)	Projected Production (2010)	Growth rate (%)
Wheat	18, 475	26,443	2.93
Rice	3,882	6,300	3.17
Maize	1,665	2,500	5.94
Cotton (Lint)	1,805	3065	5.78
Sugarcane	48,042	60,000	1.00
Pulses	577	1,512	1.00
Oilseeds	4,040	9,430	3.87
Potato	1,679	2,233	3.81
Milk	27,031	34,310	3.80
Meat	2,072	2,652	3.90
Eggs (million No.)	7,679	14,129	7.00
Fish	655	1115	5.64

Source: Agricultural Strategies for the First Decade of New Millenium (2000)

country. Mushrooms are being cultivated locally. New dairy products like cheese, yoghurt, and UHT milk of local origin are easily available, and fish-farming has been introduced in the country. Although it is not pertinent here to exhaustively review all achievements in agricultural development in the country, a few typical examples are given in the following paragraphs to highlight the progress made so far.

Being the staple food, wheat has always been important in Pakistan's agriculture. It is grown on 70 percent area in the Rabi (winter) season. Average annual production of wheat in Pakistan increased from 3.25 million tons in 1950-55 to 13.47 million tons in 1985-90 and 19.53 million tons during 2000-02. Wheat-yields during this period also showed a similar trend. Wheat-yields were in the range of 625 to 850 Kg per hectare during 1948-63, which increased to 1070 to 1316 during 1968-1978, 1679 to 1999 during 1983-1993 and ranged from 2170 to 2491 during current years, i.e. 1998-2002 (Figure-1). Rust epidemics that used to destroy the wheat-crop almost every 5 years have completely been controlled by a programme of continuous monitoring for rust-resistance of all varieties (Hashmi and Chaudhri, 1994).

Rice is an important export-crop of Pakistan and, in some years, has been the largest single export item of the country. Pakistan grows and exports a fine, aromatic basmati rice. International Agricultural Research Institutes did not conduct research on this type of rice and the country had to depend upon indigenous research capabilities for improvement of germplasm and production-technology (Akbar and Amir, 1994). Pakistan produced 0.69 million tons of rice in 1947. The production of rice has steadily

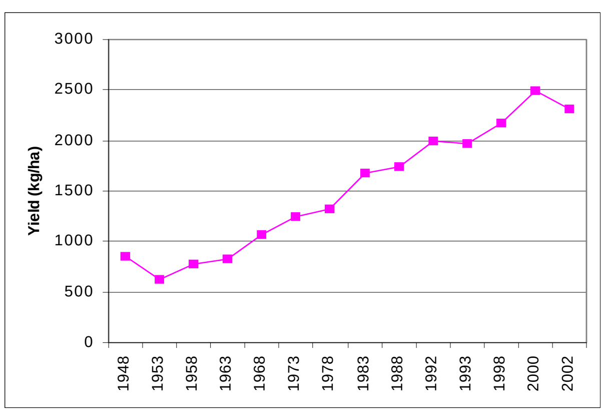

Figure - 1: Wheat Yields in Pakistan

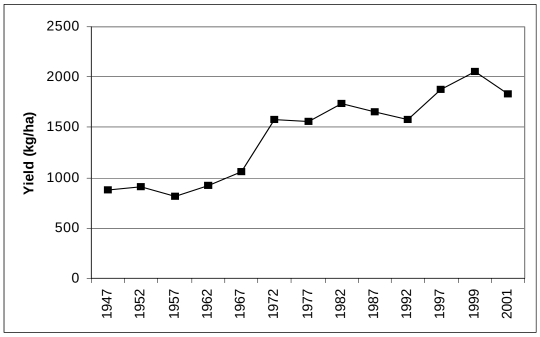

Figure - 2: Rice Yields in Pakistan

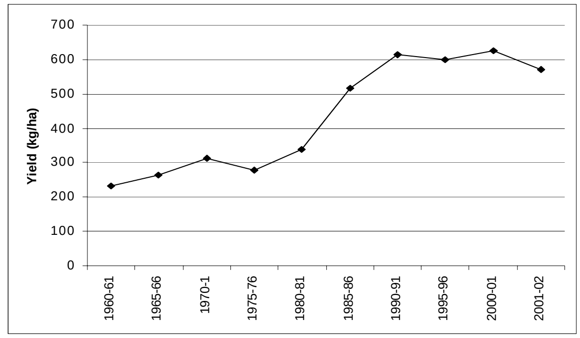

Figure - 3: Cotton Yields in Pakistan

increased and was 1.50 million tons in 1967, 2.95 million tons in 1977, 3.24 million tons in 1987 and 5.16 million tons in 1999. Corresponding yields have also increased and are 877, 1056, 1553, 1651 and 2050 kg per hectare (Figure-2).

Cotton is the single most important crop in Pakistan's economy. Raw cotton and textile-products are also the largest export-item of the country. Cotton-yield in Pakistan was very low and averaged around 235 to 300 kg per hectare in the 60s and 70s. The yield, however, almost doubled with the introduction of a locally developed variety i.e. NIAB-78. Cotton yields in Pakistan are shown in Figure-3. This single technology, developed from local research and development efforts, had a significant effect on the economy of Pakistan.

In the livestock sector, milk production has continuously been increasing and currently stands at 27.03 million tons, making Pakistan the 5th largest producer of milk in the world. Major epidemic diseases, which used to kill hundred thousands of animals each year, have been controlled through locally manufactured vaccines. Pakistan has recently declared provisional freedom from Rinderpest (the cattle plague) and is on its way to eradicate the disease and infection from the country by 2006-07. Poultry-sector has made tremendous progress during the last 40 years, with annual growth-rate of 10 to 20 per cent. Although, originally, day-old chicks were imported but now there are breeders, parents and even grand-parents being reared in the country. Local Research & Development institutes have particularly been providing technical guidance in feed-formulation and disease-control strategies. Even when an absolutely new viral infection i.e. Hydropericardium Syndrome hit the poultry, the local R&D institutes came to the rescue and not only diagnosed the infection but also developed a vaccine which has helped to control the disease.

Inspite of progress made in agricultural production, we not only lag behind the developed world but there are still tremendous yield-gaps between national averages and production obtained at research stations in the country (Table-2). This clearly indicates that there is need to improve agricultural extension service and policy-instruments.

NATIONAL AGRICULTURAL RESEARCH SYSTEM OF PAKISTAN

Agricultural research is a complex process. Its canvas spreads from basic and fundamental research, at one end, to adaptive or site-specific research, at the other end. There are a lot of shades in between these; the important ones being strategic and applied research. The boundaries of this classification are also not very sharp and, in many situations, one type slides into the other. Other than these, there is farming-system perspective of research in the agriculture. Agricultural research in Pakistan currently being undertaken can best be described as "maintenance research". This usually will be able to tackle national emergencies like plant and animal diseases, but cannot be expected to result in a quantum jump in the agricultural production in the country (Afzal, 2001).

The roots of agricultural research in Indo-Pakistan can be traced back to Imperial Council of Agricultural Research (ICAR), established in undivided India in 1929. It established several central research institutes. Unfortunately, all central research institutes established by ICAR were left in India at the time of partition and there was virtually not a single central institute located in the territories that constituted Pakistan. The only research establishments in

Table - 2: Yield-Gaps of Major Food Crops in Pakistan

Crop	Potential (kg/ha)	Average Yield (kg/ha)	Yield gap (%)
Wheat	6,400	2,200	191
Rice (paddy)	9,500	2,000	375
Cotton	1,400	500	180
Maize	6,944	1500	360
Sugarcane	100,000	46,000	248
Sunflower	2,500	1,000	150
Potato	3,128	1,000	210
Citrus	30,000	9,200	226
Mango	25,000	9,300	169
Apple	32,000	10,400	208

Source: Agricultural Statistics of Pakistan (2000-2001)

Pakistan at the time of independence were the provincial research stations that were established to undertake applied and adaptive research on the agricultural commodities of the provinces (Nagy and Quddus, 1998).

The National Agricultural Research System (NARS) in Pakistan consists of federal research establishments, provincial research institutes, agriculture universities and private agricultural research. Major agricultural research establishments in the federal government belong to Ministry of Food, Agriculture and Livestock (PARC, Central Cotton Committee, Pakistan Forest Institute and Soil Survey of Pakistan), Ministry of Commerce (Pakistan Tobacco Board), Ministry of Education (Centres of Excellence in Marine Biology and Water Resources Engineering) and Pakistan Atomic Energy Commission (NIAB, NIFA, AEARC, NIBGE). Some research on specific problems is also carried out in research centres of Ministry of Science and Technology and WAPDA. There are four Agriculture Universities in the country, located in Peshawar (NWFP), Rawalpindi (Punjab), Faisalabad (Punjab) and Tandojam (Sindh). Gomal University (NWFP) has a faculty of Agriculture and a College of Veterinary Sciences and there are five agricultural colleges located in D.G.Khan, Multan, Dokri, Quetta and Rawalakot (Azad Jammu & Kashmir). Veterinary college located in Lahore (Punjab) has recently been upgraded to University of Veterinary and Animal Sciences. Provincial research institutes carry out applied research and these are more geared towards developmental activities than hard-core scientific research. Each province has a central multi-disciplinary research institute on crops that are located at Tarnab, Faisalabad, Tandojam and Sariab-Quetta. Most of the other provincial institutes are commodity-oriented experimental station with a few working on multiple disciplines. Agricultural research undertaken by the private sector is very limited in Pakistan. Fertilizer and pesticide industries put up demonstration plots and provide some advisory services.

Table - 3: Land and Livestock Productivity in Different Countries

Country/ Region	Land Productivity {average cereal yield, Kg/HA}	Livestock Productivity {average milk yield, Kg/animal}
World/ average	3,034	2,192
Japan	6,260	6,641
USA	5,865	8,388
Mexico	2,451	1,393
Bangladesh	3,246	206
Brazil	2,690	1,380
India	2,372	917
Pakistan	2,401	1,179
Nigeria	1,212	400

Source: FAO (2000) Production Statistics Series, Vol. 54, FAO, Rome.

RELATIONSHIP BETWEEN NARS AND AGRICULTURAL PRODUCTVITY

Agricultural productivity of a country can be directly related to the developmental state of the national agricultural research system. Countries with well-developed agricultural research system have higher per unit productivity of its resources i.e. land and animals (Table-3). Average cereal production per hectare in Pakistan is almost half compared to Japan and USA, where NARS is well developed. Land productivity in Pakistan is even less than Mexico, Brazil and Bangladesh, where number of scientists per hectare are more than Pakistan. Nigeria that has less-developed NARS has lower land-productivity than many developing countries (FAO, 2000).

Size of NARS in Pakistan is proportionately smaller than in developed countries and even many developing countries in the region. A total of 4341 scientists are involved in agriculture, livestock and fisheries research in Pakistan. Distribution of these scientists among federal, provincial and educational institutions is shown in Figure 4. More than half of the scientists (52 %) are located in provincial institutes. However, the number of Ph.D. scientists in the provincial research system is lowest (Figure-5). In fact, more than 52 percent Ph.Ds. are in educational institutions. Distribution of Scientists in the provincial research system is shown in Figure-6. The number of Ph.D. scientists in all provinces are low. However, the situation in Sindh, Balochistan and Azad Jammu & Kashmir is alarming and needs immediate attention if these research systems are to contribute in agricultural development. This whole situation should be seen in the context that Pakistan NARS are supposed to conduct research and development in more than 140 commodities, with focus on 10 to 14 disciplines for each commodity. Numerically, not even one Ph.D. scientist is present to work on every discipline of each commodity.

Not only the size of Pakistan NARS is small, but the expenditure on agricultural research is also very low. The current expenditure level on agriculture research in the country is less than 0.2 percent of GNP that falls short of 2.0 per cent target set by the Commission on Agriculture in 1988. Studies carried out by independent institutions like ISNAR (Table-4) clearly shows that Pakistan spends less than Bangladesh,

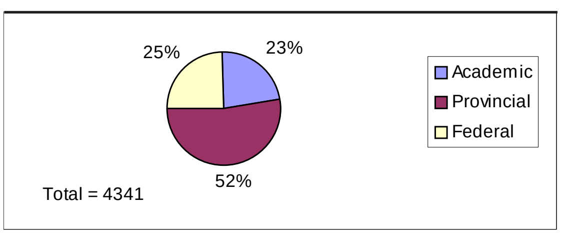

Figure - 4: NARS in Pakistan (Number of Scientists)

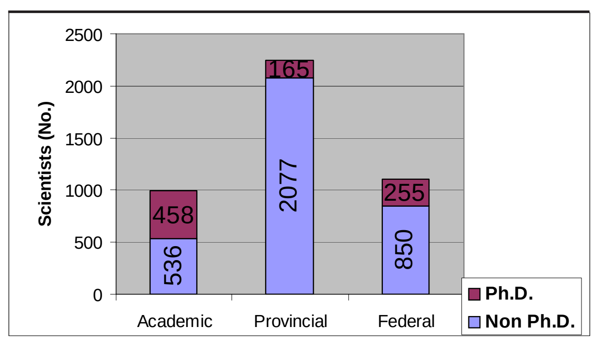

Figure - 5: NARS in Pakistan (Number of Ph.D. Scientists)

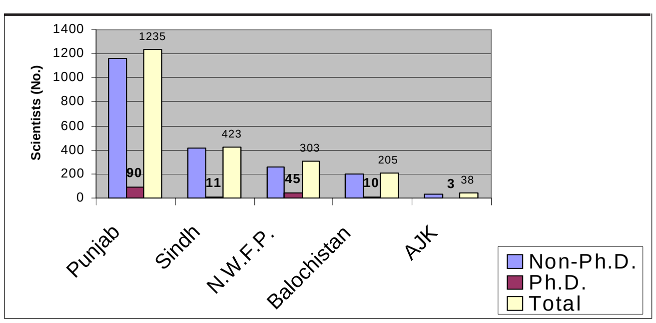

Figure - 6: Provincial Agricultural Research System

Sri Lanka, India and even Nepal on agricultural research per scientist or per hectare of the agricultural land.

CAPACITY-BUILDING

Output of an institute can be directly related to the quality of manpower employed and involved in the creative activity. Capacity-building is not a one-time activity, but is a continuous process to upgrade the expertise of the manpower.

CAPACITY-BUILDING FOR RESEARCHERS

Capacity building in agricultural sciences has mainly been strengthened in the 70s and 80s, with significant help from donor agencies. Main capacity-building activities for agricultural sciences in the past are listed below:

Local Educational Institutes

At the time of creation of Pakistan, there was only one agriculture college in Pakistan: Punjab Agriculture College and Research Institute, Lyallpur (now Faisalabad). This college, attached to Punjab University, was awarding B.Sc. and M.Sc. degrees in Agriculture. Education in livestock-sector was provided by Animal Husbandry College, Lahore, which was established in 1882. Realizing the importance of capacity-building for development of agriculture in Pakistan, the government continued to establish/ upgrade educational institutions at different locations in the country. At present, there are four agricultural universities, one veterinary and animal sciences university, 5 agricultural colleges and two faculties dealing with agriculture and veterinary sciences in a general university. All these institutes offer graduate-degrees in different disciplines of agricultural and animal sciences. Master-level programmes in various agricultural sciences are offered by 4 colleges and all universities, while universities and one college also offer Ph.D. study programmes. Training of Ph.D level scientists has been very limited. A total of less than 340 Ph.D. degrees in agricultural sciences have been awarded in Pakistan, with majority i.e. > 320 from University of Agriculture, Faisalabad.

International Agencies

Although several international agencies have contributed towards capacity-building in agricultural sciences in Pakistan, USAID and World Bank had been the major supporters of agricultural research and education (Hafeez, 1994). Historically, the efforts in development of manpower were started in 1961 when USAID supported the building and equipping of University of Agriculture, Faisalabad and provided a large degree and non-degree training-programme for upgrading the level of education of university staff (Development Support Training Project). Other major projects of USAID in capacity-building in agricultural sciences were Strengthening Research Capabilities, Management of Agricultural Research and Technology, Food-Security Management Project, Irrigation-System Management Project, Agriculture-Sector Support Project, Forestry Planning and Development Project and Transformation and Integration of Provincial Agricultural Network (TIPAN).

Under World Bank loans, Pakistan Agricultural Research and Development Project and Agricultural Research Project-II contributed significantly towards capacity-building in agricultural sciences. IDA-World Bank Third Education Project exclusively provided capacity-building to Sindh Agricultural University, Tandojam. Other significant international assistance extended for capacity-building in agricultural sciences in Pakistan include DAAD of Germany, DANIDA of Denmark, NORAD of Norway, British Council, ODA of United Kingdom, JICA of Japan, FAO, UNDP and Australian and Dutch assistance.

Efforts by the Government of Pakistan

Realizing the importance of science and technology in economic development of the country, the Federal Government has also launched various capacity-building programmes in different fields of science and technology. Agriculture, being a driving force of the economy, also got its share in these capacity-building endeavours. Ministry of Science & Technology launched Human Resource Development in High-Tech Fields project, during 1985-1992, and is currently having TROSS and Split Ph.D. Programmes. Indigenous Ph.D. and Merit Scholarship Programmes funded by MoST are also being operated by UGC (now HEC). The Ministry of Education has been encouraging talented students for higher studies abroad, through different schemes. These schemes include Merit Scholarship, Quaid-i-Azam Scholarship, Hundred Scholarships, Allama Iqbal Scholarship and COT scholarship schemes. Cultural Scholarships offered by various countries are also processed by Ministry of Education.

CAPACITY-BUILDING FOR EXTENSION WORKERS AND FARMERS

The technology and knowledge generated at the agricultural research institutes has to reach the ultimate end-users, the farmers in this case, to have impact on the crop and animal production. Most of the institutes either do not have out-reach programmes or have limited resources to carry out out-reach activity. All provincial governments have agriculture extension set-up to fill-in this gap. The basic purpose of this extension-service is capacity-building of the farmers to achieve higher sustainable productivity. For this, continuous updating of the knowledge of extension-workers is a pre-requisite. This research–extension–farmer linkage has been weak, thus there is a wide gap between yields at experiment stations and farmers' fields (Table-2). Various models have been tried in the past to improve agricultural productivity and rural development in Pakistan. These are summarized in the following paragraphs.

The Village Cooperative Movement was started soon after independence. It proposes that farmers unite under the umbrella of village cooperative societies and the thrust of the movement was education of member-farmers in new technologies. However, this movement suffered due to stronghold of rural elite on the cooperatives, lack of cooperation among Agriculture and Cooperative Departments and colonial "top down" approach (Malik, 1989). Village AID Programme (1952-1961) was started with help from forerunner of USAID and Ford Foundation. The programme sought to bring all-round development of the village, including disseminating improved agricultural technology through specially trained Village-AID workers. After an initial success, the programme became a victim of departmental jealousies and political change in the country. Basic Democracy System (1959-1970) developed awareness and local leadership among the rural masses, but failed to emphasize agricultural development.

Agricultural Development Corporations (ADC) were established to improve overall performance of the agriculture, including dissemination of information, but became farm-input suppliers. With farm-inputs devolved to other agencies and private sector, the ADC was disbanded. Integrated Rural Development Programme (IRDP) concept (1970-1978) revolved around selecting 50 to 60 villages and developing the area, through a social cooperative system under a total approach. Development of agriculture was the central force behind this rural development strategy. The programme succeeded in improving crop-production, but coordination role of IRDP was undermined due to narrow vision, jurisdictional concerns and conflict of interests of various nation-building departments. T&V Programme was sponsored by World Bank and, during the life of the project, resulted in improved research – extension – farmer linkage. However, operational funds for the programme were not provided in the non-development budget, making it virtually ineffective.

Recent model for the capacity-building of extension workers and farmers, being tried in Pakistan, is Farmers' Training Schools. It is a type of informal education. This concept brings researcher, extension-worker and farmers together on the farmers' field to jointly find a solution to the problem. Thus, farmers learn by doing. This model is currently being applied for integrated pest-management in cotton. Another effort to bring research – extension – farmer together is the use of information-technology. All available information for improved agricultural production is being compiled and put on a web-site. The extension workers from each participating district, and progressive farmers, will be able to access this web-site. An interacting forum is also being created for dialogue among the researcher, extension worker and farmers.

Table - 4: Expenditure on Agricultural Research in some of the South Asian Countries (1980 - 85)

Country	Expenditure (US $)	
	Per Scientist (000)	Per Hectare (Agri. land)
Bangladesh	64	8.52
India	54	2.63
Nepal	26	4.93
Sri Lanka	69	9.08
Pakistan	16	2.40

Source: ISNAR Working Paper No. 32 (1990).

STRATEGY FOR CAPACITY-BUILDING

Analysis of the current scientific manpower reveals that the number of Ph.D. scientists retiring or leaving the system are much higher than those entering into the system. There has been a freeze on hiring in some provinces for 10 years or so. Furthermore, majority of scientists trained through USAID and World Bank projects will be retiring in the next 5 to 10 years. Leadership crisis in some institutions and even some provinces is already evident. This scenario calls for an immediate action-plan to be developed for capacity-building in agricultural sciences for the country. Delay in doing so will result in irreparable loss to the country.

The strategy for capacity-building in agricultural sciences should at least consist of the following:

1. Strengthening infrastructure, faculty and operational funding in universities imparting education in agriculture and animal sciences.
2. Changing the governmental procedures of sending scientists on training (devolving the authority to institutional heads) and, in fact, encourage young scientists to hunt for training opportunities.
3. Instituting a system of sabbatical in all research and development institutions.
4. All development projects may be bound to have at least 25 per cent of funds allocated for capacity-building.
5. Developing a mega-project for strengthening of research and development in agriculture, with a major component of capacity-building.

Educated and skilled workforce is the basis for future development of agriculture. This workforce can only be prepared by an educational system that is based on creativity and pursuit of scientific knowledge. Furthermore, agriculture will have to be supported by (i) a network of R & D institutions that are capable of absorbing and utilizing outside information and generating new technologies for the local farming systems, and (ii) enabling policies by the government.

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RATIONALIZATION OF NATIONAL AGRICULTURAL RESEARCH SYSTEM IN PAKISTAN

*S. Nasir Hussain Shah**

ABSTRACT

The National Agricultural Research System (NARS) consists of several national research centers, provincial research institutions, Centers of Excellence at the Universities. Research in these R & D organizations comprises (i) basic knowledge-drawn research to targeted basic research, (ii)applied research and (iii)development of products and processes. Due to lack of purposeful and coherent efforts and somewhat loose and weak S & T Management Practices, the Research System has gradually deteriorated and the overall research efforts have resulted in the inadequate utilization of vast resources of the country. Low progress in the increase of per-unit productivity presents a major challenge to intensify efforts towards attaining greater production-efficiency.

To grow and maintain national economic strength and International Competitiveness, we have to transform NARS into a knowledge-based enterprise. The R & D organizations and agencies involved in Agricultural Research should tightly focus on essential programs. Every department should have a clearly defined mission, considering national priorities .It is also proposed that "Compendiums of S & T Management Practices" must be prepared for each R & D organization, in order to restructure, revamp and reform the NARS.

INTRODUCTION

Rain-fed and hand-hoe agriculture heralded the dawn of civilization. About 12,000 years ago, Irrigated Agriculture along the riverbanks resulted in production of surplus food, which in turn facilitated permanent settlements, urban societies and food trade. Demand and supply engineered science and technology. Agriculture is a way of life, a tradition, which, for centuries, has shaped the thought, the outlook, the culture and the economic life of the people. Agriculture, therefore, is and will continue to be central to all strategies for planned socio-economic development of the country.

Mainly farmers made early advances in Agriculture, such as better seed, livestock and improved implements. Agricultural Science began in 1700s, and involved scientists who applied material sciences to Agriculture. According to Dr. Norman Borlaugh, a Noble Peace laureate, called the father of "green revolution", on the basis of projected food-demand the average yield of all cereals must be increased by 80% between 1991 and the year 2025. Since the last century, the broad field of biotechnology research is a successful instrument for the improvement of agricultural production (Persley, 1989; Ahmad, 1988; Swaminathan, 1982 and Joske Bunder, 1990).

In the global context, Agricultural Research has made commendable advances. Chris Somerville (2000) has stated that in 1950,we grew worldwide about six hundred million hectares of cereal, using about 5.5 percent of the earth's surface. If we were growing the same type of cereal today, we would be using about 1.4 billion hectares of land, or actually most of the arable land on earth, because of the demands of population-growth. Because of the improvements brought by appropriate use of Agricultural Technologies, we're *still* only using about six hundred million hectares of land worldwide. About 800 million hectares of land of the world have been saved by increasing per-unit productivity, through joint efforts of Agricultural Researchers and plant breeders.

A recent study conducted by the FAO and Government of Pakistan (2002) indicated that, over the years, a lack of coherence has permeated the system and the overall research efforts, resulting in inadequate utilization of vast resources. Agricultural Statistics of Pakistan show that, during the last 53 years from 1947 to 2001, the percentage of production of wheat and cotton was 567% and 941% respectively, while per-unit productivity for same major crops was 275% and 397 %. Plant breeders and farmers are major actors for increasing overall production; however the role of research in increasing per-unit productivity is pivotal. There could be a number of reasons for the low output of research in Pakistan. Three major constraints in NARS are absence of functional linkages

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between research and extension, disproportion of educational and financial resources and lack of proper management-system for efficient utilization of Human Resources.

LACK OF LINKAGES

Five Universities, 40 Federal and 66 Provincial R & D Organizations, huge infrastructure in the form of Extension Departments in all four Provinces, are all developing their own empires and have no well defined functional linkages. Linkages between the Provincial Research & Extension wing do exist officially, but are not effective. Three Agricultural Universities and one Veterinary University and Apex Research body PARC have got no proper linkages for Research & Development.

There is sufficient capacity, in terms of buildings and experimental facilities. Quite often, wasteful duplications of resources are observed at several institutes/organizations working under different control. On the two sides of the road, research facilities have been established under same agency, essentially to undertake identical activities. Just one kilometer from these new research organizations, the comparatively older research organization is crippled due to non-availability of resources. Agricultural research is the concurrent responsibility of both the federal and provincial governments; agricultural education is controlled by the provinces; however it is receiving some technical and financial support from the newly established Higher Education Commission (HEC). HEC, however, has no direct linkages with the agriculture research. Research Institutes established by an agency in the Campus of Karachi University has got no linkages with the University. The most determined effort to link research and education was undertaken in the case of the USAID-supported project in North West Frontier Province of Pakistan, where Agriculture Research System was merged with Agricultural University (Kamal Sheikh, 2001). This failed to perform, due to mismanagement and exclusion of agriculture extension. All three pillars of Agriculture Development, such as Research, Education and Extension, should be brought under one umbrella, both at Federal and Provincial set-up. Efforts are thus needed to institutionalize research, extension and education linkages at National, Provincial and District levels.

DISPROPORTIONAL EDUCATIONAL AND FINANCIAL RESOURCE

About fifty percent (50%) of Agricultural Researchers are in Provincial Institutes. Federal Institutes, such as PARC, PAEC, PCCC and universities, have 17%, 7%, 3% and 23% of Agricultural Researchers, respectively. Highly learned staff (PhDs) are: 50 % with Universities, 32 % with Federal Institutes, and 18 % with Provincial Research Institutes. Province-wise details of PhDs are Punjab 77(9%), NWFP 30(8%), Sindh 5(3%) and Baluchistan 5(5%) (FAO-GOP Report 2002). Scientists at the universities are spending all their time in teaching. Their role in laboratory and out –reach research is non-significant. Agricultural Scientific Capacity in the provinces is very weak, where majority of R&D organization are mandated to perform research.

Agriculture sector contributes 25 percent to the National GDP, while it gets < 1.25 % of financial allocation in the Budget. This clearly indicates that, in the national budget, allocation of financial resources to the sector is not in proportion to its contribution.

Another anomaly within the Agriculture sector is that bulk of the Research Funds are used for crop-science research (79%), whereas small amounts are allocated to research on Livestock (7%) and Natural-resource management (8%). There is urgent need to rationalize resource-allocations at Federal, as well as Provincial, Research Institutes.

Continued advances are, of course, still needed in crop-production to meet the needs of growing populations but, over the next decades, there will be a disproportionate increase in the demand for livestock products, as compared with crop products, in order to meet the changing demands of peoples' diets (particularly driven by increasing urbanization and rises in per-capita income), and to address dietary deficiencies, particularly of women and children through provision of vital nutritional ingredients and micro-nutrients from animal sources.

The Agricultural Research System is a critical driver of the Nation's Economy. Investment in developing this system is thus a long-term economic imperative.

Resource Allocation to Agriculture-sector should be *at least 5% of the budget*, broken down as below:

--- 2% for crop sector
--- 3% for livestock sector

INEFFICIENT MANAGEMENT-SYSTEM

Pakistan had not inherited any major research organization in Agriculture-sector at the time of independence in the year 1947. Immediately after independence, a Food and Agriculture Conference was held in Lahore in the month of October 1947. Subsequently, an Expert Committee was constituted to organize Agricultural Research.

Food and Agriculture Committee (FAC) was formed under the Ministry of Food and Agriculture, which lead to the establishment of Food and Agricultural Council of Pakistan (FACP) in 1951. First Agricultural University of the country was established at Faisalabad in the year 1961. Agricultural Research Council (ARC) was restructured in the year 1964, and its functional capacity was enhanced with help of USAID, and in 1981, ARC was renamed as Pakistan Agriculture Research Council (PARC). Agriculture Research Division (ARD) was created at PARC, to provide more administrative and financial powers to the PARC. However, this good decision was reversed in 1993, giving an administrative setback to PARC. In the year 1984, Agricultural Research System of North-West Frontier Province was reorganized under USAID's Transformation and Integration of the Provincial Agricultural Network (TIPAN) Project.

NARS was designed on the priorities, which are no more relevant to meet the needs of 2010. It is a well-established fact that NARS of Pakistan requires overhauling and rationalization. According to Quigley (1939), rationalization is a method of dealing with problems and processes in an established sequence of steps, thus: (1) isolate the problem; (2) separate it into its most obvious stages or areas; (3) enumerate the factors which determine the outcome desired in each stage or area; (4) vary the factors in a conscious, systematic, and (if possible) quantitative way, to maximize the outcome desired in the stage or area concerned; and (5) reassemble the stages or areas and check to see if the whole problem or process has been acceptably improved in the desired direction.

On the basis of this concept, the 4 proposals in the following paragraghs have been constructed to improve the NARS.

– We have to introduce a more knowledge-based Agricultural Research System. Therefore the development of human resource should be given first priority. Hundred percent increase in PhD scientists, provision of career-growth opportunities and creation of elite force of strong research managers is needed.

– Role of PARC as an apex body should be clearly defined and strengthened. The Chairman PARC should be given full power of Federal Secretary. PARC headquarter should act as Federal Ministry of Agricultural Research, Education and Extension.

– Prime Minister's High Power Committee on S & T (Dr.Munir A. Khan): Recommendations of subcommittees on Food and Agriculture, Edible Oil and Cotton require serious consideration and Implementation.

– FAO Office at Islamabad, on the request of Government of Pakistan, prepared a report, which propose an "Agenda for Action" for senior Federal and Provincial policy-makers and research mangers that must be addressed if Pakistan is to rebuild its agricultural technology-generation system, and be competitive in WTO regime.

Finally, Management skill in the R&D Organizations is very weak. Several institutes are having no focused or coherent program with a clear mission. It is therefore essential that each and every R&D organization should have a clearly defined mission, considering national priorities .It is also proposed that "Compendiums of S & T Management Practices" must be prepared for each R & D organization to restructure, revamp and reform the NARS.

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NEED FOR CAPACITY-BUILDING ON HEALTH AND SAFETY PARAMETERS OF GENETICALLY MODIFIED FOODS FOR PAKISTAN

Hamid Ahmad & Shahnaz Hamid***

ABSTRACT

Technologies have been changing quite rapidly and, in certain cases, innovations have been held back from introduction because consumer-driven economies sometimes do not have equally quick capacity to absorb them. The developments and practical applications of food-products in this field are leaving food laws, rules, regulations and standards much behind.

Therefore, it is becoming quite possible that not all developments in the field of Genetically Modified (GM) Foods would be ethically, socially or religiously acceptable. Biotechnology has raised many kinds of doubts, which cannot be brushed aside, due to its strong possible impacts on health and the environment. It is therefore important to build S&T capacity for sound research and development and to make, adapt and practice laws, rules and standards, in order to contain the negative implications of genetically modified foods on people and nature.

Among many issues arising from the use of genetic engineering, in agriculture, is the ethical concern regarding genetic manipulation itself. Although the application of modern biotechnology to agriculture has been underway for about 15 years, the discussion on genetically engineered foods has intensified in many countries more recently. This is because food is essential to life and, in many ways and for many reasons, also expresses cultural, religious and even the political vision of the society. The genetically engineered foods, which were quietly introduced into the marketplace in 1996, have now spread rapidly. According to estimates, 60-70% of all processed foods in USA, Europe and Japan contain genetically modified ingredients.

This field should receive the attention of the Government of Pakistan, as such foods have crossed the international barrier and are expected to make inroads into our market-place soon in commercial quantities. For overall sustainable development, Pakistan needs to work for speedy capacity-building in this sector, which would include development, monitoring, testing, on the one hand, and the devising and implementing of appropriate laws and regulations, on the other.

INTRODUCTION

The current scenario of S & T in the world has been changing fast. With the emerging new multidisciplinary sciences and technologies, the pace of scientific discoveries and innovations has rapidly increased. As a result, the gestation period of innovations in S & T is fast reducing , even forcing some of the 2nd Generation innovations, in certain fields, to be kept in the hold-back position , because the consumer-driven economies may not have equally quick capacity to absorb these innovations. Another very important change has been the rapid increase in the investment, by large private MNC/TNC's, in quick turn-over fields, like biotechnology, to reap quick and high profits. Their S & T budgets (Monsanto, Aventis, etc), in some cases, are many times more that the total national budgets of countries like Pakistan. There are 6 or 7 large multinationals investing in the new avenues of biotechnology in the world (Monsanto, DuPont, Novartis, Austra-Zeneca, Aventis, etc.).The race for competition in biotechnology is getting so intense and fast that it may be about to take over, from information technology, as the next big carrier of the world economies in this century.

Before considering the need for the capacity building on health and safety parameters of Genetically Modified Foods (GM Foods) in Pakistan, an in-depth examination of the whole issue of the use of genetic engineering in foods, meant for human consumption, is highly important. It would clarify the implications of using or not using such foods, or using them under appropriate checks and balances. Also, the current status of the GM Food technology would be better understood in the light of the latest available scientific/ technical knowledge and the ongoing research-activities in this field.

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ABOUT GENETICALLY MODIFIED FOODS

The application of modern biotechnology to agriculture has been underway for over 15 years, though discussion on genetically engineered foods has intensified within many countries more recently. The debate on the benefits and possible risks of the use of genetic engineering in food-production is often emotionally laden, even when both sides are assuredly objective. This might be expected, as food is not only essential to life, but for many it also expresses cultural, religious and even political visions of society. There are those who recognize the potential benefits of agricultural biotechnology to society and advocate its rapid development and dissemination. Others urge the adoption of a slower, more cautious strategy, moving forward only as more reliable scientific knowledge accumulates.

Food biotechnology is defined as the application of biological techniques to food crops, animals and microorganisms, with the aim of improving the attributes, quantity, safety, ease of processing and production-economics of our food. The most recent application of biotechnology to food is genetic modification (GM), also known as genetic engineering, genetic manipulation, gene technology and/or recombinant DNA technology. In such processes, the DNA is introduced into them by means other than by combination of an egg and a sperm or by natural bacterial conjugation. It has been suggested that eighty percent (80 %) of biotechnology research is directed at modification of food plants. The remaining biotechnology research is on non-food crops, such as cotton, ornamental plants, and pharmaceuticals.

Random genetic variation occurs naturally in all living things and is the basis of evolution of new species through natural selection. Even before its scientific basis was understood, mankind took advantage of this natural variation by selectively breeding wild plants and animals, and even microorganisms, such as yogurt cultures and yeasts, to produce domesticated variants better suited to the needs of humans and the environment. Traditional selective breeding methods are based on the transfer of genetic material between individuals of the same species. Many changes to food-processes brought about by gene-technology may not differ from those which can take place in nature, except that the gene technologist accelerates them and reduce their random nature. Thus, within-species GM involves few fundamentally new issues. However, gene technology has made it possible to move genes across the species barrier. This property makes the technique revolutionary, in terms of the potential benefits that it may bring but, at the same time, it has also caused concern regarding issues of safety, ethics, consumer choice and environmental impact.

Currently, the development of GM Food crops, is on two type of traits, ***Insect resistant-Bt crops*** are engineered, so as to contain a gene from the soil ‘bacterium *Bacillus thurigiensis* that is specifically toxic to certain insect pests ***Herbicide resistant-HR-crops*** are genetically engineered to resist specific herbicides.

GENETIC MODIFICATION - PROCESS AND DETECTION

In simple words, the gene technologist uses a “cutting and pasting” approach to transfer genes from one organism to another. To achieve this, bacterial enzymes are required that recognize, cut and join DNA at specific locations, thereby acting as molecular “scissors-and-tape”. During the process of genetic modification, the selected gene is copied billions-fold, with the result that the amount of original genetic material used in the modified organism is immeasurably small. In addition, since DNA does not always readily move from one organism to another, “vehicles” such as plasmids (small rings of bacterial DNA) may be used; alternatively, some plant-cells may be transformed by “shooting” small particles coated with the new DNA into the target-cell, using a special type of gun, the “Gene Gun”. The modified cell can then be used to regenerate a new organism.

However, by currently available methods only small numbers of cells subjected to genetic modification-procedures are successfully modified. Furthermore, the regeneration of whole plants or animals from culture- cells may take months or years. Consequently, it is necessary to identify the modified cells in a culture mix, using “marker genes” closely linked to the genetic material to be transferred. Antibiotic-resistance has often been used to “tag” genes, since such a property can be detected easily and rapidly at the cellular level in the laboratory and so is useful as a basis for selection. The use of antibiotic marker-genes is a source of concern, and other methods are being developed.

Until the mid-1990s, it was not possible to determine whether a food or food-ingredient had been genetically modified, due to a dearth of reliable analytical methods. More recently, however, new methods based on the polymerase chain reaction or PCR (a method of DNA amplification) have been developed. Although none of these new techniques has been validated internationally , many laboratories are already using them routinely to meet the growing demand for detection and labeling of foods containing GM ingredients or components. It is expected that validation and harmonization of methodologies may occur soon.

POTENTIAL ADVANTAGES OF GM FOOD-CROPS

For the development of improved food materials, GM may have the following advantages over traditional selective breeding of food crops:

- Allows a much wider selection of traits for improvement: e.g. not only pest, disease and herbicide resistance is achieved, to date, in plants but also potentially drought resistance, improved nutritional content and improved sensory properties;
- It is faster and lower in cost;
- Desired change can be achieved in very few generations;
- Allows selection for characteristics.

These advantages could, in turn, lead to a number of benefits described below for the consumer, industry, agriculture and the environment:

- Improved agricultural performance (yields), with reduced use of pesticides;
- Ability to grow crops in previously inhospitable environments. (e.g. drought, salinity, extremes of temperature, consequences of global warming, etc.);
- Improved sensory attributes of food (e.g. flavor, texture, etc.);
- Improved nutritional attributes, with the possibility of combating anti-nutritive and allergenic factors and increased Vitamin A content in rice;
- Improved processing characteristics, which may lead to reduced waste and lower food-costs to the consumer.

It is frequently argued by some that there is not enough food to feed the world and GM Food is the answer. I personally disagree with this notion in the current global food-production situation. The real problem is not shortage of food, but it is the prevalent status of poverty in the developing countries, so that people cannot buy food for themselves. However, sometime in the future, mankind may need the possibilities of GM Foods.

POTENTIAL DISADVANTAGES AND CONCERNS WITH GM FOOD CROPS

Numerous perceived concerns regarding the safety and other aspects of GM foods are mentioned here, the concern for the safety aspects are:

Antibiotic resistance: Currently marker genes are used in the development process of GM Food crops. The transfer of antibiotic resistance from a marker gene contained in a GM plant, to a microorganism, normally present in the human gut, is a potential risk-factor. It may cause spreading resistance to therapeutic antibiotics to have serious health consequences for humans. Most scientists recommend that antibiotic resistance marker-genes should be eliminated from GM food- microorganisms that have not been inactivated by processing or cooking (as in live yogurt).

Allergenicity: The possibility of the creation of allergens by the GM-process is another important concern for the common consumer. This concern should normally be addressed during the safety-assessment of a genetically modified-food produced from. There are comprehensive Recommendation by European Commission on the scientific information, required to support an application for approval of a novel (GM) food or ingredient. It has a section covering the testing and assessment of allergenicity, to identify the allergenic potential of both the donor and of the recipient organisms.

A situation has already occurred where a research attempt to produce a soya bean with an increased methionine content by a gene-transfer from a Brazil-nut, was found to transfer the allergenicity from the Brazil-nut. If the situation had not been remedied, the resulting soya bean could have affected not only people, allergic to soya, but also those allergic to Brazil-nuts.

There are no inherent grounds for assuming that GM foods are more or less allergenic than traditional foods. However, when developing any GM Food, care must be taken that allergenicity is not inadvertently introduced into the diet. This requires assessment of the allergenicity of a new protein by predictive methods, experimental testing and a post-marketing surveillance, based on traceability.

Toxicity potential: The possible production of toxic substances in GM foods or toxic metabolites from GM fermentation organisms is a concern that has received considerable attention. It can be better understood by a case- example , which duly highlights this aspect of GM Food process. It was due to the EMS syndrome, in its first occurrence, that caused 37 deaths and over 1000 illnesses in USA in 1988-89 from a condition known as Eosinophilia-myalgia syndrome (EMS). Investigations traced the cause to dietary supplements containing L-tryptophan, and to toxic impurities in specific batches of L-tryptophan manufactured by a fermentation-process in Japan. The investigations showed that the fermentation had been carried out using a genetically modified strain of a Bacillus.

Environmental Concerns: There is a continuing need for studies on the possible risks from GM crops to the agricultural environment. Regulations in this regard will need continuous revision and updating, as new GM crops, data and improved methods on GMOs become available.

In most developed countries, any future release of GMOs into the environment is governed by regulations under the Environment Protection Acts, etc. EU Directive 90/220/EEC on the deliberate release into the environment of genetically modified organisms is applicable in Europe. Applications for the release of GM Food must include a considerable volume of data and a detailed assessment of the risk of harm to human health and the environment. All releases of GMO's are advertised locally and details are made available via a Public Register. Release-sites are subject to inspection by the Health and Safety Inspectorate and those making the release are required to report any incidents that may occur, during and after the completion of the trials.

Past experience with introductions of new species to environments where they are not naturally present has shown that potential problems may take several generations to manifest themselves. The problem of possible cross-pollination from GM crops to non-GM crops is of concern to traditional farmers. It has been suggested that the adoption of insect-resistant crops by farmers worldwide may lead to the extinction of certain insect-species (e.g. Lepidoptera), thereby reducing the biodiversity of the planet.

Some of the potential environmental risks are almost impossible to predict. Drafting environmental regulation for GM Food crops is difficult to enforce, when there are no clear standards against which the performance of a product can be measured (e.g. how many birds, butterflies and wild flowers should there be on a farm and to what extent can their numbers be affected before the environment is declared harmed?). However, consideration of some pertinent questions on environmental issues about GM in Food may be suggested here, like:

- Are GMOs harmful to the environment?
- What is the position of national experts on commercial growing of GM crops?
- Are we & who is doing research and how long will it take?
- Won't GM Food crops reduce the amount of pesticides and therefore benefit wildlife?
- Will genes from GM Food crops spread to wild plants?
- GM Food crops are widely grown in the USA, etc.. What is the effect on wildlife there?
- Is the regulatory regime for GMOs, in the country, adequate?
- Should there be statutory control of growing GM Food crops?

It is important to know that the common opinion of the multidisciplinary and GM-related experts is that only a well established statutory control of "how GM Food crops are grown" can and will ensure that biodiversity of our wildlife and the environments are protected and kept safe for our future generations.

Table - 1: Harvested Area of Genetically Engineered Crops

					Percentage share of world's area harvested for Genetically Engineered Crops
	1996	**1997**	**1998**	**1999**	**1999**
Argentina	0.1	1.4	4.3	6.7	17
Australia	<0.03	0.05	0.1	0.1	<1
Canada	0.1	1.3	2.8	4	10
China	1.1	1.8	n.a.	0.3	<1
France	0	0	<0.1	<0.1	<1
Mexico	0	0	<0.1	<0.1	<1
Portugal	0	0	0	<0.1	<1
Spain	0	0	<0.1	<0.1	<1
United States	1.5	8.1	20.5	28.7	72
World	**2.8**	**12.8**	**27.8**	**39.9**	**100**

Socio-economic concerns—Terminator gene technology: An example of a socio-economic concern is about the potential for misuse of the so-called terminator genes, which prevent seeds from germinating. Although patents exist for terminator-technology , it is not yet available commercially. There are fears, in the developing countries, that the commercial appetite of large biotechnology corporations might use such genes in all their patented GM crops to prevent farmers from storing seed for the next season. The plants using terminator-technology produce barren seed to make life more difficult for poor farmers in the developing world. Currently, our farmers grow conventional cultivars and save the seed from their produce for the next planting season in the traditional way. Furthermore, if cross-pollination occurs, GM plants with terminator genes could transfer their sterility to traditional plants grown nearby.

An example of a Canadian farmer who was fined by court in a lawsuit from a biotechnology company , should be more than enough to illustrate the future complex outlook of this technology, unless just consideration is given to the genuine concerns of the poor developing world. In this case, the farmer was fined because his traditional crop received GM traits into his seeds, from his adjacent GM crop-growing modern neighbor, as a result of cross pollination by natural process. The court upheld the view of the rich MNC, most probably represented by their high-profile attorneys, and fined the poor traditional farmer, for stealing the GMO through the air.

The ethical concerns are more regarding the genetic manipulation itself, in different socio-religious perception. Similarly, food is not only essential to life but for many it also expresses cultural, religious and even political vision of society. So, GM food with gene-

Table - 2: Globally Harvested Area of Genetically Engineered Crops (by Traits)

(%)

	1996	**1997**	**1998**	**1999**
Herbicide tolerant	23	54	71	71
Insect resistant	37	31	28	22
Virus resistant	40	14	<0.1	<0.1
Herbicide tolerant and insect resistant	--	<1	1	7
Quality traits	<1	<1	<1	<0.1

Table - 3: Harvested Area of Genetically Engineerd Crops: United States

GM Food Crops	1998 OYS	1999 OYS
HR Soybean	42	57
HR Maize	9	8
HR Cotton	33	39
Bt Maize	25	29
Bt Cotton	23	27

Note: OYS Stand for Objective Yield Survey

material from a pig for Muslims or animal for Hindus/ Budh, etc., would not be acceptable.

GM FOOD CROP IN FUTURE PIPELINE

The 2nd generation of products, many of which are already developed but not yet on the market, focus on a number of quality-traits, which will enhance their use in food-production systems, as well as improve their final use or quality characteristics. These include soybeans with improved animal nutritional qualities, through increased protein and amino-acid content. Crops with modified oils, fats and starches, to improve processing and digestibility, such as, high stearate canola, low phytate or low phytic-acid maize, are a few of the future products. Most of the output-traits of

Box-1: Summary of Consumer-Opinion Surveys on the use of Labeling for Genetically Engineered Products

Country	Survey: Author - Year - Coverage	Results
United States	International Food Information Council; October 2000	52% agree with current FDA labelling procedures. 43% agree with crities who say that any food produced through biotechnology should be labelled even if the safety and nutritional content is not changed;
	March 1997 and February 1999, International Food Council.	Question: Are you more likely agree with the labelling position of the FDA or its critics? (the positions were explained prior to the question) 58 per cent agree with FDA; 38 percent with critics.
	1997, Novartis,	93 percent of Americans want foods that are genetically altered to be clearly as such including 73 percent that strongly agree.
United Kingdom	February, 1999, Consumers Association; population representative survey, 1914 adults.	Of those that heard of Genetically modified foods, 94 percent supported clear labelling of GM foods.
European Union	1997, Eurobarometer, European Opinions on Biotechnology	Question: "It is not worth putting special labels on GM foods; 74 percent disagree and 18 percent agreed.
Australia	May-June 1999: ANZFA Stakeholders view from public consultations	Question: "Should the criteria for labelling foods produced using gene technology extend to those with the same properties as conventional foods? 91 percent strongly favoured mandatory labelling of all food produced with gene technology.
Newzealand	May-June 1999: ANZFA Stakeholders view from public consultations	Similar questions to the above: with a large majority favouring mandatory labelling of GM food products.

genetically engineered maize varieties are still in the pipeline, and have not reached the commercial market yet.

On the industrial side, we can expect colored cotton plants, so as to avoid the need for chemical dyes (some of these plants are already available). Other products, which are likely to be developed, will produce more end-user quality traits, such as nutraceuticals or 'functional foods', which are crops engineered to produce medicines or food-supplements within the plant. These could possibly provide immunity to disease or improve health characteristics of traditional foods, for instance beta-carotene canola or Vitamin A supplemented rice. Plants with greater nitrogen-fixing capacities, which reduce the need for fertilizers, or plants that resist drought, flood and extreme temperatures are also envisaged, as future developments, as are plants, which can be used for bioremediation. Some researchers also suggest that crops like cotton can be engineered to produce wrinkle-free and/or fire-resistant cotton or oilseed rape plants that produce biodegradable plastics.
Substantial research has also been devoted to the development of genetically engineered fish, such as salmon. Genetic engineering is also been applied to animals and crops for medicinal and therapeutic purposes, such as the production of vaccines or organs. Some of these are already available for use; however many are a number of years away from generalized commercial production.

It needs to be noted that the first GM food plants to be put on the market were the GM maize, resistant to the European corn-borer, a serious agricultural pest, and the GM soybean to be tolerant of the herbicide glyphosate. Both of these food-crops are of high commercial value for the developed countries, like USA & Europe. The major food-staples of the poor developing world are still in need of justified attention from the commercial priorities of the big MNC/TNC's, investing in the R & D of GM Food crops. It is food for thought, as well as height of commercialism, which needs to be noted by the national governments of the developing countries.

SAFETY AND REGULATION OF GM FOODS

When introducing any new technology, including gene technology, into the food chain, it is very important to adopt appropriate safeguards to protect human health. Most countries in the Western hemisphere started developing regulatory controls well before any GM foods reached the market, because the people were very apprehensive of lack of familiarity with GMOs.

Generally, in formulating GM regulatuions, most countries use the concept of Substantial Equivalence (SE). The concept was developed in the late 1980s by several national regulators and refined, in due time, for international recognition by the international agencies dealing in food-related matters, like FAO/ WHO & OECD. The concept is based on the idea that existing food or food-sources being used can serve as a basis for comparison when assessing the safety for humans, of GM foods or ingredients. If a new food or component, is considered to be substantially equivalent to an existing food or component the theory is that it can be treated in the same manner with respect to its safety and nutritional assessments.

G M Foods are generally assigned to three categories:

i. Products that are shown to be substantially equivalent to existing foods or food components;
ii. Products that are substantially equivalent to existing foods or food components except for defined differences;
iii. Products that are not substantially equivalent to existing foods or food components.

LABELING OF G M FOODS

GM Food labeling guidelines have been developed by a number of international organizations. Generally, the guidelines took into account the need for labeling of GM foods which contain material (e.g. allergens) that may have implications for the health of some sections of the population (e.g. infants or the elderly), as well as those which contain "ethically sensitive genes". Later on, the foods that contain copy-genes originally derived from humans or from animals were included, which are the subject of religious dietary restrictions (e.g. pig genes for Muslims) or any animal genes for vegetarians.

In Europe, the labelling of GM foods or foods obtained from GMOs, is mandatory since 1997, for those GM foods which, on the basis of a scientific assessment, were judged not to be substantially equivalent to an existing food.

"Further reaffirmation and official adoption has been recently voted by the European Parliament on July 2, 2003, requiring food and animal-feed to be labeled if they contain at least 0.9 % of GM ingredients. It may not be out of place to mention that a very common name 'Frankenstein Foods' is often used in the media to identify GM Foods all over the world."

RECOMMENDATIONS/SUGGESTIONS

Food scientists and technologists should ensure the responsible introduction of GM techniques, provided that issues of product-safety, environmental, social concerns, information and ethics are satisfactorily & adequately addressed. Furthermore, these issues need to be continuously addressed with the development of new or improved methods & procedures in this novel field. PSFST considers that there is strong and intensive need to concentrate on the capacity-building in the field of Genetically Modified Foods, at national level ,on the part of the government. In this way, the country is likely to benefit from this new technology. Provision and trade of safe and healthy food is a provincial subject, under the Pakistan constitution, but the matter of G M Foods is a new , high-tech field, requiring substantial investment, so it would need to be dealt at federal level for the establishment of uniform policy and practice, with large monetary inputs.

Currently, GM Food crops are not the answer to help feed Pakistan's or the world's escalating population. In the present scenario, the real culprit is the prevalent poverty in developing countries, as the poor are unable to buy the available food. However, in future, the long-term tested , safe and healthy GM Foods may be needed to remove the global hunger and malnutrition.

As far as Pakistan is concerned, there is strong & urgent need for the building of capacity in S & T infrastructures, specifically related to the Genetically Modified Foods and crops. It is understood that the Pakistan government has taken some initiatives on the development of National Biosafety Policy and Guidelines for the country, but the progress of the work is quite slow. Therefore, urgent political and technical attention needs to be given to fill the existing gaps in the adoption and implementation of the National Biotechnology Policy. The issue of GM Foods should be adequately included and addressed in the overall policy-framework of the Biosafety Guidelines.

It has been seen that, during the last few years, the activities in the field of biotechnology have picked up in the country at various levels, but the approach has been haphazard. So, there is a need for centrality & cohesiveness, at least in the beginning for a few years, to identify and direct priorities and avoid duplications in this expensive new domain. Without any further delay, the agricultural and other universities need to initiate special courses, at graduate level, on GM Foods at appropriate departments. Institutions involved in the education of biotechnology should add a course on Agriculture Biotechnology, which includes description and implications of GM Foods.

Last but not the least, the process of making standards, rules and regulations for the import and trading of GM Foods/products, ingredients, and seeds must be initiated at the earliest. International agencies like World Health Organization (WHO), Food and Agriculture Organization (FAO) are doing commendable scientific and technical work in this field, which we need to benefit from. Pakistan is a member of these UN bodies and is represented, or needs to be properly represented, by appropriate experts, in the Codex Alimentarius Task Force on Foods Derived from Biotechnology. The guidelines developed in their meetings can be useful starting point for evolving our own national regulations on GM Foods.

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APPENDIX

ADDRESS BY GUEST OF HONOUR

H.E. Mr. A.D. Idris Waziri
High Commissioner of the Federal Republic of Nigeria to Pakistan

Mr. Parvez Butt, Chairman, Pakistan Atomic Energy Commission,

Dr. Hameed Ahmed Khan, Executive Director, COMSATS,

Mr. Song Deheng, Political Counsellor, People's Republic of China,

Ms. Zainab Hussain Siddiqui, the Coordinator of the Meeting,

Excellencies, Eminent Scientists, Ladies and Gentlemen,

Assalam-o-Alaikum.

First of all, I would like to express my utmost appreciation over the establishment and successful performance of COMSATS. In the developing world, emergence of an institution like COMSATS amounts to a dream coming true. I have known Dr. Hameed Khan since my posting in Pakistan. He and his team have been very active in trying to spread the gospel of sustainable development in the *Third World*. This is a very commendable endeavour, destined to create awareness among developing countries. We are surrounded by challenges and problems and it is about time we take our destiny in our own hands, because nobody can do it for us except ourselves.

I would like to stress that COMSATS must be appreciated, commended and encouraged to continue to work hard, so that our goals and objectives in the realm of science and technology that we set for ourselves and the developing world could be realized. I would also reiterate expression of my appreciation for the great services rendered by Dr. Hameed Khan for the sustainable development of science and technology in the developing nations, hoping that he would continue his efforts in this direction in the coming years.

I have always upheld and supported the view that not just in sciences but in all spheres of human endeavours, whether it be politics, economy, environment or scientific research, we need capacity-building. There is no way one can talk about sustainable development unless one has the capacity to do so.If one doesn't emphasize capacity-building, then development is not sustainable at all. Therefore, one must keep the society into perspective, as science doesn't live in isolation and does not spread in isolation. We need to study the environment in which we operate. This is the objective of the present meeting i.e. to encourage all concerned to undertake the aforementioned perspective in their deliberations.

The meeting's objectives may include comprehensive discussion on drawing the short-term, middle-term and long-term plans for all of us to be able to build capacities. We must pursue them vigorously, to meet the challenges of today and tomorrow, as we urgently need sustained efforts to confront so many challenges and problems whether they are environmental, political, social or economic.

While discussing planning and recommending solutions, it must be ascertained that plans should not be over-ambitious. Moreover, we should try not to copy others and focus on our own environment, and ground realities and evolve relevant technologies that can address our problems. These technologies must be sustainable, because if they are not then development cannot be sustainable.

I congratulate COMSATS for its endeavours to evolve policies in the realm of scientific and technological development, which will be beneficial for mankind and particularly for the developing world now facing many problems. We must accept this challenge and collaborate to convert the developing world into the developed world.

I wish you success, and may God bless us.

ADDRESS BY GUEST OF HONOUR

H.E. Mr. Zhang Chunxiang
Ambassador of the People's Republic of China to Pakistan

Delivered by Mr. Song Deheng, Political Counsellor,
Embassy of the People's Republic of China

Honourable Chief Guest Mr. Parvez Butt, Chairman Pakistan Atomic Energy Commission,

H.E.Mr. A.D. Idris Waziri, High Commissioner of the Federal Republic of Nigeria to Pakistan,

Dr. Hameed Ahmed Khan, Executive Director COMSATS,

Excellencies, Ladies and Gentlemen

It is a matter of great pleasure to speak at this inaugural session of the Initial Meeting on Science and Technology Capacity-Building for Sustainable Development. I hereby felicitate the opening of the meeting and wish it a success.

What is particularly meaningful is that the objective of this meeting is to identify the challenges of Science and Technology Capacity-Building in the developing world and devise some solutions for such issues. This meeting, therefore, could be regarded as a follow-up of the United Nations Earth Summit on Sustainable Development in Johannesburg, South Africa.

It will be safe for me not to try to identify the challenges and devise their solutions, which are the work of experts attending this meeting. However, I would like to take this opportunity to make some general propositions and say a few words about China's progress in this regard.

To realize global sustainable development is a common task for all countries. Both developed and developing countries should undertake their respective obligations. On the one hand, developing countries should do their homework. We also should try to cooperate and complement each other. For instance, Pakistan and China have achieved fruitful cooperation in the fields of wind-power, small hydropower stations and bio-gas, etc. On the other hand, the developed countries should shoulder greater responsibilities. On the issue of capacity-building of developing countries, developed countries should assist developing countries in areas such as technical consultancy, training of personnel and mechanism-building.

The international community should take effective action to help developing countries improve their level of education in S&T. Developing countries lack financial resources for sustainable development, as they are constrained due to slow economic development. It is hoped that the developed countries will honour their commitments by taking effective action in financial support and transfer of technology.

The state policy of China has been: *"Science and Education Rejuvenate Nation".* Thanks to more than 10 years of hard work, China has made big headway on sustainable development. Since the Rio summit, China has acceded to a series of international conventions and completed the domestic procedure for the approval of the Kyoto Protocol.

The Chinese government has taken the lead in formulating *China's Agenda 21*. Under this Agenda, we have mapped out the strategy for rejuvenating the nation through science and technology and the strategy for sustainable development. We have also identified the key-sectors for China's sustainable development in this new century and relevant programs of action.

China's strategy for sustainable development has now run through all aspects of the country's economic and social developmental efforts, which effectively promoted a sustained and harmonious development of the economy, population, resources, and environment and has scored remarkable successes.

In recent years, China has stepped up its financial input in the environment sector. From 1998 through 2002, a total of RMB 580 billion yuan (equal to 69.88 billion US dollars) was invested in protection of environment and preservation of eco-system, accounting for 1.29 per cent of the country's GDP during the same period. China has allocated 10 billion yuan (US$1.2 billion) to fund S&T research on sustainable development during the ongoing 10th Five-Year Plan (2001-05) period. After years of searching, we have found for ourselves a format for development with Chinese characteristics, and our efforts for sustainable development are heading for a promising prospect.

As the world's largest developing country and a major player in environmental protection, China is an important force in international cooperation for clean environment. We are fully aware of the responsibilities on our shoulders. If we do a good job in running China well, it will be a great contribution to the world's cause of sustainable development. We will continue to work hard, honor our commitments with deeds, and steadfastly take the road of sustainable development.

Thank you.

INAUGURAL ADDRESS BY CHIEF GUEST

Mr. Parvez Butt, H.I., S.I.
Chairman
Pakistan Atomic Energy Commission (PAEC)

H.E. Mr. Idris Waziri, the High Commissioner of the Federal Republic of Nigeria to Pakistan,
Mr. Song Deheng, the Political Counsellor, Embassy of the People's Republic of China to Pakistan,
Dr. Hameed Ahmed Khan, Executive Director, COMSATS,
Ms. Zainab Hussain Siddiqui, Coordinator of the Meeting,
Leading Scientists, Ladies and Gentlemen

It is an honor for me to be here today, to participate in the meeting arranged by COMSATS. While the subject of this meeting is of extreme importance, first we must discuss and understand what is meant by the term '*Sustainable Development*'. This term was coined in 1987 by the then Prime Minister of Norway. According to him, it meant that whatever we do for development should not adversely affect our future.

The word 'Sustainable' has many meanings. Amongst others, it means self-sustaining — something that goes on by itself and is not dependent on others' inputs. These two together are the real sense of the term 'sustainable development' and this is what we should pursue. We should develop ourselves to influence our future. So many technologies have been developed, but we should learn to stand on our own feet and develop ourselves with our own capacities. This is the topic of my talk today.

I always wondered about life in remote villages in Pakistan, where people are at ease with their environment. They have children, some of whom die; this is a normal life pattern with them. They live, they are fed and clothed properly according to their own standards. The question is why do they need to develop. Now this is one way to live. But I think we must develop, so that our children and our children's children can live in this world as proud citizens. We must develop so that, when our children hear about the lifestyles of others, they do not feel deprived and are able to safeguard our ideology, protect our borders and sustain our freedom.

Why have we been slow in developing and have not developed as yet? There are many answers to this question but I am going to talk about one aspect only. We are not 'developed' and are yet 'developing' because we have been unable to exploit, to our advantage, what we can dig and pump below the ground, grow on the ground and construct above the ground. We have been unable to exploit the naturally endowed gifts appropriately. In some cases, these are being exploited to the advantage of others and we feel sorry and disappointed over this phenomenon. Therefore, we have to develop whatever we have, particularly our capable manpower, so that we can exploit and utilize these facilities to our advantage. This is what sustainable development should concentrate on i.e. develop the right kind of manpower to help us develop.

There are a lot of problems in every country, both internal and external; however capable manpower can help resolve these challenges. To create a harmonious society, everybody needs to be motivated and satisfied, but this level of satisfaction varies from society to society. Politics and difference of opinion exist in all societies, but the focus should never derail us from the development of manpower.

To develop the natural facilities available to us, i.e. above, on and below the ground, we need science and technology and this is where the role of COMSATS comes in. We must built capacities in science and technology within our countries, we have managed to attain a significant level of competence during the last 6 to 7 years.

For further developing our S&T facilities we need COMSATS, to facilitate the process of building capacities. In the last decade or so, we have been successful in developing science & technology in various spheres and walks of life. But to develop our own natural facilities we need to concentrate on exploiting, to our benefit, what is on the ground, above the ground and below the ground.

The progress that we have achieved is the result of the tireless efforts and unparallel contributions of the scientific community of our country. The national budget for the development of science and technology has been increased manifolds by our President, as he realizes the importance of S&T, which is an open-secret for progress and peace in the world.

Our prime focus must be to set our developmental priorities. We can't develop everything and must therefore choose and set priorities. Nevertheless, the choice is difficult to make. Either we can concentrate on flamboyant large-scale projects or on small grass-root level projects. I believe the answer lies in doing both and selecting them priority-wise, so that as we improve our education-system, certain achievements in higher technology are also realized. We should not wait too long to achieve that level and there should be the right mix of both.

Here I would like to give an example of *Pakistan Atomic Energy Commission* (PAEC). As Dr. Khan said, he is proud to be the one who served at PAEC, I would join him by saying that all of us who are, or have been, in PAEC are very proud of ourselves. We owe this pride to our founding fathers who started off with the mission of setting up PAEC some 40 years ago. They were people with great vision, requisite education and know how. They believed that they were second to none in this world and knew that this country is bestowed with natural gifts that needed to be exploited to our advantage. They believed in what COMSATS is doing now.

I recall the first Centre of PAEC, not a very large building, though it looked very large at that time but now looks relatively small. Our leaders started off with few and small rooms, literally 30ft by 40ft and even smaller. Each room was given a separate name and divisions were assigned for medicine, nuclear chemistry, nuclear physics, nuclear engineering and nuclear technology. They were dedicated professionals who showed their commitment to work even at those small places. This is how we were groomed. We took small and definite steps and therefore realized enormous growth. Throughout our careers at PAEC, there has been one phrase that we have been following: 'Indigenization and self-reliance'.

We believe that transfer of technology takes place naturally and normally. In order to have transfer of technology, there must be a recipient and we cannot blame the giver for not transferring it, as it is, for us to acquire. This is what we have done at PAEC, and have concentrated on developing capacities in many areas. We have achieved some success in all areas. We have developed the technique for extracting Uranium and other minerals from underground ores and for using them to generate electricity and to pursue other programmes. We are also operating in the field of nuclear agriculture, industrial technology and in advance sciences. Even though we are behind the developing world according to many benchmarks, we still have a standard and are moving on the road towards further success.

To achieve self-reliance and indigenization, one has to develop one's own manpower, and we at PAEC have done just that, right from the beginning. We have a university at present in Pakistan that is called *Pakistan Institute of Engineering and Applied Sciences (PIEAS)*, which started as a nuclear enigneering school in 1961 and was established by our founding fathers. Dr. Inam-ur-Rehman was the leading founder of PIEAS. He took us young graduates and engineers and taught us what nuclear engineering was. At present, PIEAS has a good reputation, with the blessings of Allah, if not world repute. We have been able to set up training centres and have carefully chosen the subjects we want to teach our people.

We know that industrialization is very important and that S&T and industry have to be developed together. We need to have a vibrant industry to sustain the budget to develop indigenous S&T prowess. Accordingly, we have developed all our facilities. We have set up the Welding Institute because we know that, for meaningful industrial development, we must know the science of it. We have also set up training institutes to operate nuclear power-plants. Moreover, we have set up institutes to do Non-Destructive Testing, and have now established centres to indigenously design and manufacture components and nuclear-power stations, so that, in future, as time develops and as we develop our nuclear power technology, we can do more and more ourselves. We want to use our indigenously available manpower, which is much cheaper than that in the West. We must utilize this available manpower to replace what we buy from abroad at higher prices.

We want to generate nuclear-power and other technological products within Pakistan, so that our economy could develop. We have now become a good-sized manufacturing facility and are manufacturing and supplying equipment to various industries in Pakistan. In the context of sustainable development, I believe nuclear-power is the best source of clean-energy, as it does not generate any carbon dioxide gas and doesn't affect the environment. World wide, there have been no serious accidents after Chernobyl and there has been so much concentration on the safety of nuclear power that it has perhaps becomes the safest source of energy in the world.

The above ground-resource i.e. *Human Capability, Intelligence and Dexterity,* is what we require in the future. PAEC has been a success story in this context and I am proud of the fact that I have been involved alongwith my colleagues in this success story.

I would like to thank Dr. Khan for having arranged this very important meeting. I agree with His Excellency Mr. Waziri, the High Commissioner of Nigeria, that there are so many advantages that we are getting out of COMSATS and its frequently organized events, such as this meeting. H.E. Mr. Waziri comes from Nigeria, which is a developing country just like ours and Mr. Song comes from China, which has transformed itself from a 'developing' to a 'developed country'--an example for us. It is the greatness of the Chinese people to say that they are still developing. They have used resources and manpower efficiently and we are proud of them. We wish that all developing countries follow their example and become developed.

I have been following the progress of COMSATS, and its present Executive Director, Dr Khan is one of our very important scientists. He has an excellent track-record as a scientist at PAEC and he has done so much for COMSATS. I wish COMSATS success for the future under his able leadership.

Thank you.

CONCLUDING REMARKS

H.E. Mr. Awad Mohamed Hasan
Ambassador of the Republic of Sudan to Pakistan

Dr. Hameed Ahmed Khan, Executive Director COMSATS,
Mrs. Zam Abdul Karim, Deputy Director, Science and Technology, Ministry of Science, Technology and Environment, Malaysia,
Mr. Rugumire-Makuza, Emmanuel, Makerere University, Center of Basic Research, Kampala, Uganda,
Distinguished guests and participants,

Assalam-o-Alaikum.

I would like to thank Dr. Hameed Ahmed Khan, Executive Director COMSATS, for the invitation extended to me to address this august gathering. It is really a pleasure and indeed an honour for me to address the scientists of our nations in the concluding session of the meeting on S&T capacity-building.

I have to confess that I am not a scientist; so as a very common and ordinary man I would like to give some suggestions and present my views. I am glad that my turn as speaker came after Dr. Hameed Ahmed Khan, who delivered a lengthy speech, which summarized the works of the last two days, and gave his comments and conclusions. Therefore, I dont have to say anything in detail; however, I would like to highlight three main points.

My first point, which my colleague H.E. the Ambassador of Bosnia would agree with, is that if we want to write a comprehensive report—a reliable report—I don't think we can accomplish it, unless we take a quick glance at our computer. One day I was here at COMSATS and saw a demonstration in which a doctor from Islamabad was diagnosing a patient from a very remote area in a village. He analyzed and gave the prescription to the patient, with whom he was interacting via tele-health services. I believe the use of science and technology is as important for us diplomats, engineers, in fact all professionals, as it is for medical practitioners. This is not only true for those professions whom we call white-collar professions, but is also true for all other professions. I also attended a session in which there was a demonstration of a system that Pakistan had developed, through which a farmer who could not read or write can gain access to Internet and get the information that he requires i.e. information about weather, markets, middlemen, etc.

So, even the layman needs science and technology to do his work. Not only that, but also if we simply talk of watching television in our leisure time, we cannot entertain ourselves without making use of science and modern technology. Even the toys of our children work with technology. I want to conclude this point by saying that we need S&T in all walks of life of the modern age of today.

But there is another point that I would like to highlight. Countries like Japan, Belgium and the Netherlands do not have substantial natural resources. Infact they have virtually nothing compared to the natural resources that countries like Pakistan and Sudan have. Yet, these countries are far more developed than us. The cutting edge that these countries have is that they groom, invest and utilize their human resources effectively, while, on the other hand, we do not make such efforts. It is a sorry state of affairs that, so far, we have been unable to capitalize on our human resources; however we have initiated the process and there is some hope.

I also listened carefully to one of the presentations delivered by H.E. Dr. Atta ur Rehman, when he was the Minister for Science and Technology. Dr. Rehman presented a vary startling comparison. He said that all the GDP of the comity of Islamic nations is less than the GDP of Belgium. Correct me if I am wrong, Dr. Khan, but I believe he said something more or less like that. My point in quoting this example is to emphasize that the future wealth and economic prosperity of a country is exactly determined by its ability to utilize and access the information of science and technology.

The third point that I would like to highlight is that it is understood that attaining prowess in science and technology requires the help of governments. I hope that politicians and relevant policy-makers adopt and implement the related recommendations made during this meeting, and I am sure they will. As I see here, with the Grace of God, Pakistan is a force which can lead the developing countries, especially ones from the comity of Muslim nations, by guiding them through the era of information technology.

COMSATS has been very keen in facilitating capacity-building in its member countries. Many projects with Sudan have already been initiated, such as the Industrial Information Network (IIN), establishment of an IT Centre and Tele-Health Centre, while many projects are in the pipeline. I am sure COMSATS also has a plan of action for developing indigenous capacities with other member countries.

In the end, I would like to thank Dr. Hameed Ahmed Khan and his colleagues, who have assumed a pioneering and guiding role and are steadfastly taking us through the era of science and technology. With these remarks I would like to thank you.

LIST OF PARTICIPATING ORGANIZATIONS

1 Ministry of Science, Technology and Environment, Malaysia
2 OIC Networks SDN BHD, Malaysia
3 Makerere University, Uganda
4 COMSATS Institute of Information Technology (CIIT), Islamabad
5 COMSTECH, Islamabad
6 ENERCON, Islamabad
7 Engineering Development Board (EDB-MoIP), Islamabad
8 Expert Advisory Cell (EAC), Islamabad
9 Federation of Pakistan Chambers of Commerce & Industry (FPCCI)
10 Geological Survey of Pakistan (GSP), Quetta
11 Government College, Sahiwal
12 HEJ Research Institute of Chemistry, Karachi
13 IUCN, Karachi
14 Dr. A.Q. Khan Research Laboratories (KRL), Rawalpindi
15 Ministry of Finance (MoF), Pakistan
16 Ministry of Industries & Production (MoIP), Pakistan
17 Ministry of Science & Technology (MoST), Pakistan
18 National Agriculture Research Centre (NARC), Islamabad
19 National Commission on Human Development (NCHD), Islamabad
20 NESCOM, Islamabad
21 Oil & Gas Development Corporation Ltd. (OGDCL), Islamabad
22 Pakistan Agriculture Research Council (PARC), Islamabad
23 Pakistan Atomic Energy Commission (PAEC), Islamabad
24 Pakistan Chamber of Engineers, Islamabad
25 Pakistan Council for Renewable Energy Technologies (PCRET), Islamabad
26 Pakistan Council for Science & Technology (PCST), Islamabad
27 Pakistan Council of Scientific & Industrial Research (PCSIR), Islamabad, Lahore, and Peshawar regional offices
28 Pakistan Institute of Engineering & Applied Sciences (PIEAS), Islamabad
29 Pakistan Ordinance Factories (POF), Islamabad
30 Pakistan Society of Food Scientists & Technologists (PSFST), Lahore
31 Pakistan Software Export Board (PSEB), Islamabad
32 Quaid-e-Azam University (QAU), Islamabad
33 State Engineering Corporation (SE), Islamabad
34 Sustainable Development Policy Institute (SDPI), Islamabad
35 United Nations Development Program (UNDP), Islamabad
36 United Nations Educational Scientific & Cultural Organization (UNESCO), Islamabad
37 United Nations Industrial Development Organization (UNIDO), Islamabad.

SUMMARY AND RECOMMENDATIONS OF THE MEETING

The meeting on 'Science and Technology Capacity Building for Sustainable Development' was held from 19 to 21 February 2003, in Islamabad. The meeting remained very fruitful with comprehensive recommendations coming out of the five technical sessions, spread over three days. The technical sessions were based on the lines of: i) Industry and Engineering, ii) Human resource development, iii) Geology and Engineering, iv) Information Technology and finally v) Agriculture. The active participation of leading scientists, eminent technologists from COMSATS member countries, members of the society from diverse walks of life and the three day deliberations brought out the following recommendations:

EMPHASIZE DEVELOPMENT AND CAPACITY BUILDING IN THE ENGINEERING AND INDUSTRIAL SECTORS

The world trade competition is posing a serious threat to the local industry of the developing countries. The challenges up ahead are to foster development of competitive industries, create employment, generate income and thus contribute to the alleviation of poverty, illiteracy and all kinds of social hardship. The focus needs to be on the creation of employment, on higher value-added products and increase of competitiveness in export markets, as well as the improvement of institutional capacities and capabilities for environmental, energy and product-quality management. This whole system that covers the perspectives of sustainable development needs to be executed in a precise and appropriate manner. This would require continuous monitoring and feedback, which is crucial for any mid-course correcting action. The recommendations given in this context are as follows:

- Implement international agreements, primarily the Montreal Protocol, the UN Framework Convention on Climate Change and the Basel Convention;
- Develop ISO 14000 environmental management systems certification scheme;
- Create awareness of national and international best-practices in the fields of technology, management-systems, and policy;
- Improve the understanding of sustainable development and, in particular, the business opportunities that sustainable development presents in Pakistan;
- Encourage industry, government and community-organizations to adopt initiatives that result in the improved use of eco-efficiency and cleaner production among their constituencies;
- Build common demonstration effluent-treatment plants for the textile and leather industry;
- Implement industrial policies that provide an enabling framework, within which the private industrial sector can operate with full efficiency and competitiveness;
- Raise awareness of potential foreign investors and technology-suppliers of investment opportunities
- Develop strategies and related institutional framework to enhance the development of more efficient and competitive small and medium-scale industries;
- Encourage the formation of industrial clusters that provide cost-effective access to highly specialized economic inputs;
- Increase the output of agro-based industries (food, textile and leather processing industries) by modernization and build support of the development of such industries;
- Identify the managerial and technical skills needed to expand specific industrial sub sectors.
- Formulate an environmental strategy that sets risk-based pollution-reduction targets and realistic time-frames for compliance;
- Build national capabilities for development of energy-management systems; promote renewable energy by introducing clean and new technologies;
- Develop human resources in the field of industrial energy efficiency;
- Develop and implement energy-saving, co-generation and recovery systems in selected industries and demonstration plants;

- Promote technologies for generation of “renewable” energy in order to reduce environmental pollution;
- Assist development of environmental regulations and transfer of advanced environmental practices for management of large cities;
- Assist development of environmental monitoring and pollution-control systems in the private sector.
- Advise industry on the best combination of pollution-prevention and abatement options that would mitigate environmental problems;
- Offer training programs that expand the availability of technical, managerial and entrepreneurial skills.
- Create a cadre of highly qualified professionals, so that they can perform functions related to technology-promotion;
- Encourage women entrepreneurs in industry, with a combination of training and consultancy services;
- Promote innovative and appropriate technologies for commercial applications in specific manufacturing branches.

STRATEGIC FOCUS OF RAPID INDUSTRIALIZATION AND ECONOMIC GROWTH SHOULD BE ON INDIGENIZATION IN THE ENGINEERING INDUSTRY

The meeting proposed change in the government policies towards industrialization, developing human resources, encouraging growth through market enhancement, developing industries with global perspective, rationalizing institutional and regulatory frameworks. The recommendations for these objectives are as follows:

- Government policies should be driven by national interest, supporting local industry without seriously infringing on WTO and other international commitments.
- Government should avoid fragmented decision-making and follow an integrated approach, with various policies complimenting and not contradicting each other.
- Allocation for higher education to be extended for Technical Manpower Training, through allocation of at least 1% of the total annual outlay to technical education and skill-development for the next five years.
- The whole Government machinery should support procurement of Engineering Products and award of contracts to local companies.
- Aggressive promotion should be made to attract relocation of industries from industrialized countries.
- Governments should take comprehensive initiatives to make themselves a member of the global supply-chain.
- Expedite enactment of effective repossession laws to further encourage leasing.
- Offer State-Credit for exports of capital goods.
- Rationalization of tax and tariff regimes carried should be continued, to provide protection and level playing-field, including withdrawal of exemptions detrimental to the local industry.

HITTING THE RIGHT BALANCE BETWEEN THE ENDEAVORS OF DONOR AGENCIES AND THE RECIPIENT COUNTRIES TO MOVE FORWARD TOWARDS SUSTAINABILITY

It was appreciated that despite enormous efforts, investment and contribution of developing agencies for the development of a country, the development does not take place as expected by the donor agencies and likewise the expectation of the recipient country remains unfulfilled. The recommendations received in this regard, called for the donor agencies to have a partnership approach for execution of development programs, the programs having multi-dimension support with duplication of efforts being avoided by joining forces with other development agencies. Also, the evaluation mechanism for monitoring the progress was recommended to be fine tuned. It was suggested that the donor/development agencies operating across the globe should undertake differentiated strategies to address the local needs.

For the recipient countries it was suggested that they should focus on building research capacity in the long run for self-sustenance, undertake the projects professionally through comprehensive planning and analysis to suit local needs. The process of identification of problems needs to be strengthened so that once the development agency undertakes the program it brings out the desired results. While receiving aid to eliminate problems, the recipient countries should make appropriate policies for a consistent application of the strategy-network they together come up with. Those firm policies and rules surely can provide a balance and organization of development-programs and would optimize the use of external help.

UTILIZING ADVANCED TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT

The meeting emphasized rapid industrialization, export enhancement, self-reliance and minimizing the imports for strengthening the economy. The recommendations given in this regard are given below:

- Enhancement of imports substitution and export of value added products in engineering sector.
- Immediate attention should be paid towards the new and emerging technologies in the fields of transport, automation, industrial production, communication, bio-medics, diagnostics of every kind, avionics and space travel etc.
- Up-gradation and improvement of technological set up.
- Improving technical skill and manpower.
- R&D input pertaining to material technology for the local production and development of advanced materials.

THE REQUISITES AND DYNAMICS OF PRESENT DAY R&D NEED TO BE REALIZED AND UNDERSTOOD

The meeting took stock of the changing dynamics and trend for research and development to be induced in the developmental process. It recommended the following initiatives for commercialization of research and development that is the need of the hour.

- A mechanism of implementation based on the so-called Third Generation R&D for extending a variety of technical services should be installed.
- Developing technology business incubators that are long-term, capital intensive, real-estate driven investments which take advantage of proximity to sources of intellectual capital and conducive infrastructure, to promote scientific research and its utilization.
- Governments should develop supportive policies and business-infrastructure, while private agencies provide the actual training, counseling, information, networking and related services in a business-like manner.

DEVELOP LOCAL CAPACITY IN THE AREA OF SCIENTIFIC RESEARCH

In a fast changing world, the South continues to face overwhelming challenges. This calls for concerted efforts to develop local capacity in the field of research and development, the foundation of science and technological advancement. The meeting proposed some solutions to achieve this target with specific reference to Uganda, which is the twentieth poorest nation in the world. These are given as follows:

- Instate active contribution of donor agencies, private sector and government bodies towards research and development through a formal mechanism.
- Allocation of adequate budget and personnel for Uganda National Council for Science & Technology (UNCST) to pursue research programs.
- Make use of and channelize the research output for mass usage, i.e., by providing sufficient funds for publications to be brought out, convening of exhibitions, seminars and workshops.
- Enhance and promote the incentive systems in the field of research and to improve the remuneration criteria.

ESTABLISHMENT OF S&T INSTITUTIONS FOR SUSTAINABLE DEVELOMENT

The meeting enlightened the people about effectiveness and relevance of scientific and technical system in the context of indigenous needs. Recommendations given in this regard are as follows:

- Establishment of regional sustainable development centers/networks in representative locations in poverty-stricken areas of the world.
- Broad availability of constructive leadership to the organization.

- Mobilization of expatriate third-world scientists, living and working in the North, to examine critical problems in developing countries.
- Achieving the critical mass in human resources complimented by adequate infrastructure, modern technology and independent research funding mechanisms.
- Research support services and ongoing training should be vital programs within the organization.
- Problem solving and decision-making are two mutually reinforcing processes that must function well at every level of an institute.
- Cultivating contacts with other institutions by building networks and centers of excellence.

COMPREHENDING THE ROLE OF UNIVERSITIES IN S&T CAPACITY BUILDING FOR SUSTAINABLE DEVELOPMENT

Education is critical for improving a country's capacity in Science and Technology and to address issues related to sustainable development. Following suggestions were given during this meeting:

- The universities should commit themselves to an on-going process of educating, training and mobilization of all the stakeholders of society linked to sustainable development.
- Strengthening of new and high-tech research for sustainable development by the universities.
- Encouragement of interdisciplinary and collaborative education and research activities.
- Revamping the present system by modifying the courses and programs providing initial education.

ENCOURAGING CAPACITY BUILDING IN BIO-MEDICAL RESEARCH IN PAKISTAN

The recent developments in biomedical technologies have the potential to change the face of the control and management of diseases. The role of our basic scientists and clinicians thus becomes paramount for evolving a health care and management plan. In this regard light was shed on the following areas:

- Basic scientists in the fields of Biology, Biochemistry, Biotechnology, Biophysics and Bio informatics need to join their forces with clinicians to carry out research for the betterment of human health.
- Orientation of the public and policy makers in the right direction for resolving our indigenous as well as global health problems.
- Setting up a decent Health Research and Delivery System should be given priority.
- Research in genomics for better diagnosis and development of new vacancies and drugs.
- Setting up an infrastructure for genomic research supported by a well-established bio-informatic laboratory.
- Strengthening the existing or establishing new institutes engaged in genomic research for achieving self-sufficiency in biomedical sciences.
- Training scientists/researchers so that they can acquire the necessary expertise in various aspects of biomedical research.

RECONSIDERING PAKISTAN'S ENERGY OPTIONS VIZ AVAILABLE GEOLOGICAL RESOURCES

The meeting recommended re-establishing the vital correlation between sustainable development; energy demand & supply; and optimal use of the geological resources. Emphases were laid to strategize the guiding principles for determining energy mix considering Pakistan's geological richness. The suggestions for policy makers are:

- Concerted efforts should be made to develop a national pool of truly competent professionals to oversee and undertake all aspects of exploration and development of energy resources.
- While R&D efforts may continue and be further accelerated on renewable energy resources, particularly solar, wind and tidal, the main thrust and focus of attention for the immediate future should continue to be on oil, gas and coal. In this connection, the Indus off-shore region in Sindh and the sedimentary troughs between Ras Koh and the Makran hills; and in Kakar-Khorasan area in Balochistan should be given high priority for exploration.
- The use of CNG should be further encouraged and at least 50 percent of the road transport be switched on to CNG by 2007.
- A re-assessment of hydel exploitation-potential should be made on proper scientific lines,

particularly in view of the phenomena of global warming and the consequent shrinking of glaciers in the Himalaya-Karakoram region, which according to some computer modeling and climatological predictions are likely to melt in the next 40 to 50 years. The Indus river system depends heavily on glacial melt for its water flows. All this needs to be urgently and very carefully researched.

- In view of the huge coal exploitation-potential established at Thar in Sindh, and additional resources of coal identified elsewhere in the country, a comprehensive National Energy Policy should be formulated, in which coal should occupy a pivotal position for power generation as well as for in-situ gasification (UCG: underground coal gasification), briquetting and washing. All the production-plants of cement & sugar and other small to medium industries should be made coal-based, instead of using imported fuel.
- The setting up of small coal-based power-plants (5 to 25MW) in the country should be encouraged to provide locally available job-opportunities and a dependable source of power. This will also help strengthen the engineering industry in the country.
- Use of LPG and coal-briquettes should be introduced / encouraged in the mountainous regions of the country, with a view to save the precious wealth of forests.

EXPLOITATION OF BIOGAS TECHNOLOGY AS THE MOST VIABLE ENERGY SOURCE FOR PAKISTAN

- Establish Biogas Research Center for research, development & diffusion of Biogas Technology in Pakistan.
- Design new plant models that are low cost.
- Study anaerobic photosynthetic technology, efficient microbes (E.M) technology & its application for enhancing the efficiency of biogas plants.
- Design and develop commercial / industrial biogas plants based on sanitary waste water, distillery waste, sugar industrial wastes & other agro-industrial wastes; and optimize operating conditions on laboratory/ pilot scale for developing design criteria for a full scale commercial plant.
- Develop methodology for pre-casting the digester and dome structure of biogas plants to enhance speed of construction & ensure gas leak proofing
- Fabricate biogas digester by cast-in-situ method
- Manufacture Ferro cement gasholder to replace metallic (M.S) gasholder, which is corroded, particularly in the coastal & saline areas.
- Accelerate gas production rate, through studies on the methanogenic bacteria, their isolation, cultivation, physiology, biochemistry, ecology etc., additive selection, digester types and fermentation technology implementation.
- Systematic training of professional masons, extension managers & technicians
- Capacity building to enhance capability at grass root level for propagating B.T on mass scale
- Develop technical, educational and promotional materials for construction and post-installation, operation, maintenance and troubleshooting of biogas plants

ACCENTUATE IMPORT SUBSTITUTION OF VITAL MINERALS AND DEVELOPMENT OF MINERAL RESOURCES

Import substitution of minerals and chemicals of vital importance to industrial development through strategic planning and development of minerals to cut down negative impact on the national exchequer of Pakistan. The priority areas highlighted for mineral development and import substitution are:

- Establishment of model mine concept, regarding coal washry, coal beneficiation, and coal banks in each province
- Utilization of mine wastes, e.g. shale, marble chromites, coal
- Acquisition of technology for value addition and R&D work on Building stones for local demand and export
- Development of indigenous technology for utilization of iron ores
- Establishment of Geo-data centers. Geochemical studies for mineral Identification, resource and geological evaluation of base metals
- Up gradation / Strengthening of existing laboratories and human resource development in the mineral sector
- Establishment of Gemstone training institutes

The meeting on 'S&T Capacity Building for Sustainable Development' presented the following practical suggestions for leveraging the powers of information technology for development and alleviating poverty in Pakistan.

NEED TO PACE UP FOR TRANSITION TOWARDS INFORMATION-SOCIETY, AND TO MAKE BEST USE OF ICTs FOR DEVELOPMENT

Pakistan has the most extensive coverage of Internet in South Asia, but has failed to initiate an effective process which could make significant impacts on the lives of the majority of citizens especially in rural areas. Pakistan in terms of grass-root level projects of ICTs has yet to present a good example. The suggestions to improve this state of affairs are:

- Develop a holistic approach that entails looking at the larger picture with deeper understanding of the use of ICTs by different sections of the society. Taking into account socio-cultural factors, like literacy and gender to encourage inclusive and partnership oriented initiatives.
- Exploration of the barriers hindering the best of ICTs for development which include: poor literacy rate, poverty, low tele-density, and unreliable electric supply as main factors.
- Moving out of this ICT paradox in Pakistan, it requires creating mass awareness of the thrust these information communication technologies have.
- Overcoming the language and cultural barriers, to make ICTs of any use to the largely illiterate population.
- Government, civil society – especially in the form of social entrepreneurship – along with business and local philanthropy should come together to form partnerships, to explore ICT4D (ICTs for development) initiatives that could be appropriately scaled up.
- Basic Urdu software tools need to be developed in the public domain. This would involve a great deal of coordination and communication, to reach all potential users of Urdu-software. So that it would be conducive to use on a mass scale.
- ICTs for Development 'Academy' should be established to help in bringing together development practitioners and ICT experts and to make need based innovative applications of the technologies for common man.
- There is a dire need to implant a mechanism for correlating and for developing long term ties among the domestic software companies and business sector. Strong cohesion among the business and IT industry members, and synergies will enable development of tailor made solutions as per local need and subsequently it will lead the local IT industry to become world class.

OVERCOMING THE CONSTRAINTS TO INSTATING E-COMMERCE IN PAKISTAN

E-readiness of Pakistan is reasonable in terms of infra-structure, promising in terms of e-payment infrastructure and regulatory environment but very weak in terms of e-commerce applications and general user demands. These can be overcome through:

- Creation of intellectual capacity within Pakistan to mobilize the e-commerce derive, It specialists and key government & business people have already invested a lot efforts in this area, these people need to be included in the initiatives proposed by UNCTAD.
- Identify how e-commerce can make difference in the lives of the people, especially poor and empower the rural women.
- On Demand side of the e-commerce applications needs to be carefully annualized in the local business culture
- Capacity constraints on e-commerce development require a thorough e-commerce strategy and policy.

CAPACITY BUILDING IN THE FIELD OF AGRICULTURE FOR SUSTAINABLE DEVELOPMENT

Agriculture continues to be the mainstay of the economies of the developing countries. It is vital to meet the challenges of sustainable development by building capacity in this field. The strategy for capacity-building in agricultural sciences should at least consist of the following

- Strengthening infrastructure, faculty and operational funding in universities imparting education in agriculture and animal sciences.
- Changing the governmental procedures of sending scientists on training (devolving the authority to institutional heads) and, in fact, encourage young scientists to hunt for training opportunities.
- Instituting a system of sabbatical in all research and development institutions.
- All development projects may be bound to have at least 25 per cent of funds allocated for capacity-building.
- Developing a mega-project for strengthening of research and development in agriculture, with a major component of capacity-building.

RATIONALIZATION OF NATIONAL AGRICULTURAL RESEARCH SYSTEMS (NARS) TO BE INSTATED FOR SUSTAINABLE DEVELOPMENT

The meeting appreciated the role of NARS. To grow and maintain national economic strength and international competitiveness, one has to transform NARS into a knowledge-based enterprise. The R & D organizations and agencies involved in Agricultural Research should tightly focus on essential programs. Every department should have a clearly defined mission, considering national priorities .It is also proposed that "Compendiums of S & T Management Practices" must be prepared for each R & D organization, in order to restructure, revamp and reform the NARS.

The recommendations for improving NARS in Pakistan with the lead role of Pakistan Agriculture Research Council are highlighted as follows:

- Introduction of knowledge-based Agricultural Research System. Therefore the development of human resource should be given first priority. Hundred percent increase in PhD scientists, provision of career-growth opportunities and creation of elite force of strong research managers is needed.
- Role of PARC as an apex body should be clearly defined and strengthened.
- FAO Office at Islamabad, on the request of Government of Pakistan, prepared a report, which propose an "Agenda for Action" for senior Federal and Provincial policy-makers and research mangers that must be addressed if Pakistan is to rebuild its agricultural technology-generation system, and be competitive in WTO regime

NEED FOR CAPACITY-BUILDING ON HEALTH AND SAFETY PARAMETERS OF GM FOODS FOR PAKISTAN

- Food scientists and technologists should ensure the responsible introduction of GM techniques, provided that issues of product-safety, environmental, social concerns, information and ethics are satisfactorily & adequately addressed.
- There is an intensive need to concentrate on the capacity-building in the field of Genetically Modified Foods, at national level, on the part of the government.
- Provision and trade of safe and healthy food is a provincial subject, under the Pakistan constitution, but the matter of G M Foods is a new high-tech field, requiring substantial investment, so it would need to be dealt at federal level for the establishment of uniform policy and practice, with large monetary inputs.
- As far as Pakistan is concerned, there is strong & urgent need for the building of capacity in S & T infrastructures, specifically related to the Genetically Modified Foods and crops.
- Urgent political and technical attention needs to be given to fill the existing gaps in the adoption and implementation of the National Biotechnology Policy. The issue of GM Foods should be adequately included and addressed in the overall policy-framework of the Biosafety Guidelines.
- Institutions involved in the education of biotechnology should add a course on Agriculture Biotechnology, which includes description and implications of GM Foods.
- Last but not the least, the process of making standards, rules and regulations for the import and trading of GM Foods/products, ingredients, and seeds must be initiated at the earliest.

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