Road to Sustainable Development

Edited by

Dr. Hameed Ahmed Khan

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Commission on Science and Technology for Sustainable Development in the South

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FOREWORD

Countries have always been involved in fierce economic competition, more so even than in war, though often including it! In the modern world this can be seen as having started with the first industrial revolution, and the accompanying amoral colonial conquests which gave old and well established countries access to riches all kinds belonging to others in less developed and/or newly discovered countries. Exploitation by any definition by countries of the generic North, of countries of the generic South! The recent and current industrial revolution, based not on coal or the steam engine, but on high technological advances centered on new electronic devices and computers have amplified the growth of life qualities in the North, generally by the formation of country cartels – the Economic European Community being a good example. The success of well-developed countries is largely to be attributed to the progress made towards sustainable development and management of society, economy and the environment. For countries of the South, massive poverty, inadequate education, healthcare facilities and low standards of living remain as the major stumbling blocks on the paths towards any real indigenous development. While the North mostly made full use of Science and Technology for its own development, the South lagged still further behind and now urgently needs to come up with vigorous scientific and technological programs of its own. No amount of external general 'aid' – with all its qualifications and special provisions – can possibly hide the need for integrated and systematic efforts to be made from within the South itself. My own opinion is that it is a moral duty on the North, however, directly to assist the South, without attached political strings, to fill the huge scientific divide separating the developing countries from the developed. In doing so the dignified deployment of extremely fine technological and scientific minds from the South itself must be a key element.

In this book Dr. Hameed Ahmed Khan and his colleagues specifically address the question of how the road to sustained development should be embarked upon, implemented and maintained. The key element of thought and practice is that whilst assistance and advice is critical, the motive force and effort must come from within. The reader will find that a striking match of scientific expertise with strategic administrative planning is vital to the cause, and this is a continuing underlying theme. Beginning from progress in the past the book comprehensively discusses current scenarios and points clearly to distinct sectors of science and technology from which sustainable development in the South will inevitably come. How the latest developments in various scientific and technological advances will be utilized is clearly set out, with corresponding concrete recommendations. In my opinion the book presents modern concerns that relate primarily to the issues of the South. Latest advancements made in various S&T fields are incorporated with tact and practicality, followed by concrete recommendations. It is my own opinion that when the reader views these recommendations with objectivity, it will be clearly seen that there is a definite plan outlined for proper effective realization of a sensible and practicable path

to real sustainable development. This is something which has long been sorely needed. Now it is necessary for the North, and time for the North, to join in as honest practicing partner, and to share as much of what has been learned as is sensibly possible and practical. It shouldn't be, but apparently is necessary to add that all of this must be carried out in a millieu in which all participants are equal humans in every possible sense.

The holistic view of the many and varied aspects of sustainable development which is a basic element of this book is extremely welcome. Triggering discussion from the commitments made at Rio Earth Conference (1992) and the follow-up actions until the Johannesburg World Summit (2002) the book presents an optimistic point of view in meeting the global challenges successfully. Here it is relevant to quote from the book directly. Thus, "the world surely can undo the failures that the decade after the Rio Summit witnessed by translating their words into action and by making good on their commitments. Doubtless, the path of global negotiations to world-wide problems is indeed a difficult one and there are no early successes. In fact, coming to a national resolve and undertaking national action is a primer to the success of international treaties. This has shifted the onus for action for most of the problems from the supra-natural to the national and even to the local level".

The specific details of various technologies which present the power to transform the way we live today, and the way they can positively affect a proper growth pattern, are clearly outlined. The book advocates an aggressive approach in building capacities in such technologies and their application for developmental purposes. Included are clean air technologies, energy technologies, biotechnology and information-communication technology. It requires both courage and a strong considered commitment to speak in favor of fostering the use of nuclear energy today, especially in the wake of growing concerns of its misuse. Nevertheless I am myself in total sympathy and empathy with the case presented for making use of nuclear energy for developmental purposes, whilst being glad for the inclusion of a discussion of concepts both in favour and against it The author writes "Success of the MDG's (Millennium Development Goals) and WSSD (World Summit on Sustainable Development) plan of action largely depends upon abundant clean energy availability. As hydro and renewables have been proved to have limited potential in the near future, the only alternative left for filling the clean energy supply-demand gap will be the nuclear energy which is a proven and reliable source of clean energy".

One of the most important aspects needing full attention at institutional and governmental levels is the creation of an enabling environment for regional cooperation science and technology. For this reason the last section of the book lays out guidelines for harnessing cooperation amongst all the stakeholders - especially between the countries of the South. Regional cooperation in science and technology should not be considered as either a free liberty or an exception. The fact remains, however, that by a process of quite natural evolution they have become imperative in the wake of global challenges set out by the World Trade Organization (WTO) and the

corresponding emerging so-called New World Order.

For concerned unblinkered scientists, for technologists, for students, and for members of the general public, and last but not the least for national politicians and diplomats everywhere – North and South – this book is the most up to date and conscientious presentation available. The message is clear. Countries of the South want and deserve, as a natural concomitant to independence, the kind of world environment which recognizes their community energy and vitality, their independence, and their wish fully to partake in the necessary establishment over time of a more comprehensive and understanding worldwide mankind. This is not a lofty ideal. It is perfectly achievable. What is required is widespread personal commitment and personal action!

Dr. Hameed Ahmed Khan is a distinguished leader and an adroit exponent of new ways. He has served both Pakistan and the world, first as an authoritative fundamental scientist, and then as an applied technologist, and as a distinguished leader of many national and international bodies. His professional and personal life is one of devotion to those less fortunate. As an individual scientist and citizen of Pakistan he is in the central genre described by that Pakistani Nobel Laureate Abdus Salam, who in Trieste coined the generic words North and South in order collectively to describe the developed and less developed countries, respectively. In a sense Hameed Khan is an Abdus Salam reincarnated for the present and a true disciple. From the word disciple comes the word 'discipline'. Hameed Khan has brought that human and discipline understanding to the Third World, which he thereby distinguishes, and to the position of Chief Executive Officer of COMSATS – Commission on Science and Technology for Sustainable Development in the South – and he has brought it to this book! It is a book one should read, think about, and act upon!

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PREFACE

'Sustainable Development' is described as development in which total "welfare" is not decreasing over time. Just as economic development is sustainable, provided economic (or man-made) capital is non-decreasing, similarly sustainable development requires total capital -- that is, economic capital, human and social capital and environmental capital -- to be non-decreasing. "Capital" in this context refers both to the stock and to the quality of the resources -- for example, the skills, health and knowledge of the population, and the quality of environment and other natural resources.

A factor that is of utmost importance and must be realized is that, for assured smooth sailing in the direction of sustainable development, the human capital has to be equipped with modern science and latest technologies in order to cope with the challenges that are multifaceted and global in nature. Science and technology provides the developing countries with the much-needed vehicle to speed up their growth and development, and also to sustain the same pattern. Countries like China, Malaysia and South Korea, which had taken concrete steps to incorporate science and technology in their developmental processes and agenda, are now economically better off within a short span of half a century. It is in this perspective that the developing countries can make apt use of the frontier sciences and technologies for continuous growth and development and can avoid compromise on any of other capital.

COMSATS - the Commission on Science and Technology for Sustainable Development in the South—which was established to serve the developing countries of the South with S&T-led initiatives, has been making humble efforts for the last ten years in promoting the cause of sustainable development. This manuscript titled 'The Road to Sustainable Development' is an effort in the same direction. The book comprehensively takes stock of the role that science and technology has to play for achieving the goals of sustainable development. Though the road to sustainable development is intricate and requires focus and concerted effort to cover safe distances, the book shows the way by highlighting the role of some important frontier science and technologies.

Leading the discussion from the Resolutions of the Earth-Summit in Rio in 1991, and making an appraisal of what had been achieved till the follow-up meeting in Johannesburg in 2002, the book uncovers myths and realities about sustainable development and discusses various aspects of development. In the later sections, the book provides insight into various frontier sciences and technologies that posses revolutionary powers and can lead the way towards sustainable development. These include renewable and nuclear energy technologies, biotechnology and biodiversity in the field of bio-sciences, and information communication technologies. In the concluding sections, a range of global developmental tools in the form of regional

cooperation are discussed and a suggestive roadmap, especially for the developing countries is provided in order to ensure involvement of all the stakeholders. I am very grateful to the team of authors that contributed chapters to this book, and took pain and time out in making the book a worthwhile resource on sustainable development. Most of the authors, besides me, belong to COMSATS headquarters, who have ample experience with COMSATS in working in its various thrust areas. I am also grateful to the team of COMSATS who made possible the publication of this very useful book and would like to make particular mention of Dr. M. M. Qurashi, Mr. Irfan Hayee, Mr. Imran Chaudhry and Ms. Nageena Safdar for this.

I conclude with the hope that the readers of this book will have an enlightening experience, after going through various chapters and I would welcome any suggestions and comments which shall help us bring an even better publication next time.

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Executive Director

FROM RIO TO JOHANNESBURG: ACHIEVEMENTS AND FAILURES IN SUSTAINABLE DEVELOPMENT

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Although not a new concept, 'sustainable development' nevertheless has assumed enormous importance at almost all levels: local, national, and international. The concept is slowly but surely becoming an integral part of all developmental debates, economic plans and research activities all over the world, given the increasing incongruity between humanity's development and the ecological limits. There have been various milestones, over the past few decades, on the path from 'development' to 'sustainable development' that finally led the world to realize that the time had come to do some serious business lest we permanently damage the capacity of our eco-system to replenish the fast-depleting natural resources. The United Nations Conference on Human Development (1972), The Brundtland Report (1987), the Rio Summit (1992) are but a few of the important landmarks before the Johannesburg Summit of 2002.

This piece begins with a brief description of the background to sustainable development, and certain landmark events, particularly the Rio Summit, which happened all along the way, till the Johannesburg summit. The primary focus shall, however, remain on how successful or unsuccessful we have remained since Rio until the Johannesburg Summit. This paper shall not deal with post-Johannesburg developments, since it is too early to measure the outcomes of the summit meeting at this point in time.

Moving From Development to Sustainable Development

It was the time of solid economic prosperity for the United States of America when it emerged successful after the end of World War-II. The per-capita income of the USA touched a whopping $1400 per year and its people were enjoying the status of a 'better society', as compared to most other countries of the world. It was the time of President Truman whose development paradigm was gaining ever-increasing popularity. The underlying theme of the his political model was that high per-capita income equals good while low per-capita income equals bad, in terms of development. The model considered low per-capita income as a deficiency which had to be replaced by affluence. The US moved with confidence on this plan, since it could boast of the success of the 'The New Deal' and 'The Marshall Plan' for the post-war recovery of Europe. The Truman Development Paradigm also had a vision of bringing about peace in the world by raising standards of all its populations to a level where traditional

means of conflict-management, like wars and aggression, would simply cease to be a viable alternative. Though the Truman development idea was impressive, it had one serious drawback: it explained social conditions in economic terms only and saw all development problems from the point of view of American ethics and Adam Smith's 'invisible hand of the free market'. But this was soon to have serious implications for the world's cultural diversity, particularly from the perspectives of the developing countries.

The idea of abolishing poverty through intensive economic activities caught on in Europe as well, and the Organization for Economic Cooperation and Development (OECD) had its major focus on poverty-alleviation by economic means. But this focus did not stay long as, with reduction in poverty in the 1950s, the paradigm shifted from 'development to fight poverty to ensure peace' towards 'economic development to further increase affluence through more production'. The point that was missed by supporters of the paradigm who believed the same model could be used to eradicate poverty in the developing countries was that social and ethical traditions of the developing countries were far different from those of Europe.

The West European countries enjoyed ever-increasing prosperity in the wake of their developmental approach based on 'Social Market Economy". The approach laid stress upon having political instruments for interference with and guidance of the market economy. But the idea of development through growth remained intact. The focus was on fairer distribution of development-benefits through all levels of society. Political and administrative decentralization structures were founded and the participation of people at national and local levels was ensured. Industrialization was at its peak.

The third-world was at a different stage of development and was not in a position, structurally, to implement economic-centered development. Nehru in 1949 very aptly had vented the thinking of the Third World when he said "It is not a question of theory; be it communism, socialism or capitalism, whatever method is more successful, brings the necessary changes and gives satisfaction to the masses, will establish itself on its own … Our problem today is to raise the standard of the masses..." (Sachs 1999: 5 as quoted in Segschneider, H, K.2001. 10 Years After Rio: Debating Development Perspectives)

The Downside

It all began with the phenomenon termed 'the London Smog'. The industrialization was starting to take its toll on the lives of the citizens. The air had become polluted and poisonous and more people were dying of heart attacks and respiratory diseases. The problem was attributed to rapid industrialization and wrong fuel (particularly low-grade coal) consumption by the private sector and electricity plants. This was the first blow to the well-entrenched development-paradigm and people had now begun to be concerned about the havoc that pollution was wreaking on the environment and on their health. The situation was not peculiar to London, but was becoming common in

Western Europe. For the first time, we saw various environment-friendly policies, such as 'Polluter Pays Principle', come to the surface.

It was altogether a different story from the point of view of the Third World. The development paradigm was simply not working. Poverty was on the rise, industrialization was no solution to food-insecurity for the burgeoning populations, and unemployment had spiralled upwards. The gap between the North and South had widened phenomenally. Not only that, the development model created a "North within South", as an elite class emerged out of the system and further marginalized the poorer segments of society. The later years of the 1960s saw the death of the development paradigm that had generated so much affluence for the US and Western Europe, but hardly anything for the developing world. The failure proved the assertion made by Garreth Hardin that the development paradigm was not based on a self-regulating mechanism. He drew the conclusion that "the approaching crisis had no technical solution, but required a fundamental extension in political morality". [The Tragedy of Commons, Science Volume 162, 1962: 1243-48 as mentioned in Segschneider, H, K.2001. 10 Years after Rio: Debating Development Perspectives].

The United Nations Conference on the Human Environment (Sweden 1972)

Realizing the gravity of the situation, the Swedish government took the initiative and was able to gather governments on a common platform. Thus we saw The United Nations Conference on the Human Environment take place at Stockholm in Sweden in 1972, which introduced the element of environment into the current developmental thinking. The world felt the concern of the scientific evidence for environmental destruction. It was realized that environmental protection and management of natural resources must be integrated with socio-economic issues.

The conference, in which 113 nations participated declared "'…the protection and improvement of the human environment is a major issue, which affects the well-being of peoples and economic development throughout the world; …in the developing countries most of the environmental problems are caused by underdevelopment;…along with social progress and the advance of production, science and technology, the capability of man to improve the environment increases with each day; … to defend and improve the human environment…[is]…a goal to be pursued together with, and in harmony with, the established and fundamental goals of peace and of worldwide economic and social development (Stockholm Declaration 1972:Introduction, as quoted in Segschneider, H, K.2001. 10 Years After Rio: Debating Development Perspectives)

The Conference saw the issue of environmental destruction as " conditions of under-development…that can be best remedied by accelerated development through the transfer of substantial quantities of financial and technical assistance…(principle 9), and environmental quality should be achieved by'… appropriate national institutions [to be] entrusted with the task of planning, managing or controlling the environmental

resources…(Principle 17)". The conference basically termed the environmental issues as those of management. One of the important outcomes of the Sweden Conference remained enhanced allocation of financial resources to address the issues of environment. This later helped generate the much-needed knowledge to establish local environmental events as a global phenomenon that was not part of development but a direct result of it.

The Brandt- Report [1980]

The control mechanism (Polluter Pays Principle, for instance) introduced by the North did succeed in bringing down the levels of pollution in their cities but, on the other hand, it shifted the polluting industries to the developing world. The developing countries, already lagging far behind in terms of technology and resources, increasingly found it hard to do anything significant to conserve their environments. It was then realized in the North that they needed some other solution to tackle the problem. Not only did the situation become worse from the environmental perspective, but also there were upward trends in poverty in the developing countries. The 1970s saw high unemployment rates in the developing world, whereas there were fears that oil-embargo by the oil-producing countries could re-introduce poverty in the North to some extent. A commission called ' The Independent Commission on International Development Issues', under the chairmanship of a former German Chancellor, Willy Brandt, brought out a report ' North-South: Program for Survival' in 1980 that focused on the ongoing development initiative and debates. The Brandt Report, as it was commonly known, found faults with the economic structure of the time and emphasized that it was responsible for the deficiencies in social human development. It called for basic reforms regarding trade, industrial investment, energy consumption, technology transfer and development financing. The report also called on the world-leaders to have a summit meeting on these pressing issues and initiate a North-South dialogue.

The Brandt Report established the direct relationship between economic structure and social development and made it a primary focus of policy planning and implementation. It, however, was not a big success in making nations see environmental issues in ecological and global contexts.

The Brundtland Report [1987]

The pace with which the world was addressing the environmental issues considerably improved when the world came face to face with problems, such as global warming, desertification, Ocean depletion, and ozone hole. The United Nations General Assembly established a commission (World Commission on Environment and Development, under Ms Gro Harlem Brundtland) in 1987 that issued a report 'Our Common Future' or more famously 'the Brundtland Commission Report', that addressed the widespread concerns of environment and development. It pointed out that economic development cannot stop, but it must be so shaped that it fits into

Sustainable Development Defined

The term sustainable development has been defined by different people in different ways. Some of these definitions are reproduced as under:

1. Development that meets present needs, without compromising the ability of future generations to meet their own needs [Brundtland Commission 1987]

2. Growth in harmony with our environment, preserving our resource-base for our economic well-being, and planning for our children's future.
[Gary Filmon, former Premier of Manitoba]

3. Development without Destruction [Maurice Strong, Secretary-General of the 1992 Rio Earth Summit]

4. Sustainable development involves the simultaneous pursuit of economic prosperity, environmental quality and social equity. Companies aiming for sustainability need to perform not against a single, financial bottom-line, but against this triple bottom-line.
[The World Business Council for Sustainable Development]

5. Development which ensures that the utilization of resources and the environment today does not damage prospects for their use by future generations. [Canada's National Task- Force on Environment and Economy]

6. Living on the earth's income, rather than eroding its capital [The United Kingdom's Sustainable Development Strategy]

Source: The Sustainability Report
http://www.sustreport.org/background/definitions.htm(accessed on May 28, 2005)

ecological limits.

The report unified the development paradigm with concepts of ecology and, hence, a triad of economy, human society and ecology emerged. The triad was described under the now term 'Sustainable Development'.

It is quite pertinent to quote Brundtlant here on environment and development. He argued:

> *"The environment does not exist as a sphere separate from human actions, ambitions, and needs, and attempts to defend it in isolation from human concerns have given the very word 'environment' a connotation of naivety in some political circles. The word ' development' has also been narrowed down into a very limited focus, along the lines of 'what poor nations should do to become richer', and thus again is automatically dismissed by many in the international arena as being a concern of specialists, of those involved in*

> *questions of 'development assistance'. But the 'environment' is where we live; and 'development' is what we all do, to improve our lot within that abode. The two are inseparable"*. (Kates, R., Parris, M., et al 2005. What is Sustainable Development? in Environment: Science and Policy for Sustainable Development Volume 47, Number 3, Pp: 10)

Sustainable development, in the Brundtland Report, laid stress on seven agendas, which were regarded as basic components of the challenge for humanity: Pollution control, human resource development, food production, bio-diversity, energy, industry and urbanization. These agendas were circumscribed on a national level by assessing the different stages and needs of nations, in accordance with their level of economic development. By linking them through 'the Commons and its management', the report tried to unify the needs of humanity with the needed action to sustain the ecology. Education, empowerment, knowledge transfer, financial aid, administrative adaptations, equity and others were identified as local development agendas. The need for an international legal framework of implementation-principles was seen as a "must" for an international cooperation that aimed at an increased efficiency and thus an increased effectiveness of programs to solve the identified problems.

The report also called for a developmental policy that would take no more potentially renewable resources from the natural world than could be replenished naturally, while not overloading the capacity of the environment to cleanse and renew itself by natural process. The report also laid stress on more efficient management of environment, by taking it on an increasing scale and all major organizations, like the World Development Bank (WDB), the General Agreements on Tariffs and Trades/World Trade Organization (GATT/WTO), United Nations (UN), as well as smaller, but nonetheless influential institutions, like for example the Business Council on Sustainable Development (BCSD), instigated ever-new programs and concepts. Their united efforts firmly embedded ecology as a new field of investment in economic thinking, but failed to establish ecological thinking into economic paradigms. 'Green' became a popular label for selling products, but production itself was in most cases not ecologically conforming! Brundtland believed it was important to recognize that sustainable development implied some limits.

"The concept of sustainable development does imply limits—not absolute limits, but limitations imposed by the present state of technology and social organization on environmental resources and by the ability of the bio-sphere to absorb the effects of human activities". (Kates, R., Parris, M., et al 2005. What is Sustainable Development? in Environment: Science and Policy for Sustainable Development Volume 47, Number 3, Pp: 11)

The following gives a rough summary of only some central events in sustainable development:

Central Events in Sustainable Development Over the Years

18th and 19th centuries

- 1776 'The Wealth of Nations', by Adam Smith
- Industrialized production replaces manufacturing

20th century (first half)

- 1928 'Black Friday', Wall Street stock-market crash that triggers the first worldwide economic crisis for industrialized countries
- 1932 Pigou introduces his 'Internalized Market' economic theory in his publication 'The Economics of Welfare'
- 1930s 'The New Deal' program of US president Roosevelt makes the standard of living of the nation's poor and unemployed a policy focus
- 1946 General Agreement on Tariffs and Trade (GATT) established, on a provisional basis, to promote trade liberalization
- 1949 Harry S. Truman coins the term 'under-developed' for poor countries, as opposed to 'developed' for affluent countries

20th century (second half)

Throughout the 1950s: First signs of environmental stress in London, Los Angeles and other population centers in industrialized countries

- 1959 United Nations Development Program evolved to maturity
- Through-out the 1960s: Increased concern among scientists and the general population in developed countries about the environment
- 1964 UNCTAD United Nations Conference on Trade and Development established
- 1968 Increase in worldwide human populations clearly perceived as a threat to humanity's future (Ehrlich publishes his book 'The Population Bomb')
- Garret Hardin publishes his article 'The Tragedy of the Commons' and introduces the concept of human environmental perception and planning
- 1972 Earth Summit I, First U.N. Conference on Environment (Stockholm)
- Limits to Growth published by the Club of Rome
- 1973 The World Bank concedes the failure of the development paradigm in alleviating growth
- U.N. Environment Program launched
- 1979 First World Climate Conference, Geneva, concludes that CO_2 emissions could have long-term impact on climate
- 1980 Brandt Commission (Independent Commission on International Development) chaired by Willy Brandt. Report North-South: A program for Survival
- 1983 UNGAS establishes the 'World Commission on Environment and Development
- 1984 Industrial accident kills thousands of people in India

- 1986 Melt-down of the atomic reactor in Chernobyl
- 1987 Brundtland Commission (World Commission on Environment and Development). Report: Our Common Future

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- 1991 Group of 77 meet in Beijing and demand 'the right to development'
- 1992 Earth Summit in Rio de Janeiro and resolution on AGENDA 21
- Parallel Conferences publish 'Alternative Treaties'
- U.N. Commission on Sustainable Development created to advance Agenda 21
- Pronk-Iglesias Report on proposed CSD role and structure ignored
- Framework Convention on Climate Change (FCCC) signed at the UN Conference on Environment and Development, Rio de Janeiro 1994
- World Trade Organization formed at the Uruguay round of GATT negotiations as an international legal institution to administer the global framework of trade rules and Agreements 1995
- World Summit for Social Development 1997
- An international process is initiated (Group 77, USA, EU) for a conference on financing for
- Development 1998
- U.N. Climate Change Conference in Buenos Aires
- Massive worldwide protests stop the Multilateral Agreement on Investment negotiations (MAI) of developed countries 1999
- The 54th session of UNGAS calls for a high-level, intra-governmental 'event' on financing for development to be held in 2001
- WTO ministers meet in Seattle
- World NGO conference

21st century

2000

- First organizational meeting to prepare the 'event' on the financing for development
- Earth Charter
- NGO Millennium Forum New York, precursor to the "The People's Assembly"
- The Hague Conference on Climate, negotiations break down
- UNGAS decides to call for the next Earth Summit in Johannesburg in 2002 under the title:
- 'The world Summit on Sustainable Development

2002

- The World Summit on Sustainable Development in Johannesburg

Source: Extracted from Segschneider, H, K.2001. 10 Years after Rio: Debating Development Perspectives. Heinrich Boll Foundation: Chiang Mai (Thailand)

The UN Conference on Environment and Development [Rio de Janeiro 1992]

"Humanity stands at a defining moment in history. We are confronted with a perpetuation of disparities between and within nations, a worsening of poverty, hunger, ill-health and illiteracy, and the continuing deterioration of the eco-systems on which we depend for our well-being" (Earth Summit- Rio http://www.earthaction.org/en/archive/97-05-envinst/bground.html accessed 30 May 2005)

The UN Conference on Human Development (1972), the Brandt Report (1980), and the Brundtland Report (1987) all culminated in the UN Conference on Environment and Development—the Rio Summit--- at Rio de Janeiro in 1992. It was a milestone event that saw the participation of more than a hundred heads of state, international agencies and non-governmental organizations. The international community pledged to secure economic well-being, social development and environmental stability—the three pillars that needed to be simultaneously addressed if sustainable development was to be achieved.

The major outcomes of the Summit were the Framework Convention on Climate Change (FCCC) and the Convention on Biological Diversity (CBD), the Rio Declaration on Environment and Development and the Forest Principles. But most important was a 300-page document called Agenda-21, which became the centerpiece of the summit. [Ibid]. The Agenda-21 gave "a comprehensive plan of action to be undertaken globally, nationally and locally by organizations of the United Nations System, Governments and Major Groups in every area in which human impacts on the environment". [http://www.un.org/esa/sustdev/documents/agenda21/index.htm accessed June 3, 2005]

Agenda 21 encompassed social, economic and environmental issues. It comprised detailed proposals on such topics as: combating poverty, changing patterns of production and consumption, human health, human habitats, population, protecting the atmosphere, oceans, biodiversity, forests, promoting sustainable agriculture, freshwater resources, waste and more [http://www.unlimited-power.co.uk/Agenda_21.html accessed June 3, 2005]. Agenda 21 encouraged people, governments and nations to work together towards a global partnership for achieving sustainability. The interconnectedness between countries, and the effect one country's activities may have on another, were recognized -- encouraging an atmosphere of mutual respect. Every individual and all individuals of the world were made responsible for sustainable development in the world. The Agenda 21 document has 40 chapters, divided into 4 categories: Social and Economic Dimensions; Conservation and Management of Resources; Strengthening the Role of Major Groups; Means of Implementation. The following reproduces some of the salient features of Agenda 21:

Summary of Agenda 21

The United Nations Conference on Environment and Development, Having met at Rio de Janeiro from 3 to 14 June 1992, Reaffirming the Declaration of the United Nations Conference on the Human Environment, adopted at Stockholm on 16 June 1972, and seeking to build upon it, With the goal of establishing a new and equitable global partnership through the creation of new levels of cooperation among States, key sectors of societies and people, Working towards international agreements which respect the interests of all and protect the integrity of the global environmental and developmental system, Recognizing the integral and interdependent nature of the Earth, our home, Proclaims that:

Principle 1
Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.

Principle 2
States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

Principle 3
The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations.

Principle 4
In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.

Principle 5
All States and all people shall cooperate in the essential task of eradicating poverty as an indispensable requirement for sustainable development, in order to decrease the disparities in standards of living and better meet the needs of the majority of the people of the world.

Principle 6
The special situation and needs of developing countries, particularly the least developed and those most environmentally vulnerable, shall be given special priority. International actions in the field of environment and development should also address the interests and needs of all countries.

Principle 7
States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem. In view of the different contributions to global

environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command.

Principle 8
To achieve sustainable development and a higher quality of life for all people, States should reduce and eliminate unsustainable patterns of production and consumption and promote appropriate demographic policies.

Principle 9
States should cooperate to strengthen endogenous capacity-building for sustainable development by improving scientific understanding through exchanges of scientific and technological knowledge, and by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies.

Principle 10
Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.

Principle 11
States shall enact effective environmental legislation. Environmental standards, management objectives and priorities should reflect the environmental and developmental context to which they apply. Standards applied by some countries may be inappropriate, and of unwarranted economic and social cost, to other countries, in particular developing countries.

Principle 12
States should cooperate to promote a supportive and open international economic system that would lead to economic growth and sustainable development in all countries, to better address the problems of environmental degradation. Trade policy-measures for environmental purposes should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade. Unilateral actions to deal with environmental challenges outside the jurisdiction of the importing country should be avoided. Environmental measures addressing transboundary or global environmental problems should, as far as possible, be based on an international consensus.

Principle 13
States shall develop national laws regarding liability and compensation for the victims of pollution and other environmental damage. States shall also cooperate in an expeditious and more determined manner to develop further international law regarding liability and

compensation for adverse effects of environmental damage caused by activities within their jurisdiction or control to areas beyond their jurisdiction.

Principle 14
States should effectively cooperate to discourage or prevent the relocation and transfer to other States of any activities and substances that cause severe environmental degradation or are found to be harmful to human health.

Principle 15
In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Principle 16
National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.

Principle 17
Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.

Principle 18
States shall immediately notify other States of any natural disasters or other emergencies that are likely to produce sudden harmful effects on the environment of those States. Every effort shall be made by the international community to help States so afflicted.

Principle 19
States shall provide prior and timely notification and relevant information to potentially affected States on activities that may have a significant adverse transboundary environmental effect and shall consult with those States at an early stage and in good faith.

Principle 20
Women have a vital role in environmental management and development. Their full participation, is therefore essential to achieve sustainable development.

Principle 21
The creativity, ideals and courage of the youth of the world should be mobilized to forge a global partnership in order to achieve sustainable development and ensure a better future for all.

Principle 22
Indigenous people and their communities and other local communities have a vital role in environmental management and development because of their knowledge and traditional

practices. States should recognize and duly support their identity, culture and interests and enable their effective participation in the achievement of sustainable development.

Principle 23

The environment and natural resources of people under oppression, domination and occupation shall be protected.

Principle 24

Warfare is inherently destructive of sustainable development. States shall therefore respect international law providing protection for the environment in times of armed conflict, and cooperate in its further development, as necessary.

Principle 25

Peace, development and environmental protection are interdependent and indivisible.

Principle 26

States shall resolve all their environmental disputes peacefully and by appropriate means, in accordance with the Charter of the United Nations.

Principle 27

States and people shall cooperate, in good faith and in a spirit of partnership, in the fulfillment of the principles embodied in this Declaration and in the further development of international law in the field of sustainable development.

Source: Press Summary of Agenda 21(based on the final text) August 1992 United Nations, Department of Public Information [accessed at http://www.jaygary.com/agenda21.shtml]

Achievements and Failures in Sustainable Development: Post-Rio Analysis

The decade after the Rio-Summit saw both successes and failures in the pursuit of tangible sustainable development at all levels: local, national and global. It is, for one, not possible to label the decade in question as a complete failure or a complete success, since there were many encouraging developments that promised a bright future for the coming generations. At the same time, certain developments cast a scary shadow on the future of our efforts to attain a meaningful sustainable development. We, in the following, try to have a look at a few successes and failures in our quest for sustainable development after the Rio-summit, but before the Johannesburg Summit of 2002. Let us take the failures first.

FAILURES

1. Poverty Intact

The Rio Declaration promised action to combat poverty, change consumption-patterns, provide clean water and health-care, protect the atmosphere, forests, rivers and oceans, combat desertification, and much more, with new and additional resources to be made available for these tasks. The situation on the ground indicates that the poverty situation has worsened. Figures collected in 1997 showed that 'a quarter of humanity had grown poorer, more people than ever lack access to clean water, pollution had increased, desertification had spread, consumption-patterns remain fundamentally unchanged, forest- destruction continues and development-assistance had declined'.[http://www.earthaction.org/en/archive/97-05-envinst/bground.html] (accessed on May 30, 2005).

Figures collected 10 years after the Rio Summit were no different. About 1.3 billion people live on less than $1 a day, and around 160 million children suffer from malnutrition. The wealth-gap has increased phenomenally. A study published in early 2002 found that the richest one per cent of people in the world earn the same as the poorest 57 per cent. According to the United Nations, the net worth of the three richest families in the world--namely the Gates family, the Sultan of Brunei and the Walton family--is equal to the GDP of the world's poorest 43 countries put together. One of the greatest rifts between rich and poor can be found in Brazil, where nearly half of the nation's income goes to just 10 per cent of earners. Chile, Honduras, Zimbabwe, Tanzania and Kenya also experience similar rifts. The gap did not remain confined to the South, but the Eastern Europe also witnessed it. The sharpest deterioration in living standards during the 1990s took place in Eastern Europe and the former Soviet republics!

In order for the world to meet the goals agreed upon at the Rio Summit, it is necessary that the challenge that poverty presents is met with resolve, commitment and action. There is no other way of dealing with this menace that has threatened to dismantle the quest of the world for sustainable development.

2. Species Extinction

The signatories of the Earth Summit at Rio had pledged that they would take steps in the areas where species were being wiped out. Developed countries promised to provide "new and additional" resources for the conservation of species and ecosystems in developing countries. Facts suggest that they have so far not made good on their promises. Five years after Rio, one leading authority, Harvard University's E.O.Wilson, estimated that at least one species was being extinguished every 20 minutes, due to expanding human activity. Scientists are warning that if things continue as they are, we may wipe out half of the life-forms on our planet within the next century.

The figures available today, though tentative, tell that anywhere between 20,000 and 100,000 species a year are believed to be disappearing permanently from the face of the planet. Many plants and animals are thought to become extinct before they are even known to science.

One of the biggest causes of the mass extinction currently under way is a loss of habitats, and in particular the destruction of species-rich rainforest, which is home to as many as half of the world's species. Tropical rainforest is disappearing at the same rate as it was 10 years ago--about one per cent a year. This loss of species undermines the ability of ecosystems to withstand natural and man-made pressures and regulate processes that keep air and water clean and the planet livable.

3. Loss of Forests

The world is depriving itself fast of the rich forest-resources and the rate of their degradation is phenomenally high. A total of 13.7 million hectares of forest - roughly the size of Nepal -are cut or burned each year. The causes of the poor implementation of existing instruments and insufficient international regulation include the fact that governments are unable to agree on the basic principles of sustainable management and protection of forests. In addition, the industrialized nations are reluctant to subject the way they manage their forests to international scrutiny. This gap between their words and actions is not helping the cause of sustainable development.

4. Global Warming

In order to prevent the ever-increasing phenomenon of global warming, a Convention on Climate Change was signed at the Rio Summit. It promised to prevent global warming and take significant steps regarding cutting back the emissions. Despite the pledge, global emissions of carbon dioxide have continued to rise. Record-setting temperatures in the 1990s are part of the twentieth-century warming trend. Just over the last three decades (between 1969-71 and 1996-98), global average temperature has risen by 0.44 degrees Celsius. The 3 parts per million increase in the atmospheric concentration of carbon dioxide in 1998 was the largest ever recorded! In the 21st century, temperature is projected to rise even faster.

5. (Over)Consumption Patterns

"*To achieve sustainable development and a higher quality of life for all people, states should reduce and eliminate unsustainable patterns of production and consumption....*" *(Principle 8 of the Rio Declaration)*

The way we live our life affects the environment. The homes we live in, the way we travel, where our food comes from and how we dispose of our waste, all count. Headline indicators, such as greenhouse gas emissions, energy-use and personal travel are the sum total of millions of individual decisions. Today most of the major indicators of pollution still point in the wrong direction. It seems the principle of sustainability has yet to make a serious impact on everyday living. International Energy Agency reveals that in the 10 years ending in 1997, energy consumption in North America rose by 16 per cent, in South America by 35 per cent, and in the Middle East and North Africa by 58 per cent. Meanwhile in the 10 years 1990 to 1999, vehicle miles traveled by car, in the U.S. and the European Union rose by nearly 80 per cent. Globally, air traffic doubled. The situation is not improving, as people living in the Third World have begun to emulate the lifestyle of the West. This is surely piling up on the agony for the planet earth.

6. Governments and Failure to Deliver

At Rio, it was remarkable to see that both developed and developing countries had resolved to work together towards the sustainability-targets set at the Summit. Numerous conventions were signed, treaties concluded, arrangements made for the purpose, but a quick look at the current situation shows that promises were not made good. One prime example is that of the Kyoto Protocol to the UN Framework Convention on Climate-Change, which still awaits implementation since it does not have the backing of the major polluters, the US in particular. The tall-talking at the Summit has so far not been translated into any meaningful action. [Post-Rio Failures Make the World less Safe http://www.hartford/hwp.com/archives/25b/022.html] (accessed on May 30, 2005).

Like the governments in the North, the governments in the South have also failed to deliver on their side of the trade-deal, developing countries have responded in a lukewarm fashion to their environmental commitments. The result has been largely "business as usual". Habitat loss continues, finite resources get scarcer and atmospheric greenhouse-gas concentrations keep rising. Such failures on the part of the governments point towards questionable intentions and weakness of institutions whose responsibility was to ensure implementation of the steps prescribed at Rio. There is a serious need today to reassess where we went wrong and what can now be done to ameliorate the situation.

7. Health

The health situation, particularly in the developing countries, is far from satisfactory. The HIV epidemic is devastating sub-Saharan Africa, a region of 800 million people. Life expectancy-a sentinel indicator of progress-is falling precipitously as the virus spreads. Before the onslaught of AIDS, life expectancy in Zimbabwe was 65 years. In 1998, it was 44 years. By 2010, it is projected to fall to 39 years. Other countries, such as Botswana, Kenya, Namibia, South Africa, and Zambia, are experiencing similarly graphic declines.

Unlike most diseases, which tend to single out the very young and the old, AIDS has struck people in the prime of their lives. In practical terms, this means mothers, fathers, teachers and farmers--the very individuals on whom developing countries depend, in order to lift them out of the poverty-trap. According to the International Monetary Fund, children who lose a parent to AIDS in rural Tanzania are 50 per cent more likely to suffer malnutrition than those who are supported by both parents. And studies in Latin America have shown that children who are orphaned by AIDS are much less likely to continue attending school. Figures like these highlight the connection that exists between AIDS and poverty. This, in turn, means that a growing case can be made for targeting international financial assistance towards efforts for AIDS-prevention.

Nations like Uganda and Senegal have reduced their HIV infection-rate substantially, partly because they intervened at a relatively early stage in the epidemic. Unfortunately, positive progress is still the exception rather than the rule. Scarce resources are being wrongly directed, while drug patents are keeping the cost of treatment far beyond the reach of most sufferers. The decade after the Rio Summit is indicative of a lack of commitment by governments, particularly those of developed countries, which simply are not doing enough to stem the tide of AIDS epidemic.

8. Resources for Sustainable Development

The North had pledged, at Rio, to provide 'new and additional' resources to help protect the environment and meet human needs in the developing countries. Unfortunately, they have yet to provide the resources they had pledged at Rio. The environmental and developmental priorities require funding of a different order of magnitude from that available today. Based on the cost estimates emerging from major UN conferences in the 1990s, the cost of protecting the environment and meeting the basic needs of the world's poorest citizens would approach $150 billion a year.

The existing scarcity of funds for the UN system, and the shrinking resources for development-assistance, strongly suggest that the necessary funds are unlikely to come from national budgets alone. Solving global problems of poverty and environmental degradation is not a top priority for most national governments. It isn't what they are elected to do.[Ibid] . Aid is hardly coming from the developed countries

to address the sustainable development issues. The global aid has fallen and financial resources continue to move out from developing countries through debt-servicing and declining terms of trade. Net flows of official development- assistance, on which least developed and several other low-income countries depend, after increasing in 1993, declined in real terms in later years. Countries of Sub-Sahara Africa still lose around 15 percent of their GDP through the fall in their terms of trade, and even more through debt-servicing. In all, $300-500 billion flows out from the South to the North each year, creating a huge financial vacuum that the small and fast-declining volume of aid is unable to offset. Net capital flows of private direct investment, portfolio investment and commercial bank-lending have increased during the period 1992-1995, but have been concentrated in a relatively small number of developing countries.

9. Depleting Water Resources

According to estimates available, more than a billion people have no clean drinking water. Asia and sub-Saharan Africa are the regions where the shortage is most severe. The United Nations warned in 1997 that, if current trends continue, two-thirds of the world's population will suffer moderate to severe "water stress" by 2025. The decade after the Rio Summit has not seen any improvement in the availability of water. The resource-condition has rather worsened in the stated period, as populations have risen, agriculture has become more intensive and urbanization has pushed up the demand for clean water.

The over-extraction of aquifers, concentrated in China, India, North Africa, the Middle East, and the United States, exceeds 160 billion tons of water-per year. In India, one of many countries where population is outrunning water-supply, water pumped from underground far exceeds aquifer-recharge. The resulting fall in water-tables will eventually reduce irrigation water supplies, threatening India’s food-security and it may, like Africa, face a decline in life- expectancy.

The shortage of water has not stopped waste of this precious resource. “Misuse of water is widespread and farmers use large amounts of water poorly," reported a recent study by the International Programme for Technology and Research in Irrigation and Drainage. Water-shortages are closely linked to food-shortages. It takes around 1,000 tonnes of water to raise a tonne of grain. Without adequate water for growing crops, people in developing countries go hungry. Developing countries whose demand for water exceeds the supply are faced with an impossible choice: make do with even less, or resort to using untreated water. The former leads to famine; the latter to disease. According to Joanne Green of the “Water Matters” campaign, a child dies every 15 seconds from a waterborne disease. Because rivers and aquifers frequently cross national boundaries, tensions between neighbouring states over water are commonplace. A decision to divert water away from a river--into an irrigation network, for example--can have dire consequences downstream. The disputes over the Nile, the Zambezi and the Rio Grande point towards such consequences.

10. Conflicts and Sustainable Development

'Warfare is inherently destructive of sustainable development' (Rio Declaration 1992)

The decade after the Earth Summit of 1992 has shown, on a massive scale, the suffering that war can inflict on ordinary people. At its worst, warfare unravels decades, or even centuries, of civilization, and reduces prosperous nations to mediaeval living-standards. It precludes the sustainable management of natural resources, undermines the fight against poverty, prevents foreign investment, destroys infrastructure and prevents planning for future generations. It also strikes those countries that are least able to recover. In the last 10 years, 15 of the world's 20 least developed nations were plagued by warfare.

One rare ray of hope is the redefinition of security in terms of people, rather than the state, most recently by the International Commission on Intervention and State Sovereignty, which was convened in 2000, in response to the catastrophes that unfolded in Rwanda and Kosovo. It is pertinent to quote the UN Secretary General Kofi Annan who recently said that even the costliest policy of prevention is far cheaper, in lives and in resources, than the least expensive intervention.

11. Globalization and Sustainable Development

Sustainable-development agenda may not be sustainable in the current globalized structure. Commerce and the need to be competitive in the global market have become the top priority in many countries; the environment, welfare of the poor and global partnership have been downgraded on the agenda. The kind of globalization prevailing today is inequitable, benefiting a few but marginalizing many. It is based on, and is rapidly spreading the same "consumption and production patterns" that has been already proclaimed unsustainable. It represents the growing power of big business that is increasing its monopoly of the economy and extending its reach to policy-making bodies.

For instance, instead of the promised technology-transfer at Rio, the new intellectual property rights agreement at the WTO is creating new barriers to the South's access to environmentally sound technology. It is accelerating the practice of bio-piracy, in which genetic resources and the knowledge of local communities on the sustainable use of biodiversity are hijacked and transformed into patents and patented products that are the new source of enormous profit for the big corporations. Needless to say, the main victims are the poor communities and ordinary people who endure the destruction of their environment and the indignities of poverty.

ACHIEVEMENTS

1. Emergence of Well-Informed Civil Society

This was not planned, but one of the very encouraging outcomes of the Rio-summit was the emergence of a "Civil Society Force' as a watch-guard of national and international policies concerning environment and development. The participation of NGOs in the UNCED led to a flourishing of these NGOs all across the globe, and they almost assumed it as their right to participate in all significant conventions and treaties. The later years saw a growth in magnitude as well as areas in which civil society forces operated—from agriculture and trade policies to climate change and human rights.

Today in a complex and rapidly changing world, policy-makers are becoming increasingly dependent on the knowledge and experience that NGOs can bring to the table. One manifestation of this evolution has been the emergence of global policy-networks--broad-based alliances of organizations connected by a common theme.

2. Restoration of Ozone-Layer

There is no huge success story about restoration of the ozone-layer and there has been continuous depletion of ozone layer in the 1990s. But to consider the ozone- problem as just more bad news would be to overlook the substantial progress that has been made in the last decade. Gases like chlorofluorocarbons (CFCs), used as solvents and refrigerants among other applications, will take many years to disappear from the upper atmosphere. After all, it is their high degree of chemical stability that allows them to reach the stratosphere in the first place. Although ozone-damage continues, particularly at high latitudes, actual emissions of the main ozone-depleting gases--CFCs, halons, methyl bromide and so on--have fallen sharply.

The Post-Rio decade saw that the rate at which ozone-destroying gases were building up in the atmosphere was slowing. The concentration of one of the key agents, CFC-11, has actually begun to fall. If progress is maintained on eliminating ozone-destroying gases, the ozone layer is expected to start recovering in the next few years, and to be fully restored by around 2050.

3. The Kyoto Protocol

The roots of the Kyoto Protocol of 1997 can be traced to the UN Framework Convention on Climate-Change (FCCC) signed at the Rio Summit (1992). The Kyoto Protocol represents a landmark in the climate-change process. While the consensus reached was an impressive achievement, Kyoto actually represents a very modest first success on the journey. The Kyoto Protocol to the FCCC is notable for its reliance on hard science, as embodied in the IPCC assessments. Signed by 159 nations, it prescribes an overall reduction in greenhouse-gas emissions of 5.2 per cent below the

1990 levels, to be achieved as an average over the period 2008–2012. The Protocol applies to 38 developed countries and transitional economies--the so-called Annex I Parties.

The progress towards achievements of Kyoto targets has been rather mixed. At the end of 2000, overall emissions of carbon-dioxide among Annex I countries were down by 2.6 per cent, thanks largely to a sharp decline in fossil-fuel consumption in former Eastern Bloc countries. The European Union managed a cut of 0.5 per cent. However, emissions from the U.S. and Japan had risen by 13 per cent and three per cent, respectively.

The protocol, which is yet to come into force, requires ratification by at least 55 of the 159 Parties to the Convention, including enough Annex I parties to account for 55 per cent of that group's emission. The withdrawal of the US from the treaty has seriously jeopardized the future of the protocol.

4. Science and Technology Framework

Sustainable development is always a distant dream if it is not supported by strong scientific framework, within which to work. Otherwise problems can never be quantified and targets cannot be met. In he post-Rio decade, promising developments have taken place in all of the major branches of technology. Fuel- cell research has edged forward substantially, bringing forward the prospect of clean transport-fuels and the so-called "hydrogen economy." Genetic engineering, for all its potential risks, has enabled farmers to curb their use of toxic chemicals. Meanwhile, industry, in part motivated by ever-stricter environmental legislation, continues to make valuable advances in such areas as cleaner production and eco-efficiency. For business, an investment in research and development is commonly rewarded with lower costs and reduced liabilities, with a better image.

It is therefore advisable that decision-makers ensure that sufficient funding is directed to those areas of research that have a direct bearing on sustainable development. On the other hand, new channels of communication must be opened up between science and policy-making, to ensure that critical decisions are based on rational assessment and are not biased.

5. 'Environment' on the National Agenda

The post-Rio decade has seen various governments committing themselves to incorporating environment on their national policy agendas. Environmental governance is gaining currency in many parts of the world. New Zealand was among the first to make significant moves in this direction, with the appointment of an independent Parliamentary Commissioner for the Environment (PCE). The role of this independent officer is to review and offer advice on environmental issues, and to scrutinize the government's policies through a green filter. Other countries have

subsequently adopted variations on the PCE theme. Canada appointed its first Commissioner of the Environment and Sustainable Development in 1996, to monitor the environmental impacts of federal policies.

China, since 1992, has also been working closely with Canada on the environmental front under the Canada-China Council for International Cooperation on Environment and Development. Environmental policies adopted in The Netherlands are widely acknowledged to have been a driving force behind the European Commission's own sustainable governance agenda, the Fifth Environmental Action Programme--"Towards Sustainability." This was adopted in 1992, and was recently superseded by a sixth action-programme, "Our Future, Our Choice," which runs until 2010. The agenda singles out four priority areas: climate change, nature and biodiversity, environment and health, and natural resources and waste. By adopting a more strategic and inclusive approach than its forerunners, it sets the tone for the European Commission's first strategy on sustainable development; the 'Strategy' was signed in 2001 by as many as fifteen European heads of state.

While the national agendas of European countries have, to some extent, well-defined environmental governance policies, the developing countries, though small 'contributors' to the global pollution-problem, need also to make similar initiatives to help this cause of global proportions.

6. Local Initiatives: Local Actions and Global Thinking

National governments may have been lackadaisical in their pursuit of "sustainable development goals set at the Earth Summit of 1992; the contrast has been seen over the last decade so far as local initiatives are concerned. A survey by the International Council for Local Environmental Initiatives (ICLEI) reveals that more than 6,000 initiatives in over 100 countries have been set in motion under the "Local Agenda 21" program.

In developed countries, local authorities have been quick to identify opportunities for putting sustainability principles into practice--for example by promoting energy-efficiency in homes and offices, by staging "green commuter" events, or by setting up recycling programs. A large number of towns and cities have arranged themselves into loose coalitions, focusing on particular aspects of sustainability. For example, the European Sustainable Cities and Towns Campaign (ESCTC) has attracted 1,300 local authorities, representing more than 100 million people. The Cities for Climate Protection initiative has 500 members around the world, bringing together developed and developing nations. And the World Health Organization's "Healthy Cities" Program gets support from 1,500 municipalities worldwide.

The voluntary sector, too, has continued to play a vital role in putting sustainability into practice. Communities in developing countries, meanwhile, have benefited from the work of organizations like Oxfam and the Aga Khan Foundation, which provide direct,

hands-on assistance to help them become self-reliant. Micro-credit programs, such as the Grameen Bank, provide small collateral-free loans and other financial services to the poorest of the poor for self- employment projects that generate income.

All this indicates that sustainable development has been able to create a lot of enthusiasm where it matters most--at the level of ordinary people. This raises hopes that, though sustainable development may be a difficult target, it is very much achievable if the responsibility is assumed at all levels i.e., local, national and global.

7. Corporate Social Responsibility (CSR)

Prior to the Earth Summit of 1992, whenever the business community talked about sustainability, it was hardly taken seriously since people in general believed that the corporate sector was more interested in profits than environmental or sustainable development-related tasks and that their talk of sustainability was aimed at polishing their image in public, so as to attract more and more customers or strike deals. But this line of thinking underwent a change after the Rio-1992 since, throughout the 1990s, the idea that corporations can have a social conscience while turning a profit gradually took root, and is now well established. Business leaders are beginning to look well beyond regulatory compliance, and to talk in terms of a "triple bottom line" --in which economic performance is assessed alongside environmental and social impacts.

There are many initiatives already in progress. The European Union is drafting its own policy, setting out what CSR (Corporate Social Responsibility) entails. There are even tentative plans for an international standard governing CSR, similar to ISO 14000.

Multinational corporations are clambering over one another to demonstrate their CSR credentials. For example, the 2002 World Economic Forum in New York saw 36 chief executives from giants like Coca Cola and Siemens sign a joint commitment to corporate citizenship, which places CSR squarely on the boardroom table. While making their commitment public, they declared that the frameworks they adopted for being a responsible business must move beyond philanthropy and be integrated into core business-strategy and practice.

There are however many antagonists who do not believe in CSR, maintaining that a company is obligated to its shareholders, and to no one else. Another challenge is to persuade the many thousands of small and medium-sized businesses around the world to follow the lead set by these multinationals. This will not be easy, since many small-business managers regard CSR--with some justification--as a luxury they cannot afford.

8. Post-Rio Agreements on Chemical and Biological Risks

Several treaties were signed in the post-Rio decade, which had the potential to further the objectives of the Rio-Treaty. These treaties represent valuable progress towards a

cleaner, safer world. And taken together, they hint at a new era of international cooperation on environmental protection. Some of them are given as under:

- *Convention on Persistent Organic Pollutants (POPS-Stockholm 2001)*
  The POPs agreement is based on the philosophy of phasing out harmful chemicals and replacing them with benign alternatives, rather than relying on end-of-pipe treatments. POPs are a group of toxic chemicals (such as DDT and chlordane), principally pesticides and industrial by-products, that has collectively been linked to cancer, damage to the nervous system, reproductive disorders and disruption of the immune system.The POPS Convention was signed by 91 governments.

- *Cartagena Protocol on Biosafety (CPB-Cartagena 2000)*
  The protocol deals with trans-boundary movements of living modified organisms (LMOs). Among other things, it establishes an "advance informed agreement" (AIA) procedure that requires exporters of certain LMOs to obtain consent from the importer before making a shipment. The Cartagena Protocol also calls for the creation of an Internet-based "bio-safety clearing house" to promote information-sharing between countries.

- *Rotterdam Convention on Prior Informed Consent (PIC-Rotterdam 1998)*
  The principal aim of the Convention is to protect people and the environment, especially in developing countries, from the risks associated with imported pesticides and other toxic chemicals. The treaty gives the importing countries the power to decide which chemicals they wish to accept and which they do not. It also creates a new duty to label listed chemicals with information about their potential health and environmental effects.

9. Information for Decision Making

The last decade has seen some valuable progress towards informing and involving ordinary people--thanks in no small part to the explosive growth in electronic communications, such as the Internet and the cellular phone. This is encouraging since Sustainable development cannot be delivered by governments alone. Informed citizen-involvement is essential. Principle 10 of the Rio Declaration states: "At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities… and the opportunity to participate in decision-making processes." National governments, it adds, "shall facilitate and encourage public awareness and participation by making information widely available." [Summary of Agenda 21. http://www.jaygary.com/agenda21.shtml]

A significant move in this direction was made in June 1998 with the adoption of the Aarhus Convention. One of the three pillars of the treaty deals with access to information. It enables the public to obtain information on environmental matters from the authorities, as an essential step towards participation in decision-making. The public is being made aware of environmental information through disclosure: the

requirement that companies disclose pollutants released into the environment. Individuals concerned about the health-impacts of a particular industrial facility can increasingly turn to published databases of emissions, or environmental quality indicators, to find out whether their health is at risk. The Internet has simplified this process.

The access of individuals and communities to information is one of the ways of empowering them and this is one of the most significant achievements since Rio, literally transforming how the world goes about its business.

FINAL REMARKS

To sum up the discussion, it is indeed pertinent to quote again the UN Secretary General. He described four broad areas where 'gaps in implementation were particularly visible':

a) A fragmented approach towards sustainable development: Policies and programmes at both national and international levels do not reflect the inextricable connections between economic, social and environmental objectives;
b) No discernible changes in the unsustainable consumption and production patterns, which are putting the natural life-support system at peril;
c) Lack of mutually coherent policies or approaches in the areas of finance, trade, investment, technology and sustainable development, particularly in the context of a globalizing world;
d) The financial resources required for implementing Agenda-21 have not been forthcoming and mechanisms for transfer of technology have not improved.

(Kofi Annan at WSSD Preparatory Committee, New York, January 2002. www.frontlineonnet.com/fl1906/19060810.htm. accessed May 29, 2005)

The world surely can undo the failures that the decade after the Rio Summit witnessed, by translating their words into action and by making good on their commitments. Doubtless, the path of global negotiations to world-wide problems is a difficult one and there are no early successes. In fact, coming to a national resolve and undertaking national action is a primer to the success of international treaties. This has shifted the onus for action on most of the problems from the supra-national to the national and even to the local level.

The World Summit on Sustainable Development (WSSD-2002) in Johannesburg ended with almost similar resolve to what one saw at the end of the Earth Summit at Rio de Janeiro in 1992. Post-Johannesburg, the world has yet to see any tangible improvement in the environmental and developmental fronts. But then it is a bit too early to expect to see the positives (or negatives) coming out of the summit outcomes. One, however, cannot help saying that nations have to fill the gap between their commitments and actions if they really wish to see the gap filled between

'development' and 'sustainable development'.

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IMPORTANT ASPECTS OF SUSTAINABLE DEVELOPMENT BASED ON SCIENCE AND TECHNOLOGY

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INTRODUCTION

Sustainable development is a great challenge that humanity faces. For countries to develop in a sustainable manner, many fundamental issues need to be addressed urgently, not only at the local level but also at regional and global levels. Bridging the developmental gap between the North and the South, and alleviating poverty to provide a more equitable and sustainable future for all, requires an integrated approach that fully incorporates existing and new scientific knowledge. At all stages and by all standards, the role of science and technology is crucial. Scientific knowledge and appropriate technologies are pivotal to resolving the economic, social and environmental problems being faced today that obstruct development.

SUSTAINABLE DEVELOPMENT AND SCIENCE AND TECHNOLOGY

In his Millennium Report to the General Assembly, the UN Secretary-General, Kofi Annan, used the following words: "Freedom from want, freedom from fear, and the freedom of future generations to sustain their lives on this planet". These words represent an increasing consensus, as being the three grand challenges facing the international community at the beginning of the 21st century. In order to deal with these with a measure of success, the role of science and technology is being recognized and promoted.

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

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

The Knowledge Divide

Globalisation has meant rapid creation and dissemination of knowledge, accompanied by rapid technological advances affecting all areas of life. However, impacts and results have been different in various parts of the world and the manner in which nations have chosen to deal with the phenomenon and its consequences have also not been the same. In this regard, factors to be considered are economic growth and the opportunities for social progress that have been created by expansion in investment, trade, commercial activity, education and employment. These opportunities have been uneven and have not come without social and environmental costs – and developing countries face the brunt of such challenges.

Undoubtedly, improvement in knowledge has enabled us to understand the root causes of socio-economic problems. Knowledge, science and technology hold great power to overcome the difficulties and provide effective solutions that can help to lift economies, increase livelihoods and strengthen the campaign against poverty. The greatest benefit perhaps is that well-informed developmental decision-making is facilitated.

Advancement in knowledge is particularly important for developing countries and some progress has been made. An important factor seen in such progress is inclusion of all the stakeholders in a participatory process. Sustainable development is achievable through continuous participation in the generation, evaluation and adjustment of new and emerging technological conditions by both developed and developing countries.

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

These conditions have, therefore, created a growing gap between the developed and developing countries that pushed the dream of sustainable development further away. The 1999 Human Development Report of UNDP highlighted this problem, as an issue of the global gap between haves and have-nots, saying that this gap has hardly closed and is further threatened by the growing gap between "those who know and the know-nots".

Science and Technology and Economic Development

Technological progress plays a highly productive role in economic growth and development, helps in job-creation, facilitates higher agricultural output, provides breakthrough improvements in healthcare and education systems, and helps in adding greater value to goods and services at lower prices for consumers.

Investing in science and technology, therefore, can pay substantial dividends. Due to the increasing interaction between the economies of the world and the global technology-revolution, countries would need to give due importance to technology and innovations, if they wish to be successful.

Technologies and the products of science cannot have any real benefits for humanity until they are commercialized. Innovation in this regard has taken on a pivotal place in the international discourse on the subject. Innovation is said to drive technology and is not just limited to economic or production-systems. It has in fact been extended to include social-sector innovation. The term 'National Innovation Systems' is a term which is now widely used, though not always well understood in right context. It can be defined as "a network of institutions in the public and private sectors whose activities and actions initiate, import, modify and diffuse new technologies" (OECD).

National Innovation Systems would therefore include:

- Macroeconomic conditions and regulatory frameworks, providing the environment for innovation in the private sector;
- National systems managing and coordinating S&T institutions;
- Communication networks and information technology;
- The capacity to monitor and assess relevant information;
- Mechanisms for linking academic institutions with society;
- Scientific and technological services and mechanisms to promote and facilitate the diffusion and transfer of technology, such as metrology, norms and standards, information services, and technological consulting;
- Operating conditions and procedures;
- R&D capacity to generate knowledge and techniques;
- Programs to educate and train personnel;
- The scientific and technological know-how of the labor force; and
- Financial intermediaries and resources.

This approach increasingly breaks down the difference between the idea of producers (scientific research by public and university for creating knowledge) and consumers of knowledge (*firms and productive sector users/buyers of technology*). It also the emphasizes the relationships between all the components in a complex system.

The idea of a systematic approach to S&T policies is not new. What is new is a greater emphasis on the demand-side and on the overall macroeconomic climate. Also new is

the stronger evidence that efforts to develop S&T without taking into account the nexus between all parts of the system, tend to fail as has happened so often in the past.

Challenges of Sustainable Development and the Potential Areas of Contribution by Science and Technology

Practitioners have believed that sustainable development that is not damaging to the planet is possible. However, vested interests and political difficulties are always involved. The amount of success achieved so far in moving towards sustainability appears to be unsatisfactory. The concept of sustainability means many different things to different people and (though attention paid to it may have been low), sustainable development and all the inter-related issues associated with it, including the need for improved science and technology, is an urgent issue. In fact this has been the case for many years, although political will has been slow-paced at best. The following statistics highlight this scenario:

- 1.3 billion people in the world do not have access to clean water.
- Approximately 50% of people in the world lack access to adequate sanitation and are living on less than 2 dollars a day.
- Approximately 2 billion people do not have access to electricity.

We are living in a time where there is more than plently, but in fewer and fewer hands. There is an inequality of consumption and, therefore, also in the use of resources. In many countries, regardless of the level of economic development, this is often due to a perception that sustainability, especially with regard to science and technology, is expensive to implement. It is especially difficult for poor countries, as they often lack the physical infrastructure and skilled manpower to integrate sustainability with science and technology and to incorporate it into their developmental planning. These views impact decisions on the kind of policies that may be adopted or excluded, on who would be involved in the process, what the objectives would be and who the beneficiaries would be.

In this overall scenario, certain important issues in sustainable development, where science and technology has an important role to play, can now be discussed. These include Water, Energy, Health, Food and Agriculture.

WATER

Water is central to life. Therefore, sustainable development cannot be an obtainable objective unless this natural resource is optimally utilized. Water resources are exhaustible. Although two-thirds of the earth's surface is water, only 2.5% is freshwater suitable for the needs of living organisms. Furthermore, the majority of the freshwater resources are largely in the form of glaciers and deep, underground aquifers, to which access is difficult if not impossible in certain cases.

Water Consumption: No doubt as the number of people who inhabit the Earth increases, the strain on water-resources also increases. About 54% of available freshwater resources are now harnessed for human use, worldwide. With the tripling of the globe's population in the last 70 years, water-use has increased six times.

Available freshwater resources are not equally distributed on Earth. Four billion people, or two-thirds of the world's population, live in regions that receive only 25% of the annual worldwide rainfall. This is the reason why there are often severe shortages of water in such areas. Currently, there are 31 countries characterized as "water stressed" (less than 1,700 cubic meters of water per person annually) or "water scarce" (less than 1,000 cubic meters of water per person annually).

In addition, many countries, especially developing countries that already face pressure on natural resources, use freshwater for agriculture. Yet during irrigation 60 percent of the water used is lost to evaporation and wastages.

Another aspect as important as availability of water is its quality. Hundreds of millions of the world's people do not have access to clean and safe water, a situation that exposes them to health hazards, some of them fatal. Statistics show that unclean water and inadequate sanitation take an enormous toll.

In the world today, more than 1 billion people consume unclean water and over 2 billion people do not have access to basic sanitation. As many as 12 million people die each year from unclean water and/or unsanitary conditions. Diarrheal diseases alone take the lives of over 1.8 million people around the world. The most unfortunate aspect of the picture is that many of the water-borne diseases, like malaria and diarrhea, are easily preventable and curable. This has been termed as the silent emergency by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF).

Water and Current Issues: Women across the world are almost always directly affected by issues of water-resource. This is because, most often, women are the ones who are made to bear the responsibility for providing and managing water for household use. Especially in developing countries, compared to men, women spend five times as much time on bringing water to their homes. According to statistics, women walk an average of almost 4 miles per day to collect water, which can weigh more than 40 pounds. There is no doubt that this task is not only time-consuming, but is also an exhausting one.

Therefore, when water supplies decrease or are contaminated, women are exposed to risks that their male counterparts may not face. Almost 12 million people die annually from water-related causes. Most of them are women and children. As it usually falls to the women to care for those who get ill from contaminated water, they must face additional exposure to risk and take on more responsibilities.

Also water is being excessively wasted due to its current methods of usage. Irrigated agriculture accounts for about 80% of water withdrawals in the world. In many irrigation schemes, up to 60% of this water is lost on its way from the source to the plant. More efficient irrigation practices will lead to substantial freshwater savings.

Economic and human losses due to natural disasters like floods and droughts, increased three-fold between the 1960s and the 1980s. Sustainable development in some developing countries is hindered because investments are not being made in basic data collection and disaster preparedness. The expected climatic changes and rising sea-levels will threaten the apparent security of existing water resources.

Water and the Future: The enormous amount of pressure from human use of freshwater-resources leaves little for rivers, lakes and wetland ecosystems. These are important to animal life and other systems in nature that ultimately support human life.

There are only two ways in which we can hope to meet and balance both environmental and human needs in the future. These are improvement in the efficiency of water-usage and tapping additional resources. The usage of water in agriculture, industry and in domestic water supplies possesses great potential for savings and reuse. Recycling is one method that can possibly reduce the consumption of many industrial consumers by 50% or more. Better management is another way of reducing losses in available sources of water as on average, 36% of the water produced by urban water utilities in developing countries is "unaccounted for". In the context of sustainable development, humanity has no choice but to endeavour to provide universal access to clean water and adequate sanitation, and this will be at substantial cost, for which public and private investment would have to be mobilized. Crucial in this scenario would be improving the efficiency of irrigation, by introducing techniques, technologies and methodologies, such as low-cost drip-irrigation, which could help double the efficiency of water-use in agriculture. This is where science and technology has an essential role to play.

ENERGY

Energy has played a pivotal role in human progress; it has enhanced the quality of life and was the single most important factor in the industrial revolution. Now energy is perhaps one of the most decisive elements in the economic development of any country at any level of development. Energy is essential, even for basic activities like cooking food, powering transportation systems, fueling heating and cooling systems as well as economic activities like running our factories and generating the power needed to obtain electricity. Oil, coal and gas that are termed ‘fossil fuels’ are currently the primary engines of economic activity. It is becoming increasingly obvious that these energy-sources have impacted the environment in a negative manner. In addition, since fossil fuels are exhaustible, rapid population-growth and rising consumption, expected in the future, warrants thorough reconsideration of energy sources and

technologies.

Energy Consumption: The pattern and amount of energy that countries have harnessed and utilized over the last century has transformed today's developed and developing nations. Statistics show that in the past one hundred years, the use of conventional forms of energy has tripled, while the use of fossil-fuels alone has increased by twenty times.

There is a great difference in the amount of energy received and consumed by various segments of the world, with the richest people using 25 times as much energy per person as the poorest ones. While the human race has made progress in the energy sector, it is an unfortunate fact that more than 2 billion people have no access to modern supplies of energy. They are forced to depend on rudimentary and inefficient sources, such as wood, animal-dung and charcoal. These are not only obtained after a daily ordeal, but also adversely affect the environment, upon which the poor depend for their livelihoods. This link means that the poor get caught in a vicious cycle, escape from which becomes excruciatingly difficult. In addition, due to lack of access to reliable energy, the productivity of one third of the global population is severely undermined. This brings with it economic hardship and the constant pressure of being under-provided.

With such inequity, and inequality in the access, consumption and effective distribution of energy, sustainable development remains an unachievable objective. Alleviating these inequities directly helps the cause of poverty-reduction, as it increases productivity, stabilizes economics for the poor and helps improve the environment upon which they depend to earn their livelihoods.

Energy and the Environment: The impact that the use of energy has on the environment has a large role to play in sustainable development. Regardless of whether these sources are traditional or modern, their supply efficiency, and capacity to pollute have a deep association with issues of sustainability.

Modern technology can greatly improve the choices available to the poor, but it is also clear that technologies at present are costly in financial, health and environmental terms. Impacts can be viewed at two levels. One is the local level, where burning of biomass for energy contributes to hazardous air-pollution, while at a global level the burning of fossil-fuels is dangerously threatening the atmosphere and the environment.

Energy for the Future and the Future of Energy: As consumption increases with the increasing population, it has been forecast that global energy-use will expand at 2% per year. It is also anticipated that a considerable portion of the increase would be in developing countries.

The primary challenge for the future would be to decrease inequities in energy-use,

provide energy-alternatives that are sustainable and whose byproducts would be least harmful to the environment and the health of people. Some of the strategies popular in this regard include:

- Encourage efficiency in the use of energy, with special focus at the point of "end use", such as vehicles, buildings, electrical appliances, and production processes;
- Encourage the rapid development and deployment of new and alternative energy technologies, with special focus on maximum use of renewable sources that have zero or almost zero emissions.

It is in the finding of these appropriate technologies and devising solutions to balance human and environmental needs that we must place the greatest trust in science and technology.

Motivating Research and Development and Deployment of Renewable-Energy Technologies

Technology has almost become the domain of the developed countries, while global realities make it impossible for the developing countries to avoid consuming or acquiring technology from developed countries. Therefore, continuous and rapid creation of new products, processes and services is resulting in a widening gap between developed and developing countries.

The traditional comparative advantage of developing countries, through the availability of natural resources and cheap labour, is rapidly being eroded. New technologies are both resource-saving and performance-enhancing. This, accompanied by wider trade and investment worldwide, has increased competitive pressures. These patterns require preparation of a pragmatic strategy for increasing the efforts of R&D and technology to enhance and complement economic development.

Clean or renewable technologies are an important aspect of the process of sustainable development that was given a deserving place at the World Summit on Sustainable Development (WSSD) RIO-2005. Particular direction was provided to the scientific and technological community in this regard. Renewable energy and its deployment is vital, in order to have a global energy-system that is sustainable. This is true in terms of supply and demand, and is as true in terms of environmental sustainability. This process can only be successful if intensified research and development (R&D) efforts devise appropriate foundations.

Significant technological and non-technological R&D efforts must, for example, aim at:

- Development of awareness-building strategies;
- Facilitating deployment and optimum utilization of existing technologies, in order

to increase the share of renewable energy in global energy-usage;

- Aim specific efforts towards existing renewable-energy technologies that work, in order to make them more efficient;
- Research and experimentation in potential technologies that are more suited to consumer-needs and are easier and cheaper to deploy. Encourage joint-ventures and international cooperation in this regard, especially between developing and developed countries;
- Encourage energy-efficiency for all sources, aiming to reduce pollution; standards may be applied and implemented and economic incentives may be introduced in this regard;
- Engaging and developing ways and means to involve the private sector;
- Involve industry to assess their specific needs, so that research and development efforts can incorporate these needs;
- Facilitate opening up of new avenues of funding, networking and sharing of resources.

Thoughts on Finances for New Research and Deployment of Clean Technologies: It is interesting to note that renewable-energy technologies differ from traditional fuel-systems in that the investment-costs for renewable- energy technologies are high, whereas operating costs are low. While developed economies may face financing challenges in replacing one system with the other, developing countries must cope with a general lack of financing capacity. It may also be kept in view that the challenge would be different for emerging market economies, such as China, Brazil and Indonesia, or for transit-economies such as those of Eastern Europe or Russia.

Therefore, it needs to be said that the peculiar situation of an economy or sets of economies would decide what financing-methodology is best suited. Both public and private financial institutions have years of experience with providing financing for conventional energy. Therefore, it is not only important to change the financial products to meet the needs of the renewable-energy scenario, but it is also imperative to change the mindsets of financiers. Building of Awareness is necessary amongst the consumers of renewable energy, but more so amongst those who will make delivery of renewable-energy possible.

HEALTH AND CURRENT ISSUES

Health: Mankind has made great progress in the health sector, especially in the last 50 years, which has improved life-expectancy and child- survival rates. However, there are challenges that still need to be effectively addressed if sustainable development is to be achieved. It is clear that, despite vast improvement in health-facilities and health-practices, hundreds of millions of people still lack access to basic health services and fall victim to diseases that can be easily and inexpensively treated.

One of the important factors that needs to be taken into account is that health is intimately linked to environmental conditions. When the environment is

compromised, so is health. This vicious link perpetuates poverty. Poor environmental conditions contribute significantly to communicable diseases that account for 20-25% of deaths worldwide, including infectious and parasitic diseases and respiratory infections and diseases.

- About 1.5 billion people at present do not have access to safe potable water;
- Another 3 billion – half the global population – lack sanitation facilities, such as a sanitary latrine, covered wastewater drain, or a flush toilet;
- Diseases associated with unclean water kill between 5 and 12 million people a year, mostly women and children.

Box - 1

"The main causes of avoidable death in low-income countries have been well documented: they include HIV/AIDS, malaria, tuberculosis, childhood infectious diseases, maternal and prenatal conditions, micronutrient deficiencies and tobacco-related illnesses. There is little doubt that improvements in health in these areas alone would translate into higher incomes, higher economic growth and reduced population-growth — all major contributing factors to sustainable development."

Water, Energy, Health, Agriculture and Biodiversity – Synthesis of the Framework Paper of the Working Group on Water, Energy, Health, Agriculture and Biodiversity (WEHAB)

These statistics are highly alarming in a modern age where humanity prides itself on its achievements in improving the life of others.

The rapid rise of non-communicable diseases is also threatening not only the lives of millions of people, but also their economic and social development. These diseases are mostly connected to unhealthy lifestyles and consumption-processes (unhealthy diets, physical inactivity and tobacco and alcohol use) and poor environmental quality. This puts additional strain on developing countries, whose national health programs are already under-funded and facilities are weak.

Box - 2: Factors Affecting Health in the Twenty-First Century

- Widespread absolute and relative poverty
- Demographic changes: ageing and the growth of cities
- Epidemiological changes: continuing high incidence of infectious diseases increasing incidence of non communicable diseases, injuries and violence
- Global environmental threats to human survival
- New technologies: information and telemedicine services
- Advances in biotechnology
- Partnerships for health between the private and public sectors and civil society
- Globalization of trade, travel and spread of values and ideas.

Poverty is a major cause of under-nutrition and poor health, as it plays a role in the spread of diseases and environmental degradation. In addition, it impedes the effectiveness of health-care systems and infrastructure. There are other factors also, which include uncontrolled urbanization and industrialization that have negative affects on the quality of the physical and social environment. The poor live in unsafe and congested accommodations, mostly in rural areas or urban slums which are underserved and lack access to safe water or sewerage. The children in these areas suffer from ill health mostly due to environment-related diseases. Industrialization has exposed people to grave environmental hazards, addressing which is beyond the capacity of the basic health services of the poor local governments.

Health and the Future: Significant progress has been made in science and technology which have contributed in health and medicine and increase in infrastructure but despite all this, on many occasions the gaps in health between and within countries is widening. Developing countries have to deal with problems arising due to lack of basic amenities and services which have a large impact on health. New technologies could transform health-systems and improve health. Stronger partnerships in this regard between private and public sectors and civil society could lead to stronger joint-action, in support of improved health solutions based on S&T.

SCIENCE AND TECHNOLOGY FOR AGRICULTURE AND BIODIVERSITY

Agriculture: Due to development in agricultural science and technology, there is no doubt that people around the world now have a greater variety of nutritious and affordable foods to choose from. The average human life-span, which serves as an indicator of quality of life, has increased steadily in the past century. This is even true for many less developed countries.

Another indication is that, even though population has seen a phenomenal growth, (from 3 billion to more than 6 billion people since 1950), the global malnutrition-rate has decreased in that period from 38 percent to 18 percent. Remarkable examples of the benefits of applications of science and technology are India and China, which are the two most populous countries of the world: both countries have quadrupled their grain production.

However, even with these very encouraging statistics, many less developed countries are suffering from acute food-insecurities, which will only grow worse with the stress on resources like water, land, and finances. Due to various natural, human and sometimes political reasons, the benefit of agricultural technology development has not spread equally across the globe. Many people in Africa and parts of South Asia continue to suffer from miserable rural poverty. At the heart of their poverty are low incomes, as a result of poor farm productivity. Some 740 million people go to bed daily on an empty stomach, and nearly 40,000 people (that include 20,000 children) die every day of starvation or malnutrition. Unless trends change soon, the number of undernourished could well surpass 1 billion by 2020.

Improvement in the machines applied for agricultural produce has been one factor in improving output. The use of better fertilizers, insecticides, herbicides and principles of Integrated Pest-Management has been extremely useful in this regard. However, the quantum boost has been provided by a better understanding of the genetics involved in food production. The most rudimentary kind of genetic improvement has been practiced for hundreds of years when seeds from the largest or tastiest crop were selected for further propagation.

This is the reason why cultivated varieties are so different from their wild counterparts that often are not appropriate for human consumption. With the help of modern science and technology, these rudimentary processes have been taken further to produce more healthy and nutritious food. This brings us to a valuable branch of science and technology – biotechnology.

Box - 3: Definition of Biotechnology

> "Transgenics (often referred to as biotechnology) is the application of scientific knowledge to transfer beneficial genetic traits from one species to another, to enhance or protect an organism. Leaders in biotechnology's development are applying scientific processes at the gene level to affect expressed and inherited traits."
>
> Dupont Biotechnology website

Biotechnology includes a wide range of diverse technologies, and includes technologies such as:

- Gene modification (manipulation) and transfer;
- Use of molecular markers;
- Development of recombinant vaccines and DNA-based methods of disease characterization/diagnosis;
- In-vitro vegetative propagation of plants;
- Embryo transfer and other reproductive technologies in animals.

In the food-processing sector, biotechnology targets the selection and improvement of microorganisms, with the objectives of improving yields, efficiency, quality, safety and consistency of bio-processed products. Microorganisms or microbes are generic terms for the group of living organisms that are microscopic in size, and include bacteria, yeasts and moulds.

Genetic modification has opened a whole new world and scientists in both the private and public sectors are viewing it as such. Because the science offers great potential, in terms of the quantity and quality of production, there is a major shift of research-activity from the public to the private sector. This shift will affect the areas in which advancement will be witnessed and where maximum investment will take place.

In the present focus on biotechnology and its applications, there are issues which require attention so that resultant crops are sustainable in terms of production, safety, quality and are accessible to the greater part of humanity.

An effective strategy would therefore include the following aspects:

- Promotion of the sustainable and safe use of biotechnology- applications for food and agriculture;
- Helping developing countries to improve their agricultural productivity through biotechnology, which would include North-South and South-South research partnerships and building public-private partnerships;
- Building general awareness on the potential of biotechnology to contribute towards food-security, enhancing nutrition and improving quality of agricultural produce.

THOUGHTS ON GENETIC MODIFICATION AND SCIENTIFIC RESPONSIBILITY

Science affects humanity in a pervasive manner, just as humanity affects science and its direction. Therefore, with great advancements in science and technology, there are issues and concerns that are reflected in today's public opinion.

There is ensuing debate over transgenics and whether foods containing GMO ingredients should be labeled. This has only accentuated the fact that transparency is important. People do not fully trust genetic engineering and its aims. Their concerns must be addressed if the fruits of biotechnology are to be realized for the betterment of humanity.

In this regard, it is important that standards for the sector not only be implemented with great honesty, but also made well known to the general public. Unless there is deliberate effort, GMOs will ultimately not achieve the higher goals they were originally fashioned for.

Box - 4: Basic Facts on Biodiversity

"Biodiversity or biological diversity is a collective term meaning: the totality and variety of life on Earth. Biodiversity includes genetic diversity within species; the variety among species; and the range of ecosystems within which life exists and interacts. Estimates of the number of species on Earth vary from 3-100 million. The UN Convention on Biological Diversity says there are some 13 million species, of which 1.75 million have been described. A more updated figure comes from the World Conservation Union's 2004 Red List of Threatened Species that says 1.9 million have been described out of an estimated 5-30 million in existence."

Scidev.Net

Biodiversity: It is a layperson's observation that those areas that have a healthy natural environment support a large and diverse variety of plants and animals. The UN Convention on Biological Diversity recognizes this fact and declares that biodiversity is important "for maintaining life-sustaining systems".

The increasing attention that is being given to biodiversity and its issues highlights the magnitude of the challenges faced in this regard. It also points towards the increased need of biodiversity research.

It was Carolus Linnaeus who introduced the current hierarchical, binomial classification 250 years ago. During this time, only an estimated 10 percent of the species of organisms have been described. It is believed that most of the remaining 90 percent can be discovered, diagnosed, and named in the next 25 years. This increased capacity to accomplish is the result of two very important developments that have greatly benefited research in biodiversity.

The first is Information Technology. It is now possible to obtain high-resolution digitized images of specimens, no matter how small, allowing scientists to study them far better than they could with traditional microscopes. Global information on specimens available in labs, museums or research institutes can now be accessed with ease via the internet, without traveling the distance. All that needs to be done is for them to be put online, which now many important institutes are doing around the world.

The second revolution about to catapult biodiversity studies forward is Genomics. Advances in the ablility to decipher the genetic make-up of organisms would result in their cataloguing and classification enhancing the current state of microorganism taxonomy. Combining both advantages now available to humanity from Information Technology and Genomics, an "electronic encyclopaedia of life" can be put together that will place a mind-boggling amount of information at the disposal of scientists and practitioners the world over.

Some Relevant Information on the UN Convention on Biodiversity: The UN Convention on Biological Diversity (CBD) is one of the most important international agreements, under which the nations of the world recognized that maintaining biodiversity was a key-factor in sustainable development. It has three principal objectives:

- To conserve biological diversity;
- To encourage the sustainable use of biological resources;
- To ensure the fair and equitable sharing of benefits derived from such use.

The Convention was signed at the 1992 UN Conference on Environment and Development in Rio de Janeiro, Brazil. The conference is also remembered as the Earth Summit. It came into force in December 1993, after it had been ratified at a

national level by 30 of the countries that had signed it in Rio. Its member-countries currently number 188 and they meet approximately once every two years.

Thoughts on the Uneasy Relation between Agriculture and Biodiversity: Since a considerably large number of people in developing countries depend on agriculture for their livelihoods, great emphasis has been laid on improving agricultural productivity and output. Having a healthy agricultural sector would unquestionably result in strengthening the economy and facilitate social uplift, by enhancing livelihoods and food-security. However, studies indicate that application of modern techniques to improve agriculture has come at the cost of biodiversity. This makes for a strange equation for the farming communities as agriculture can only thrive in a biologically diverse environment.

The relationship between agriculture and biodiversity has remained an uneasy one. Most funds have been diverted to modern agriculture, research and technologies. However, there is no doubt that where both elements compete for consideration and funds, they are highly dependent on one another in the overall development scenario. The conservation of agricultural biodiversity, and wild biodiversity occurring near agricultural land, can be considered as the easier task to accomplish as it provides benefit for both people and natural ecosystems.

Neither improved agriculture nor biodiversity can be overlooked in the quest for sustainable solutions. This must be at the heart of scientific research when new technologies are designed and policies are drawn up.

FOOD SECURITY

Many economies of developing countries are dependent on agriculture. Ensuring that current and future generations are adequately fed becomes one of the most important issues in sustainable development.

The sad aspect of this matter is that there is enough food produced in the world today for all people on earth. Yet there are a disturbing number of people starving across the world, because food is unequally distributed and not everyone has access to adequate food supplies. The statistics speak for themselves:

- About 825 million people worldwide are suffering chronic malnourishment;
- Two billion people – a third of the earth's population – lack food-security, defined as sufficient safe and nutritious food to maintain a healthy and active life;
- Nearly two thirds of the world's population lives in countries that cannot maintain self-sufficient food-production and cannot afford to import the food necessary to support their inhabitants.

Food Security and the Environment: The environment pays a price for the human effort of trying to produce enough food for the 6.2 billion people that inhabit the planet.

Overworked soils are more vulnerable to erosion and the use of agricultural chemicals can not only poison soils, making them unfit for use, but they can also have significantly adverse affects on human health.

It is to point out the obvious that, with growth in population there will be pressure on food supplies, making food-security an important concern. The growth in population and the increase in production do not present a balanced picture, with gap between the two threatening to increase as the years go by.

If all of the 8 billion people expected to be on the planet in 2025 are to be provided sufficient and reliable food-supplies, production of food will have to double in the next two decades. This means that farmers raising grain will have to produce 40 percent more by the year 2020 to meet the demand.

Some problems existing in the agriculture sector are due to natural circumstances, while others exist due to agriculture-related technologies whose performance at the moment is doubtful. Whether humanity decides to devise nature-based solutions or technology-based solutions for these problems, science and technology remains one of the inevitable options to facilitate the endeavour.

Food security and current issues: In the majority of developing countries peasants and small commercial farmers use family or at some level wage labor who utilize standard technologies at a very small level, the use proper planning and management and the use of applied agronomy is lacking. The people in the rural areas involved in food production activities require basic infrastructure and means for transport. The also are in dire need of the technological skills that are crucial to establish and maintain small scale industries. Professionals and people with expertise in the field of agriculture are unfortunately not utilized to their full capacity and most do not have the ideal working conditions .There is a lack of much needed infrastructure, suitable mechanisms for advancements in science and technology for sustainable development and mandatory policies and political will, that has led to weak culture for promoting science and technology for development in the region.

Food security and the future: Science and technology has made vital contributions towards the growth of the agricultural sector in many developing regions as a result of which global food production ha increased by more then 70% since the 1960s. In order to augment the use of science and technology for sustainable development in food development and security, efforts should be made in the following areas; human resource development, investment in agriculture, establishment of institutions, formulation of suitable policies as well as creations of venues and opportunities for cooperation and collaboration within the countries as well as among them.

MAINSTREAMING SCIENCE AND TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT

Science and technology has a central role to play in meeting the ever increasing requirements of the human race. Given that the issues facing the human race today have global repercussions and that there is an increased recognition of interdependence, the importance of mainstreaming science and technology by strengthening international linkages becomes apparent.

There are several kinds of linkages that help the cause of sustainable development in the context of science and technology. These are discussed in the following sections.

a) International Cooperation amongst Nations; North-South and South-South Collaboration: Developing countries lack science and technology capacity, which in turn makes the creation and dissemination of new knowledge difficult. This gap is linked to the development gap.

South-South cooperation is highly useful to help capacity building in science and technology, but is not sufficient to narrow the gap. Today more than 90% of global investment in Research and Development (R&D) and innovation occur in developed countries. Linkages with the developed world would, therefore, be important to successfully build and sustain a critical mass of knowledge, institutions and experts for science and technology.

(b) International Networking Amongst Scientific Organizations: Given the development issues of today's world, there is an urgent need to make optimal use of available knowledge-resources, both technical and financial, so that even with a little, effective socio-economic change can be made possible.

Modern communication and information technologies allow expanded access and facilitate, the sharing of all kinds of resources that include experts, information, equipment and other technical facilities. ICTs have also helped to enhance capacities and have provided methodology alternates for training, learning and researching.

- In order to create a critical mass of scientists for sustainable development, to exchange valuable information on methodologies, to share facilities and expertise, to globally work on local problems with global affects and to learn from each other's experiences, networking of scientific institutions has a vital role to play.
- It has also been observed that support for science does not automatically lead to technological innovation. One of the main goals of successful public policy in science has sought to encourage more linkages with technology. Because the paybacks from S&T come over the long term, that is through compounded growth in productivity, a stable environment with long-term plans and funding, as well as a focus on institutional development, is required. It takes a long time to create R&D groups and little time to destroy them. High-level research-institutions, as

well as the private sector, cannot afford "stop and go" projects and delayed payments due to erratic public funding. Countries unable to isolate their S&T institutions from the oscillations, crises, political uncertainty, and erratic budgets run the risk of paying the front-end costs of S&T, without reaping lasting benefits. In this respect it is important to focus on the sustainability and delivery capacity of institutions.

- Science and Technology now has no country or regional boundaries. In order to achieve individual developmental goals and regional cooperation for development, countries will need to encourage importation of technology and sharing of scientific ideas, as well as sharing and diffusion of regional successes and lessons learned.

Government's Key Role: Public goods often merit funding by governments, because lack of incentives for private funding would otherwise lead to under-investments in technologies from which society as a whole can expect to benefit. Most fundamental research falls into this category, as well as research related to public goods, such as public health and defense. If the new knowledge is available to all and cannot be protected through patenting, there are minimal incentives for private investors. A market failure resulting in under-investment by private firms may also take place.

Government intervention would thus be justified when private costs are higher than the private benefits and individual firms are unable to capture the full benefits of their investment. Empirical studies show that this is often the case. Even though the R&D will find its eventual applications in industry, those applications may be well in the future and hard to predict. If so, private firms have little incentive to invest, since they cannot expect to capture the returns within the time horizons of alternative investment decisions. In some cases, the firm may not be sure that it can protect and exploit the results. Economic history is full of examples of imitators becoming rich, while inventors go bankrupt. Unless government helps finance the R&D (which may be conducted in the government's own laboratories, in educational institutions, or in private industry), society will not be able to reap the full measure of benefits from technological innovation.

- Government investments can also be justified in providing basic scientific literacy for citizens, in training teachers who will provide this literacy, and in training scientists and engineers. Research conducted in universities and technical institutes helps train creative professionals in all fields who not only learn the principles and methods of science, but also take the latest knowledge with them, which is necessary to identify and adapt new technologies, when they enter the labor market. Public expenditures for industrial R&D can be further defined in terms of path-breaking, generic, and strategic technologies, corresponding to the generalized market-failure described above. Path-breaking innovations, such as those associated with solid-state electronics or the Internet, affect large portions of the economy and can establish a new growth trajectory. They may or may not result from basic research, but share with much basic research, lengthy time

horizons and high uncertainty in outcomes and impacts.

Generic technologies are more incremental, with benefits that are widely applicable and thus hard to protect. Examples are improved construction and manufacturing processes. Strategic technologies are those where, for one reason or another, governments perceive that a national interest is at stake.

- In short, a strong public role is justified in basic scientific research and in pre-commercial R&D; but there is also a role to play in directly encouraging technological innovation. The key in public technology-policy is to identify and then support those elements of technology which incorporate the greatest social payoffs and do not yield sufficient private returns to compensate private costs. While the case for public financing is clearly justified, the case for public provision is less compelling, since, in many cases, private institutions with a variety of public subsidies can provide the service more efficiently than the public sector.

It should also be noted, of course, that S&T may not solely result in economic progress. Public policies are needed to ameliorate or guard against deleterious impacts of S&T, such as war or mass destruction, pollution and environmental degradation, social dislocation and unrest, technological unemployment, etc.

Critical Policies for Scientific and Technological Innovation: Successful scientific and technological innovation requires a policy-focus on ensuring that all stakeholders are provided an environment of continued future-oriented strategy, protection of ideas and facilitation in commercializing those ideas. This involves having a macro-environment that encourages competition and is conducive to scientific thought and technological innovation, which will flourish only if the incentives and regulatory framework are right and if all the actors and stakeholders in a complex system find it profitable to innovate. It requires programs and policies which foster and respond to demand for the identification, selection, and adaptation of available technologies, including strengthening the exchange of information, using rapidly evolving information and communication-technologies.

Of particular importance is investment in transmission and generation of knowledge at all levels of the education and training system to build human capital. The basic skills learned in primary and secondary schools are the necessary foundation for development and an indispensable base for technology and science. Mid-level technical workers are needed with skills in many technological areas (e.g., electronics, computing, use of automatic machines), as well as in management areas (quality-control, information-management, inventory-management, cost-accounting). Higher and graduate education and training are fundamental to manage innovation. Science research is fundamental to generate and transmit new knowledge and train creative technology manpower.

Thoughts on Financial Resources for Sustainable Development: Financial resources

are the decisive factor in any undertaking and, even more so, when developing countries with limited resources implement development initiatives and strive for their success. At the International Conference on Financing for Development, governments agreed that attention was required in several key-areas to channel resources for development:

- Mobilizing domestic financial resources;
- Mobilizing international resources;
- Promoting international trade;
- Debt-relief and preventing developing countries from falling into the debt-trap;
- Increasing official development assistance.

Working closely with the donor-community is a necessary but not a sufficient means of ensuring the availability of financial resources for a developing country's developmental agenda. However, if development is to be sustainable, it is essential that the government is able to direct and channel its resources in such a manner that most of the prioritized initiatives receive adequate funding. Good governance, therefore, has an important role to play in this regard. Promoting economic activity within a developing country no doubt would lead to two highly favourable situations. Firstly, it would increase the overall resources, making available additional funds for development purposes and, secondly, it would improve the condition of livelihoods in the country, reducing poverty and allowing more people to access better facilities in regards to sanitation, water, health and energy.

FINAL THOUGHTS

"What we most need to learn is that in the major scientific matters which now affect human destiny, one cannot safely take decisions for today unless we realize that those same decisions determine the future. This realization may not lead to the right decisions; but it might help to obviate some of the worse (ones)."

Sir Solly Zuckerman, British physiologist and science advisor British Prime Minister
Caltech 1959

- There has probably never been a more opportune time than our present time to harness the full strength of science and technology to help the human race in facing the complex challenges posed to it. Whether it is health, food-security, biodiversity, energy, water or climate-change, these issues have a profound impact on human living and human survival. The contribution of science and technology therefore, is to the very essence of life.

- Our strategies in this regard must reflect this fundamental truth. The challenges we face demand from us that we be innovative in our thinking and compassionate in our actions. Our efforts must be focused and organized, and implemented in an effective cohesive manner so that the envisioned outcomes are actually achieved.

In the words of Albert Einstein: "Today's problems cannot be solved if we still think the way we thought when we created them"

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EDUCATION FOR SUSTAINABLE DEVELOPMENT

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INTRODUCTION

Education is vitally important for the progress of any developing country. The widening gap between the developed and underdeveloped countries is not due to lack of resources but rather to the difference in effective use of these assets. Indeed, investment in human capital translates into efficient use of such resources and the most direct form of any such investment is education. Education is, thus, an essential tool for achieving sustainability.

In the changing global scenario of today, the knowledge-economy not only demands highly specialized skills, it also moves faster. People must therefore know how to learn, or they will be left behind in all economic and social sectors. It is also true that people around the world recognize that current economic development-trends are not sustainable and that the key to move society towards sustainability is through education, public awareness and training.

Definition

Education is held to be central to sustainability. Indeed, education and sustainability are inextricably linked, but the distinction between education, as we know it, and education for sustainability is enigmatic for many.

ESD (Education for Sustainable Development) is a commonly used term; it is most frequently used at the international level and within the UN setup. It is however, up to the particular community or nation to name or describe ESD in any way, relative to language and cultural differences. As with any sustainable development initiative, the name and the content of a particular project must be relevant to the local needs and sensitive to the prevalent cultivated. (McKeown R., 2000)

Fundamentally, ESD is about "values, with respect at the centre: respect for others, including those of the present and future generations, for difference and diversity, for the environment, for the resources of the planet we inhabit" (UNESCO, 2005). In other words, ESD calls for giving people knowledge and skills for lifelong learning to help them find new solutions to their environmental, economic, and social issues.

Education allows us to understand human beings as a race and clarifies our connections with the natural and social environment that we live in. Assuredly, this understanding serves as the concrete basis for building mutual respect, along with a sense of justice, responsibility, exploration and dialogue. All in all, ESD aims to move humans towards adopting behaviors and practices that allow all mankind to live a complete life, without searching for basic needs.

Education for Sustainable Development is an investment in our future… each respective country should ensure that appropriate resources are made available for its development' - World Summit on Sustainable Development: Plan of Implementation (2002)

An important distinction, however, that must be kept in mind is the difference between education *about* sustainable development and education *for* sustainable development. Education about sustainable development is essentially an awareness lesson or a discussion. Education for sustainable development is the use of education *as a tool* to achieve sustainability. It is however critical that, at this juncture, efforts should be channeled towards more than just theory and discussion. All education serves some purpose or else a society would not invest in it. ESD promises to make the world more livable for this and future generations (McKeown R., 2000).

HISTORY OF EDUCATION FOR SUSTAINABLE DEVELOPMENT

From the time sustainable development was first endorsed at the UN General Assembly in 1987, the parallel concept of education to support sustainable development has also been explored. From 1987 to 1992, the concept of sustainable development matured, as committees discussed, negotiated, and wrote the 40 chapters of Agenda 21. Initial thoughts concerning ESD were captured in Chapter 36 of Agenda 21, "Promoting Education, Public Awareness, and Training."

Unlike most educational movements, ESD was initiated by people outside of the education community. In fact, one major push for ESD came from international political and economic forums (e.g., United Nations, Organization for Economic Co-operation and Development, Organization of American States). As the concept of sustainable development was discussed and formulated, it became apparent that education is a key to sustainability. In many countries, ESD is still being shaped by those outside the education community. The concepts and content of ESD in these cases are developed by ministries, such as those of environment and health, and then given to educators to deliver. Conceptual development independent of educator-input is a problem recognized by international bodies as well as educators.

Decade on Education for Sustainable Development

The 1992 Earth Summit marked the beginning of an unprecedented effort to understand and work towards achieving 'sustainable development' addressing human

needs holistically, by integrating environmental, economic and social goals. The World Summit on Sustainable Development (WSSD) (Johannesburg, 2002) re-emphasized the vital role of education, not only in building awareness of the need for sustainable development, but also in fostering the necessary changes to bring it about at all levels. Toward that end, beginning in 2005, the UN launched the UN Decade of Education for Sustainable Development, DESD, (2005-2014). The UN has appointed UNESCO as its Lead Agency for planning the Decade. Their goal is to build broad ownership at all levels; global, regional, national and local/community, for the goals of the Decade and to engage all possible partners among governments, Non-Governmental Organizations/civil society and the private sector in this work. Many reports, conferences and action plans have defined what should be done to achieve sustainable development, but progress has been slow, and the global environment continues to deteriorate. This failure has largely been due to a lack of political will and motivation to make the necessary changes in individual lifestyles and social action. The need to address motivation is the reason for the planned UN Decade. (The 7th Annual Conference of the International Environment Forum (IEF) Orlando, Florida-USA, December17-21, 2003)

The Rio Declaration (1992) states: "Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life, in harmony with nature." It took 10 years to come to the profound realization of the synergistic nature of sustainable development and education. The WSSD in Johannesburg (2002) recognized that education would be critical to changing things. The problem is that there are 1000 definitions of sustainable development. The Johannesburg Declaration expressed the commitment of world leaders "to build a humane, equitable and caring global society, cognizant of the need for human dignity for all". Our biggest challenge in this new century is to take an idea that sounds abstract, sustainable development, and turn it into a reality for all the peoples of the world. (IEF, 2005)

WEHAB and ESD

At the WSSD-2002, Mr. Kofi Annan, the UN Secretary General, proposed that by conserving water and energy, providing health care, and ensuring food security through responsible Agriculture, we should be able to conserve Biodiversity—what came to be known as the WEHAB initiative. This has also been linked to the Millennium Development Goals (MDGs).

The WEHAB initiative has great relevance to a nation's socio-economic and political development. Water, energy, health, agriculture and biodiversity resources are some of the basic ingredients needed to eradicate poverty, boost economic development and enhance the health-status of people. These resources need to be developed in a sustainable way. These resources have been used since time immemorial, but recent studies show that the utilization has not been sustainable. The relationship between the WEHAB initiatives and Millennium Development Goals (MDGs) has been

Table - 1: The Relationship Between the WEHAB Initiatives and MDGs

WEHAB	MDGs
Water	- Key to poverty eradication supports agriculture, livestock, industry. - Supports biodiversity. - Safe drinking water reduces child mortality and improves maternal health. - Water borne diseases lead to poverty and death.
Energy	- Provision of energy to the poor is vital in reducing poverty. - Renewable energy, energy efficiency and clean conventional fuels are vital in ensuring environmental sustainability. - Reduction of pollution from energy-sources improves health.
Health	The three goals that directly relate to health need interventions, such as clean water, sanitation, household energy and sound environmental management. - Eradicating extreme poverty and hunger leads to the improvement of human health. - Universal primary education is the key to improving health. - Promoting gender-equality and women's empowerment improves the health of children. - Environmental sustainability ensures that health-gains are sustained in the long-term for the benefit of future generations.
Agriculture	- Agriculture is the key to stimulating sustainable economic growth and rural employment. - Enhances food security and reducer poverty. - Women have main role into agricultural growth in developing countries and hence gender equality and women's empowerment are important for achieving SD.
Biodiversity	Biodiversity ensures the survival of human societies by providing food, income and medicines, which is why conservation, use and equity issues are important. - Women are custodians of traditional knowledge and direct users of biodiversity; therefore gender equity and women's empowerment are important. - Biodiversity reduces risks associated with natural disasters and stress resulting from human activities, pollution and climate change.

highlighted in the Table-1.

There is a scarcity of relevant learning support-materials for effective ESD—a critical need that ought to be addressed. Primary schools and NGOs mostly lack the capacity to deliver effective and locally relevant education on issues relating to SD. This problem should be addressed for improving the understanding of SD throughout the society,

resulting in the better implementation of SD initiatives at all levels. Such initiatives have the potential to reduce poverty, improve people's livelihoods in many other ways, and prevent or reverse environmental degradation. Therefore, their implementation becomes a high priority. Enhancing the educational capacity of schools and NGOs is therefore, imperative and it can lead to an improved understanding of SD in two main ways:

- Firstly, schools will be able to improve understanding among their students. These students will impart at least some of their new knowledge to their parents, and will soon go on to become influential members of their communities and, in some cases, important decision-makers.

  This improved understanding among students, their parents and other members of local communities will enable them to make informed decisions about actions which have positive or negative impacts on their local environment. These citizens will also become more aware of their right to key environmental services and a sustainable livelihood, and will be better able to protect this right by demanding that decision-makers in positions of power implement appropriate initiatives.

- Secondly, NGOs will be much better equipped to educate the communities they work with. These communities include the poorest people in the society, who have the most to gain from SD because they are the most dependent on natural resources.

  Therefore, the improved understanding among decision-makers will strengthen their ability to identify alternative development-options and assess their relative merits.

METHODOLOGY

The UN Decade of Education for Sustainable Development also seeks to

a) incorporate quantitative and qualitative ESD indicators into on-going monitoring and evaluation of Education for All (EFA) and the UN Literacy Decade;
b) monitor the progress of activities undertaken by UN agencies, Governments and NGOs in observance of the Decade and facilitate implementation and follow-up;
c) evaluate the achievement of measurable results in realising the aims and objectives of the Decade, particularly in regard to the integration of ESD in national educational policies, programmes and systems; and
d) make recommendations to further promote ESD based on results and lessons learnt from the Decade. (GDRC, 2005)

UNESCO has defined ten Priority Areas for the UN Decade:

i. Poverty alleviation

ii. Gender equality
iii. Natural resources
iv. Health promotion
v. Rural transformation
vi. Human rights
vii. Peace
viii. International understanding
ix. Cultural/linguistic diversity
x. The potential of information and communications technologies (ICTs)

The emphasis is on:

- Supporting local initiative.
- Ensuring that structures (national, regional, and international) provide direction and guidance for local initiatives.
- Re-orienting educational policies. It's about the way we live our lives; the way we respect the lives of others; and our attitudes to the world around us.
- Broad-based strategies to build peace, hope, stability, tolerance, and mutual understanding.
- Gender equality
- Overcoming poverty
- Literacy - "literacy for all is at the heart."
- Education as a central strategy for sustainable development. (IEF, 2005)

Education: Promise and Paradox

Two of the major issues in the international dialogue on sustainability are population and resource-consumption. Increases in population and resource-use are thought to jeopardize a sustainable future, and education is linked both to fertility-rate and resource-consumption. Educating females reduces fertility-rates and therefore population-growth. By reducing fertility-rates and the threat of overpopulation, a country also facilitates progress toward sustainability. The opposite is true for the relationship between education and resource-use. Generally, more highly educated people, who have higher incomes, consume more resources than poorly educated people, who tend to have lower incomes. In this case, more education increases the threat to sustainability.

Unfortunately, the most educated nations leave the deepest ecological footprints, meaning that they have the highest per-capita rates of consumption. This consumption drives resource-extraction and manufacturing around the world. The figures from the United Nations Educational, Scientific and Cultural Organization (UNESCO) Statistical Yearbook and World Education Report, for example, show that in the United States more than 80 percent of the population has some post-secondary education, and about 25 percent of the population has a four-year degree from a university. Statistics also show that per-capita energy use and waste generation in the

United States are nearly the highest in the world. In the case of the United States, more education has not led to sustainability. Clearly, simply educating citizenry to higher levels is *not* sufficient for creating sustainable societies. The challenge is to raise the educational levels without creating an ever-growing demand for resources and consumer goods and the accompanying production of pollutants. Meeting this challenge depends on reorienting curriculums to address the need for more sustainable production and consumption patterns.

Every nation will need to reexamine the curriculum at all levels (i.e., pre-school to professional education). While it is evident that it is difficult to teach environmental literacy, economics literacy, or civics without basic literacy, it is also evident that *simply increasing* basic literacy, as it is currently taught in most countries, will *not* support a sustainable society.

THRESHOLDS OF EDUCATION AND SUSTAINABILITY

For instance, when educational levels are low, economies are often limited to resource-extraction and agriculture. In many countries, the current level of basic education is so low that it severely limits development-options and hinders plans for a sustainable future. A higher educational level is necessary to create jobs and industries that are "greener" (i.e., having lower environmental impacts) and more sustainable.

The relationship between education and sustainable development is complex. Generally, research shows that basic education is a key to a nation's ability to develop and achieve sustainability targets. Research has shown that education can improve agricultural productivity, enhance the status of women, reduce population growth-rates, enhance environmental protection, and generally raise the standard of living. But the relationship is not linear. For example, four to six years of education is the minimum threshold for increasing agricultural productivity. Literacy and numeracy allow farmers to adopt new agricultural methods, cope with risk, and respond to market signals. Literacy also helps farmers mix and apply chemicals (e.g., fertilizers and pesticides) according to manufacturers' directions, thereby reducing the risks to the environment and human health. A basic education also helps farmers gain title to their land and apply for credit at banks and other lending institutions. Effects of education on agriculture are greatest when the proportion of females educated to threshold level equals that of males (Education for Sustainable Development Toolkit by Dr. Rosalyn McKeown with assistance from Charles Hopkins, Regina Rizzi, and Marrianne Chrystalbridge).

Education benefits a woman in life-altering ways. An educated woman gains higher status and an enhanced sense of efficacy. She tends to marry later and have greater bargaining power and success in the "marriage market." She also has greater bargaining power in the household after marriage. An educated woman tends to desire a smaller size of family and seek the health-care necessary to do so. She has fewer and healthier children. An educated woman has high educational and career expectations

of her children, both boys and girls. For females, education profoundly changes their lives, how they interact with society, and their economic status. Educating women creates more equitable lives for women and their families and increases their ability to participate in community decision-making and work toward achieving local sustainability goals.

Another educational threshold is primary-education for women. At least a primary education is required before birthrates drops and infant health and children's education improve. Nine to twelve years of education are required for increased industrial productivity. This level of education also increases the probability of employment in a changing economy. Few studies have been carried out on how education affects environmental stewardship, but one study suggests that a lower-secondary education (or approximately nine years) is necessary to intensify the use of existing land and to provide alternative off-farm employment and migration from rural areas. Finally, a subtle combination of higher education, research, and life-long learning is necessary for a nation to shift to an information or knowledge-based economy, which is fueled less by imported technology and more by local innovation and creativity (UNESCO-ACEID, 1997).

EDUCATION DIRECTLY AFFECTS SUSTAINABILITY-PLANS IN THE FOLLOWING THREE AREAS:

a) Implementation. An educated citizenry is vital to implementing informed and sustainable development. In fact, a national sustainability plan can be enhanced or limited by the level of education attained by the nation's citizens. Nations with high illiteracy rates and unskilled workforces have fewer development options. For the most part, these nations are forced to buy energy and manufactured goods on the international market with hard currency. To acquire hard currency, these countries need international trade; usually this leads to exploitation of natural resources or conversion of lands from self-sufficient family-based farming to cash-crop agriculture. An educated workforce is the key to moving beyond an extractive and agricultural economy.

b) Decision Making. Good community-based decisions - which will affect social, economic, and environmental well-being - also depend on educated citizens. Development options, especially "greener" development options, expand as education increases. For example, a community with an abundance of skilled labour and technically trained people can persuade a corporation to locate a new information-technology and software-development facility nearby. Citizens can also act to protect their communities by analyzing reports and data that address community-issues and by helping to shape a community-response. For example, citizens who were concerned about water-pollution reported in a nearby watershed started monitoring the water-quality of local streams. Based on their data and information found on the World Wide Web, they fought against the development of a new golf-course, which would have used large amounts of fertilizer and herbicide in maintenance of the grounds (Education for

Sustainable Development Toolkit by Dr. Rosalyn McKeown, with assistance from Charles Hopkins, Regina Rizzi, and Marrianne Chrystalbridge).

c) Quality of life. Education is also central to improving the quality of life. Education raises the economic status of families; it improves life-conditions, lowers infant mortality, and improves the educational attainment of the next generation, thereby raising the next generation's chances for economic and social well-being. Improved education holds both individual and national implications.

STRATEGIC PATH TO EDUCATION FOR SUSTAINABLE DEVELOPMENT

Improving Basic Education. The first priority of ESD as outlined in Chapter 36 of Agenda 21 was the promotion of basic education. The content and years of basic education differ greatly around the world. In some countries, for instance, primary school is considered basic education. In others, eight or twelve years is mandatory. In many countries, basic education focuses on reading, writing, and ciphering. Pupils learn to read the newspaper, write letters, figure accounts, and develop skills necessary to fulfill their expected roles in their households and community. Girls, for example, may learn about nutrition and nursing. Pupils also learn how their government functions and about the world beyond their community.

Simply increasing basic literacy, as practised in most developing countries, will not advance sustainable societies. Indeed, if communities and nations hope to identify sustainability goals and work toward them, they must focus on skills, values, and perspectives that encourage and support public participation and community decision- making. To achieve this, basic education must be reoriented to address sustainability and expanded to include critical-thinking skills, skills to organize and interpret data and information, skills to formulate questions, and the ability to analyze issues that confront communities.

In many developing countries, the current level of basic education is too low, severely hindering national plans for a sustainable future. In Latin America and the Caribbean, many countries have six to eight years of compulsory education, with approximately five to fifteen percent of the students repeating one or more years. In parts of Asia, especially Bangladesh, Pakistan, and India, many children only attend school for an average of five years. A complicating factor in this region is that many girls receive fewer years of schooling to create that average. In parts of Africa, where life is constantly disturbed by drought or war, the average attendance in public education is measured in months, not years. Unfortunately, the lowest quality of education is often found in the poorest regions or communities. The impact of little and/or poor-quality education severely limits the options available to a nation for developing its short- and long-term sustainability plans.

As nations turned their attention towards education in the 1990s and the new millennium, they have made much progress in basic education. In fact, enrollment

rate in primary education is rising in most regions of the world. Also, enrollment of girls has increased faster than that of boys, which is helping to close the gender gap evident in so many countries. At the global level, the gender-gap in both primary and secondary school is narrowing. Despite all of this progress, too many female children remain out of school, and the gender gap will not close prior to the "Education For All" target date of 2005. The recognition of the need for quality basic education sets ESD apart from other educational efforts, such as environmental education or population education (Education for Sustainable Development Toolkit by Dr. Rosalyn McKeown, with assistance from Charles Hopkins, Regina Rizzi, and Marrianne Chrystalbridge).

RE-ORIENTING EXISTING EDUCATION

The term "reorienting education" has become a powerful descriptor that helps administrators and educators at every level (i.e., nursery school to university) to understand the changes required for ESD. An appropriately reoriented basic education includes more principles, skills, perspectives, and values related to sustainability than are currently included in most educational systems. Hence, it is not only a question of quantity of education, but also one of appropriateness and relevance. ESD encompasses a vision that integrates environment, economy, and society. Reorienting education also requires teaching and learning knowledge, skills, perspectives, and values that will guide and motivate people to pursue sustainable livelihoods, to participate in a democratic society, and to live in a sustainable manner.

The need to reorient basic and secondary education so as to address sustainability has grabbed international attention, but the need at the university level is just as great. Society's future leaders and decision-makers are educated there. If these young people are expected to lead all sectors of society (e.g., government, medicine, agriculture, forestry, law, business, industry, engineering, education, communications, architecture, and arts) in a world striving toward sustainability, then the current administration and faculty members must reorient university-curriculums to include the many and complex facets of sustainability.

In reorienting education to address sustainability, program-developers need to balance looking forward to a more sustainable society with looking back to traditional ecological knowledge. Indigenous traditions often carry with them the values and practices that embody sustainable resource-use. While returning to indigenous lifestyles is not an option for the millions of urban dwellers, the values and major tenets of indigenous traditions can be adapted to life in the 21st century.

Reorienting education to address sustainability is something that should occur throughout the formal-education system - that includes universities, professional schools (e.g., law and medicine), and technical schools, in addition to primary and secondary education.

Public Understanding and Awareness: Sustainability requires a population that is aware of the goals of a sustainable society and has the knowledge and skills to contribute to those goals. The need for an informed voting citizenry becomes even more important with the increase in the number of democratic governments. An informed voting citizenry, which lends support to enlightened policies and governmental initiatives, can help governments enact according to sustainable measures. Citizens also need to be knowledgeable consumers who can see beyond the "green wash" (i.e., public-relations efforts that highlight the activities of corporations that are more environmentally responsible while ignoring or hiding the major activities that are not). In today's world, people are surrounded by media (e.g., television, radio, newspapers, magazines) and advertisements (e.g., bill boards, banners on World Wide Web sites, and logos on clothing). As a result, people must become media-literate and be able to analyze the messages of corporate advertisers.

Years of resource-management has shown that a public that is aware of and informed, about resource-management decisions and programs, can help achieve program goals. In contrast, an uninformed public can undermine resource-management programs. Education has also been essential in many other types of programs, such as public-health efforts to stop the spread of specific diseases.

Training: Training was also stressed in Chapter 36 of Agenda 21. The world needs a literate and environmentally aware citizenry and work-force to help guide nations in implementing their sustainability plans. All sectors - including business, industry, higher education, governments, nongovernmental organizations (NGOs), and community organizations - are encouraged to train their leaders in environmental management and to provide training to their workers.

Training is distinct from education, as training is often specific to a particular job or class of jobs. Training teaches workers how to use equipment safely, efficiently and comply with regulations (e.g., environmental, health, or safety). For instance, a training program might teach workers to avoid changing the waste stream without notifying their supervisor. Further, an employee involved in a nonroutine activity, such as cleaning a new piece of equipment, is instructed not to dispose of the cleaning solvent by pouring it down a storm sewer drain that leads to the river. Some training, such as training women to use solar cookers rather than cooking on open, wood-fueled fires, involves tremendous change in social dynamics and practices. In this case, women must not only learn the mechanics of solar cookers, but they must also change daily routines of meal-preparation to cook while the sun is high in the sky, rather than in the evening.

Training enables people to learn the accepted practices and procedures and gives them skills to perform specific tasks. In contrast, education is a socially transforming process that gives people knowledge, skills, perspectives, and values, through which they can participate in and contribute to their own well-being and that of their community and nation.

Formal, Non-Formal, and Informal Education: For a community or a nation, implementing ESD is a huge task. Fortunately, formal education does not carry this educational responsibility alone. The nonformal educational sector (e.g., nature centers, nongovernmental organizations, public- health educators, and agricultural extension agents) and the informal educational sector (e.g., local television, newspaper, and radio) of the educational community must work cooperatively with the formal educational sector for the education of people in all generations and walks of life.

Because ESD is a lifelong process, the formal, nonformal, and informal educational sectors should work together to accomplish local sustainability goals. In an ideal world, the three sectors would divide the enormous task of ESD for the entire population by identifying target audiences from the general public, as well as themes of sustainability. They would then work within their mutually agreed realms. This division of effort would thus reach a broader spectrum of people and prevent redundant efforts.

LOCALIZING THE GLOBAL INITIATIVE

While many delegates at the UN Commission on Sustainable Development (CSD) meeting in 1998 enthusiastically agreed that ESD was essential for achieving sustainable development, they were stymied about its implementation. Progressing from the global concepts of ESD to locally relevant curriculum is a difficult process. Many decisions, assumptions about the future, and examinations of local cultures have to be made. Creating ESD curriculums will require knowledge of the present and foretelling of the future. Although the resulting ESD programs may be well- or poorly targeted, the consequences of doing nothing are unacceptably high. Therefore, even if it is not precisely targeted, creating an ESD program is imperative.

To create an ESD curriculum, educational communities will need to identify knowledge, issues, perspectives, skills, and values central to sustainable development in each of the three components - environment, economy, and society. Table-2 is an

Table - 2: Some Possible Combinations

	Environment	Economy	Society
Knowledge	Hydrologic cycle	Supply and demand	Conflict
Issues	Protecting and managing fresh water; managing hazardous wastes	Combating poverty	Changing consumption patterns
Skills	the ability to acquire, Manage, and analyze Data	the ability to identify components of full-cost accounting	the ability to think critically about value issues

example of what one community may select. However, many possible combinations of knowledge, issues, skills, perspectives, and values for ESD curriculums exist. The program should be tailored to fit community situations and needs.

Strengths Model

The cost of reorienting education to address sustainability is so great that nations cannot afford to rely on a remediation model to retrain the world's 59 Million teachers. Rather than primarily retraining inservice teachers to teach sustainability, we need to design new approaches to pre-service and inservice teacher-education in order to address sustainability. One such innovative approach is the "strengths model." In this approach, every discipline and every teacher can contribute to sustainability education (Education for Sustainable Development Toolkit by Dr. Rosalyn McKeown with assistance from Charles Hopkins, Regina Rizzi, and Marrianne Chrystalbridge).

Many topics inherent in ESD are already part of the formal education curriculum, but these topics are not identified or seen to contribute to the larger concept of sustainability. Identifying and recognizing components of ESD is the key to moving forward. Fortunately this step is easy and affordable.

To implement the “strengths model”, begin by ensuring that educators and administrators understand the concept of sustainability and are familiar with its principles. Once they understand the concept of sustainability, educators from each discipline can examine the curriculum and school activities for existing contributions to ESD. Next, educators can identify potential areas of the existing curriculum in which to insert examples that illustrate sustainability or additional knowledge, issues, perspective, skills or values related to sustainability.

After identifying existing and potential contributions, leaders can create awareness among the educational community of these contributions to the larger ESD picture. Then, these contributions can be woven together to create ESD programs that are taught overtly to pupils and students. In this approach, the synergistic strengths of combined educational disciplines can convey the knowledge, issues, skills, perceptions, and values associated with ESD.

No one discipline can or should claim ownership of ESD. In fact, ESD poses such broad and encompassing challenges that it requires contributions from many disciplines. For example, consider these specific disciplinary contributions to ESD:

- Mathematics helps students understand extremely small numbers (e.g., parts per hundred, thousand, or million), which allows them to interpret pollution data.
- Language Arts, especially media literacy, creates knowledgeable consumers who can analyze the messages of corporate advertisers and see beyond "green wash.”
- History teaches the concept of global change, while helping students to recognize that change has occurred for centuries.

- Reading develops the ability to distinguish between fact and opinion and helps students become critical readers of political campaign literature.
- Social Studies helps students to understand ethnocentrism, racism, and gender inequity, as well as to recognize how these are expressed in the surrounding community and nations worldwide.

Each discipline also has associated pedagogical techniques. The combined pedagogical techniques and strategies of each discipline contribute to an expanded vision of how to teach for creativity, critical thinking, and a desire for life-long learning - all mental habits that support sustainable societies.

The contributions of the environmental education and science-education communities to the environmental strand of ESD have been well-documented in the literature; however, equal attention has not been focused on the social and economic strands. Yet, the efforts of schools to create more just, peaceable, and equitable societies suggest that the social strand appears to be well-developed in many countries. In fact, schools that have programs in multicultural education, anti-racist education, gender equity, anti-bullying, and peace-education contribute substantially to the social strand of ESD.

Use of this "strengths model" requires that a cadre of educators and administrators, who are sufficiently well-versed in the transdisciplinary concepts inherent in ESD, pull together the disciplinary and pedagogical pieces to form a comprehensive ESD program. The integration process will prevent omissions and duplication. In order to create a generation of educators and administrators who understand the strengths model, it must be employed by institutions of teacher education and overtly taught to pre-service professionals.

ESD, AN EVOLVING CONCEPT

In reorienting education to address sustainability, it is important for educators not to lock the definition, content, scope, and methodology of ESD into a static time-frame. The temptation exists to use Agenda 21 to define ESD curriculums; however, the global discussion and understanding of sustainability has grown greatly since the 1992 Earth Summit. Educational efforts must reflect this broader understanding and its evolving nature.

While Agenda 21 clearly identifies critical issues that governments around the world need to address, the concept of sustainability continues to evolve as societies change and as our awareness and perceptions of Earth, humanity, and human-environmental interactions correspondingly change. Subtle changes, such as a shift in focus or emphasis, will of course be regional in nature and reflect the conditions of local ecosystems and cultures. As a result of the maturing nature of sustainability issues, those educating for sustainability should continually adapt the content, scope, and methodology within geographic and temporal contexts. This constant adaptation will

require flexibility on the part of educators as they work together on local and international projects. Definitions and practices that are admirably effective in one part of the world can be ineffective or inappropriate in another. Some of the challenges facing ESD are:

- It is so comprehensive, including the provision of basic education and a wide range of themes addressed by the World Summit on Sustainable Development - including water, energy, health, agriculture and biodiversity - WEHAB. This leads to a lack of clarity in communicating what is meant by sustainable development education.
- There is an ambition to educate everyone to bring about a global citizenship.
- Social, organizational or institutional factors constrain change to sustainable development, yet there is an emphasis on formal education.
- There is a lack of balance in addressing the social and economic dimensions of the field, leading to an interpretation that it is mainly about environment and conservation issues.
- New learning and knowledge-management approaches are called for, to promote more debate in society.

Higher Education and Sustainable Development

Bertrand Russel said, "World could be transformed if the basis of education is knowledge wielded by love & values for a sustainable development. Through education we need to pass on the message to the society that to maintain the quality, it requires commitment, acceptance, reverence & eloquence. It is not the quantity of education but the quality that is important. To maintain quality, it requires constant efforts, courage, conviction & commitment".

There is a great need to make sustainable development a central part of the education strategy for the future development of the higher-education sector. Every country's vision should be to make the higher education sector a major contributor to society's efforts to achieve sustainability - through the skills and knowledge that its graduates learn and put into practice, and through its own strategies and operations.

Higher Education for Sustainable Development does not only require new methods and forms of learning, but the content itself also requires reorientation and a comprehensive change of perspective. Sustainable solutions for the ever more complex problems of today's world call for cooperation and exchange between industrialized countries and the countries of the Southern Hemisphere. Intercultural and global approaches play a central role in this respect, as do aspects of "Managing Diversity".

The following steps can be taken in this regard:

- Developing curricula, pedagogy and extra-curricular activities that enable

students to develop values, skills and knowledge to contribute to sustainable development;

- Universities should encourage interdisciplinary and collaborative education and research-programmes related to sustainable development, as part of the institution's central mission. Universities should also seek to overcome competitive instincts between disciplines and departments;
- Universities should support efforts to fill in the gaps in the present literature available for students, professionals, decision-makers and the general public by preparing information didactic material, organizing public lectures, and establishing training programmes;
- Academia should contribute to educational programmes designed to transfer educationally sound and innovative technologies and advanced-management methods;
- Educational institutes should take the initiative in forging partnerships with other concerned sectors of society, in order to design and implement coordinated approaches, strategies and action plans;
- Strengthening links to businesses, the community, civil society, government and others in pursuit of sustainable development.

Increased emphasis on postgraduate-level research-programmes, specifically dedicated to sustainable development in accordance with the needs of every country and for the guidance of policy makers.

Building new skills, knowledge and tools needed for sustainable development through research.

Sensitizing People to the Importance of ESD

The stakeholders across all the sectors i.e. education, media and NGOs should play an integral role in creating awareness and becoming co-owners of the ESD vision. The following steps in this regard can be helpful:

- Curriculum development, teacher's education, (especially pre-service education), a methodology to ensure quality education, the creation of a tertiary institution to embrace and support ESD, and the need to share best practices in ESD to be encouraged by the decision makers, education planners and policy makers;
- Initiating practical, structured training-programmes and related activities with a dual focus on philosophical and practical knowledge (basic information and skills) related to sustainable development;
- Associating media with all stakeholders, NGO's, the private sector, schools and policy makers;
- Sensitizing media owners and publishers about ESD issues;
- Development of Website and media for advocacy, information exchange, training, and coordination;
- Preparation of generic training/sensitization materials for policy makers,

education planners, teachers and teacher trainers.

Given below are the examples of Japanese and Korean education-systems as reference points for developing countries and provide a clear picture of their educational experiences:

SOME TYPICAL CASES

Japanese Educational Achievements

At the time when a modern educational system was introduced into Japan, Japan confronted "quantitative expansion," "qualitative upgrading," and "management improvement," like developing countries today. As a result of actively tackling these issues, Japan was able to realize the diffusion of basic education within a comparatively short period of time. Japan's experience of this process may contain elements that could be useful for developing countries today.

At the time when Japan introduced a modern education system, emphasis was laid on the quantitative expansion of primary education. Then, when the diffusion of primary education was virtually complete, emphasis shifted to qualitative upgrading and to the expansion of secondary and higher education. Educational management has been a consistent focus of attention, but it is possible to observe a trend whereby in terms of educational administration, there has been a devolution of authority and responsibility from the central government to the local governments and to schools; but on the other hand, in terms of educational finance, while in the beginning, large burdens were borne by parents and communities, over the years, the burden borne by the national treasury has gradually increased. This kind of changing pattern in terms of educational development is likely to be of use as a reference point to developing countries thinking of their own educational development.

In Japan, the prioritization of educational policy and the consistent implementation of educational improvements by central government against a background of comparatively favorable socio-educational conditions (including the wide diffusion of traditional education), and roads, the educational development was carried out in a context of cooperation between government and the people. And at the classroom level, a characteristic that deserves to be highly considered is the way in which teachers repeatedly use their creativity and ingenuity in their continuing efforts to tackle the qualitative upgrading of education. The characteristics mentioned earlier can be seen as offering perspectives to developing countries at the time they consider their educational development.

The Educational experience that Japan has passed through is not only useful information for countries that are examining educational development matched to the development stage that they have reached, but it can also be referred to in the form of case-studies or utilized in the form of development-options in the context of

educational development. Japan's greatest educational achievement is the high-quality basic education most young people receive by the time they complete high school. Japanese students consistently rank among world leaders in international science-tests. Recent statistics indicate that well over 95 percent of Japanese are literate, which is particularly impressive since the Japanese language is one of the world's most difficult languages to read and write. The above-mentioned educational strategies adopted in Japan were extremely helpful to trigger the process of sustainable development in the country and the excellence achieved in the field of education paved the way for Japan towards progress and prosperity.

Korean Education

Along with the strong belief in the family and cultural traditions, Koreans value the education and are willing to make significant personal sacrifices to ensure that their children are afforded the best available learning opportunities. No nation has a higher degree of enthusiasm for education than Korea, and nowhere are children under more pressure to study. Evidence of major educational accomplishments, such as degrees from prestigious colleges and universities, strongly influence a person's suitability for employment, marriage, and everyday interpersonal relations.

In 1996 Moo-Sub Kang, director general of the Korean Educational Development Institute, noted that administration of education was gradually moving from the national Ministry of Education to individual schools. In 1998, a Presidential Commission for a New Education Community was established to encourage further reform. More recent educational policy encourages a modest degree of curriculum decentralization. Local boards of education, similar to those in the United States but covering larger geographic areas, now have the requisite degree of autonomy to interpret the national curriculum in terms of local needs. For example, some schools now offer more computer, art, music, and writing courses, eliminating the need for their extra curricular studies. Principals now can work with social-studies teachers in developing aspects of the curriculum that reflect local needs, such as character-education and community-service programs. In response to a changing society, the Korean government established a new vision for education. Unveiled by the Presidential Commission on Educational Reform in May 1995, this vision projected open, lifelong education that would provide individuals with equal and easy access to education, at any time and place. Further, the Commission felt that education suitable for the twenty-first century would be achieved through technology. The long-range goal was to raise the quality of education to a world-standard level of excellence. In short, education has contributed immensely to the growth of Korea's democratic government. It has produced hardworking and skilled employees who have brought forth an economic miracle within a single generation. It has reaffirmed traditional values, while maintaining its commitment to modernization, citizenship, and global involvement. The ambitious and comprehensive reform plans developed in 1995 by the Ministry of Education still appear to enjoy widespread public and professional support. A broad spectrum of the society recognizes the need for lifelong learning as a

precept for social and economic improvement and sustainable development.

CONCLUSIONS

The overarching goal is to infuse the concepts of sustainable development into all learning, from structured schooling in formal education settings to lifelong learning in non-formal programs. Education for sustainable development can help prepare our society for a fast-paced world of rapid scientific, social, technological workforce, and demographic changes.

The establishment of guidelines and objectives for educational programs embracing the basic principles of sustainable development will provide a basis for the development of an integrated, holistic and interdisciplinary approach. It would also encourage the promotion and use of appropriate, as well as innovative, emerging technologies and knowledge-based alternatives.

Education is a linking bridge from the past to the present, and from the present to the future. A deep recognition of the importance of education is the necessary first step if we are to achieve the level of democratic participation envisioned by a country. Infusing the concepts of sustainable development throughout our learning experiences will help foster that awareness. Involvement of educators, government, businesses, and non-governmental organizations, working toward common goals, will lead to an understanding of multiple perspectives and informed decision-making. How we meet the future is in our hands. Education for sustainable development provides an opportunity to craft the future we want for the world.

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NUCLEAR POWER AND SUSTAINABLE DEVELOPMENT

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INTRODUCTION

Since the last quarter of the 20th century, the need for sustainable socio-economic development through sound strategies and unambiguous implementation plans has been gaining increasing importance in the entire world community. The most serious issue has been the poverty alleviation. Several major world initiatives taken in this direction, the latest being the Johannesburg Summit of 2002, represent steps in the right direction but seem to be too ambitious to be implemented in a timely manner. To fulfil the objectives of such initiatives and achieve the assigned targets, it will be necessary to accelerate the energy growth in this century, restraining as much as possible, the use of carbon emitting fossil sources. The environmental burden and climatic degradation due to greenhouse gases will have corresponding adverse effects on the progress of socio-economic development. The developing countries will suffer the most from such adverse effects. A balance will have to be struck between the desired level of economic growth and the permissible levels of environmental degradation.

Nuclear energy, as a proven source of clean and assured energy supply, can greatly help in achieving the benefits and goals of sustainable socio-economic development and tilt the balance in favour of higher economic growth with lesser climatic degradation. The world opinion is now shifting in support of nuclear power due to its increasing economic competitiveness, stringent safety standards and better waste disposal solutions. The world is expecting a turn around of nuclear electric power and a so-called "second wind" is in the offing. Continuously increasing fossil fuel prices and devastations occurring due to climatic change are the main reasons for the nuclear energy to come back.

Innovative nuclear reactors and fuel cycle systems are going to be the main technological advancements of nuclear power in the 21st century. The new technological initiatives in this regard will improve economics, safety and security, waste disposal management and proliferation resistance. IAEA's International Project on Innovative Nuclear Reactors and Fuel Cycle (INPRO), US-led Generation IV International Forum (GIF) and the European Michelangelo network for competitiveness and sustainability of nuclear energy (Micanet), are already making progress. Asia is currently showing much interest in nuclear electricity generation and

the projections show that the demand of nuclear power will grow further in this region in coming decades. Developing countries can benefit from the new innovative approaches, much so from INPRO if they join its programmes at the present evolving stages. Nuclear power generated from innovative reactors will provide more acceptable energy component in the overall energy mix needed to successfully pursue the goals of sustainable socio-economic development at global level. Close collaboration between the three world innovative initiatives will be useful for the rapid development and success of the anticipated improved nuclear technologies in the next half century.

SUSTAINABLE DEVELOPMENT

The term "sustainable development" has been assuming increasing importance and popularity in the economic, social, political and environmental circles throughout the globe during the past few decades. The main reason for its popularity is that it embodies a wide range of concepts related to development and, hence, serves the purpose of comprehensive debate for decision and policy-making entities in the governments, private entrepreneurship, academia, NGO's and others. Owing to its widespread use related to the matters concerning human welfare, it is necessary that an exact concept of sustainable development is agreed upon, so that difficulties or ambiguities could be avoided while deciding the implementation of strategies and programmes that normally involve very high capital investments. This is more so when we set out to discuss the role of nuclear power, in relation to sustainable development.

The popularization of the term sustainable development started with the UN Conference for Environment and Development, generally known as Earth Summit in 1992. This Conference was the result of a report entitled "Our Common Future" by the World Commission on Environment and Development, also known as the Brundtland Commission {Brundtland, G.,Chairman, WCED, 1987, Oxford University Press}which called for strategies to strengthen efforts to promote sustainable and environmentally sound development. Brundtland gave the definition of sustainable development as "Development that meets the needs of the present, without compromising the ability of future generations to meet their own needs". Although the Brundtland definition is generally employed to depict sustainable development, its precise meaning has been widely debated and it is interesting to note that just after two years of the popularization of the definition, around 140 definitions of sustainable development had been put forward.

The Brundtland definition contains two key concepts, first the concept of "needs", in particular the essential needs of the world's poor to which overriding priority should be given and the second concept of limitations imposed by the state of technology and social organizations on the environment's ability to meet present and future needs. Several further definitions and ideas have been associated with the terminology, depending upon the nature of interests and professions of those who use it and also in

relation to the circumstances in which it needs to be fitted. Many people reject the term sustainable development, as an overall term, in favour of sustainability and reserve sustainable development for specific developmental activities, such as energy development, the former being the process by which we can achieve the latter. A good descriptive definition seems to be that "sustainable development is maintaining a balance between the human need to improve lifestyles and feeling of well-being, on the one hand, and preserving natural resources and ecosystems on which we and our future generations depend, on the other". However, sustainable development may preferably be considered to be more like a journey than a destination. "The immediate goal is to take steps in the right direction that enhance the range of available options, rather than foreclose any of them. Along the road, further choices and trade-offs will be required" {NEA/OECD report on Nuclear Energy in a Sustainable Development Perspective, 2000}.

No matter how many definitions or concepts of sustainable development there may be, it is clear that the idea of conservation of the environment is always an essential part of all these definitions and explanations. Generally speaking, sustainable development would comprise three basic components, i.e., economic development, social development and environmental development. Energy is a cross-cutting developmental driving force to achieve all the aforestated components. Assured, dependable and secure clean-energy supplies would be needed in an increasing quantum to meet the goals of the sustainable development for the near and distant future.

One should not, however, ignore the fact that sustainable development has been received differently by the developed and the developing societies. For the rich nations, sustainability is an essential requirement for all the developmental plans in the poor countries. On the other hand, the poor countries are more concerned with that kind of development which meets their *immediate needs* to address hunger, poverty, health and education. Immediate remedial development, rather than sustainable development is the preference of several developing nations facing acute problems of hunger and disease. This sentiment was amply manifested in the World Summit on Sustainable Development held in Johannesburg, South Africa from 26 August to 4 September 2002. A typical sense of expression on these lines was clearly present in the speech delivered by the President of Tanzania which, inter alia, stated "Agenda 21 was designed to achieve a balance between the needs of people and their environment, balance between the basic requirements of the living, and our inescapable, collective obligations to future generations. But the poor, the hungry and the diseased cannot be expected to put the preservation of their environment above their struggle to survive this very day. So they mine soil-nutrients, cultivate steep slopes, cut trees for wood fuel and overgraze range lands. Many of them know this is harmful to the environment. But for them, it is not the quality of life that is at stake, it is life itself. For them sustainability is a secondary concern, the primary one is to get the wheel of development turning, and turning faster".

It is, therefore, evident that poorer nations whose main concern is "development now" and the richer nations whose desire rests on the concept of "sustainable development", represent two distinctly different camps and, hence, will most likely tackle the challenges of development in different ways. Nevertheless, the development, whether sustainable or not, is the common objective of every one and meaningful development will always require energy as an essential propellant for any kind of development.

Internationalisation of Sustainable Development

The twentieth century's dramatic advances in science and technology had major impacts on social and economic patterns of the world.Barriers of distances, time and communication were broken which brought the nations of the world; at common man's level, much closer to each other. Decolonialisation resulted in the emergence of new business and trade relationships between the rich and the poor countries. Many new countries were born in Asia and Africa, giving new dimensions to political and economic scenario of the world. Two world wars, appearance and elimination of Russia as a superpower, exploitation of new economic resources, like oil and gas, and several other world-scale events gave a big stir to the socio-economic, political and ethical concepts throughout the world. The readjustment patterns that emerged at that time resulted in strong polarity, both in political and economic fields. Rapid industrial growth in the North, with corresponding military advancement, and deterioration of economies of the South accentuated the already existing gap between the two worlds. The poor countries could not manage to improve their competencies in knowledge, social coherence, economy and environmental protection. This trend prevailing over several decades resulted in such widespread underdevelopment in the world that approximately one-third of the world's population is now living with an income of under one US dollar per day. Obviously, such a vast disparity, between the predominantly small proportion of rich population and vastly large proportion of the poor of the world, was the result of reckless utilization of natural resources, human exploitation and, above all, serious degradation of the environment. Overdrawing the energy resources by the industrialized world led to the startling scenario that, by 2000, some 1.64 billion people (around 27% of world population) did not have access to electricity {Planet's Voice, Special Ed.1, June 2004}.

Since the middle of the last century it was becoming increasingly evident that the growing economic disparity between the rich and the poor nations of the world would have unpleasant implications for the world's peace and stability. The idea of combined international action against this growing trend came into being and several international fora, including the UNO, started a serious consideration of the issue of development. Several regional groupings came into existence; based on anticipated political and economic advantages noteworthy being the European Community, OECD, ASEAN, SAARC. Member countries of these groupings were in a much better position to collectively bargain on developmental issues than those who were fighting their own battles separately. Useful ideas came out of these groups, which assisted in the clarification of problems, formulation of strategies, identification of possible areas

of cooperation and future lines of action for globally addressing the pressing issues of sustainable development. However, due to lack of effective implementation, these ideas could not provide significant improvement in alleviation of poverty nor did the economic unions produce any sizeable difference as far as the issues of health, food, education and industrialization in the poor regions of the world were concerned. However, one positive and praiseworthy outcome of all such activities was that the world awareness on the poverty issue was recognized, on international scale, and the need for collective action to mitigate the continuing negative effects of underdevelopment was clearly established.

Some Important World-Initiatives

A lot has been written and debated on sustainable development on a worldwide basis, during the last few decades, concerning the issues of energy, economics, sociology, education, health, industry, agriculture and environment. It is not pertinent to quote here the vast literature available on these issues, as the subject of this Article is related to the linkage of nuclear power with sustainable development. However, it may be useful to peruse some relevant publications where the significance of science and technology has been highlighted for positive contributions to sustainable development. In this regard, an excellent book entitled "Education, Science and Technology in Developing Countries: Some Thoughts and Recollections" by Dr. Hameed Ahmed Khan (COMSATS Publication, Nov. 2004) and the other called "Science and Technology for Sustainable Development" (COMSATS Publication, Sept 2003) are recommended for further reading in order to get a quick and concise view of the debate. Additionally, numerous reports and papers are available in professional publications, which treat the subject with respect to its different components and can be consulted for specialized reading.

With regard to the three complex and cross-linked components of sustainable development, i.e., economic, social and environmental, which are directly related to the problems of poverty, health, education and food existing on a very large scale in the world of today, some important and well-intentioned initiatives have already been taken by the world community at the global scale. Prominent among these are (1) United Nations Conference on Human Environment, Stockholm, 5-6 June 1972, (2) United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992, and (3) the World Summit on Sustainable Development, Johannesburg, 26 Aug – 4 Sept 2002. Between the Rio and Johannesburg meetings, the world's nations have met in several major conferences under the auspices of the UN, including the International Conference on Financing of Development, Monterrey, Mexico, 18-22 March 2002, and the Doha Ministerial Conference of November 2001. In the year 2000, world leaders agreed on an ambitious plan to support global development-objectives in this century, referred to commonly as the Millennium Declaration. This global agreement lists eight fundamental Millennium Goals (MDG's), with 18 specific targets, to serve as a blue print and plan of action to address the most pressing global developmental needs. The main undertaking is that 189 nations are committed to

reduce by half the proportion of people living on less than a dollar a day, by the year 2015. The Devos Conference in Switzerland is another popular gathering of world-leaders to discuss the economic issues and their likely social and political implications. As the titles of the aforestated major global initiatives indicate, the Stockholm Conference was mainly concerned with environmental issues, the Rio Conference dealt both with the crucial issues of environment and development, whereas the Johannesburg initiative included the idea of sustainability in the global debate on development. The disappointments of both Stockholm and Rio conferences in the ensuing period paved the way for the Johannesburg Conference. The problem with these world-initiatives is that all of them are overambitious, qualitatively and quantitatively, and are based on the presumptions that the will and commitments of the partnership-factions, particularly those of the governments, will remain perpetually strong. It is obvious that such assumptions do not hold ground in the international geo-political and socio-economic realities over a long period of time. In addition, there were other loopholes in the initiatives, which needed to be addressed. For example, it is surprising that there is no MDG related to energy, which is an essential cross cutting need of all the sustainable developmental activities. Also important was to include vigorous debate and sound action-plans in the WSSD agenda for the control on unchecked growth of human population in the poor countries, as this factor is regarded as a major hindrance in sustainable economic development. Another surprising aspect is that these initiatives could not recognize nuclear power as an option for sustainable development.

Significance of the World Summit on Sustainable Development, Johannesburg -2002.

The World Summit on Sustainable Development (WSSD), held in Johannesburg from 26 August to 4 September, 2002, is an important milestone reached by the world community on the bumpy journey towards sustainable development. The importance and strength of this Summit is evident from the document issued at the end of this world-event, entitled "Johannesburg Declaration on Sustainable Development". This document is now serving as the most transparent and unambiguous declaration of the agreements reached through well-considered decisions of the delegates before and during the conference. The Declaration covers a wide range of components, political, social, economic, environmental, collaborative, technical, administrative, financial and strategic, which are essential to make the goal of sustainable development a reality in a foreseeable future. The most significant feature of the agreement is that it lays down detailed and well defined action-plan for the success of the implementation of the Summit agreements. There are fifteen points included in the commitment part of the Declaration, which have been rightly considered as essential to cover the wide scope of activities to be undertaken by the countries of the world with shared collective responsibility.

Another important aspect of significance of the WSSD is that it clearly explains the challenge of globalization and relevance of multilateralism as the necessary requirements for achieving the objectives of the Summit. In this context, the

document underlines the support of all the parties associated with the agreements to the leadership-role of the United Nations as "the most universal and representative organization in the world, which is best placed to promote sustainable development".

Energy, Sustainable Development and the Johannesburg Declaration

The importance of energy in connection with sustainable development has been clearly emphasized in the Johannesburg Declaration. More so, the need to link the energy with environmental protection has been emphasized repeatedly under various sections of the document. It is evident that energy plays a central role in sustainable development and poverty- reduction efforts. The UNDP view on this important aspect has been amply given out in its various publications affirming that energy affects all facets of development; social, economic and environmental, including livelihood, access to water, agricultural productivity, health, population and gender-related issues. Major improvements are needed in the quality and quantity of the energy services to achieve every Millennium Development Goal.

In the Johannesburg Declaration, the protection of environment and clean-energy generation has been highlighted again and again. For example, in the most important section on commitments to sustainable development, the declaration under item 18 states,"We welcome the focus of the Johannesburg Summit on the indivisibility of human dignity and are resolved, through decision on targets, timetables and partnerships, to speedily increase access to such basic requirements as clean water, sanitation, adequate shelter, energy, healthcare, food-security and the protection of biodiversity…..".

Under the section on Plan of Implementation of the World Summit on Sustainable Development, item 9, it states "Take joint actions and improve efforts to work together at all levels to improve access to reliable and affordable energy services for sustainable development sufficient to facilitate the achievement of the MDG's, including the goal of halving the proportion of people in poverty by 2015, and as a means to generate other important services that mitigate poverty, bearing in mind that access to energy facilitates the eradication of poverty. This would include action at all levels to :

a) improve access to reliable, affordable, economically viable, socially acceptable and environmentally sound energy-services and resources, taking into account national specificities and circumstances, through various means, such as enhanced rural electrification, etc.

b) develop national energy-policies and regulatory frameworks that will help to create the necessary economic, social and institutional conditions in the energy sector to improve access to reliable, affordable, economically viable, socially acceptable and environmentally sound energy-services for sustainable development and poverty eradication in rural, peri-urban and urban areas.

With respect to the section on "Changing unsustainable patterns of Consumption and Production", the item 20 of the Declaration calls upon Governments as well as relevant regional and international organizations and other relevant stakeholders to implement, taking into account national and regional specificities and circumstances, the recommendations and conclusions adopted by the Commission on Sustainable Development concerning energy for sustainable development at its ninth session, including the issues and options set out below, bearing in mind that, in view of the different contributions to global environmental degradation, states have common but differentiated responsibilities. This would include, inter alia, actions at all levels to:

a) take further action to mobilize the provision of financial resources, technology-transfer, capacity-building and the diffusion of environmentally sound technologies according to the recommendations and conclusions of the Commission on Sustainable Development as contained in Section A, para 3, and Section D, para 30 of its decision on energy for sustainable development.
b) support efforts, including through provision of financial and technical assistance to developing countries, with the involvement of the private sector, to reduce flaring and venting of gas associated with crude-oil production.
c) accelerate the development, dissemination and development of affordable and cleaner energy-efficiency and energy-conservation technologies, as well as the transfer of such technologies, in particular to developing countries, on favourable terms, including on concessional and preferential terms, as mutually agreed.
d) promote education to provide information, for both men and women, about available energy sources and technologies.
e) support efforts to improve functioning, transparency and information about energy- markets with respect to both supply and demand, with the aim of achieving greater stability and predictability and to ensure consumer-access to reliable, affordable, economically viable, socially acceptable and environmentally sound energy-services.
f) strengthen national and regional institutions or arrangements for enhancing regional and international cooperation on energy for sustainable development, in particular to assist developing countries in their domestic efforts to provide reliable, affordable, economically viable, socially acceptable and environmentally sound energy-services to all sections of their populations.
g) promote cooperation between international and regional institutions and bodies dealing with different aspects of energy for sustainable development within their existing mandates, bearing in mind the relevant paragraphs of the Programme of Action for the Further Implementation of Agenda 21, strengthening, as appropriate, regional and national activities for the promotion of education and capacity-building regarding energy for sustainable development.

It is clear from the above-mentioned provisions of the Johannesburg Declaration and Plan of Implementation that sustainable socio-economic development has been strongly linked, inter alia, with two major factors, first the utilization of energy and second clean environment. As a matter of fact, both these factors are strongly

interrelated. Clean environment means clean energy. Although its relationship has also been heavily correlated in numerous studies by the relevant entities, a clear reiteration on policy-level has reinforced its importance for future developmental efforts to achieve the MDG's.

Another noteworthy aspect of WSSD provisions, regarding the energy, is that it has very pertinently chosen to keep the decision on energy-option reasonably flexible. A lot of work has been published regarding the energy choice debate and it is evident that it is not possible to make definite decision in favour of one as against the other. The use of wide-ranging terminology in the WSSD to characterize the desired components of an energy-option include national and regional specificities and circumstances, differentiated responsibilities, cleaner energy-efficiency, affordability, predictability, reliability, economic viability, social acceptability and environmental soundness. This wide range of parameters helps the nations to decide what kind of energy-mix would suit their interests, keeping in mind two essential features, i.e., the clean energy as much as possible and saving the environment from degradation. The Declaration and the Plan of Action points to another important requirement from the policy-makers in the governments, regulatory bodies and the industry. This requirement pertains to the adoption of clean consumption-processes of energy in the industry. The present-day industrial processes cause significant pollution-problems to global environment through discharges in the air, water and on land. Cleaning the environment by energy-production precautions alone is not sufficient to achieve the targets set by Rio and Johannesburg moots. Industry has to undergo major technological restructuring, in order to make the processes clean and this may cause a major obstacle in practical terms to make decisions by the industry in favour of WSSD objectives and targets, as such technological changes would be highly capital-intensive. The discussions, conclusions and the language of the text of WSSD Declaration and Plan of Action does not exclude any energy-source to be utilized for sustainable development, provided the choice is made for one kind or the other or for a mix in a prudent manner. This argument answers the criticism of some quarters which are in favour of restricting the use of nuclear energy for power- generation meant to achieve the objectives of the Johannesburg Conference.

Johannesburg's Poverty Reduction Targets and Unclean Energy

A World Bank Report entitled "Johannesburg and Beyond: An Agenda for Action", published before the WSSD Summit and anticipating the post-Summit scenario on environmentally and socially sustainable development, points out an important paradox. While achieving the goal of poverty-reduction in the world, it will be necessary that the world's economy grows to a certain level, but it is necessary to use more energy to achieve the world's economic growth. And this energy will predominantly be from fossil fuels, causing increased threats to the environment. According to this report the following main features emerge :

i) The world population will be around 9 billion by 2050;

ii) In order to meet Millennium Development Goal of halving, by 2015; the approx. 29% of world population living on less than a US dollar; per day, the low-income countries will have to grow at per-capita rates of 3.6%;
iii) If MDG's are achieved by mid 21st century, at plausible and conservative world growth-rates, the world product in 2050 will be around 140 trillion US dollars;
iv) At estimated growth-rates of in per capita GDP of 2% in rich countries and 3.3% in low and middle income countries, by 2030 the world-income will rise to over 80 trillion US dollars, with 65% of it in the high-income countries. By 2050, the world-income will be around 140 trillion, with 40% of this in low and middle income countries;
v) If per capita incomes in low and middle income countries rise at 3.3% per year, this would yield US dollars 6300 per capita by 2050;
vi) In 2050, around 65% of all people will be living in urban areas, if the present trends continue;
vii) At current rates of loss, the world of 2050 will be much less biologically diverse and it will need find finances to preserve the biodiversity;
viii) Around 80% of the global GDP is shared by only 20% of the rich nations; consumption patterns on energy, water, food, manufactured goods and services are highly skewed and will remain so for the near future.

With reference to the above pattern of growth, the World Bank report contemplates that this quantum of growth poses risks to the natural environment, and these risks are greatest in the developing countries. As far as sustainable energy is concerned, not only will energy-output have to grow, but the quality of energy used in poor countries will have to increase as well. Improvements todate only help on the margins. The low level of current energy-consumption, especially electricity, in poor countries indicates that energy consumption will grow with the same pace as GDP. This would suggest that by 2050, around 150 million megawatts of new electricity-capacity would be required, which will most likely entail an environmental threat, within the current technological paradigm. Although the average carbondioxide emitted per constant dollar fell by 12.5% from 1980 to 1996, this still leaves today's world operating with high environmental burden and presents a major challenge for future growth.

Two important studies, out of several published during the past few decades, on the future patterns of world's unclean-energy use and carbondioxide emissions clearly indicate the major challenge the world will face while moving on to the path of economic growth. The first one is a short-range scenario, which relates to the European Commission's publication of 2003 entitled "World Energy, Technology and Climate Policy Outlook 2030". The relevant projections from the baseline of 1990 and moving upto 2030 are given in Table-1.

The second study pertains to well known World Energy Council's report on "Global Energy Scenarios to 2050 and Beyond" which particularly takes into account the long-term issues of environment and climate change. This report, with further inputs from the International Institute of Applied Systems Analysis (IIASA), gives a coverage of

Table - 1: (World Basis) Scenarios upto 2030

	1990	2000	2010	2020	2030	Percentage per year		
						1990/00	2000/10	2010/30
Population (Million)	5248	6102	6855	7558	6164	1.5	1.2	0.9
Final Energy Consumption *(Mtoe)	6270	7124	8682	10425	12132	1.3	2.0	1.7
Electricity Generation (TWh)	11945	14865	19339	26122	34716	2.2	2.7	2.9
of which Nuclear	2013	2622	3161	3137	3498	2.7	1.9	0.5
Percent Renewables in gross inland consumption	13	13	11	9	8	-0.2	-1.8	-1.4
Electricity Consumption per capita (KWh/cap)	1.8	2.1	2.4	3.0	3.7	1.1	1.7	2.1
Carbondioxide Emissions (MT of CO 2)	20843	23781	29376	36738	44498	1.3	2.1	2.1

*"Mtoe: Mega tones of oil equivalent

scenarios upto 2050 and then moves upto 2100. It is evident that the more the time span of a scenario, more will be the uncertainties associated with it. Therefore, for our current estimates of future energy-prospects, particularly from sources causing environmental problems, it may be more appropriate to refer to the projections upto 2050, which could be regarded as long-term scenario compared to 2015 scenario. Table-2 from the above-referred source gives such a picture.

This Table represents middle-of-the-road evolution (but not simply Business As Usual) scenario of the WEC study (Case B), which gives a Reference Scenario, reflecting stronger growth in energy-consumption in developing countries (China and India in particular) and poorer performance in the improvement of energy-efficiency. Both the above Tables indicate dramatic increase in the demand and supply of energy and increase of carbon emissions. These carbon emissions in Table-1 show an increase of 2.1% every decade from 2000 onwards and Table-2 (b) shows 66% increase in 2050 as compared to the value of 1990. These figures should act as wake-up signal to all the responsible inhabitants of this globe. In Table-2 (b) carbon emissions from developing countries is worth noting. If strict measures are not taken on global level to manage patterns of energy consumption and production, the world poverty is bound to

Table - 2: (World Basis) Primary Energy Supply and Carbon Emissions Scenarios upto 2050

(a) Energy Supplies

	1990	2050 (Gtoe)
Coal	2.2	4.1
Oil	3.1	4.0
Gas	1.7	4.5
Nuclear	0.5	2.7
Hydro	0.4	0.9
New Renewables	0.2	2.8
Traditional Biomass	0.9	0.8
Total:	**9.0**	**19.8**

(b) Comparisons for Various Types of Economies

Carbon Emission (GtC)	6.0	10.0
OECD Countries	4.2	5.6
Economies in Transition	1.7	2.4
Developing Countries	3.1	11.8
Total:	**9.0**	**19.8**

Note: GtC: Giga tones of carbon

increase appreciably, rather than the desired decrease as envisaged in the MDG's and in the WSSD.

The major devastating factor will be the adverse climate-change, which is already there and is being witnessed by the world community, though, without much serious response. The climate experts have identified that rises in average global temperatures are associated with steady rise of sea level, flooding of coastal areas, frequent extreme weather conditions, frequent poor harvest, water shortage, devastations, loss of biodiversity and increase of infections {European Renewable Energy Council publication "The Solution to Climate Change", pp 2-5, www.erec-renewables.org}. The Inter-governmental Panel on Climate Change (IPCC), in its Third Assessment Report in 2002, predicts that global average temperatures are likely to rise between 1.4 to 5.8 degrees Celcius over this century, depending on the amount of fossil fuels to be burned and the sensitivity of the climate-system. It is, therefore, necessary, that in order to avoid the aforestated threat of global degradation due to climate change, the global temperature increase should be limited to less than 2 degrees Celcius above pre-industrial levels. It is likely that a more than one degree Celcius temperature-increase in the climate system is already irreversible, so keeping to the 2 degree limit will need urgent action over the next two decades. The same source has indicated the increasing number and costs associated with major climate-related natural disasters over the past five decades, which are worked out in Table 3.

The Table shows more than fourfold increase in the number of disasters over the past

Table - 3: Major climate related natural disasters (Growth and Costs since 1950)

Decade	No. of Natural Disasters	Costs (Billion Euro)	Average Cost per Event (Billion Euro)
1950-59	20	32.7	1.6
1960-69	27	58.7	2.1
1970-79	47	105.6	2.3
1980-89	63	164	2.6
1989-1999	89	505.6	5.7

Note: The Tsunami disaster in December 2004, though not yet confirmed as totally due to climate change, alone costed approx. 6.2 Billion Euros (New Scientist, www.newscientist.com)

50 years, with increasing costs totaling more than a Trillion US dollars. The above discussion leads to the conclusion that the world has to shift to non-carbon emitting sources of energy by adopting alternative sources, better technologies of energy production and applying economic and social restraints on production-demands. The World Energy, Technology and Climate Policy Outlook, 2003, while commenting on the impacts of climate change-policies, points out two world scenarios,

i) "By attaching a carbon value to fossil-fuel use, carbondioxide emissions in 2030 are 21% lower than in the Reference at world-level and 26% lower in the EU and Accession Countries. At the world-level and in most regions, this reduction is achieved by equal reductions in energy-demand and in the carbon-intensity of energy consumption".
ii) "In the carbon-abatement case, more than half of the world energy-demand reduction is achieved in the industry sector. The decrease in the carbon-intensity comes mainly from the substitution of gas and biomass for coal and lignite and to a lesser extent, oil; gas-demand remains roughly stable, as fuel switching in favour of gas takes place. In contrast, the consumption of biomass increases significantly and nuclear progresses considerably, while large hydro and geothermal remain stable; finally wind solar and small hydro jump by a factor of 20".

A warning published in the same WETO study of 2003, P. Busquin, Member of the European Commission and responsible for Research has summed up the key results of carbondioxide emissions and policy-guidelines as "In a Reference scenario, i.e., if no strong specific policy-initiatives and measures are taken, world carbondioxide emissions are expected to double by 2030 and, with a share of 90%, fossil fuels, will continue to dominate the energy system." The foregoing discussion and the results of numerous other scientific studies have converged on strong inferences that, for the future sustainable development, it is imperative that the world now seriously looks for massive sources of clean energy, so that fossil fuel could be avoided as much as possible, keeping of course, economic and technical limitations in mind. It is evident

that the trends given in the Tables 1 and 2 associated with carbon emission growth must be checked through the mechanisms agreed in various world-initiatives and through the respect for commitments made by the world governments and leaders during the past three decades.

Help from Nanotechnology to Solve World Energy-Problems

The importance of clean energy for meeting the sustainable developmental goals in the 21st century, prescribed by various world initiatives and discussed in the previous sections of this text, need no further emphasis. It is also clear that sources of clean energy are extremely limited. Mostly the world is banking upon renewables and hydro. Nuclear is also coming back in a substantial way as a reliable source of clean energy. But, with the exception of nuclear, the other two have limited scope. It would, therefore, be extremely useful if help would be available from other new technologies to expand the scope of application of the above stated three sources of clean-energy. One such technology, which has come up recently with solid promise, is undoubtedly the nanotechnology.

Nanotechnology is defined as fabrication of devices with atomic or molecular-scale precision. Devices with minimum sizes, less than 100 nanometers (nm), are categorized as products of nanotechnology. The nanoscale marks the evolving boundary between the classical and quantum mechanical worlds; thus realization of nanotechnology promises to bring revolutionary capabilities. Fabrication of nanomachines, nanoelectronics and other nanodevices will, of course, solve an enormous number of problems faced by mankind today. {Nanoword net, Introduction to Nano technology, 2005 www.nanoword.net/pages/intro.htm}. Recognition of the enormous potential of nanotechnology, in a diverse array of everyday appliances, has triggered extensive R&D throughout the world with huge investments. Its potential in helping to meet the world's future energy-requirements for sustainable development has also become apparent lately and extensive developments are reported to be taking place in the areas of technology- improvements and cost-effectiveness. As the share of renewables, other than biofuels, in the production of primary-energy is expected to grow in the next half century, it would be an appropriate argument to explore the possibility of the help of nanotechnology to augment the effectiveness of clean technologies through R&D. Solar photovoltaics, Gratzel cells, Hydrogen fuel (storage, distribution and use), batteries, energy transformation, clean conventional energies, clean industrial production, energy-saving and computer-chips are some of the salient areas where nanotechnology has started showing its benefits {I. Malsch, Nanotechnology helps solve the world's energy problems; www.nanoforum.org;last update Dec 2004} These are briefly presented in the following summary:

From the summary (Figure-4), it is evident that nanotechnology research can contribute to solving future needs for energy-technologies, especially in new generations of photovolaics, the hydrogen economy, better conventional energy production and energy-saving for industry as well as consumers. Substantial budgets

Fig.-4 Summary: Applications of Nanotechnology to Solve World Energy Problem

Applications	Role of Nanotechnology	Remarks
Solar Photovolaics	Thin film nanostructured amorphous silicon deposited on glass, copper indium diselenide (CIS) and cadmium telluride	Currently less efficient than conventional materials, need technology improvement, attracting more market.
Gratzel Cells	Nanosized titanium dioxide particles of 20 nm dia with organic dye absorbed in the pores.	Long-term alternative of conventional crystalline silicon material of construction for PVs. Currently with low efficiency but with possibility of technology improvement. Finding increasing markets. Australian Sustainable Energy Development Authority (SEDA) investing to adopt it for CSIRO Energy Centre, Newcastle.
Hydrogen fuels, storage etc.	Nanostructured hydrides, carbon nanotubes,nanomagnesium, metal hydridecarbon,nanocomposites, Nanochemical hydrides and alanates.	Increasing use of metal hydride hydrogen storage systems for dry hydrogen storage for use as fuel in light transport systems. Further technology R&D in progress for carbon nanotubes, DIMES,TUDelft, silicon and lithium carbides, composites of carbon metal oxide, etc.
Cleaner conventional energy	Nanotechnology to improve conventional energy sources like coal,oil,gas,electricity and nuclear energy. Also contribution to electricity production and primary energy production. Efficient electric production form coal and gas by using nanotechnology in turbine plants. In nuclear energy, it can help improve the radiation resistance of materials.	Electricity production and nuclear energy are going to play major role in the realization of sustainable development goals set by the WSSD,Rio and Kyoto moots.
Batteries	Rechargeable batteries using nanostructured materials like lithium (lithium ion batteries) as dry batteries and metal hydrides, carbon nanotubes for wet batteries.	Large commercial use in near future. Extensive R&D on applied side is in progress.

continue...

continued...

Energy transformation	Conversion of primary energies including nuclear energy into heat, electricity and mechanical power through the use of nanotechnology. New nanostructured materials or nanocomponents under development for the aforestate uses. Less prominent nanotechnologies such as catalysts and membranes for gas separations are being actively researched.	Improvements in energy transformation have a great potential for clean energy availability. Gas separation will have applications in fuel cells and other transforming technologies.
Cleaner energy production	Nanotechnology based material to help reduction in energy use (energy saving) or increasing energy efficiency. Application in lightweight vehicles, automotive and oil industry, combined heat and power installations.	This application will serve a great purpose in diminishing the quantities of pollutants and CO_2 in the environment.
Energy saving	Nanotechnology use for evolving new nanotstructured materials like better isolation materials (nanofoams,etc.)	Major component of Govt. energy policies meant for consumers and industry.
Computer chips manufacture (Semiconductor electronics)	Application of new techniques based on nanotechnology to produce nanoscale circuit sizes (less than 100 nm)	A revolutionary advancement in computer industry with wide applications in power and energy sector. Hardship and hazard resistance improvement will widen the scope of applicability in commercial industrial power plants including nuclear particularly safety and security instrumentation.

for research have been dedicated to nanoresearch (both in the Government and private sectors), including the energy applications. Much of this potential is likely to be realized in the coming decades.

As nuclear power is expected to play a greater role in this century for meeting clean-energy demands for sustainable economic development of the world, nanotechnology can assist in this role more effectively and efficiently and it will assume greater significance in the near future. The major applications will be in the materials of

construction of a large majority of instruments, components and insulators, etc., in the nuclear island of the power plants where the levels of radiations are particularly high. This will have a positive bearing on the economy of power- plant operation, in safety and safeguards arrangements. All these factors are of direct importance to the innovative nuclear power-plant studies now being undertaken in the world. Such innovations will usher in a new era of nuclear-power generation in the world, whereby mankind will have more clean energy for its socio-economic development.

THE CASE FOR NUCLEAR POWER

Role of Nuclear Power in Sustainable Development

In 1933, Lord Ernest Rutherford had said "the energy produced by the breaking down of the atom is a very poor kind of thing. Anyone who expects a source of power from the transformations of these atoms is talking moonshine". In 1954, twenty-one years later, Lewis Strauss, Chairman, US Atomic Energy Commission, gave an entirely different opinion saying "it is not too much to expect that our children will enjoy in their homes (nuclear generated) electrical energy too cheap to meter". Incidentally, this was the same year when in the town of Obninsk, near Moscow, the first nuclear power plant sent electricity to residences and businesses. This was the time when atomic energy had crossed the divide from military uses to peaceful ones, demonstrating its potential to fuel civilian electric power plants. Now, after another half century in the end of 2003 about 361000 MW(e) was being generated by 439 nuclear power plants in the world. According to some reports, the number was 440 by the end of 2004. This constitutes about 16% of the world's electric generation.

Thus, assessing the validity of the two extreme views of Rutherford and Strauss, it appears that the truth lies somewhere in between the two. {IAEA Nuclear Technology Review 2004}. It is ironic that, despite nuclear power being established as a clean and reliable source of energy, the Johannesburg Summit could not include the atomic energy as an option for sustainable development. The irony is accentuated when one considers the dramatically increasing prices of fossil fuel in the world market.

It is true that the nuclear debate for the past few decades has seen extreme positions, in favour and against, with a vast array of arguments based on interpretive biases. However, it seems pertinent that the debate, arguments and assessments are carried out to prove the sustainability rather than to prove the unsustainability of a certain type of energy-source for the developmental needs discussed earlier. A detailed analysis of all possible contributing factors, like economy, safety, technology, energy-supply assurance, waste-disposal, environmental impacts and public acceptance have been thoroughly investigated and reviewed by many, including, M. El Baradei, European Parliament Conference, "Nuclear Power: An Evolving Scenario", IAEA Statement Brussels, March 2004; M. Deutch et al, "The Future of Nuclear Power", a joint MIT-Harvard interdisciplinary study, July 2003; Pedro Mignel Santos de Sampio Nunes, "Prospects for Nuclear Power in the 21st Century", World Nuclear Association Annual

Symposium 2001; IAEA Symposium on Sustainable Development – "A Role for Nuclear Power, 1999"; NED-OECD Report on "Nuclear Energy in a Sustainable Development Perspective, 2000"; Bourdaire and Paffenbarger, "Nuclear Power and Sustainable Development", Uranium Institute Int. Symposium 1997; IAEA Report on "Sustainable Development – Nuclear Power, 1997". Considering the views expressed in these studies, it can be concluded that (1) Nuclear power has to play an important role as a component in the overall energy-mix during the 21st Century, as it has the potential to be a sustainable energy source; (2) Other non green house gas emitters like hydro and renewables, will not yet be able to meet the growing energy needs in an adequate and assured manner; (3) Nuclear power plants will become fairly competitive with fossil-fuel fired plants due to rapid increases in the fossil-fuel prices; (4) Technology improvements could adequately alleviate public fears about safety and waste-disposal; (5) An increasing need is being felt in the advanced countries to revive nuclear power, due to increasing blackouts, climate hazards and international commitments to cut down the carbon-emissions which will cost the industry heavily.

However, some of the issues and concerns pointed out by the participants of the IAEA's 2nd Scientific Forum on Sustainable Development; "A Role for Nuclear Power", 1999, are worth considering. These issues have been put together into three time-related groups and their salient features are mentioned below,

a) The first period called "nuclear power of today" includes the issues of operational costs in an increasingly free market-system of electricity (OECD countries), safety of nuclear power-plant operations (Central and Eastern Europe, the Russian Federation and the Newly Independent States and economies in transition) and effective technology-management (in the developing countries).
b) The next period referred to as "nuclear prospects for tomorrow" extends from present till 2020, where the issues would be the public confidence or tolerance particularly for high-level waste-disposal and competitiveness in terms of capital-cost and construction periods, global climate-change, local air-quality and regional acidification. Need was also shown for an IAEA-led initiative on innovative proliferation-resistant reactors and fuel cycles and international standards for new generation of nuclear-reactor design.
c) The last period could be called "unclean power for the future", extending from 2020 onwards. This would include the main issue of the central role that nuclear can play if greenhouse gases are to be limited, given that half the available hydroelectric potential appears to already have been exploited and there are doubts over the potential of other renewables. Concern will also be directed on the issue of uranium-fuel supplies and related adoption of closed fuel-cycle system. (It may be recalled that the MIT-Harvard joint study for the US energy future has recommended the deployment of once-through fuel-cycle).

All the issues and concerns related to nuclear power so far are not of the kind that cannot be addressed adequately during the 21st Century by paying attention to technology- evolution and economy-management. The IAEA and its Member States

have already started working on the recommendations of the 1997 Scientific Symposium which, inter alia, calls for the continuation of the scientific and technical debate on the future of nuclear power under the IAEA fora, and bringing in participants with a broad energy background, including members from NGO's, trade unions and industry. Innovative approaches to the above issues and others have already become an important policy-component of those countries of the world that have competence in nuclear fuel cycles and which have already benefited economically from the nuclear power.

Advantages of Nuclear Power

It will be unfair if one does not take note of the several important advantages of nuclear power, while making an impartial assessment of various energy-options for sustainable development and may thus have the possibility of being drawn into doubts or ambiguities on the grounds mentioned in some previous parts of this text. The advantages of nuclear-power have been discussed in the IAEA's report of 1997 entitled "Sustainable Development – Nuclear Power" and are accompanied with convincing and supportive statistical data.

The arguments and data have covered some critical parameters, which are necessary to make clear and impartial policy-decisions about the merits of nuclear power over other energy sources. These parameters include, inter alia, environmental impacts and advantages, waste quantities, security of supply, external costs of energy generation and a wide range of applications in non-eclectic sectors associated with economic growth. All these parameters when analyzed, undoubtedly point to various clear and distinct advantages in favour of the practicability of nuclear power, as compared to fossil and many renewable energy sources.

These distinct advantages of nuclear energy for production of electricity further reinforce the view of greater participation of nuclear electricity for sustainable development in the present Century. This is supported by the information published in the June 2004 edition of "Planets' Voice", indicating that around 1.64 billion people (27% of world's population) had no access to electricity in 2000; more than 90% of people without electricity live in developing countries and four out of five live in rural areas. If proper measures are not taken in time, 1.4 billion people will still be without electricity in 2030. It is not easy to understand how poverty- alleviation initiatives for sustainable development culminating into WSSD in Johannesburg in the past three decades could ignore the potential of nuclear electricity as a clean-energy source and as an important component of the overall energy-mix needed to drive the world-economy in the 21st Century.

The continued importance of nuclear power for 21 Century's Europe can be judged from the outcome of the Ist European Nuclear Assembly convened by FORATOM in November 2004. This Assembly was attended by 240 people, mostly from European nuclear industry, Utility as well as five Permanent Representatives to EU, 45 EC staff,

18 European Parliament Members, 17 Journalists and some environmental activists. At the end of the Assembly, a declaration, signed by 24 industry executives, was delivered in which the European nuclear industry leaders stated "that nuclear-generated electricity should remain at the heart of Europe's energy-supply system for the foreseeable future, primarily due to positive contribution to economic competitiveness, maintaining security of energy-supply and reducing carbon-dioxide emissions" and further called for "the creation of a level playing-field, allowing different energy-sources, including nuclear, to develop and compete under liberalized market-conditions". The IAEA representative brought up the issue of lifting the exclusion of nuclear power in the flexible mechanisms of Kyoto Protocol. These indications are clearly pointing towards the recognized necessity of nuclear power's role in the future energy-scenario in Europe, which is already utilizing the largest proportion of nuclear electricity in the world. The importance of nuclear electricity for the other regions of the world, thus, cannot be underestimated.

Nuclear Power – Current Status

According to IAEA's "Nuclear Technology Review" (2004), there were 439 operative nuclear-power plants in the world by December 2003 and they supplied 16% of he world's total electricity. This percentage has been stable since 1986, which suggests that nuclear power has grown almost at the same rate as total global electricity for 17 years. In addition to the 439 operative power-plants, there were 31 units under construction. The worldwide energy- availability factor for nuclear power plants has increased steadily from 74.2% in 1991 to approximately 84% in 2003, which represents a significant improvement. The general global status of nuclear power is summarized in Table-4

The data from Table-4 clearly indicates that maximum share of nuclear energy is enjoyed by advanced countries, despite the fact that the public opinion in these countries has not been in favour of nuclear power. Out of 30 countries listed, 20 utilize more than the world average of 16.1% of the nuclear power share and with the exception of 3 (Japan, ROK and US), all others belong to Europe. On the other side of the spectrum, countries like China and India having more than 2 billion of people and with rapid pace of industrialization, are utilizing only 2.2% and 3.3% of nuclear power share, respectively. Pakistan, with fast growing economy and with high energy-needs for sustainable development, is similarly, sharing a meager 2.4% of nuclear power. A much higher nuclear-power share is required by these three countries during this century, to keep their economies growing in a satisfactory manner.

Other indicators, which highlight the soundness of the world nuclear power status, are briefly given below,

i) In 2003, two new NPP's were connected to the grid, one in China (665 MWe PHWR) and one in South Korea (960 MWe PWR). Canada restarted two shutdown units. Construction started on one new NPP in India. Four units (50 MWe) in the

Table - 4: Nuclear Power Reactors in Operation and Under Construction in the World (as of 31 December 2003)

COUNTRY	Reactors in Operation		Reactors under Construction		Nuclear Electricity Supplied in 2003	
	No.of Units	Total MW(e)	No.of Units	Total MW(e)	Twh	% of Total
ARGENTINA	2	935	1	692	7.03	8.59
ARMENIA	1	376			1.82	35.48
BELGIUM	7	5 760			44.61	55.46
BRAZIL	2	1 901			13.34	3.65
BULGARIA	4	2 722			16.04	37.71
CANADA	16	11 323			70.29	12.53
CHINA	8	5 977	3	2610	41.59	2.18
CZECH REPUBLIC	6	3 548			25.87	31.09
FINLAND	4	2 656			21.82	27.32
FRANCE	59	63 363			420.70	77.68
GERMANY	18	20 643			157.44	28.10
HUNGARY	4	1 755			11.01	32.69
INDIA	14	2 550	8	3 622	16.37	3.30
IRAN, ISLAMIC REPUBLIC OF			2	2 111		
JAPAN	53	44 139	3	3 696	230.80	25.01
KOREA,DEM.PEOPLES REPUBLIC			1	1 040		
KOREA,REPUBLIC OF	19	15 850	1	960	123.28	40.01
LITHUANIA	2	2 370			14.30	79.89
MEXICO	2	1 310			10.51	5.23
NETHERLANDS	1	449			3.80	4.48
PAKISTAN	2	425			1.81	2.37
ROMANIA	1	655	1	655	4.54	9.33
RUSSIAN FEDERATION	30	20 793	3	2 825	138.39	16.54

continue...

continued...

SLOVAKIA	6	2 442	2	776	17.86	57.35
SLOVENIA	1	656			4.96	40.45
SOUTH AFRICA	2	1 800			12.66	6.05
SPAIN	9	7 584			59.36	23.64
SWEDEN	11	9 451			65.50	49.62
SWITZERLAND	5	3 220			25.93	39.73
UKRAINE	13	11 207	4	3 800	76.70	45.93
UNITED KINGDOM	27	12 052			85.31	23.70
UNITED STATES OF AMERICA	104	98 298			763.74	19.86
TOTAL	**439**	**361 094**	**31**	**2 5387**	**2524.03**	

Note: The total includes the following data in Taiwan, China:
- 6 units, 4884 MW(e) in operation; 2 units, 2600 MW(e) under construction; 37.37 TW.h of nuclear electricity generation, representing 21.5% of the total electricity generated in 2003.

UK, one unit (640 MWe) in Germany and one unit (148 MWe) in Japan were retired.

ii) Prospects of Current growth and expansion are centered in Asia. Out of 31 reactors under construction at the end of 2003, eighteen are located in China, India, Japan, South Korea and DPRK. Twenty one of the 30 reactors which were scheduled to be connected to the grid were in the Far East and South Asia.

iii) It is anticipated that in Western Europe, capacity is likely to remain relatively constant despite nuclear phase-outs in Belgium, Germany and Sweden. On the other hand, Finland is having strong plans for nuclear- power expansion as its 1600 MWe European Pressurised-Water Reactor is in advanced stages of realization.

iv) The Russian Federation is continuing its programme to extend licences at eleven NPP's. In 2003, the Russian Regulatory Body issued a 5 years extension for one of its reactors. Bulgaria issued long-term (8-10 years) extensions to its two NPP's. Romania also issued a two-year extension for one of its NPP.

v) In 2003, the US Nuclear Regulatory Commission (NRC) approved nine licence-extensions of 20 years each (total licence life of 60 years for each NPP), bringing the total number of approved licence extensions to 19 by the end of the year. It also approved 8 upratings, totally 401 MW(th). Three companies applied for the NRC's new early-site permits. In Canada, near-term expansion is taking the form of restarting some or all of the 8 nuclear units out of 22 that have been shut in recent years. Two restarts have already taken place in 2003. Also, licences have been

extended for 4 units in 2005 and for 8 units until 2008.

It is clear from the above status-scenario that Western countries already well advanced in nuclear technology are showing increased interest in establishing the current nuclear-power base, as well as in expanding it for future clean-energy requirements. This is a healthy and welcome sign for the viability of nuclear power, which is expected to play an important role in the socio-economic development goals set by WSSD and other world- initiatives. The nuclear power can take a lead in South Asia and Far East, where nuclear-power technology base is sound and further technological improvements in NPP systems can take place more easily than in many other regions of the world.

According to IAEA assessment and on the basis of several studies on the future prospects of the nuclear power, it can be summarized that the key-issues affecting the near-term nuclear expansion are economics, safety and security, waste, proliferation resistance and public acceptance. The following sections of this text will deal with these factors, with a view to surmount the obstacles and establishing a rational, sound and effective basis for nuclear power to act as a reliable and environmentally clean source of energy, to play its due role in the sustainable socio-economic development of the world.

THE FUTURE AND INNOVATION

The previous parts of this text amply show the credibility of nuclear power as important component of the energy-mix which the world is going to consider carefully for its future socio-economic needs. The most important and outstanding advantage of nuclear power is its environmental cleanliness. Hydro and renewables have limited potential to meet the near-future growing energy-needs of the world. The issues related to the rapid progress of nuclear power, i.e., economic competitiveness, safety and security, waste-disposal and proliferation are being tackled by the world community in a serious fashion. Much progress has been achieved and new initiatives are on way to address the remaining parts of these issues. It may not be forgotten that the nuclear power of today took several decades to reach the satisfactory level of its utilization. Some of the major initiatives are given in the following sections:

A) Advanced Fission and Fusion

For advanced NPP designs, efforts are under way to make the power plants simpler to operate, inspect, maintain and repair. In the near term most NPP's will have evolutionary designs based on proven systems but incorporating advanced technologies and often economies of scale. For the longer term, the focus will be on innovative designs, several of which are in the small-to-medium range (upto 700 MWe). Some are designed for operation without onsite refueling. Other advantages with small units are easier financing, greater suitability for small electricity grids or for remote locations and their potential for district heating, seawater desalination and

other non-electric applications. These types of reactors should increase their usefulness for many developing and some advanced countries.

Important design efforts on large evolutionary light water reactor (LWRs) are underway in China, France, Germany, Japan, ROK, the Russian Federation and the USA. The main efforts on small and medium-size evolutionary LWR designs are being made in China, France, Japan, the Russian Federation and the USA. Both India and Canada are working on advanced heavy water reactor designs, and advanced gas cooled reactor designs are being developed in China, France Germany, Japan, the Russian Federation, South Africa, the UK and the USA. For liquid metal cooled fast reactors, development activities are going on in China, France, India, Japan, ROK and the Russian Federation. Development activities for Lead alloy and Sodium liquid metal cooled fast reactors and for gas (Helium) cooled fast reactors are being conducted in the Generation IV programme and in the Russian Federation. Research on fast neutron spectrum hybrid systems (e.g. accelerator driven system) is being pursued in India, ROK, Japan, the Russian Federation, the US and in the 8 EU countries.

Much of the present experimental and theoretical research on nuclear fusion is focused on the International Thermonuclear Experimental Reactor (ITER). Its engineering design stage activities have been completed. The proposed sites are either France or Japan. Research is also underway on other magnetic confinement approaches, and inertial confinement is being developed by national programmes in France and the USA. The National Ignition Facility (NIF) in the USA is expected to be completed in 2008.

The above mentioned worldwide interest in improving the status of nuclear power in the coming years shows that the current concerns or issues will diminish considerably and the world community will have far less inhibitions towards its acceptance as a clean, reliable and assured energy source. Continuous GHG emissions into the environment by burning fossil fuel and its rapidly increasing costs will give a boost to nuclear power and it is highly likely that future policy makers will adopt a more favourable attitude towards this useful source of energy.

B) Innovation

The great potential of nuclear power for socio-economic development was substantially established in the last decade of the nineteenth century and clear signs of its revival were already apparent to many nations which were serious about the continuity of their economic growth. People all over the world are now feeling the advent of "second wind of nuclear power" to benefit the nations in their quest for cleaner energy for cleaner environment. However, in order to get rid of exaggerated doubts and fears associated with nuclear fuel cycle activities, several multinational initiatives have been taken during the past few years aiming at clear prospects for medium and long term development of nuclear energy. This is a welcome sign for the

future of the nuclear industry. The approach on these initiatives will be innovative in order to make a difference from the past when the approach was centered around commercialization of technologies evolved from the war.

The IAEA has taken a special note of the importance of innovation of nuclear power and associated fuel cycles. In its Technical Document 1362 it states, "The 21st Century promises the most competitive, globalised and industrialized markets in human history, the most rapid pace of technological change over, and the greatest expansion of energy use, particularly in developing countries. For a technology to make a truly substantial contribution to energy supplies, innovation becomes essential. It will be the defining feature of a successful nuclear industry and a critical feature of international cooperation in support of that industry, cooperation that ranges from joint scientific and technological initiatives, to safety standards and guidelines, and to security and safeguards activities. Innovation is also essential to attract a growing, high-quality pool of technical scientists, engineers and technicians as needed to support a truly substantial nuclear contribution to global energy supplies".

Realising the importance of innovation for promotion of nuclear technologies in the 21st century to meet the growing clean energy demand in the world, the nuclear community involving technology companies, government agencies, R&D organizations and other stakeholders have become active during the past many years. Several innovation related efforts have come up at international level with good future prospects.

There are three major innovative initiatives concerning nuclear power reactors and fuel cycles,

i) The US led Generation IV International Forum (GIF).
ii) The IAEA's International Project on Innovative Nuclear Reactors and Fuel cycles (INPRO) and
Iii) European Michelangelo network for competitiveness and sustainability of nuclear energy in the EU (Micanet).

There have also been two other studies (a) a joint investigation by the IAEA with the OECD's International Energy Agency (IEA) and the Nuclear Energy Agency (NEA), entitled "Innovative Nuclear Reactor Development; Opportunities for International Cooperation and (b) an interdisciplinary study by the Massachusetts Institute of Technology (MIT) called "The Future of Nuclear Energy", the later already referred to in the previous text with some inferences taken from the study. There is growing international cooperation between GIF and INPRO.

Generation IV International Forum (GIF): This is essentially a US initiative which started its activities in 1997. It focuses on the collaborative development and demonstration of one or more fourth generation nuclear energy systems which may be able to offer advantages in economics, safety and reliability, sustainability and could be

deployed commercially by 2030. The aim is to share expertise, resources, and test facilities to improve efficiency and avoid duplication. The US interagency collaboration with GIF, with policy support that the expansion of nuclear energy as a major component necessary to meet the growing US energy requirements, GIF is working on the R&D of four out of six types of innovative reactor systems with supporting fuel cycles. {J. Perera, IAEA Bulletin 46/1, June 2004, pp. 44-47}. The selected reactor systems and fuel cycles are,

i) Gas-cooled Fast Reactors (GFR); a fast neutron spectrum, helium-cooled Reactor and closed fuel cycle.
ii) Very-High-Temperature Reactor (VHTR); a graphite moderated, helium-cooled reactor with a once-through uranium fuel cycle.
iii) Supercritical-Water-Cooled Reactor (SCWR); high temperature, high pressure water-cooled reactor that operates above the thermodynamic critical point of water.
iv) Sodium-Cooled Fast Reactor (SFR); a fast spectrum, sodium-cooled reactor and closed fuel cycle for efficient management of actinides and conversion of fertile uranium.
v) Lead-Cooled Fast Reactor (LFR); a fast spectrum, lead/bismuth eutectic liquid metal-cooled reactor and a closed fuel cycle for efficient conversion of fertile uranium and management of actinides.
vi) Molten-Salt Reactor (MSR); producing fission power in a circulating molten salt fuel mixture with an epithermal spectrum reactor and a full actinide recycle fuel cycle.

The above mentioned types are expected to be deployed by 2030. Comparative advantages include reduced capital cost, enhanced nuclear safety, minimal generation of nuclear waste and further reduction of the risk of weapons materials proliferation. The goals prescribed for GIF nuclear energy systems are:

a) Sustainability; meet clean air objectives and promote long term availability of systems and effective fuel utilization for worldwide energy production, minimize and manage nuclear waste and reduce long term stewardship.
b) Economics; offer life-cycle cost advantage over other energy sources, offer level of financial risk comparable to other energy projects.
c) Safety and Reliability; excel in safety and reliability, have a very low likelihood and degree of reactor core damage, eliminate the need for offsite emergency response.
d) Proliferation Resistance and Physical Protection; represent a very unattractive and the least desirable route for diversion or theft of weapons usable materials, and provide increased physical protection against acts of terrorism.

Studies have also been conducted on four classes of nuclear fuel cycles including once through, with partial recycle of plutonium, with partial recycle of plutonium, with full plutonium recycle and with full recycle of trans uranium elements. Results of these studies are providing important information for policy makers both on technical,

Table - 5: Membership of INPRO, GIF and Combined

INPRO	Both INPRO & GIF	GIF
Argentina	Argentina	Argentina
Armenia	Brazil	Brazil
Brazil	Canada	Canada
Bulgaria	France	France
Canada	Republic of Korea	Japan, Republic of Korea
Chile	South Africa	South Africa
China	Switzerland	Switzerland
Czech Rep.		United Kingdom
France		USA
Germany		
India		
Indonesia		
Morocco		
Republic of Korea		
Pakistan		
Russian Federations		
South Africa		
Spain		
Switzerland		
Netherlands		
Turkey		
Organizations EC	Organizations EC	Organizations FORATOM, EC

management and economic issues. The studies have also found that nuclear energy is unique in the market since its fuel cycle contributes only about 20% of its production cost. They further suggest that adoption of a fuel cycle that is advanced beyond the once through cycle, may be achievable at a reasonable cost. GIF is basically in the hands of technology holders and designers. The time horizon (around 2030) for the Project is reasonable and the commitment of the industrially advanced countries for such a time horizon indicate their conviction that nuclear energy has a good future in the 21st Century.

Innovative Nuclear Reactors and Fuel Cycles (INPRO): The second major innovative initiative is called "International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO). This is basically an IAEA led project which started in 2000 on the basis of the mandate given to the Agency by its Member States in the General Conference Resolutions GC(44)/RES/21 and GC(44)/RES/22, inviting all interested Member States to combine their efforts under the aegis of the Agency in considering the issues of the nuclear fuel cycle, in particular by examining innovative and proliferation-resistant nuclear technology and inviting Member States to contribute to a task force on innovative nuclear reactors and fuel cycle. The main objective was to ensure that nuclear energy will be available, as a sustainable resource, to help in

fulfilling energy needs in the 21st century.

INPRO was also mandated by the IAEA Member States to take into account concerns about economic competitiveness, safety, waste and potential proliferation risks. But here a wider membership was involved than in GIF. This was the forum which could accommodate the interests of the developing countries also and which would be playing active participatory role in various developmental phases of INPRO. Table 5 gives a comparative statement of the membership of the two innovative programmes.

There are many countries with strong nuclear programmes which hold membership of both the projects. The interest of European Countries and USA in these initiatives is worth noting as they had adopted the policies of restraints over the expansion of nuclear power in the past. INPRO's time frame is more than that of GIF and it is expected to go on till 2050, although some of its outcomes earlier than that may also see earlier tests of experiments. It's users include a wide range of groups like investors, designers, plant operators, regulatory bodies, local organizations and authorities, national governments, NGO's and the media as well end users of energy.

The scope of INPRO covers nuclear reactors and fuel cycle facilities expected to be operative in the future. It has not yet addressed any specific technologies as it adopted the approach first to start with Basic Principles, Users Requirements and Criteria to compare various relevant variables including globalization. It then studied from 2003, the validation of INPRO methodology through case studies and examination of innovative nuclear energy technologies made available by Member States. Six INPRO Member States have offered to carry out national case studies by applying INPRO methodology to select national innovative nuclear systems. They are:

i)	Argentina:	CAREM-X system including CAREM reactor and SIGMA fuel enrichment process.
ii)	India:	APHWR and fuel cycle including FBR and an ADS for transmutation of waste.
iii)	Republic of Korea:	DUPIC fuel cycle technology.
iv)	Russian Fed:	Nitride-fuelled BN-800 reactor family and adjacent fuel cycle in the equilibrium state.
v)	China:	Pebble Bed High Temperature Reactor.
vi)	Czec Republic:	Molten Salt Temperature Reactor

Results of these studies and several other case studies by individual experts were presented to the 7th meeting of the INPRO Steering Committee held in December 2004 {IAEA Nuclear Power Newsletter, March 2005} which has approved the objectives and activities to be carried out further on the basis of assessments made of the earlier studies. Due to its promising results in the future, INPRO has increasingly been drawing political and financial support from the Member States. More countries are joining in as observers or members. The Agency has placed the funding of INPRO

into its regular budget which means assured funding.

Regarding sustainability, INPRO is working on two basic principles, one related to the acceptability of environmental effects caused by nuclear energy and the second to the capability of Innovative Nuclear Systems to deliver energy in a sustainable manner in the 21st Century. Protection of environment is considered as fundamental, and to be sustainable the system must not run out of important resources during its intended lifetime. The system should also use them at least as efficiently as acceptable alternatives, both nuclear and non-nuclear.

As the demand for electricity is expected to grow in the developing world, INPRO intends to give more attention to the developing countries. For those countries which need small number of nuclear power plants, it would not be rational to develop a fully capable domestic supply structure. Help could be sought from internationally operated companies for necessary infrastructure for the construction and operation of nuclear power systems. Due to the very systematic and well planned strategy based on long term time frame, INPRO is expected to play an important role in this century to strengthen the nuclear power as a better option for sustainable energy source.

Joining the Strengths of GIF and INPRO

The need to develop new nuclear technologies, allaying the misgivings of the last half century and to meet the challenges of the present century to combat global poverty, has generally been acknowledged throughout the world community today. There is also a general consensus that innovative technology development initiatives should have strengthened cooperation and more countries should join these collaborative efforts. This matter has been discussed at length among the member countries and progress has been made in the modalities of cooperation between GIF and INPRO.

There is a good scope for the desired cooperation. GIF technology goals and INPRO user requirements have many similar or identical statements relating to economics, safety, environment, fuel cycle, waste disposal, proliferation resistance and sustainability. Approaches for scanning and selecting candidate innovative concepts also appear to be quite similar. However, there are some differences also:

i) GIF is far ahead in initiating R&D than INPRO.
ii) GIF focuses on the demands of a few industrially developed countries whereas INPRO's approach will be country-specific while giving in-depth consideration to nuclear power in general.
iii) INPRO is expected to involve a broader spectrum of technology proposals for innovative reactors and nuclear fuel cycles which could meet the demands of nearly all countries and not just nuclear stakeholders.
iv) INPRO also takes into consideration issues like infrastructure and innovation in legal and institutional structures.
v) GIF limits its consideration to separate nuclear energy systems with reactors of

different types and accompanying fuel cycles whereas INPRO considers that combinations of such systems should be tailored to different scenarios of nuclear power development at national, regional and global levels.

Both GIF and INPRO have convincing basis of closer cooperation. INPRO has already received inputs from other international organizations, with the Three-Agency Study, a Study conducted jointly by OECD/IEA, OECD/NEA and IAEA on specific innovative nuclear reactor developments being one particularly useful joint input of all the three Agencies. In GIF, the IAEA is represented as an observer, at the Policy and Experts Group wherein IAEA experts participate in the technical meetings of GIF. INPRO's TEC DOC 1362, Section 6 recommends that cooperation and coordination between INPRO and other initiatives in innovative nuclear energy systems should be strengthened.

At the IAEA General Conference in September 2003, Member States adopted a Resolution stressing the need for international collaboration in developing innovative nuclear technology and high potential and added value that could be achieved through collaborative efforts. The Resolution also stressed the importance of identifying synergies with other international initiatives on innovative nuclear technology development. It is expected that more collaborative role by the interested international community will be forthcoming in the near future.

Future of Innovative Initiatives & Conclusions

The innovative initiatives described above have now gained considerably solid grounds. The stakeholders, i.e., industry, governments, end users, etc., are providing support. IAEA is taking the INPRO programme seriously and is vigorously pursuing it. The Project has published a report on "Methodology for the Assessment of Innovative Nuclear Reactors and Fuel Cycle {IAEA-TECDDOC – 1434, Jan. 2005}. The updated methodology given in this document will be used for the assessments of innovative nuclear energy systems by Member States in the second part of INPRO Phase-1B, starting in 2005. A further TECDOC by the Agency on the next phase is expected to be released by the end of 2005. Further relevant material can be examined {www.parisnuclear 2005.org} which is the outcome of the IAEA convened International Ministerial Conference "Nuclear Power for the 21st Century", held in Paris from21-22 March, 2005.

The IAEA's INPRO programme focuses on the needs of developing countries with particular emphasis on the countries of Asia where the future need of nuclear power will be the most. It is evident that the success of the new initiatives will largely depend upon cooperation and free exchange of ideas between all the countries where nuclear power has to play its due role for the socio-economic development. The Asian region where such a need will be the most, involves the countries with inhomogeneous strengths in nuclear knowledge, expertise, infrastructure, capacity and technological base. This means that unrestricted transfer of technology from the developed to less

developed collaborators will be essential if all of them have to equally contribute in reducing the carbon burden of the atmosphere and diminishing the risks of natural calamities associated with the climate change. All the nations with good futuristic policies have to realize this fact and remove the barriers and restrictions to help one another in effectively implementing the technological measures recommended as a result of the ongoing studies on innovative nuclear technology programmes. Countries and regions in addressing the concerns related to atmosphere and climate, cannot gain benefits in isolation from one another. The risks and threats are common to all the humanity hence the efforts by the international community should be concerted and wholehearted.

CONCLUSIONS

a) The world initiatives to eradicate poverty through sustainable socio-economic development are positive steps in the right direction. However, the commitments made under MDG's and WSSD in Johannesburg are too ambitious to be fulfilled by the world-community in a timely manner, due to wide differences in political, economic and social priorities among nations and regions and also due to the differences in the approaches adopted to address the issues.
b) Seeing the results already emerging on implementation of the commitments, it appears that some amendments in the action-plans in the WSSD would become desirable sooner or later. A shift in the strategies to prioritize addressing the most immediate needs of the poor countries demand serious consideration.
c) Practical solutions will have to be sought soon, to effectively manage the poverty and underdevelopment problems of those larger sections of the world-community, which will remain outside the benefits of the ongoing initiatives.
d) Environmental degradation will have negative impact on the efforts to achieve sustainable socio-economic development due to progressive climate-change. Ongoing campaigns against this menace are not enough to control the present speed of degradation of the atmosphere. Developing countries will suffer the most from the anticipated climatic perils.
e) The growth in energy demand in this century and the corresponding growth in burning of fossil-fuel will remain a paradox between energy-consumption requirement and economic growth, necessary for sustainable socio-economic progress. A balance will have to be struck soon between the desired quantum of economic gains and the loss of environmental health, in order to avoid any problems of the future implementation of the various plans of actions agreed under different ongoing initiatives.
f) Success of the MDG's and WSSD plan of action largely depends upon abundant availability of clean-energy. As hydro and renewables have been proved to have limited potential in the near future, the only alternative left for filling the supply-demand gap for clean-energy will be the nuclear energy which is a proven and reliable source of clean energy.
g) Public opinion in many industrialized countries is continuously shifting in favour of nuclear power, due to its major advantage of being free from carbon-emissions,

good safety-record, assured supply and increasing economic competitiveness with carbon-emitting fossil-sources whose prices are dramatically increasing with the passage of time. Good prospects of waste, disposal and enhanced international safety-standards, coupled with strict regulatory control all over the world have substantially enhanced the level of confidence of the public in the nuclear power. The turn around of nuclear power and the "second wind" of nuclear electricity is in the offing.

h) Innovative approach in nuclear power reactor-designs to successfully address the few remaining issues of economic competitiveness, safety and security, safeguards, waste disposal and proliferation resistance, will give a quantum boost to the nuclear power in the near future. In this context, two innovative projects, INPRO and GIF, are already making good progress. Their collaboration can greatly enhance the process of achieving the objectives of innovation.

i) INPRO is more oriented towards the needs of the developing countries. South Asia and Far East are exhibiting particular interest in developing nuclear power. It will be useful if more developing countries of Asia join INPRO at this initial stage and take benefits from its ongoing activities and the associated technological spin-offs.

j) Owing to the overwhelming advantage of nuclear power having a unique characteristic of being an environmentally clean base-load energy and its highly promising prospects under the INPRO and GIF programmes, it has a strong case to be included in the WSSD plan of action as an important energy source for sustainable socio-economic development. The world-community must take full advantage of its proven potentials.

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RENEWABLE ENERGY FOR SUSTAINABLE DEVELOPMENT

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1. ENERGY FOR SUSTAINABLE DEVELOPMENT

Sustainable Development could not be mentioned without energy and it is one of the basic and main human needs for development in all aspects of life; socio-economic and environment, which includes livelihood, water, agriculture, health and education. It is also a fact that the quantity of energy used generally determines the quality of life. Energy plays an important role in poverty-reduction, especially in accordance with the Millennium Development Goals (MDGs) which aim at reducing poverty to half by 2015. UNDP and other UN agencies are working with all governments of the world, to enable policy-frameworks, develop local capacity and provide knowledge-based services to have an appropriate access to energy, for the poor in particular. The central role of energy in achieving the goals of sustainable development takes into consideration the following facts:

- Nearly one third of the global population of six billion people, mostly living in developing countries, continue to lack access to energy services;
- Wide disparities exist in the levels of energy-consumption within and between developed and developing countries;
- Current patterns of production, distribution and utilization of energy are unsustainable.

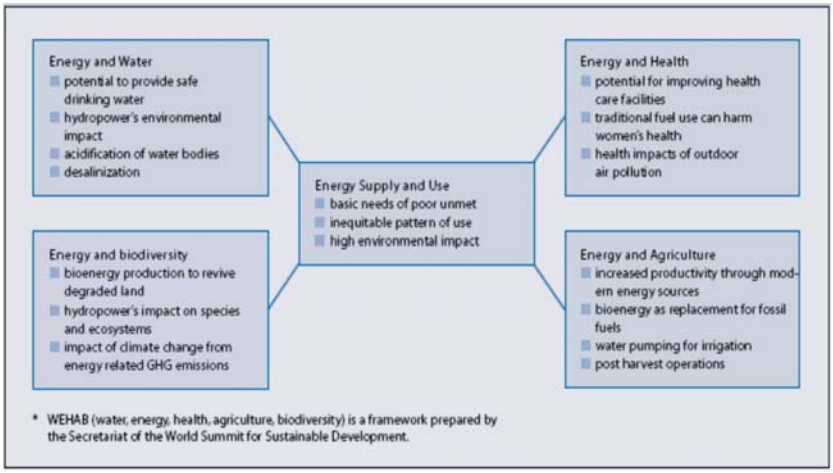
Furthermore, it was recognized that ensuring access to modern energy-carriers for the two billion people without access is one of the prerequisites for meeting poverty-reduction goals.

The 18th World Energy Congress in 2001 declared economic growth, social progress, and environmental protection as basic pillars of sustainable development and decided to focus its 2002-4 work-programme on the following objectives:

- Achieving access to commercial energy for the two billion people in the world who do not now have it;
- Developing stable regional trade policies, clear legal frameworks, and sensible regulations for energy-development;
- Keeping all energy-options open, including the safe use of nuclear power and the promotion of renewables;
- Increasing efficiency through competition and technology-diffusion;

- Implementing advanced, cleaner technologies, to reduce the impact of human-induced emissions on the quality of human life and the natural world around us.

The World Summit on Sustainable Development (WSSD) held in August/September 2002 consisted of a series of intergovernmental preparatory meetings, to provide greater clarity on the issue. The "WEHAB" framework highlighted energy and goals related to energy, emphasizing its relationship with sustainable development. Development in water, health, agriculture and biodiversity cannot come about without appropriate energy-inputs. This critical role is indicated in the following Figure-1:



Source: Modified from WEHAB, 2002

Figure - 1: Examples of the Critical Role of Energy in WEHAB Priority Areas

Overall, the agreements on energy detailed in the Plan of Implementation point to key areas for national, regional, and international co-operation on energy issues. Energy as a means to support the attainment of overall sustainable development objectives beyond the energy-sector is clearly recognized, and the important role of the public sector in establishing supportive policy environments, to facilitate this, is a common thread throughout the Plan.

1.1 The Environmental Concerns and Energy

The Present Situation:
The conventional energy-generation options can damage air, water, climate, land and wild life, through particulate and gaseous emissions, as well as through raising levels of harmful radiations. Renewable Energy Technologies (RETs) are much safer. This is the current driving force in development and deployment of RETs.

The impact of energy-systems, through particulate matters, gases and radiation, occurs all around, from household level to global scale. This includes harvesting, combustion

(fossil fuels as well as renewables), health effects, green-house gases, biomass, coal, oil and gases, hydropower and other renewables. Nuclear dangers contribute to various types of environmental concerns for human society at a local, national, regional as well as global level. The emissions caused by humans can be categorized into two types: (i) energy-related activities: including combustion, extraction, processing and distribution of fossil fuels and biofuels and (ii) due to non-energy activities, burning agriculture-waste industrial processes, deforestation and uncontrolled waste burning. This does not include volcanic activity, which contributes 76% Nitrogen Oxide. Energy related activities pollute with 56% non-methane organic compounds, 46% CO and 34% Methane. The Global distribution of particulate matter in the air in urban areas is shown in Figure-2, which has been taken from the 2000 UNDP World Energy Assessment Report. It may be noted that:-

i) Sulphur and Nitrogen Oxides play a role in the formation of acid-deposition, because they can be changed to acid in the atmosphere and can cause acid-rains. These being a major precursor to the formation of regional tropospheric ozone can cause climate-change. Carbon Dioxide gas also acts as an indirect greenhouse, with potential of global warming. In addition, Carbon Monoxide is toxic to humans and is a critical component of many photochemical reactions in the atmosphere and it also reduces the ozone production.
ii) Non-methane volatile organic compounds consist of a variety of chemical species and are very important in the chemistry of atmosphere, due to the fact that these can destroy ozone.
iii) Ammonia can help to neutralize acid in the atmosphere; but when it falls on the land, it can be converted into acids. Ammonia largely comes out of animal waste, fertilizer and combustion. Most ammonia-emissions are recorded from Asia and other developing countries, due to use of Bio-mass in the rural nature of these countries.
iv) The latest energy-projections indicate that global Sulphur dioxide is likely to stay constant roughly between 1990 and 2020, at about 59 teragrams of Sulphur. This problem has been shifted to the developing world, with emission in Latin America, Africa and Middle-east expected to increase 30% between 1990 and 2020. The problem is in Asia, where it is already as high as 17 teragram (1990-2020). China is the largest contributor to Asian Sulphur-dioxide emissions, emitting about half of the Asian continent, because of the extensively used coal-fired power plants, which can easily be replaced with natural gas in order to control the emission.
v) Ozone is an important air pollutant that can cause damage to crops, trees and human health. It is a major component of the harmful smog that forms around suspended particles during periods of high temperature, intense solar radiation, low wind-speed and in the absence of precipitation. High concentrations are common in mega cities of Southern Asia, viz Bangkok, Hong Kong, Mumbai and Shanghai.

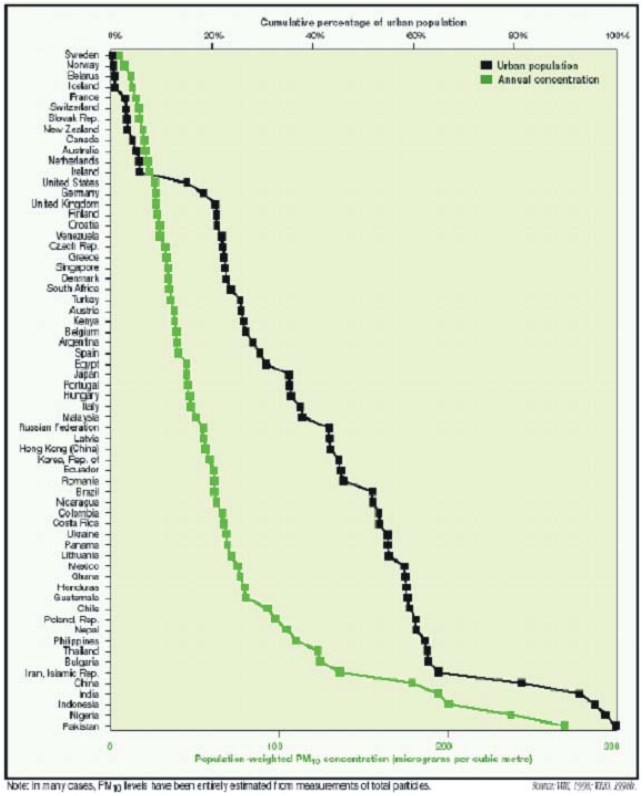


Figure -2: Global Distribution of Urban PM10 Concentration

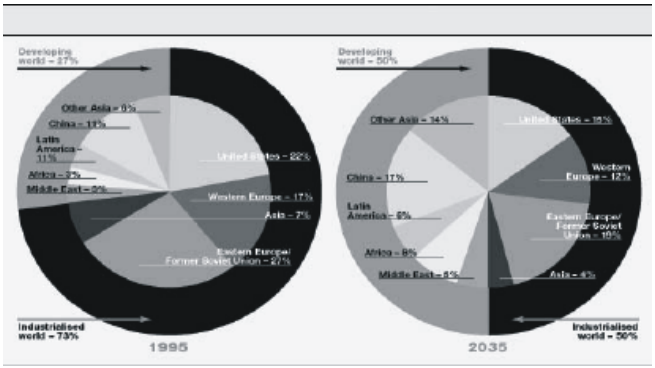


Figure - 3: Source of Industrial Carbon Dioxide Emissions, 1995 and 2035

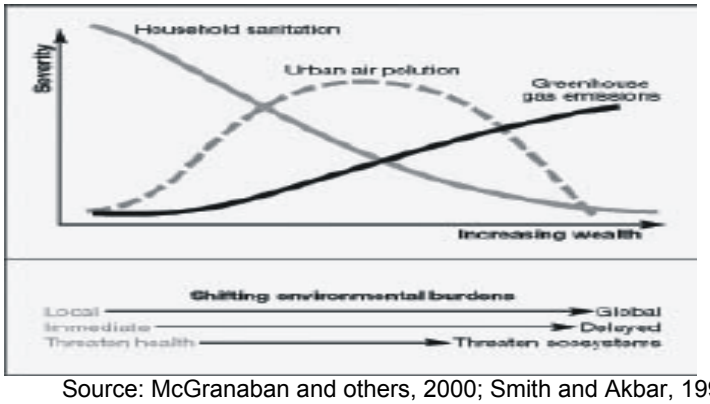
Table - 1: IPCC Scenarios for Stabilizing Carbon Dioxide Levels, 2075-2375

To stabilize concentrations at (parts per million by volume)	450	550	650	750	1,000
By about the year	2075	2125	2175	2200	2375
Cumulative emissions in 1990- 2100 would need to be	550-750	750-1, 100	970-1, 270	1,090-1, 430	1,220-1,610

in the range of (billions of tones of carbon)					
Average emission in 1990-2100 would be in the range of (billions of tones of carbon per year)	5.7-5.9	7.9-9.0	10.2-10.8	10.0-11.8	12.7
And peak emissions (billions of tones of carbon per year)	9.5	11	12.5	13.5	15
In the year	2012	2030	2050	2060	2075

Two most important human-caused problems associated with environmental pollution at the global scale, are:

i) Emission of Greenhouse gases and
ii) Depletion of Ozone



Source: McGranaban and others, 2000; Smith and Akbar, 1999

Figure - 4: Environmental Risk Transition

The most important greenhouse gases naturally present in the Earth's atmosphere are water vapour, carbon dioxide, Methane and Nitrous Oxide, although water vapors cause large part of the greenhouse effect. Energy-systems generate two-third of the human-caused greenhouse gases, which are linked to potential climate change. It can have direct impact on human health and the Earth's ecosystem.

Projection for the future

Some projections for industrial Carbon Dioxide emissions are shown in Figure-3. In 1995, developing countries were contributing 27% of emission, whereas they will share equally (50%) with the industrialized countries in 2035. However, per-capita emission from developing countries will remain smaller than that from industrialized countries.

W.H.O estimates that air pollution causes 2.7 - 3 million pre-mature deaths a year i.e 5-6% of global mortality.

In order to keep the levels of emission below those in future, significant improvement in energy-system are required globally, and one of the simplest solutions to the problem is to enhance the use of RETs with lowest emission. Table-1 is a summary of some I.P.C.C. Scenarios for stabilizing levels of Carbon Dioxide levels over the 300 years from 2075 to 2375 A.D.

An illustration of the environmental risk-transition between scales is seen in the Figure-4, which plots the relationship between urban PM10 (particulates smaller than 10 microns in diameter) concentrations and country development status as indicated by their UNDP Human Development Index (a function of income, literacy, and life expectancy). Superficially, urban PM10 concentration seems to follow the so-called Kuznets environmental curve – that is, they first rise during development, reach a peak, then decline. (The curve (see Figure-4) is named after the Nobel Prize-winning economist Simon Kuznets, who noted in the 1960s that many countries go through a period of increasing income inequality during development before becoming more equitable). From the standpoint of the risk-transition, however, this curve only addresses the community scale in the form of ambient urban air- pollution. It ignores what happens at other scales, which may be more important.

The main concern about particulates is their impact on human health. From a health standpoint, it is not so much urban concentrations that are critical but human exposure, which is a function of not only where the pollution is but also where the people are. Because people spend a lot of time indoors and in other places close to local sources of pollution-exposure patterns can be quite different from patterns of ambient pollution. Thus, as shown in the Figure-5 the household sources dominate exposure in the poorest countries, therefore the pattern of exposures is quite different than that of urban ambient concentrations. Instead of rising and then falling, exposures decline continuously – illustrating that the Kuznets curve misses the actual trend, meaning that the overall risk tends to fall even though community risk rises because of the shift of household to community impacts.

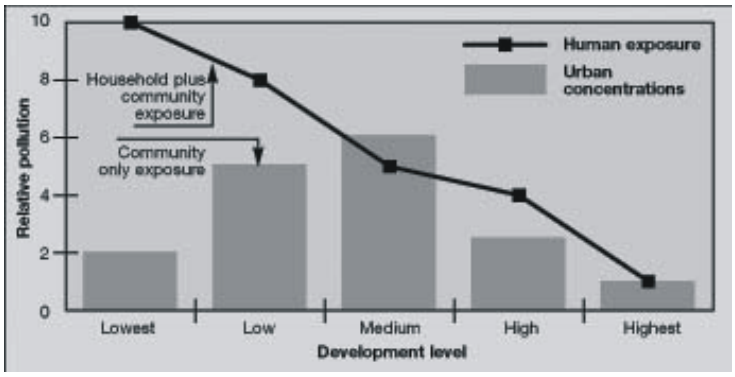


Figure - 5: Urban Particulate Concentrations, Human Exposure, and National Development

1.2 Global Issues and Challenges for Sustainability

Energy-use is linked with economy, social, environment protection and health-care, and leads to sustainable development. The optional energy use for sustainable development:

i. Access to affordable Energy in accordance with human needs.
ii. Two billion people are without access to affordable energy and live in poverty.
iii. Environmental degradation due to emission and threatened human life.
iv. Emission of greenhouse gases is expected to change the climate, and global warning, being observed over fifty years, is attributed to increase of Carbon Dioxide in the atmosphere.
v. Present import of fossil fuel is a burden on the economy of developing and least developing countries, which is geographically concentrated in a few regions and controlled by trans-national companies in their favour.

The above issues indicate the need for a radical change in the energy-system development, world-wide. The resources and technology-options available to meet these challenges include: renewable energy resources and energy efficiency.

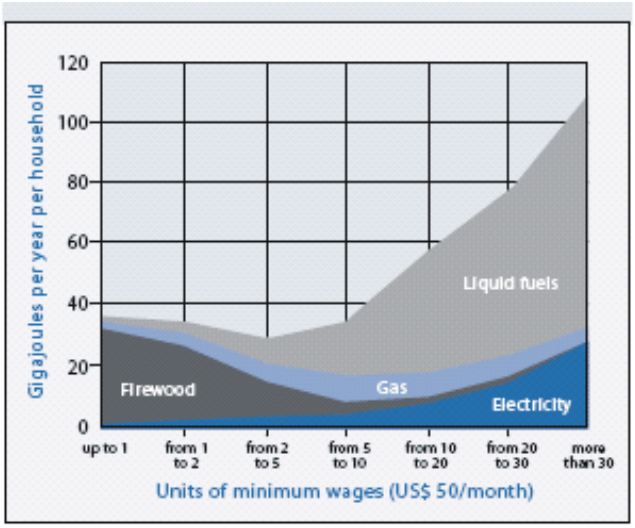
Social Issues
The energy demand and supply, quality, availability and affordability effect the social life of any community. Lack of access to energy is closely linked with poverty, poor health, lack of education, specially for women and urbanization (This basic amenity is some time missing in the rural areas) some 1.3 billion people in the developing world live on less than $1 per day. The energy available to the poor people is tradition-fuels which cannot help in development and income generation. Two billion people in the world rely on Bio-mass (traditional) fuel for cooking and this has adverse affect on health (especially women). They have inadequate lighting (lack of electricity) and limited telecommunication. They spend most of their time for gathering fire-wood and water, and so have no opportunity of education. Table-2 summarizes some of the possible specific improvements.

Table - 2: Energy-Related Options to Address Social Issues

Social Challenge	Energy Linkages and Interventions
Alleviating poverty in developing countries	• Improve health and increase productivity by providing universal access to adequate energy services – particularly for cooking, lighting, and transport – through affordable, high quality, safe, and environmentally acceptable energy carriers and end-use devices. • Make commercial energy available to increase income-

	generating opportunities.
Increasing opportunities for women	• Encourage the use of improved stoves and liquid or gaseous fuels to reduce indoor air pollution and improve women's health. • Support the use of affordable commercial energy to minimize arduous and time consuming physical labour at home and at work. • Use women's managerial and entrepreneurial skills to develop, run and profit from decentralized energy systems.
Speeding the demographic transition (to low mortality and low fertility)	• Reduce child mortality by introducing cleaner fuels and cooking devices and providing safe, potable water. • Use energy initiatives to shift the relative benefits and costs of fertility – for example, adequate energy services can reduce the need for children's physical labour for household chores. • Influence attitudes about family size and opportunities for women through communications made accessible by modern energy carriers.
Mitigating the problems associated with rapid urbanization	• Reduce the "push" factor in rural-urban migration by improving energy services in rural areas. • Exploit the advantages, and moderate the disadvantages, of high-density settlements through land-use planning. • Provide universal access to affordable multi-modal transport services and public transportation. • Take advantage of new technologies to avoid energy-intensive, environmentally unsound development paths.

Source: World Energy Assessment, Overview: 2004, Part-III Energy and Major Global Issues, page 35.



Source: E. Almeida and A. De Oliveira. "Brazilian Life Style and Energy Consumption," in Energy Demand, Life Style Changes and Technology Development (London:World Energy Council, 1995)

Figure 6. Average Energy Demand, By Income Segment In Brazil, 1998

Low-income households in developing countries typically use traditional fuels and inefficient technologies. Figure-6 shows the average primary energy demand for various fuels, as a function of income-levels in Brazil, indicating that higher-income segments of the population increasingly rely on modern fuels as the income grows.

For low-income households, firewood is the dominant fuel. At higher incomes, commercial fuels and electricity replace wood, offering greater convenience, energy efficiency, and cleanliness. Because convenient, affordable energy can contribute to a household's productivity and income-generating potential, its availability can help families and communities break out of the cycle of poverty.

It is widely understood that growth of population has a direct impact on energy, by increasing demand. It is less widely understood that access to adequate energy-services is associated with increased life-expectancy and reduced child-mortality and can shift the relative benefits and costs of fertility towards a lower number of desired births in a family.

Crucial developmental tasks, including improving the environment, educating women, and ameliorating the extreme poverty that may make child-labour a necessity- all these tasks have links to the availability of affordable clean-energy services.

In developing countries, addressing the energy-needs of the poor, who represent a large majority, will require major structural changes.

Eradicating poverty is a long-term goal of development. But long before that goal is achieved, convenient and affordable energy-services could dramatically improve living-standards and offer more opportunities to people. Today's inequity is unsustainable. Satisfying the energy-service needs of the poor with modern technologies has the potential to improve standards of living and health, and to create new jobs and business opportunities. Allowing one third of the world's population to continue to endure the constraints associated with traditional energy is unacceptable from a humanitarian and a moral standpoint.

1.3 Energy Policies for Sustainable Development

1.3.1 The Key Elements of Sustainability:
(Brundtland Report: "Our Common Future", p.169)

Following are the key elements of energy needed for human needs:-

- Sufficient growth of energy-supplies to meet human needs (which means accommodating a minimum of 3% growth of per capita income in developing countries);

- Energy efficiency and conservation measures, such that waste of primary resources is minimized;
- Public health, recognizing the problem of risks to safety, inherent in energy-resources; and
- Protection of the biosphere and prevention of more localized forms of pollution.

The energy has been used in an unsustainable manner. These dilemmas have yet been addressed by the international community with a sufficient sense of urgency and in a global perspective.

1.3.2 Key Sustainability Issues

- Energy services – cooking, heating, cooling, lighting, transport, communications, lighting, powering machinery – are essential for sustainable development.
- Nearly 2 billion people still without electricity; over 2 billion rely on wood, dung, and agricultural waste.
- Huge disparity in energy-use per capita between rich and poor countries and people. Chronic inefficiency/waste.
- Oil and natural-gas supplies coming under severe constraint, but 'new' renewable energy growth too slow.
- Fossil-fuel use is the largest contributor to carbon dioxide in the atmosphere (CO2 82% of GHG in EU)

In the light of the above it is obvious that there is lack of access of energy and electricity for the major population of the developing world. One third of the world is using traditional Bio-mass and there is wide disparity in energy-use per capita.

1.3.3 The Energy Policy for Sustainable Development should provide:

i) Access to modern energy-services: cooking, lighting, heating cooling, transport, communication industry, which are essential of sustainability.
ii) Measures to conserve energy and improve energy efficiency
iii) Promotion of Sustainable energy (Renewable) through creation of markets.
iv) Public awareness, as well as improved appliances through incentives given to indigenous R&D
v) Reduction of fossil fuel dependency.

1.3.4 Sustainable Energy Policies

The Context for Energy Policy and Sustainable Energy
There are certain trends that will affect energy developments, as much as these development would affect trends. Some of these sustainable energy policies are:

Globalization

The global economy is steadily becoming more integrated through mergers, acquisitions, joint ventures, and the expansion of multinational companies. The Multinational companies are playing an increasing role in fossil-fuel production and distribution, gas and electric systems, and manufacturing of energy end-use technologies. In this light, policy would also need to be more coordinated in order for them to have the desired effectiveness.

Governmental Responsibilities
Due to globalization, it has become more difficult for governments to raise taxes and still stay competitive globally. Governmental activities are therefore moving toward regulation and supervision, to ensure that markets work efficiently and advance social benefits.

De-Regulating and Liberalizing Energy-Markets
Many nations are privatizing formerly government-owned utilities and petroleum and natural gas companies, and introducing competition and new regulatory frameworks, so as to increase efficiency and attract private capital to the energy sector. But it must be remembered that Government supervision is essential to protect public benefits in a market-driven energy sector.
The Emerging Information Technology Revolution
The Internet and related information-technologies offer great potential to enhance technology-transfer, capacity building, and awareness raising. Breakthroughs in ICTs will have a large impact on the energy-sector as in other sectors, although this impact is difficult to predict in advance.

Public Participation
Throughout the world, large numbers of people are gaining voice. Local groups are becoming more involved in the decision-making process and are influencing public-policy formulation and adjustment. Women are becoming more active. These trends are likely to keep sustainable development high on the political agenda, with energy as an important ingredient to that goal.

International Cooperation
The ongoing process of globalization means that it is easier to share and pool ideas, finances, and energy across geographic boundaries. Cooperation to combine efforts to reduce emission, and increase use of renewable energy would be a natural way forward. There are some good examples of this. Two are:

i) The European Union Member States agreement on renewable-energy targets, increasing the share of renewable primary energy from 6 percent in 1995 to 12 per cent by 2010, and increasing the proportion of electricity generated from renewable sources from 14 percent in 1997 to 22 per cent in 2010.
ii) The Latin American and Caribbean Initiative, signed in May 2002 in São Paulo, included a target of 10 percent renewable energy by 2010. As a whole, this region had 24.4 percent of energy use as renewables in 2002, but that includes 15.6 percent in the form of combustible renewables and waste, which in most countries is

not renewable (see footnote 5). Most of the Caribbean countries and a few in Latin America were below the 10 percent mark in 2002.

Affordability for Rural Community
Rural areas need affordable energy to meet basic needs. This affordability may, at least initially, require subsidies-to be reduced over time. There are two options in this regard:

a) Target the subsidies to the neediest consumers
b) Introduce market-efficiencies and extend the smallest subsidy needed to achieve social objectives

The task of supplying energy to the large, currently under-served or unserved rural population is one of the greatest challenges faced by developing countries. These are only some of the options and these certainly do not cover all scenarios and all energy conditions.

Develop Capacity
Building the capacity is a long-term process that must be achieved through activities at the individual and institutional levels. The public sector, both at national and local levels, is the key target and recipient of capacity development. The most critical targets for capacity development in the energy-sector are energy policymakers, new regulatory agencies and economic planners. Adaptability in the face of changing energy demands is the key to success both for developed as well as developing countries. Building the capacity to adapt and change is important, though not simple, when we speak of the public sector.
To facilitate this objective, capacity to effectively regulate and supervise the functioning of the energy markets is important. But this alone is only one element of the whole process of capacity development. It should be a priority in new policy frameworks, and funding should be part of domestic energy-planning. It should in fact serve as a cross-cutting element of all development cooperation and energy-sector programmes.

Energy Efficiency
Although improvements in the means of generating and distributing energy can enhance efficiency, the greatest advantage in terms of economics and adaptability is reached when there is enhancement in end-use equipment. In addition to reducing externalities associated with energy-use, improvements in energy efficiency can stimulate new industries in energy-saving goods and services.

Numerous technical options and players in the public and private sectors could be involved in achieving higher end-use efficiency. There is need to develop equipment devices for generation as well as energy user end. There are significant barriers as well, some of which include:

- Lack of adequate information, technical knowledge, and training;

- Uncertainties about the performance of investments in new and energy-efficient technologies;
- Lack of adequate capital or financing possibilities;
- High initial and perceived costs of more efficient technologies;
- External costs of energy- use not included in energy-prices;
- Patterns and habits of consumers, operators, and decision-makers, which may be influenced by many factors, including ideas of social prestige and professional norms;
- Lack of attention to R&D investments in energy-efficiency improvements.

Although energy-efficiency policies that use direct or indirect price mechanisms (such as the removal of subsidies and the incorporation of externalities) are effective, even without changing the overall price environment, it is beneficial to pursue energy-efficiency policies to address market failures.

Research and Development Energy Innovations
As there are many barriers that restricts energy-innovations, it is important to identify these so that they can be removed. The salient links in the energy-innovation chain are research and development, demonstration projects, cost buy-down and diffusion and each link is affected by the existing barriers.

The success of policies aimed at removing or mitigating the effect of these barriers depends on governmental priorities and the trade-offs in emphasis that are required to be made in the light of limited financial resources. Many of the barriers are also a result of market imperfections and differences of view about needs, corporate priorities, relevant time-horizons and reasonable costs.

Policy interventions should aim at helping the most promising energy-innovations to facilitate energy efficiency at generation, distribution and at user end.

Energy Pricing and Marketing
Market-based approaches are not a complete solution, especially in the energy sector, where significant market-imperfections require attention and supervision. In many countries, energy-markets barely function. Huge populations of both city dwellers and rural families are excluded from markets, due to extreme poverty. The following policies can improve the functioning of energy-markets.

- Price the energy correctly;
- Restructure subsidies to support sustainable development;
- Address externalities.

2. RENEWABLE ENERGY FOR SUSTAINABLE DEVELOPMENT

Energy has begun to play a more crucial role than ever in the development and well being of every nation. Energy impacts the lives, livelihood, growth and progress not only

at a collective level, but also at the individual, grassroots level. The source and nature of energy, the supply and environmental impacts of its supply and utilization are matters that are complex and, only recently, it is being realized that concerns arising out of these issues need to be addressed in a comprehensive and effective manner.

Renewable-energy resources and technologies have the potential to provide solutions to the long lasting problems being faced by the economy, the industry, the environment and the masses in the consumption of traditional sources of energy. It is only through devising such solutions that the development of nations can continue without hindrance, and in fact contribute towards sustainable development goals. This has been recognized at several international forums, including the World Summit on Sustainable Development in 2002 and, subsequently, at the International Conference for Renewable Energy in 2004.

Statistics on poverty and on the major challenges that humanity faces, as a consequence of that, highlight the fact that renewable energy has an important, rather crucial role to play in sustainable development. Environmental concerns have further brought renewable energy into the limelight, due their zero emission nature.

In devising strategies to approach the development and deployment of renewable-energy technologies, it needs to be emphasized that each country would devise its own renewable energy mix, customized to its geographic features and strengths. A sound strategy would encourage adaptability, and accessibility in accordance to its geographic location, economic condition and social acceptance.

Furthermore, renewable-energy policies and the manner in which the government chooses to provide oversight has a heavy influence on the direction, progress and success in the sector. Policies that work are ones that involve the public, increase capacity, encourage innovative technologies and solutions, improve market- conditions for energy and foster international cooperation in the field.

2.1 Present Status of Renewable-Energy Use

Tables 3&4 clearly indicate the present use of renewable energy production globally and its contribution. Improvement in energy efficiency, encouraging energy- conservation, reducing fossil-fuel dependency, effectively encouraging Renewable Energy deployment, reducing traditional Bio-mass consumption, safeguarding future supplies of energy or reducing “Greenhouse gas” emission from energy-use as a key element of sustainable energy criteria (Brundtland Report) is being satisfactorily implemented.

Table - 3: Increase in Energy Production from “NEW” Renewables1997-2001 (% per year)

Biomass electricity	2.5
Biomass heat (eg steam, hot water)	2.0
Biomass – ethanol	2.0

Bio-diesel	1.0
Wind powered electricity	30.0
Solar PV electricity	30.0
Low-temperature Solar Heat	10.0
Hydro-small	3.0
Geothermal-electricity	3.0
Geothermal-heat	10.0
Marine	0.0

Source: World Energy Assessment Overview, 2004, Update, Table 7, p.50, UNDP

Table - 4: "NEW" Renewables by Source, 2001 (% contribution)

Modern Biomass	68.0
Geothermal	23.8
Small Hydro	4.1
Low-Temperature Solar Heat	2.3
Wind electricity	1.7
Solar PV electricity	0.04
Solar Thermal electricity	0.04
Marine energy	0.03

Source: World Energy Assessment Overview, 2004, Update, Table 6, p.49, UNDP

2.2 The Basic Problem

The fundamental issue involved in the efficient use of non-conventional energy sources is to bring about the integration of socio-economic changes with technological innovations, which essentially should be made simple, easy to understand and operate (maintain) by the agrarian population. Most of this agrarian population is either illiterate or semi-literate in the developing countries. In view of this basic issue, the problem here is mainly the identification of available technologies, their testing to make them suitable in the local situations and for their acceptability, in relation to their costs as well as, the financial or technological capacity of the rural people to operate, maintain and repair the hardware involved.

The technological problems of adaptation and innovation, to match the available technologies and hardware with the local circumstances, may prove to be serious constraints to many developing countries in implementing their programmes. However, these problems will need to be divided into manageable proportions, in terms of (i) what is available for immediate application, and (ii) what needs further Research and Development. Technologies are currently available, even in many developing countries, for simpler application of both direct and indirect solar energy. In regard to the first category, the critical technological problems are in providing the appropriate software for use in primary consumption of the energy made available from alternative non-conventional sources.

The rural energy problems revolve mainly around lack of proper level of education and knowledge amongst the farmers, leading to the continued adoption of old customs and traditions handed down from generations. In order to break the shackles of these old traditions, radical measures have to be adopted, particularly in the matter of improving the level of their scientific and technological education, through visual aids and other effective techniques, and the introduction of new concepts in close collaboration with them.

3. RENEWABLE ENERGY OPTIONS

3.1 The Present Situation

It is well known that nearly all renewable energy sources on the earth, e.g. hydro, biomass, ultimately derive their energy from the sun, which itself gets energy from the basic fusion-reaction that converts Hydrogen into Helium, with the release of 2 neutrons and a tremendous amount of energy. The basic differences between the various forms of renewable energy lie in the fact that (a) the vehicle is readily available, e.g. biomass, wind or water, and (b) the overall cost of obtaining the energy in a usable form for industry, transportation is relatively low.

In 2001, China was far ahead in Solar Thermal Systems and Biogas and Small / Micro Hydropower plants while India has excelling in the region in Wind Power as per the figures of 2001. These figures given in Table 4 reflect the growing importance of renewable-energy sources in the region, which comprises both developing and developed countries.

Table - 5: Renewable Energy Technologies in Selected Asian Countries As of December 2000

Country	Solar thermal system (1000 m^2)	PV system (MW_p)	Wind power plants (MW)	Small/micro hydropower plants (MW)	Power Plants (MW)	Biogas Plants (1000 units)	Improved cookstoves (1000 units
Bangladesh		0.15		--	--	1	82
China	5000	6.00	344	20,000	800	6800	180,000
India	467	50	1167	217	272.74	3000	32,000
Indonesia	--	5	0.5	54	178	--	--
Japan	57	3.6	75	--	--	--	--
Korea	--	0.48	--	5	--	--	--
Malaysia	--	2	0.15	24	200	--	--
Nepal	10	1.08	0.02	11.46	--	49.28	250
Pakistan	--	0.44	--	20	--	4.13	68
Philippines	--	0.52	0.06	70	--	--	--
Sri Lanka	--	--	3	6	--	4	--
Thailand	50	5	0.2	128	1230	10	500

Vietnam	--	0.47	0.1	95	--	3.08	--

* The plant size of small/micro hydro plants varies widely across Asian countries, from 5kW in Vietnam to 50 MW in China; they are classified as 'small/micro' because they receive special incentives from the corresponding governments for their implementation includes waste-fired power plants

Source: Govinda Timilsina, Thierry Lefevre and S.K. Noim uddin "New and Renewable Energy Technologies in Asia", Renewable Energy World/July-August 2001, p.53

During the last two decades, a tremendous amount of work has been done on the various renewable-energy technologies, so that today many of them are commercially viable and even available in units of medium to large size. A summary of the overall picture, as of now, is presented in the accompanying Table 4, taken from World Energy Assessment: Energy and the Challenges of Sustainability", in 2000 by UNDP report. An examination of this Table 4 shows that Low-temperature Solar Heat, Hydroelectricity, Geothermal Energy and, to some extent, Solar-Thermal electricity are already in the viable stage. Energy from Biomass, Wind-Electricity, Photo-voltaic Electricity and Marine-Energy are seen to be the next on the list. Using the above-mentioned table from the UNDP report, we may summarise the estimated costs of these RET's in chart of Table-.

On the basis of cost / kWh alone, the relative grading, as per the foregoing table, leads to the following three presently available groups, which fall broadly in the, more or less, viable groups of; (A) 5 c/kWh, (B)9 c/kWh and (C)14 c / kWh, followed by photovoltaics at >30 c / kWh:The first two groups are already competitive with present costs of electricity generation, while Solar-thermal and Biomass Ethanol are also expected to become viable after a decade or two as further clarified in Table. Electricity generation through Photo-voltaic Systems, on the other hand, presently costs around 40c/kWh, but may possibly become competitive after two decades or so; presently, it is feasible for remote and desert areas.

3.2. The Basis for Prediction and Planning

The World Energy Council (WEC) Statement 2000 emphasized the need to increase the use of new renewable-energy sources wind, solar, geothermal, oceanic, but excluding modern biomass. The question to be studied in detail is: which ones are most suitable for which countries conditions? The decision would rest primarily on three factors, namely:

i) The cost of energy (kWh)
ii) The capital cost, and
iii) The ready availability of the relevant material for production (biomass, wind, solar radiation, water, etc.)

Table - 6: Current Status of Renewable-Energy Technologies

Technology	Increase in installed capacity in past five years (percent a year)	Operating capacity, end 1998	Capacity factor (percent)	Energy production 1998	Turnkey investment costs (U.S. dollars per kilowatt)	Current energy cost of new system	Potential future energy cost
Biomass energy Electricity Heat Ethanol	 -3 -3 -3	 40 GWs >200 GW 18 tin litres	 25-80 25-80	 160 TWh (o) >700 TWh (th) 420 PJ	 900- 3,000 250- 750	 5-15 c/kWh 5-15 c/kWh 8-25 $/GJ	 4-10 c/kWh 1-5 c/kWh 6-10 $/GJ
Wind electricity	-30	10 GWs	20-30	18TWh (o)	1,100- 1,700	5-13 c/kWh	3-10 c/kWh
Solar photovoltaic electricity	-30	500 MWs	8-20	0.5 TWh (o)	5,000 – 10,000	25-125 c/kWh	5 or 6-25 c/kWh
Solar thermal electricity	-5	400 MWs	20-35	1 TWh (o)	3,000 – 4,000	12-18 c/kWh	4-10 c/kWh
Low-temperature solar heat	-8	18GWth (30 min m^2)	8-20	14 TWh (th)	500- 1,700	3-20 c/kWh	2 or 3-10 c/kWh
Hydroelectricity Large Small	 -2 -3	 540 GWs 23 GWs	 35-60 20-70	 2.510 TWh (o) 90 TWh (o)	 1,000- 3,500 1,200- 3,000	 2.8 c / kWh 4-10 c/kWh	 2-8 c/kWh 3-10 c/kWh
Geothermal energy Electricity Heat	 -4 -5	 8 GWs 11 GWs	 45-90 20-70	 46 TWh (o) 40 TWh (th)	 800- 3,000 200-2,000	 2-10 c/kWh 0.5-5 c/kWh	 1 or 2-8 c/kWh 0.5-5 c/kWh
Marine energy Tidal Wave Current OTEC	 0 - - -	 300 MWs exp. phase exp. phase exp. phase	 20-30 20-35 25-35 70-80	 0.5 TWh (o) - - -	 1,700- 2,500 1,500- 3,000 2,000- 3,000 -	 8-15 c/kWh 8-20 c/kWh 8-15 c/kWh -	 8-15 c/kWh -- 5-7 c/kWh -

Combining the above tabulated information (Tables 6&7) with data on availability in specific areas and the local socio-economic conditions, the following tentative

assignment of options for four broad areas of the Developing World may be proposed (see Table-6). In doing this, one can of course, at best make an educated guess, but the relative merits of the various Renewable-Energy Technologies are expected to be more or less stable for the next decade or two. The choice between Mini-Hydro and Biomass in any particular place or region, would be dictated by availability and terrain, whether hilly or forest.

Table - 7: Currently Usable RETs

Category	Range of Cost / Unit/ (kWh)	Type of RETs
A	5±2 cents / kWh	Geothermal and mini-hydro
B	9±3 cents	Biomas; wind; low temp / solar heat; Tidal and Ocean – current energy
C	14±4 cents	Solar-Thermal, Biomass ethanol; also wave energy
D	50±14 cents	Photovoltaics (PV)

It is clear that mini-Hydro, Bio-mass and Solar-thermal are probably the most viable RETs for all four regions of the developing world. For Bio-mass and mini-Hydro, the choice depends on the terrain, whereas solar-thermal is applicable in almost all the regions, in general, and sun-belt countries in particular. Needless to say, Photovoltaics are currently in the market, specifically for far-flung areas and special applications like telecommunication and refrigeration of medical supplies or PV stand alone system for electrification.

Wind power can only be applicable where the required wind-velocity, sustained over a sufficient period, with appropriate density, is available along coastal areas or even further into territorial water-systems of the oceans. This needs extensive survey in individual countries of the developing world.

The ocean/ wave-energy may also be exploited in the near future wherever facilities are available. However, serious sustained development-efforts would be needed for economic exploitation of these particular renewable resources. Perhaps several neighbouring countries could get together for jointly launching such a project. The first commercial wave (OWC) 500kW power-station was installed and commissioned at Islag, Scotland, in 2000. It is estimated that there are some 2-3 million MW worth of power in the waves on all the coastlines in the world. A 60kW system (RVCo Hydroventuri, UK) has been working in North of England since June 2002. It is performing within 3% of the design capacity. Australian had planned to install (Energetech) (OWC) wave turbine at Port Kembla by the end of 2003.

Table - 8: Viability of Renewable Energies

Presently Viable		Viable in Near Future	Special Applications
5 c / kWh	9 c / kWh	14 c / kWh	~40 c / kWh
Mini-Hydel, Geothermal	Biomass, Wind, Low-Temp. Heat, Tide / Current	Wave Energy, Solar Thermal, Biomass, Ethanol	Photovoltaics

3.2 Renewable Energy Perspective (2010 and 2015)

Energy is a basic necessity for socio-economic uplift that leads, and is leading, to sustainable development. The goal of energy depends upon: Accessibility, Acceptability and Availability (3A strategy) for both developed and under-developed countries. Accessibility means to provide clean-energy at affordable prices for all people. Availability relates to reliable source and security. Acceptability of an energy-source relates to public attitude, social and cultural circumstances.

Table - 9: Proposed RETs for Specific Developing Countries/Regions

REGION	RETs in order of Priority	
AFRICA	i.	Mini Hydro
	ii.	Biomass
	iii.	Solar Thermal
	iv.	Ocean & Wind
SOUTH ASIA	i.	Mini Hydro
	ii.	Biomass
	iii.	Solar Thermal
	iv.	Wind
MIDDLE EAST	i.	Wind
	ii.	Solar Thermal
	iii.	Mini-Hydro
	iv.	PV – for Isolated Villages
SOUTH AMERICA	i.	Mini Hydro / Geo-thermal
	ii.	Bio-mass & Wind
	iii.	Solar Thermal
	iv.	Ocean and PV

Keeping in view the 3A principle, the policy of renewable-energy may be designed for each country to satisfy the basic needs of their people and to achieve the target growth-rate in their economies. The overall aim should be to provide sustainable modern energy for all segments of the population, at the latest by 2020 (goal set by WEC) or 2030, with special focus on the developing world (targeting 2 billion poor people currently without

light). The energy-policy would naturally vary from country to country, but general guidelines can be given, as follows:

i. Assessment of various Renewable-Energy Resources through surveys.
ii. Establishment of Institutional arrangements to develop these resources
iii. Development of appropriate technical manpower
iv. Regulatory frame-work to encourage development of entrepreneurship
v. All energy options must be kept open, to develop Renewable Energy Resources and their technologies in future.
vi. Promotion of energy-efficiency tools
vii. Allocation of funds for R & D
viii. Cost-reduction, to cater for needs of the poor
ix. Awareness-programme for rural areas
x. Relaxation of Taxes/Duties, to make RETs competitive
xi. Encourage RET industry with incentives.

RETs can be promoted, based on the above guidelines. However, this has to be supplemented with a yearly action-plan, so that the whole population can be benefited. All RETs should be used to satisfy needs of the common man, in accordance with its Availability, Accessibility and Acceptability. RET-based local industry should be encouraged to achieve self reliance and sustainability. Financial institutions may be set up to finance projects for indigenous development, and sustainable credit-facilities should be made available for launching such projects in the field of Renewable-Energy Technology, through small and medium entrepreneurs.

While the developed countries have already set their targets to generate, say, 10% of their energy needs from renewables by the year 2010, it is a massive task to bring Renewable-energy to millions of rural families in the developing world. This may require thousands of small entrepreneurs to engage in the RETs business and would need extensive training and capacity-building, but can also be a major source of employment and mobilizing the economy. The G-8 report estimated that about one billion people will be serviced with their basic energy-needs, of which 800 million will be from developing countries served by 2010. The G-8 plan hopes to serve 2 billion people by 2015.

The enormous potential of renewable energy sources can meet many times the world energy-demand. These can enhance diversity in the energy-supply market, contribute to long-term sustainable energy-supplies, reduce harmful emissions and create new job-opportunities, as well as, offer manufacturing-opportunities, bringing socio-economic change especially in the developing world.

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INFORMATION COMMUNICATION TECHNOLOGIES AND THE MILLENNIUM DEVELOPMENT GOALS

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INTRODUCTION

In order for sustainable development to take place, it requires translation of desired global social, economic and environmental objectives into concrete and comprehensive action plans. The global community in the wake of rapidly depleting natural resources, intense climatic changes, alarming state of poverty, threatening food insecurity, malnourishment, and inaccessibility of masses to potable water, besides ever growing economic and knowledge-divide voiced its concern on the platform of the United Nations. It was after successive discussions and international conventions, that global think-tank articulated eight agenda, which are to be achieved by 2015, we today know these as 'Millennium Development Goals' (MDGs). The eight Millennium Development Goals – which range from halving extreme poverty to halting the spread of HIV/AIDS and providing universal primary education, all by the target year of 2015 – form a blueprint agreed to by all the states and leading international development institutions. They have galvanized unprecedented efforts to meet the needs of the world's poorest.

The Secretary-General of United Nations Organization in a public address in London (July 2005) expressed his earnest hope that Millennium Development Goals can be achieved if we all put in all our efforts and in the right direction. He presented his feelings in the following words, "We will have time to reach the Millennium Development Goals – worldwide and in most, or even all, individual countries – but only if we break with business as usual. We cannot win overnight. Success will require sustained action across the entire decade between now and the deadline. It takes time to train the teachers, nurses and engineers; to build the roads, schools and hospitals; to grow the small and large businesses able to create the jobs and income needed. So we must start now. And we must more than double global development assistance over the next few years. Nothing less will help to achieve the Goals."
Role of Information Communication Technologies (ICTs)

Within the broader context of achieving sustainable development and the articulated Millennium Development Goals, the role of modern day Information Communication Technologies (ICTs) besides other breathtaking technologies is pivotal.

"Information and communication technologies are key building blocks for future economic and social development and job creation. ICT can be powerful tools for empowering people to make better choices through improved information flow, making possible broader formal and informal educational opportunities, facilitating human as well as institutional capacity development, and can directly spur economic growth by creating opportunities and addressing barriers and inefficiencies".

José Antonio Ocampo, Chairman, United Nations Information and Communication Technologies Task Force (2005)

There is no denying of the fact that after industrial revolution, information revolution has changed the face of the earth yet again. With the advent of transistor early in the 20th century and thereafter development of various digital gadgets and present-day computing machines, the whole of human society and the way we used to live has been transformed. The information revolution riding the tide of incessant inventions and innovations, gained strength with every passing day, covered a decent distance that now lands us in the 'information-age' and in the arena of Information Communication Technologies (ICTs). Despite the overwhelming support that humanity received from technologies such as ICTs, the split between rich and the poor is ever widening. There is a dire need to put the focus straight and make concerted and global efforts to win the war against poverty and illiteracy. This chapter takes stock of the issues related to achieving the millennium development goals for sustainable development through ICTs. It is however impressed upon that provision of education and safeguarding healthcare are one of the main constituent for continued progress and growth. Reviews of some revered reports are also presented to support the arguments and ICTs' role in both the areas of education and healthcare is presented in detail.

Before we go deeper into understanding how ICTs can play their due role, we need to understand what exactly we mean by sustainable development.

DEFINING SUSTAINABLE DEVELOPMENT

The issue of sustainable development is at the heart of society setting the future course of humanity on the planet. The concept of, as opposed to the term of, "sustainable development" is not new; the profound and complex problems subsumed by the term can be traced back to the earliest human civilizations and the perennial tension between population growth and economic development, on the one hand and, the use of natural resources and ecosystem on the other.

The term 'sustainable development', however, is a recent invention, coming into common usage very recently. The Brundtland Commission, which is responsible for most frequently citing definition of sustainable development, states it to be the process "to meet the needs of the present without compromising the ability of future generations to meet their own needs".

The concept of sustainable development can be broken into two parts. On the one hand, "sustainability" relates to the question of the "carrying capacity" of the Earth, while giving no attention to social issues, particularly those concerning equity and social justice. "Development", on the other hand, would appear to assume and even necessitate continual economic growth and ignore the question of ecological constraints or "carrying capacity". When these two concepts are put together, a very different one emerges, and the result is much more than the sum of the parts. It is therefore a multi-dimensional concept, and it must be addressed at various levels simultaneously.

Sustainability may be divided into three types: social, ecological and economic. The ecological definition is perhaps the clearest and most straightforward, measuring physical and biological processes and the continued functioning of ecosystems. Economic definitions are sharply contested between those who emphasize the "limits" to growth and carrying capacity and those who see essentially no limits.

In the narrowest sense, global sustainability means indefinite survival of the human species across all the regions of the world. A broader sense of these meaning specify that virtually all humans, once born, live to adulthood and that their lives have quality beyond mere biological survival. The broadest sense of global sustainability includes the persistence of all components of the biosphere, even those with no apparent benefit to humanity.

ICTs IN RELATION TO SUSTAINABLE DEVELOPMENT

The development of novel and affordable information and communications technologies, and the emergence of information society with new economic models, has the potential for making major contributions towards sustainability of the earth's ecosystems. Innovative use of information technology offers substitutes for travel and for the transportation of goods, and a major shift towards less resource-intensive production, consumption, trade, and services. Such changes can significantly reduce the environmental impact of industrial and commercial activities and thus contribute to sustainable development.

Earlier societies were taking advantage of conventional ICTs such as radios, television, and fixed telephone lines to meet their informational needs. Today's information society is being built on further advanced technology, knowledge and intelligence. Now talking of ICTs mean, talking of wireless networks, personal computers and Internet. Information Technology (IT) in general empowers both people and machines with information, which is transformed into knowledge and intelligence. Appropriate use of the knowledge by both people and machines contributes to sustainable development. While informed and empowered people know their role as citizens in an environmentally sustainable society, empowered machines have the knowledge to minimize energy and material use, wastage, and pollutants.

Box - 1

"It can be no accident that there is today no wealthy developed country that is information-poor, and no information-rich country that is poor and underdeveloped"

Tun Dr. Mahathir Mohammed,
Former Prime Minister of Malaysia

Information communication technology facilitates fast, cheap, equitable, and resource-efficient access to information, accumulated knowledge, learning opportunities, and co-operation support tools for its citizens. Internet, today's cyberspace, facilitates people from across the globe to co-operate and perform various activities of human life and endeavor. Processing, storage, transmission, and sharing of information in electronic form, without any spatial or temporal constraints, empower people with instant information along desired lines. Information analysis contributes to knowledge and intelligence, which have increasingly become commodities in the information age. As information becomes accessible to anyone, and anywhere, it is increasingly becoming a basic economic resource and a structuring factor in today's society.

Miniaturization and innovation in electronics have equipped machines with intelligence and communication technologies, enabling them to collaborate with each other in their work. By empowering machines, ICTs offer a high potential for making a positive contribution towards sustainability of our economy and environment, particularly by reducing the impacts arising from manufacturing and transportation activities. Moreover, such opportunities are emerging in various other sectors too.

MILLENNIUM DEVELOPMENT GOALS (MDGs)

The eight Millennium Development Goals (MDGs) as depicted in Box-2 were agreed at the United Nations Millennium Summit in September 2000 and nearly 190 countries so far have endorsed them. The Goals range from improving health and sanitation conditions, tackling illiteracy, halving global poverty and hunger, doing away the discrimination against women to protecting the environment. These were pronounced to encourage comity of nations to join forces to start doing something about it.

Alongside the Goals, a series of 18 targets were also drawn up to give the international community a number of tangible improvements to aim for within a fixed period of time, and also make it easier for them to measure their progress to date. The intention is that almost all of these targets will be achieved by 2015. Unfortunately, while some significant progress is being made towards meeting some of the targets in some of the affected countries, in many cases progress is patchy, too slow or non-existent.

International Telecommunication Union (ITU) in its report on World

Box - 2: Millennium Development Goals

GOAL 1. ERADICATE EXTREME POVERTY AND HUNGER

Target 1.
Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day

Indicators

1. Proportion of population below $1 (1993 PPP) per day (World Bank)
2. Poverty gap ratio [incidence x depth of poverty] (World Bank)
3. Share of poorest quintile in national consumption (World Bank)

Target 2.
Halve, between 1990 and 2015, the proportion of people who suffer from hunger

Indicators

4. Prevalence of underweight children under five years of age (UNICEF-WHO)
5. Proportion of population below minimum level of dietary energy consumption (FAO)

GOAL 2. ACHIEVE UNIVERSAL PRIMARY EDUCATION

Target 3.
Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling

Indicators

6. Net enrolment ratio in primary education (UNESCO)
7. Proportion of pupils starting grade 1 who reach grade 5 (UNESCO)
8. Literacy rate of 15-24 year-olds (UNESCO)

GOAL 3. PROMOTE GENDER EQUALITY AND EMPOWER WOMEN

Target 4.
Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015

Indicators

9. Ratio of girls to boys in primary, secondary and tertiary education (UNESCO)
10. Ratio of literate women to men, 15-24 years old (UNESCO)
11. Share of women in wage employment in the non-agricultural sector (ILO)
12. Proportion of seats held by women in national parliament (IPU)

GOAL 4. REDUCE CHILD MORTALITY

Target 5.
Reduce by two thirds, between 1990 and 2015, the under-five mortality rate

Indicators

13. Under-five mortality rate (UNICEF-WHO)
14. Infant mortality rate (UNICEF-WHO)
15. Proportion of 1 year-old children immunized against measles (UNICEF-WHO)

GOAL 5. IMPROVE MATERNAL HEALTH

continue...

...continued

Target 6. Reduce by three quarters, between 1990 and 2015, the maternal mortality ratio

Indicators

16. Maternal mortality ratio (UNICEF-WHO)
17. Proportion of births attended by skilled health personnel (UNICEF-WHO)

GOAL 6. COMBAT HIV/AIDS, MALARIA AND OTHER DISEASES

Target 7

Have halted by 2015 and begun to reverse the spread of HIV/AIDS

Indicators

18. HIV prevalence among pregnant women aged 15-24 years (UNAIDS-WHO-UNICEF)
19. Condom use rate of the contraceptive prevalence rate (UN Population Division)

19a. Condom use at last high-risk sex (UNICEF-WHO)

19b. Percentage of population aged 15-24 years with comprehensive correct knowledge of HIV/AIDS (UNICEF-WHO)

19c. Contraceptive prevalence rate (UN Population Division)

20. Ratio of school attendance of orphans to school attendance of non-orphans aged 10-14 years (UNICEF-UNAIDS-WHO)

Target 8.

Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases

Indicators

21. Prevalence and death rates associated with malaria (WHO)
22. Proportion of population in malaria-risk areas using effective malaria prevention and treatment measures (UNICEF-WHO)
23. Prevalence and death rates associated with tuberculosis (WHO)
24. Proportion of tuberculosis cases detected and cured under DOTS (internationally recommended TB control strategy) (WHO)

GOAL 7. ENSURE ENVIRONMENTAL SUSTAINABILITY

Target 9.

Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources

Indicators

25. Proportion of land area covered by forest (FAO)
26. Ratio of area protected to maintain biological diversity to surface area (UNEP-WCMC)
27. Energy use (kg oil equivalent) per $1,000 GDP (PPP) (IEA, World Bank)
28. Carbon dioxide emissions per capita (UNFCCC, UNSD) and consumption of ozone-depleting CFCs (ODP tons) (UNEP-Ozone Secretariat)
29. Proportion of population using solid fuels (WHO)

Target 10.

Halve, by 2015, the proportion of people without sustainable access to safe drinking water and sanitation

continue...

...continued

Indicators

30. Proportion of population with sustainable access to an improved water source, urban and rural (UNICEF-WHO)
31. Proportion of population with access to improved sanitation, urban and rural (UNICEF-WHO)

Target 11.
By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers

Indicators

32. Proportion of households with access to secure tenure (UN-HABITAT)

GOAL 8. DEVELOP A GLOBAL PARTNERSHIP FOR DEVELOPMENT

Indicators for targets 12-15 are given below in a combined list.

Target 12.
Develop further an open, rule-based, predictable, non-discriminatory trading and financial system.
Includes a commitment to good governance, development and poverty reduction - both nationally and internationally

Target 13.
Address the special needs of the least developed countries.
Includes: tariff and quota-free access for least developed countries' exports; enhanced programme of debt relief for heavily indebted poor countries (HIPC) and cancellation of official bilateral debt; and more generous ODA for countries committed to poverty reduction

Target 14.
Address the special needs of landlocked developing countries and small island developing States (through the Programme of Action for the Sustainable Development of Small Island Developing States and the outcome of the twenty-second special session of the General Assembly)

Target 15.
Deal comprehensively with the debt problems of developing countries through national and international measures in order to make debt sustainable in the long term

Some of the indicators listed below are monitored separately for the least developed countries (LDCs), Africa, landlocked developing countries (LLDCs) and small island developing States (SIDS)

Indicators

Official development assistance (ODA)

33. Net ODA, total and to LDCs, as percentage of OECD/Development Assistance Committee (DAC) donors' gross national income (GNI)(OECD)
34. Proportion of total bilateral, sector-allocable ODA of OECD/DAC donors to basic social services (basic education, primary health care, nutrition, safe water and sanitation) (OECD)

continue...

...continued

35. Proportion of bilateral ODA of OECD/DAC donors that is untied (OECD)
36. ODA received in landlocked developing countries as a proportion of their GNIs (OECD)
37. ODA received in small island developing States as proportion of their GNIs (OECD)

Market access

38. Proportion of total developed country imports (by value and excluding arms) from developing countries and from LDCs, admitted free of duty (UNCTAD, WTO, WB)
39. Average tariffs imposed by developed countries on agricultural products and textiles and clothing from developing countries (UNCTAD, WTO, WB)
40. Agricultural support estimate for OECD countries as percentage of their GDP (OECD)
41. Proportion of ODA provided to help build trade capacity (OECD, WTO)

Debt sustainability

42. Total number of countries that have reached their Heavily Indebted Poor Countries Initiative (HIPC) decision points and number that have reached their HIPC completion points (cumulative) (IMF - World Bank)
43. Debt relief committed under HIPC initiative (IMF-World Bank)
44. Debt service as a percentage of exports of goods and services (IMF-World Bank)

Target 16.
In cooperation with developing countries, develop and implement strategies for decent and productive work for youth

Indicators

45. Unemployment rate of young people aged 15-24 years, each sex and total (ILO)

Target 17.
In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries

Indicators

46. Proportion of population with access to affordable essential drugs on a sustainable basis (WHO)

Target 18.
In cooperation with the private sector, make available the benefits of new technologies, especially information and communications

Indicators

47. Telephone lines and cellular subscribers per 100 population (ITU)
48. Personal computers in use per 100 population and Internet users per 100 population (ITU)

Source: http://www.undp.org/mdg/abcs.html

Telecommunication Development' highlighted the significance of ICTs in achieving millennium development goals. It states that as one of the eight Millennium Development Goals (MDGs), the Declaration makes a commitment that the number of people who live on less than one dollar a day should be halved by the year 2015. The goals outline specific areas for achieving improvement in people's lives including in the areas of poverty reduction, education, gender, health and the environment. The last goal, developing a global partnership for development, proposes a means of achieving the first seven. Attached to the eight goals are 18 specific targets for achieving the MDGs (Box-2). This monitoring activity aims to turn the goals and targets into widely recognized measures of international cooperation. Monitoring is based on 48 indicators formulated to measure the targets.

Significantly for the work of International Telecommunication Union (ITU), and for this report, the Millennium Declaration acknowledges that ICTs are an important tool to achieve its overall goals. ICTs can help alleviate poverty, improve the delivery of education and health care, make governments more accessible and accountable to the people, and much more. Target 18 of Goal 8 calls upon the Declaration's adherents to: "In cooperation with the private sector make available the benefits of new technologies, specifically information and communications."

The three indicators were chosen to measure ICTs availability in countries. These indicators are the total number of telephone subscribers per 100 inhabitants, personal computers per 100 inhabitants and Internet users per 100 inhabitants. They were selected because they were widely available, and covered many years and most countries.

The ITU report further highlights the role of ICTs and narrates that of all the different MDG targets, number 18 is the most open-ended (raising the questions of which ICTs should be made available, to whom and by when), but it is also the one where the most progress was made during the 1990s. All of the developing sub-regions of the world have grown their fixed and mobile telephone networks (total tele-density) to a greater extent since 1990 than in the entire period before that date. In the exceptional case of East Asia (which includes China), the level of total tele-density in 2002 was more than 35 times higher than ten years earlier, and in all cases, except the developing Pacific nations, total tele-density was at least five times higher in 2002 than it was in 1992.

Looking at all the articulated eight goals, and having an understanding of what ICTs possess, it is easy to relate the role of ICTs in every sphere of activity. The role in the provision of education, health, business activity, agriculture extension, global networking, building knowledge based societies and what not is possible through the present day ICTs. The application of ICTs in the fields of education and healthcare are the two main areas of significant importance. Informed and educated masses lead to progress and growth of a country in every other sphere of life. While healthier the nation the more creative, progressive and energetic it is to undertake any challenging task and meet any difficult situation.

Education, ICTs and Millennium Goals

John Daly the author of 'Education, Information and Communication Technologies, and The Millennium Development Goals' taking note of 'ICTs for Education' impress upon the fact that new technologies open new possibilities, both for better and for worse; cultural, political, economic, social, and institutional processes determine which opportunities are accepted, and the degree to which they are utilized. Information and communication technologies (ICT) will not cause countries and communities to improve education, but can be used to help in those countries and communities that mount effective efforts to do so.

Daly further comments that, the educational target within the MDG is to "ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling." This is an important objective, as is increasing literacy in developing nations. However, it should be clear that the MDGs will not themselves be met without much broader targets for training teachers, public health workers, and large numbers of other professionals.

Reaching the educational levels needed to achieve either the MDGs or an Information Society will require strong institutions and supportive policies. These levels will not be achieved without broadly based social and economic development - there is no technological fit. Yet, it is clear that information and communication technologies will have an important role to play in improving educational systems, as well as in setting the standards for education for an information society.

Reaching the Goal's specified educational levels is also likely to depend on the overall progress achieved toward the MDGs. In environments marked by poverty, hunger, and ill health, children are often forced to work instead of going to school - and even those who are free to receive structured educations tend to suffer from physical and

Box - 3

"ICTs have brought about a new hope for the developing world. Many of these countries continue to labour in the agricultural age and their economic development is thus restricted and unable to move on and catch up with the developed world. Most developing nations have also been unable to industrialize their economies leading to greater impoverishment and dependence. In this context, the very prospect of 'leapfrogging' the traditional stages and cycles of progress, is seen as revolutionary. Telemedicine, distance education, wireless applications, the use of the Internet for a wide variety of critical information dissemination tasks hold the promise of overcoming fundamental barriers of infrastructure which have plagued the developing world."

-- *"Promoting ICT for Human Development in Asia, Realizing the Millennium Development Goals," (2002) An Initiative of the Asia-Pacific Development Program and Human Development Resource Centre (UNDP), New Delhi.*

motivational impediments far beyond those that are in other parts of the world.

ICTs Provide Educational Opportunities

ICTs allow the possibility that vastly larger numbers of students may learn from the best teachers, and indeed from the most profound thinkers and most involved participants in the field being studied. One of the problems of education in developing countries (as compared to other countries) is that students can't dependably gain access to good teachers. Indeed, this situation exemplifies a more general problem - lacking skilled human resources, it is often the case that the person with the right skills is not present when those skills are needed. Clearly one of the benefits of information and communications technology is that people with scarce skills can technologically amplify their usefulness. They can use point-to-point communication media (e.g., telephone to save travel). They may use broadcast media to reach larger numbers of people for each presentation. They can use storage media (including movies, videos, tapes, and so on) to record information, allowing for future study and distribution. They may use computing power to amplify their efforts (e.g., PC-based courseware to expand the numbers of learners that can take a class). Indeed, now artificial intelligence techniques can be constructed to embody expertise within devices (e.g., expert systems).

More knowledge can be made available to students, in more accessible forms; hyper-linking knowledge bases can allow unparalleled opportunities to explore and organize bodies of information. Learners can be provided with unprecedented facilities for storing information and reviewing what has been learned.

Teaching productivity can be increased, and good teaching made more affordable. Learning productivity can also be increased, and studying therefore made cheaper.

The best pedagogical practices can be shared more widely among teachers via media, and in principle can be embodied in ICT devices. Likewise, best learning practices can be shared more widely among students, and (again, in principle) can be aided by or embodied in devices. Positive reinforcement for students (and teachers) can be provided more effectively and efficiently, stimulating more interest in learning (and teaching).

The educational process can be made more asynchronous, allowing people to learn when they choose; distance can be spanned, allowing people to learn where they choose. Learning may become more of an “on demand” process, and as such more motivated; efforts to learn materials never to be used can be reduced. Skills that once required long practice for mastery can be transferred from man to automated device; the training in those skills than can be reduced in or removed from the curriculum, and the time saved used to provide new learning opportunities.

Technology can radically expand the range of experiences and experimental

procedures within the reach of students. Models can clarify the nature of complex processes. “What if" scenarios can be explored via simulation. Language barriers can be overcome for textual materials, and students will have increasing access to materials in many languages.

Historical events from the recent past can be viewed on film, those from the more distant past can be simulated or reenacted. Distant places can be viewed in real time, their experts seen and heard. Dangerous or prohibitively expensive experiments can be viewed as performed by experts, or, again, simulated. Rare events or conditions can be seen on film or in recreation, and compared one with another. Indeed, virtual reality offers the possibility of unparalleled immediacy of experience among large groups.

Group learning processes can be facilitated, made more asynchronous and less dependent of co-location of the members of the group. Best practices in group learning can be shared more widely.

Indeed, technology change may induce changes in the very objectives of education. Currently the educational model can be linked to storing many things in a warehouse so that a student will have anything s/he needs later in life. With the new technology learning on demand becomes the model. When a need arises, a person goes online to obtain materials to allow her/him to learn what is required to meet that need. Such learning would be highly motivating, and would leave little opportunity for the knowledge to decay before being used and reinforced.

As information and communication technologies can be tools for the learner in informal situations, or for the student in formal situations, so too can they facilitate the work of the teacher, and improve the interactions between student and teacher. Moreover, they can be used to improve efficiency and effectiveness of all the other participants in the educational system – from school administrators to educational planners. They can facilitate the production of educational supplies, and improve markets for school inputs and outputs.

The potential benefits from the appropriate applications of ICT in the Information Society are nearly limitless. Great as have been the benefits from the applications in advanced developed nations, they do not begin to tap the potential inherent in the technology; resource constraints and the inertia of educational, social, and economic systems slow the appropriation of the benefits to society. They are likely to slow the transformation of education still more in poor countries, which have a sad history of being slow to take advantage of technological opportunities.

Indeed, one can imagine situations in which educational disparities will be exacerbated by ICT, and in which most of the poor will be left watching those better able to utilize the technology as they take advantage of its potential to become still more educated and still more affluent. It is not accidental that the countries that have

most invested in ICT have generally seen income disparity increase as the technology has become more ubiquitous.

The educated and relatively affluent can be expected to have more access to ICT, as those with political power can be expected to have more success in appropriating its benefits through the political process. With limited financial and human resources suited to introducing ICT in developing nations, competition for these resources is likely to favor those already advantaged. Moreover, the technology increases the potential for brain drain, and indeed increases the incentives for rich nations to seek the talented, educated elites from poor countries to supply their workforce needs.

Involvement of Education and Application of ICTs in Achieving MDGs

Educational systems will have to be improved generally to achieve the MDGs. Thus, one will not eliminate extreme poverty (Goal 1) without improving the education of managers, engineers, and many other professions. One will not eliminate hunger (also Goal 1) without educating agronomists, entomologists, plant pathologists, veterinarians, agricultural economists and many other professions. Promoting gender equality and empowering women (Goal 3) involves not only the primary educational and literacy indicators cited below, but also educating large numbers of women beyond primary school, and preparing them for a wide range of careers and professions. The health goals (4, 5 and 6) will not be achieved without a well prepared health-service workforce, and this workforce will include not only paraprofessionals, but a wide range of health professionals. Environmental sustainability (Goal 7) will not be achieved without trained environmental professionals, and without the engineers and managers who will reduce the pollution from industry and urban development.

Developing a global partnership for development (Goal 8) is a catchall goal, and accomplishing it alone involves a huge educational challenge. The Goal involves: improving international trade, improving development prospects of the least developed nations, dealing with the special problems of landlocked and small island states, dealing comprehensively with debt problems of developing countries, providing productive work opportunities for youth, improving access to pharmaceuticals, and utilizing information and communication technologies.

Goal 2, its target, and the indicators specified are given below. Right now over 100 million children around the world get no access to education and another 150 million will not complete their primary education ("Rich countries languish at bottom of class on education funding,: http://www.campaignforeducation.org/_html/2003-news/11-rc-rept/frameset.shtml). Most countries in Sub-Saharan Africa have very low primary completion rates, with many less than fifty percent. Only 37 of 155 developing countries analyzed in a recent World Bank study had yet achieved universal primary completion (http://www.developmentgoals.org/Education.htm). Literacy rates are very low in many developing countries, not only as a legacy of the low enrollment rates in primary education, but frequently because of the poor quality of that education, and

Goal 2: Achieve universal primary education	
Target	**Indicators**
Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling	• Net enrollment ratio in primary education • Proportion of pupils starting grade 1 who reach grade 5 • Literacy rate of 15 to 24-year-olds

because of a high rate of decay of literacy after leaving school (for those who were poorly educated to begin, and who had little opportunity to use their literacy skills as adults).

The education target and indicators of Goal 3 are given below. As of the year 2000, the ratio of girls to boys in primary school was 0.92 in North Africa and the Middle East, 0.82 in Sub-Saharan Africa, and 0.81 in South Asia (http://www.developmentgoals.org/Gender_Equality.htm#facts). Thus, ambitious as are the targets for primary school and literacy for males, they are still more ambitious for females!

Goal 3: Promote gender equality and empower women	
Target	**Indicators**
Eliminate gender disparity in primary and secondary education preferably by 2005 and in all levels of education no later than 2015	• Ratio of girls to boys in primary, secondary, and tertiary education • Ratio of literate females to males among 15- to 24-year-olds

Within Goal 6 (Combat HIV/AIDS, malaria, and other diseases) there is an indicator: "Ratio of school attendance of orphans to school attendance on non-orphans aged 10-14".

There are several indirect paths by which the Information Revolution can affect the supply and demand for primary education among the target communities now so poorly served:

- The effects of the technology on social and economic growth and development may change the general economic and social climate, in ways favoring or militating against the expansion of primary education;
- The technology can be used to help improve the productivity of investment in the educational system and/or of educational services themselves, helping make limited resources go farther;
- The technology can indirectly change incentives for educating children;
- The technology can change the opportunity costs of having those children in school.

It may well be that these effects will be more powerful than any direct effects of the introduction of the technology in the school system.

Keeping primary school costs low is certainly critical for achieving the objectives of universal primary education and universal literacy. Communities and families that were not sending their children to school at all are not likely to pay large amounts per pupil in the next decade. Theirs are the children who will be on the wrong side of the Digital Divide. While kids in rich countries will grow up in information societies, poor kids in poor countries will attend poor schools, if they attend schools at all. Similarly, literacy training for the large numbers of illiterate poor is going to have to be efficient and low-cost if it is to be affordable by their communities and nations.

Appropriate, affordable technologies, such as interactive radio, can help extend education to all, and to improve the quality of education for even the poorest schools in the next decade. Similarly, there are encouraging technological possibilities in literacy training and maintenance becoming available through appropriate and affordable applications of ICTs, including non-formal approaches using television.

Perhaps more importantly, appropriate applications of ICTs throughout the educational system can improve productivity and quality in the expansion and operation of the school system. Schools will have to be built - and better, more efficient schools should be made possible through the use of ICTs by architects, builders, and suppliers of building materials. Teachers will have to be trained, and retrained; the training can be facilitated by ICTs. Teaching materials will have to be produced and distributed; the production and distribution can be facilitated with ICTs. Schools, districts and larger school systems will have to be managed; the management can be facilitated, again, by use of ICTs.

There is a tendency to think of the educational system as a teacher on one end of a log, and a student on the other end. That is not true. Learners are of course central, and the teacher-student interface is important. But clearly parents, peers, neighbors, and the community are also involved in education. There are lots of examples, from field trips, to internships, to work-study programs in which people outside the school help students to learn. Communities will have to be involved with the education of their children, and this involvement can be promoted and facilitated by appropriate use of ICTs such as community radio.

Similarly, a massive effort will be needed to empower hundreds of millions of current illiterates to read and write. Programs will have to be mounted, teachers prepared, materials published and distributed, administrative mechanisms expanded, and monitoring and evaluation of programs put in place. ICTs can play many useful and important rolls in all these efforts. (While the challenge of education of HIV orphans is perhaps less administratively burdensome, ICTs can also play a role.)

These various ambitious objectives will not be achieved without the mobilization of

social and political support. ICTs can have an important role in this mobilization. Progress toward the goals will not be effectively measured without the use of the technology, nor can the quality of education be monitored without ICTs. The media, and their ICTs infrastructure, will be invaluable in helping societies hold their educators and educational officials accountable for progress in meeting these goals.

The effect of ICTs on continuing education, secondary education, higher education, skills training, and other forms of learning and education will almost certainly be greater than that on primary education for the poor. Moreover, ICTs applied to post-primary education offers great potential benefits for social and economic development.

ICTs IN HEALTHCARE

Not only is the intervention of ICTs in the arena of education very critical, medicine and healthcare is yet another area where information communication technologies are playing its due role. The concept of tele-health is fast gaining reputation and credibility with ever improving mediums of communication. Telehealth is one such application that will facilitate to achieve the much effectively.

Tele-Health

As per modern definition of tele-health it is the use of information and communication technologies to transfer healthcare information for the delivery of clinical, administrative and educational services. The evolution of telehealth is not only expected to reshape the delivery of consultations, monitoring and treatments it is also expected to reshape healthcare providers' and patient/citizens' access to healthcare services. Healthcare delivery is no longer controlled and will be less and less controlled by secondary and primary healthcare providers in the times to come. Tele-health is a new platform on which healthcare provision can be reshaped to meet the challenges of an aging population and more demanding and discerning patients/citizens. It involves automating all routine healthcare processes, from monitoring blood sugar levels to administering drugs, and extending the distribution of more complex and expert medical expertise, by modern ICTs to deliver consultations or healthcare support.

Besides the aging population and their medical demands, tele-health is a very successful model for a population of remote and underprivileged areas of a developing world, where time, money and geographic location are main barriers to the provision of simple medical advice.

Tele-health provides a tool to eradicate ordinary and low-value healthcare processes and maximise the core skills and expertise of deployed human resources.

Telehealth has emerged from the developed countries that are using this system for their remote areas. For instance Canada and Australia have a vast land and

telemedicine has been successfully implemented there to provide medical services to their remote areas. Canada has about 300 companies working in different applications of Tele-health. Tele-health and telemedicine are often used interchangeably, but tele-health is a bit broader term which includes:

- The application of Tele-education and multi-media applications for professional and patient education and research
- Preventive medicine through awareness raising and
- Above all live consultations between remote clinics and medical centers of excellence generally referred as Tele-medicine.
- Other examples of telehealth applications include call centres (known as telecare or teletriage), telemonitoring, and telehomecare.

Potential of ICTs in Healthcare to Positively Impact Healthcare

Telehealth has a great deal of potential to improve access to health care, education and health information.

- Having to travel over long distances and in bad weather to access health care places patients and health providers at risk. It also makes even more difficult the recruitment and retention of local health providers. Tele-health can reduce the travel cost by limiting the travel to only when absolutely required e.g. for operations, procedures.
- Telehealth can potentially benefit all community members by improving access, reducing unnecessary travel, improving overall health status, increasing level of comfort and security, and giving opportunities to increase knowledge on health and capacity to deliver health care at the community level.
- Community health providers often feel alone and overwhelmed. Telehealth can help them to access support and it can also help them to better manage their workload. They can learn new techniques to deliver services. They can save time looking for patient files.
- Increased access of patients and health care providers to varied applications and services i.e.: diagnosis, prescriptions, treatment, grand rounds, continuing care/follow-up, professional education/training.
- Facilitate linkages among individuals and groups, places and knowledges:
  - Networking among communities and organizations.
  - Educational connections, information sharing , internet access/webpages.
  - Links for family support in homes/communities (monitoring, supervision, education)
  - Links among programs e.g. Treatment Centers
- Contribute to effective administration/management of health-related programs and resources:
  - Upgrade infrastructure/info structure (e.g. access to adequate telephone lines)
  - Longitudinal electronic health records
  - Recruitment

Benefiting from Telehealth

Although telemedicine and telehealth have many socio-economic benefits, it can generate new sources of revenues for service providers and equipment suppliers and can optimize the use of available human and capital resources in developing countries, it is important to recognize that investing in a telehealth delivery system will cost something and that something will be competing for scarce resources in developing countries. Therefore, the telehealth services has to be planned by taking all the aspects into consideration including preliminary research, proper design according to need and resources and dedicated implementation.

The success of a telemedicine service will depend heavily on what technologies and services are used, on how appropriate they are to particular countries, recognizing that the situation may differ from country to country. Or, to put it another way, what may work in one country may not meet the needs of another country.

Maximizing Utilization of Telehelath to Meet MDGs

In order to realize all the potential benefits of telehealth and make it an effective tool in sustainable development, it has to be designed, implemented and supported properly. Following list highlights the major issues that need to be addressed while discussing the maximum utilization of telehealth for development.

i. Establish a team of individuals to create a strategic plan for the design, implementation and evaluation of the telehealth network.
ii. Review the previous telehealth activities that have occurred in the region, country and other similar locations.
iii. Conduct a research of any current telehealth technologies and telecommunications that are, or could be supported in the target area. The research also must include of resources of people, e.g. people who have been involved in telehealth and / or those who are interested in participating in the future.
iv. Develop an educational package and disseminate this to all individuals potentially affected by telehealth. This will educate people about Telehealth and prepare them to answer questions in the Needs Assessment.
v. Develop and conduct a Needs Assessment. This should go to all individuals / sites that could potentially be affected by telehealth. Results from the need assessments that help direct what clinical, educational and administrative needs have priority.
vi. Review, establish and formalize relationships with potential sites (referral and remote).
vii. Review the type of telehealth technology and telecommunications links at all potential sites. Make sure the technology chosen is interoperable with the referral centres.
viii. Match the needs (identified by the Needs Assessment) to the ability to meet the needs via telehealth (obtained from referral centers). The ability to meet the need

includes having health professionals who want to use telehealth technology to meet the need.

ix. Identify the telecommunications options and work with the vendor(s) to test and implement the preferred option.
x. Identify telehealth technology that best meet the needs of communities, meet the technical requirements (including security) and is compatible with the referral centers. A bridge will be required to facility interoperability between different videoconferencing systems / protocols and multi-site connections.
xi. Educate and train potential users (including support staff) about the telehealth system and how to use it.
xii. Educate and train potential technicians how to trouble-shoot and repair the technology.

Information and communication technologies and services can improve the health care and working conditions of isolated healthcare staff only if those technologies are selected, developed, adapted, and carefully deployed to suit the population's real needs in their real environment. The real time consultations over internet or Telemedicine may seem to be the one which produces the most substantial results in short-term but the preventive and educational activities can produce long-term impact on the health care delivery system.

The intervention of ICTs in the field of medicine and healthcare is more than welcoming. One major reason that the achievement of millennium development goals is being viewed so optimistically is due to heavy reliance on information communication technologies. The concept of tele-health was a far reality before the emergence of modern day information communication tools such as personal computers, digital communication gadgets and Internet.

The contribution of ICTs in the field of healthcare has become unprecedented. Not only has it made the provision of healthcare economical and accessible in short time it is enabling patients and clinicians to satisfy their personal and professional needs effectively. In terms of achieving millennium development goals, i-e providing health education and health service to children, women, and underprivileged is quite feasible. With regards to meeting the challenge of child mortality (goal4) and improving maternal health (goal 5), ICTs provide a dynamic platform through web-portals and other means for information dissemination and raising awareness about health matters in most simple and comprehensible manner.

The 8th goal of MDGs, to build global partnerships for development, is being materialized with tele-centres being established and linked across national boundaries and regions. The opportunities for significant progress in distance medicine are great. Now, the major objectives set forth are to narrow the gap between rural and urban medical services, while recognizing that urban centers are likely to continue to be more attractive places for most health-care specialists to work.

Difficulties in Setting up Tele-health in Developing Countries

Despite so many fruits of this technology, there are some issues in implementation of Tele-health:

- Lack of money to purchase the minimum technology or telecommunications required for Telehealth
- Limited number of people who know how to operate, install or repair the technology or telecommunications
- Limited availability of spare parts
- Limited access to and unstable electrical supply
- Videoconferencing requires a telecommunications connection at higher speed (called high bandwidth). Many rural and remote communities do not currently have access to the bandwidth required to conduct videoconferencing.
- Unreliable telecommunications infrastructure
- Health care system that may be poorly organized
- Limited number of health professionals interested in experimenting new concepts rather than orthodox ways healthcare system

Recommendations for Promoting Tele-health in Developing Countries

After accepting tele-health to be an important tool of ICTs in healthcare, it is important to make best use of it by implanting tele-health system in a country. This is especially important for developing countries having meagre financial and other resources. Taking into account the additional difficulties associated with setting up telehealth in developing countries, it would be prudent to utilize telehealth technologies that are relatively inexpensive, robust and are easy to operate and maintain. It would also make sense to choose activities that result in a high degree of benefit for as many people as possible. One must also take into consideration what technology is available and what can be supported. Further aspect to keep in mind is that the technology chosen should be compatible with the technology used by those who will meet your needs. Telehealth activities should also operate on low bandwidth telecommunications. Technology should be chosen to meet immediate health care needs.

- High expectations should be managed by communicating that telehealth is not a solution to all problems.
- Most people with telehealth knowledge and experience agree that it is not the technology, rather the human side of telehealth that is most difficult to negotiate. Adequate and continuous (or periodical) training and guidelines for use of the equipment are important to ensure rapid adaptation and high usage of the equipment.
- A sufficient testing and demonstration period is required to familiarize staff with the equipment.
- Local health providers must be involved at the outset of the project with due incentives to ensure their long-term participation and use of the equipment.

- The telehealth activities must be well coordinated to avoid chaos and de-motivation.
- The human infrastructure that supports telehealth must be developed.
- The development of human infrastructure will rely principally on training and establishing protocols/guidelines or standard operating.
- The subject of health informatics should be introduced and encouraged at the university level to produce well trained human resource for such projects.
- Tele-health equipment should include computer hardware and software, peripherals (otoscopes, dermascopes, digital cameras, ECGs, etc.) and efficient data transfer technologies.
- Time management is a concern for practitioners using telehealth since conducting teleconsultations often require more time than a face-to-face consultation. The practitioners should be briefed before hand about the hindrances and difficulties they would face.
- Technologies must be easy to use and the equipment purchased at both ends of the connection must be interoperable.
- The real needs of the user, which vary greatly due to educational, social and cultural differences as well as language must also be kept in mind. The key to a successful project is to use different technologies strategically to solve specific problems and improve on existing ways of working. The full benefit of Internet technologies will only be apparent when they meet real needs and add value to health services delivery.

It is important to remember that tele-health is not a universal solution; it cannot do all things for all people. It is not designed to replace clinicians or other health care staff, but it is designed to improve access to health care for those people in remote locations or whose access is limited by culture, language, or clinical resources. It is now required that mindset of the health professionals and masses is molded to raise the acceptability of new ways for delivering healthcare.

CONCLUDING REMARKS

Information and communication technologies hold great potential to help those seeking to take lead in attain millennium development goals at national level. Be these be in the arena of achieving universal primary education, literacy or provision of sound health management system in a country. Even if these targets sound overly optimistic at the moment, expected innovations in ICTs should help improve access, efficiency and quality of services in all spheres of life.

It must be understood that the provision of accessible education and affordable healthcare to every segment of society would ensure safeguarding environment, boosting economy and developing vibrant society as a whole.

Education and access to healthcare facilities is a right of every individual and the application ICTs in a befitting manner can assure extending these services in a most economic and accessible way. Focus in the provision of these two areas of immediate

social attention can help deliver the goods in the other concerned areas of MDGs, such as eradicating extreme poverty, promoting gender equality, women empowerment and improving maternal health. The most fundamental effects of ICTs involve: reducing the costs of transactions carried out over distances; the ability to obtain and manage (environmental) data on scales and in situations previously impossible; the ability to conduct quantitative analysis (of environmentally relevant information) in real time at unprecedented depth; the ability to communicate among public, civil society, government and the private sector with unprecedented coverage and efficiency, and the ability to control processes electronically, enabling great precision to be achieved in real time control of complex systems. All of these characteristics will be used in ways that change society, and all offer opportunities to improve environmental sustainability.

Life expectancy in developing nations has increased, without doubt as the result of better health and nutrition, and improved abilities of people to care for themselves and their children. If ICTs can be brought to bear and help reduce and eradicate the worst poverty, and the worst aspects of poverty, then in it will clearly help breach the development divide separating the rich from the poor. Bringing ICT to bear to extend basic education and literacy to all is a part of the effort to fight poverty.

ICTs will result in new industries; bring radical changes in the efficiencies of existing industries and indeed of entire economies. It will change the incentives people face in deciding where to live and work, thus changing the growth of cities and the migration of peoples. It will allow resources to be used with greater efficiency than ever before, but also seems likely to raise demand for the products manufactured from those resources.

Advances in ICT have made it possible for the first time in history to detect environmental problems at very large and at very small scale. They permit unprecedented monitoring of environmental quality, and unprecedented accuracy in detection of the sources and projection of the development of environmental problems. ICTs can be used to empower people with unprecedented understanding of environmental systems, and of the interplay between environment and development. It can be used to allow unprecedented intensity of communication on such issues among all sectors of society. Almost any intervention that can be identified to improve sustainability or reclaim degraded environmental systems can benefit from appropriate applications of ICTs.

Narrow views focusing on applications of ICTs in environmental monitoring or natural resource protection projects have an important place, but reductionism taken too far will result in radical underestimates of the effects of ICTs on the environment. Indeed, it may be more important to environmental sustainability of development programs to see that ICTs is fully applied to agricultural and land use planning, to improving industrial processes and reducing industrial pollution, and to appropriate agricultural and silva-cultural intensification, than to focus on narrowly defined "environmental" applications of ICTs. Similarly, it may be more important to

understand the effects of the ICT revolution on trends of urban growth, and to incorporate such considerations in national planning, than to focus on ICTs in planning for the sustainability of "environmental projects".

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BIODIVERSITY AND SUSTAINABLE DEVELOPMENT: PAKISTANI PERSPECTIVE

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INTRODUCTION

The history of modern man is not very old. It has been postulated that the "modern man" appeared on this planet about 1.5 million years ago (Colbert, 1966). For a long period of time, human race obtained whatever it needed from its surroundings, or the environment as we recognize it today (Mufti, 1997). This was especially true in terms of food and space. The early human populations could find abundant food, as grain, fruit and water, in their immediate surroundings. There was no dearth of space either, where they could sleep as well as take shelter against predators and/or harsh weather conditions.

As their number increased, the natural laws of competition and survival started to operate, as a result of which an elementary agriculture and tool making came into existence. It appears that they had no concept of conservation of the natural resources, nor perhaps they felt its need! Presumably, when all natural resources were exhausted at any one place, they just moved on to "greener pastures".

This scenario apparently continued for thousands of years, till such times that there was a significant increase in their numbers, resulting into a situation where natural resources around them had to be regenerated for them to survive. Thus, agriculture practices took a firm root and crop rising became quite well established. This also enabled them to have permanent settlements, in the form of villages, towns or cities. In fact, one of the earliest such settlements could be traced to have existed about 5000 to 6000 years ago and we have records of those times (Miller, 1985). There are indications that by that time, a basic understanding of the environmental components as well as natural resources had been evolved while conservation practices were also recognized to some extent. Thus, at least theoretically, the idea of sustainable development is almost as old as the mankind itself.

The advent of modern times coincided with a pretty rapid increase in the world population, resulting into urbanization, intensive agriculture and above all, expanding industrialization. By 15th and 16th century, adverse effects of human activity on the environment could be identified and caused certain degree of concern (Mufti, 1997). It has been during the last century, however, that the condition of the earth's environment had become so bad that a genuine need to rectify the situation was

urgently felt. We now know that our agricultural and industrial practices have been such over the last few decades that we have caused grave damage to our environment. Ozone layer depletion, greenhouse effect, deforestation, desertification and gross water, soil and air pollution are all too familiar concerns for us. We have now reached a situation where we have destroyed our environment to such an extent that continuity of human race on this planet is now being questioned. No wonder that almost all nations of the world are now ready to do whatever it takes to rehabilitate our environment so that mankind could survive.

Most simply put, biodiversity means the existence of all life form i.e. the animals and plants (including microorganisms) in any given area of the planet earth. It has been estimated that there are 5 to 30 million species of animals and plants in the world (Kapoor-Vijay, 1992). Inspite of hundreds of years of work in documentation of this biodiversity, not more than 1.5 million species have so far been discovered (UNEP Profile, 1990). It obviously means that there are still millions of species of plants and animals which have yet to be discovered, what to speak of their utilization. Presently, out of all the known plant species, only about 5000 have been used for their medicinal properties (Kapoor-Vijay, 1992). It is therefore, not very difficult to calculate the amount of benefit which could be derived from the discovery of the rest of the plant species. In addition, it must be understood that knowledge of biodiversity of any given area is essential for understanding the health and viability of the total ecosystem operating there, a rich biodiversity of an area is a clear indication of a sound and well balanced ecosystem and vice-versa (Mufti, 1997).

Pakistan is one of the most fortunate countries in the world, in terms of its geological and biological history. Within the few hundred miles of its territory, Pakistan represents parts of at least three distinct zoogeographical zones, namely Palaearctic, Ethiopian and Oriental (Roberts, 1977). There are represented almost all types of habitats in this country, including dry cold, tropical, sub-tropical plains, deserts, estuaries and marine (Mufti and Hassan, 1997). These areas have a great variety of plant and animal life on it. Like the rest of the world, however, only 10-15% of the biodiversity of Pakistan has been determined as yet (Mufti, 1997).

The concept of sustainable development is quite complex. It is multi-dimensional, to say the least. It has no more remained a matter of understanding the physico-chemical and biotic components of our surroundings (the ecosystems); it now cuts across social, cultural and economic dimensions as well. It is, therefore, imperative to design policies which take into consideration all these aspects of human existence.

It is now universally accepted that Biodiversity plays an extremely important role in the sustainable development of a country. In the year 2000, The United Nations Millennium Summit defined reduction in environmental degradation and hence improvement of biodiversity, as one of the key factors in achieving poverty alleviation. In the year 2002, the Parties to the Convention on Biological Diversity (CBD) recognized that biodiversity plays a central role in the sustainable development of a

nation, established 2010 as the target year for halting the loss of biodiversity. Again the same year, UN Secretary General, introduced a program called WEHAB, which prioritized Water, Energy, Health, Agriculture and Biodiversity (WSSD, during the World Summit on Sustainable Development). Since biodiversity plays a vital role in the betterment of all the other sectors, WSSD especially called for significant reduction in the loss of biodiversity by the year 2010. The principal message, therefore, is that without conservation, sustainable use and benefit-sharing of biodiversity, many goals of sustainable development cannot be achieved.

The present paper, thus, would try to give an overview of the issue of the importance of biodiversity in the sustainable development of a country, with special reference to Pakistan. It is important to be able to clearly define the reasons for believing in conservation of biodiversity in the sustainable development of a country.

There are compelling economic, scientific, aesthetic and ethical reasons for preserving biodiversity (Ledec and Goodland, 1992). A brief description of these factors is as follows.

Food Supplies: Among animals, not more than two dozed species have yet been domesticated for food. Among these fewer than 10 supplies nearly total animal protein for mankind. These are cattle, sheep, goats, chickens, ducks and fish, in addition to ducks, turkeys and pigs, consumed mostly in the West. Among these, fish, both marine and fresh-water, produced through aquaculture, is being extensively utilized as a rich protein source both in the developed and developing world.

China already produces half of their fish through aquaculture while shrimp is grown quite profitably even by some developing countries like Philippines and Bangladesh (Bryant, 2002). Pakistan is also making rapid progress in this field and has already started earning foreign exchange through aquaculture.

Plants: It has been established that out of existing almost 2, 50,000 species of plants in the world, there may be as many as 10-50,000 edible plant species, out of which only about 150 are used as human food while 90% of the world food actually comes from only 20 species (Mayers, 1979). Even out of these only three, wheat, corn and rice contribute almost two thirds of the total food. Similarly, Bananas are staple food crop for millions of people in the tropics, especially in West and Central Africa, while more than 10 million tonnes are produced each year (Bryant, 2002).These figures indicate the promise which animals and plants, the major biodiversity components, have in terms of their food value. This potential assumes that a new perspective when almost half of the world population is undernourished. In this context it may also be noted that too much dependence on too few crops can also be quite hazardous. It was amply shown by the Great Irish Potato Famine of 1845-1847, when potato blight fungus brought about complete failure of the crop resulting into more than a million deaths (Bryant, 2002).

Importance of Plants as a Genetic Resource: The importance of genetic diversity for sustaining and increasing agricultural production is now a well-established fact (Ledec and Goodland, 2002). Without such adverse base for plant breeding, it would have been impossible to develop and sustain high yielding crop varieties. it has been noted with great concern that the disappearance of many domesticated crop varieties and their wild relatives has made many of the world's productive farming areas increasingly susceptible to devastating attacks by insects and other pests and diseases. It was amply demonstrated in Peru, where the standard potato crop plant was hybridized with a wild relative resulting into a variety which was resistant to the blight disease. Similarly, a wild barley plant from Ethiopia provided a gene that protected the $160 million California barley crop from the lethal yellow dwarf virus (Bryant, 2002). All these and similar other examples show that wild plant species usually have a great deal of genetic variability and these then can be used to develop many new strains through selective breeding.

A more modern way of introducing a new gene into species has been given the term "genetic modification" in plants and animals. A desirable gene from one species can be isolated, cloned and then transformed into another species (Genetic Engineering). Such transgenic plants (also called genetically modified or GM plants) are usually disease resistant and/or high yield varieties. These have been now produced in a number of countries and have been claimed to provide a great source of additional food for the starving millions of the world. As of 1999, more than 60 such GM crop varieties have been approved in USA and Canada. However, the idea of GM food has not caught on as much as was expected. There are a number of issues which shall need to be settled, including the issue of genetic contamination of the world ecosystems and other human health risks.

Plants as Source of Medicines: Perhaps the greatest service the plants provide to mankind after food is through their medicinal properties. Almost 50% of all prescriptions written the USA contain one or more drugs that originated from wild species of plants and animals, including bacteria and fungi, with a sale value of over $ 8 billion (Ledec and Goodland, 1992). More than 120 prescription drugs are derived exclusively from higher plants. These include the famous drugs such as morphine, codeine, quinine, atropine and digitalis etc (Bryant, 2002). Some of the more recent anti-cancer drugs, such as vinblastine and vincristine are isolated from periwinkle plant. Treatment with these drugs has increased the chances of remission to 99% in childhood leukemia and to 70% in Hodgkin's disease. Similarly, rosy periwinkle was used in Cuba, Philippines and South Africa for the treatment of inflammation, rheumatism and diabetes. As of 1991, over 800 higher plants have been shown to have some anti-HIV activity. The case of antibiotics, having been isolated from fungi (e.g. penicillin) or bacteria (e.g. erythromycin) are now world famous. In addition, the utilization of wild plant and animal species in many other industries, as sources of oil, dyes, gums and tannins etc is increasing by the day. The use of some recently discovered bacteria which are capable of fixing nitrogen and thus acting as fertilizers or the use of other bacteria for bioremediation of soils or anti-pollutants etc are all too

familiar to us now.

Is it not strange then, that in spite of all these, and many more, of the economically important properties of animals and plants, only about 10% of all the world's species have been inventoried or have been even named so far (Mufti, 1997)? Needless to re-emphasize that these biological resources, unlike petroleum and other fossil fuels are completely renewable, but only if we care to keep them alive and allow them to reproduce.

Environmental Services: Life is the unique aspect of our planet in the solar system (Hasan, 2002) and it would be absolutely accurate to state that life on this planet would not have been possible was it not for the biodiversity on earth in the form of green plants. These are the plants that capture the solar energy and convert it into chemical energy on which all the living forms depend for existence. Thus, it has been rightly claimed that biodiversity is the "lifeline" of mankind. There has evolved over billions of years of earth's history a delicate balance between the livings (biotic) and the non-living (abiotic or physico-chemical) components present in various parts of this planet. This balance, commonly referred to as an appropriate environment thus sustains life on the planet Earth in its each nook and corner, from the depth of the seas to the peak of mountains and from the arid deserts to the tropical rain forests (Hasan, 2002). Biodiversity provides free of cost, all kinds of services to the environment so that life could sustain itself. These services include clear water, pure air, fertile soil, crop pest control, pollination, nutrient cycling, erosion control and purification of wastes etc. It has been estimated recently by a group of ecologists and economists that such environmental services may cost as much as $54 trillion a year, if man was to bring about these services by himself (Bryant, 2002). The greatest environmental service of plants perhaps is the production of oxygen, vitally needed for all living beings and their removal of carbon dioxide and thus slowing up global warming. There are then hyper-accumulator plants which selectively sequester many heavy metals present in the soil, such as Copper, Lead, Cadmium, Chromium, Mercury and zinc etc, thus making the soil decontaminated and useful for mankind. In California's San Joaquin valley, growing mustard plants have resulted into a 50% reduction in the levels of selenium in the soil at the depths down to one meter (Bryant, 2002). Other sites where this technique has been used include abandoned mines, military sites, municipal waste dumps and sewage dumps etc. These few examples clearly show that biodiversity provides so many useful services which make our environment safe and useful for us. We apparently take these services for granted, and even create circumstances under which provision of these services become difficult.

Another important and useful function provided by natural ecosystems is in terms of scientific benefits. From their study we understand the natural interaction of life forms and their environments, without the human interference. We also understand how different species have come to poses unique morphological, biochemical and population characteristics, the study which can help us understand basic life processes better (Ledec and Goodland, 1992).

Aesthetic Value of Biodiversity: The aesthetic justification of wild species of plants and animals is in the form of awe and wonder, inspiration and joy which we experience just by looking at them. Their beauty, fascinating appearance, colors and intriguing behavior arise a sense of rapture and happiness to all of us. A French anthropologist, Clande Levi Staruss described wild species as "an irreplaceable marvel, equal to the works of art which we religiously preserve in museums" (Ledec and Goodland, 1992). Wild animals and plants produce inspiration not only to biologists but also to millions of naturalists, explorers, painters, photographers, writers, poets and musicians. According to a survey conducted for the U.S.Fish and Wildlife services, 77 millions Americans participated in wild-life related recreation in one year alone, spending as much as $ 108 billions (compared to only $81 on cars). Thus preserving healthy biodiversity is not only good for the soul, but for the economy as well (Bryant, 2002)!!

Ethical Value of Biodiversity: The basic ethical or moral issue is that whether or not we, the humans, should have the power to obliterate other inhabitants on earth at will even those species which apparently may not have any "practical value" to us at this time. This ethical view point has been labeled the "Noah's Principle". To eradicate another species is to deprive future generations of options and thus to fail in the duty of stewardship (Ledec and Goodland, 1992). A leading biologist, E. O. Wilson (1985) has rightly pointed out "the worst thing that can happen…….. In the 1980's is not energy depletion, economic collapse, limited nuclear war or conquest by a totalitarian government. As terrible as these catastrophes would be for us, they can be repaired within a few generations. The one process ongoing in the 1980s that will take millions of years to correct in the loss of genetic and species diversity by the destruction of natural habitats. This is the folly that our descendants are least likely to forgive us for". A brief outline above, of the extreme importance of biodiversity for our survival and well being would have been appreciated by the reader till now. If would have become clear by now that biodiversity plays a profound role in the economic emancipation of mankind and even his survival. Before looking into the various aspects as to how it is imperative in the sustainable development of a country, let us briefly study the status of biodiversity of Pakistan.

Status of Biodiversity in Pakistan: Let this be said on the onset that very little work has been done on the collection, identification, preservation and documentation of biodiversity in this country. There are only handful organizations which are involved in this activity. Pakistan has only one natural history museum and that too has started work in 1980's. Some universities and other public sector organizations such as Quaid-i-Azam University, Punjab University and Pakistan Agriculture Research Center etc have made attempts to our biodiversity. A few NGOs such as IUCN and WWF as well as some individuals, have done their bit in the documentation of our biodiversity and the latest information pertaining to animals is as shown in the following table (Hasan, 2002).

Flora: about 6000 species of vascular plants have been recorded so for from Pakistan, out of which almost one third have been used by locals as medicinal plants. Centers of

Group	# of Species Reported	Endemics	Threatened
Mammals	174	6	20
Birds	668	3	25
Reptiles	177	13	6
Amphibians	22	9	1
Fish(fresh water)	198	29	1
Fish(marine)	788	-	5
Echinoderms	25	-	2
Molluscans	769	-	8
Crustaceans	287	-	6
Annelids	101	-	1
Insects	>5000	-	-

Source: Pakistan Biodiversity plan

endemism are in the northern and western mountains at altitudes of 1200 meters and above (Hasan and Rizvi, 2002).

Biodiversity and Sustainable Development: As a general principal, it can be safely said that conservation and sustainable development represent two sides of the same coin, closely interlinked with one another, in that one can not be achieved at the expense of other (Ramakrishnan, 2001).As far as importance of biodiversity for sustainable development is concerned, there are four principles which need to be kept in mind. These are: minding the ecological integrity or balance of any particular area, looking after the basic human needs of that area, in an equitable manner, promotion of biological diversity as well as social and cultural activities and Research, public education and awareness.

Ecological Integrity: In spite of having a varied climate and vegetative zones, and thus having a rich and interesting faunistic and flouristic diversity, Pakistan's habitats are under threat due to a wide range of human activities (Hasan and Rizvi, 2002). These include agriculture expansion, deforestation and drainage of wetlands, pollution and eutrophication, water related engineering works, mineral extractions, new settlements and over-exploitation of rangeland by livestock. Degradation of ecosystem is most evident in the upland forests, sub-forest, mangrove forests, arid and semi-arid rangelands, inland wetlands, Indus delta and coastal waters. The forest covers as such is quite small to begin with in Pakistan; with a total cover of about 4.2 million ha. (Hasan and Rizvi, 2002). If plantation and such forests are excluded, the forest cover is just 2.4 million ha. In fact, good quality (50% or more tree cover) forests occupy a land area of only 400,000 ha, which represents only about 200th part of the land area of Pakistan. Another important co-relation exists between agriculture practices and biodiversity. This aspect is all the more relevant to a country such as Pakistan which has basically an agricultural economy, but it is indeed as a world wide phenomenon. It has been estimated that only about 35% of the land resources present on earth are under farming till recent times, while almost 10% of the land has been "protected"

exclusively for the growth and development of biodiversity. However, it is an unfortunate fact that as much as 45% of the area reserved for biodiversity has been annexed by people all over the world, for farming purposes. Almost 50% of the world temperate and dry tropical/subtropical forest areas have been converted to agriculture use since the 1700's (as much as 25% of this activity took place during the last 4 to 5 decades alone). As a result of this thoughtless activity, it has been estimated that at least 70% of all threatened species of birds and 50% of the plant species are such because of habitat loss brought about by agriculture. There are more than billion people who live in and around the biodiversity-rich "hotspots" and this figure is likely to rise if appropriate remedial measures are not adopted soon.

Intensive Farming: To add to the already dismal situation, the most recently introduced "intensive farming" has further aggravated the problem. This practice as has been advocated by multinationals tends to extend the use (abuse?) of the land resources to their limits. The basic idea of this practice was and remains the use of all available land, water and other resources, including use of chemicals, to produce maximum amounts of food for the growing populations. Unfortunately, this practice has played havoc from at least two major perspectives, the water recourses and the habitat destruction.

The high fresh water demand, which is an integral part of intensive farming, has resulted into an immense reduction in ground as well as surface water, resulting into an almost 50% reduction in the wetlands of the world, rendering about 3,500 species of aquatic animals under dire threat. Furthermore such huge water consumption has brought about water logging and salinity over vast areas of land, rendering these useless for further farming. The building of a large number of dams and barrages for water conservation further bring about riverine habitat. Destruction and consequent disruption of animal distribution.

The extensive use of chemicals such as fertilizers and pesticides in this type of farming has perhaps added the most destructive element to our ecosystems. These chemicals do not remain confined to their target organisms, but instead spread throughout the ecosystem, bringing about adverse effects to non-target plant and animal species and even human beings. The loss of plant and animal species therefore is a great loss to our genetic resources while humans have now been known to develop a large number of diseases due to the presence of these chemicals in their food chain.

It is obviously from the above description that on the one hand we do need to significantly increase our food production for feeding the ever increasing population on earth, while at the same time the intensive farming practices we have adopted and continue to use, need to be thoroughly re-evaluated and modified if we are to protect the present and future generations from potential disaster. In other words, we need sustainability in both our agriculture and biodiversity. It is not impossible to achieve and there are already indications all over the world that it can be done.

Sustainability of Both Biodiversty and the Community: It is interesting to note that both the Rio (1992) as well as Johannesburg (2002) conventions noted with great concern the unprecedented rate of disappearance of the world's animal and plant life, but no significant progress has been made in this direction. One of the most important reasons for this trend has been the non-recognition of the issues of equity and fairness while dealing with conservation practices. It is quite well understood that poverty is an underlying impediment to conservation. It is a fact that the greatest amount of biological diversity is found in the tropical developing countries, which are generally quite poor. It is imperative that such countries, especially their rural communities, have sustainable livelihoods, based on conservation principles. Policies should be such that these communities are able to live in harmony with their surroundings, with assurance for adequate food and shelter, family cohesion, self esteem and basic education and health care. In this way all the grass root activities in terms of conservation can be adopted, which should be supported by the governments and/or international agencies. Basically, the local villages and communities should feel that conservation practices indeed present a better alternate than the short term income generated through destructive exploitation of their resources.

It is, however, easier said than done. It is a challenge that national governments and international community must accept and they must create such structural conditions that would ensure reversal of the tendency to destroy. In fact, a unique and daring policy has been formulated by Pakistan in the form of allowing a limited trophy hunting for community support. The Wildlife Department of the Government of NWFP issues permits, on yearly basis, to hunt a local sheep, Markhor, on the payment of heavy fee, to tune of 50 thousands US dollars. This amount is than distributed to the local community, which therefore, is encouraged to protect the animal. This policy has been in operation for a number of years and is going on quite successfully; perhaps many more of such endeavors are required to be really effective on a world wide basis.

Social and Cultural Aspects: Traditionally biodiversity related knowledge (TBRK) has the potential to play a key role in the supporting global actions to ensure the sustainable use of biological resources (Schnierer, 2002).

Human societies have always relied on biological resources for physical and spiritual sustenance, in addition to the more obvious benefits such as food, medicines and materials. Indigenous people, in common with all others, have a right to derive benefits from the sustainable use of biodiversity formed within their territorial borders according to their cultural practices. A key element of the relationship between local communities and their surrounding biodiversity is detailed and understanding these people have about the components of biodiversity and the dynamics of the systems operating around them. This know-how, for example, includes breeding methods, agricultural patterns, harvesting techniques, pharmaceutical properties of different plants etc. Although not much attention was paid previously to this TBRK, but now it is widely acknowledged that it has a vital role to play in the conservation and sustainable use of biodiversity. The CBD acknowledges this role formally and many governments

have included this knowledge in their strategies. For local communities, however, the preservation and protection of TBRK are major concerns. These communities want to protect their intellectual property rights by managing and controlling access to TBRK (Schnierer, 2002). It is imperative that adequate legal systems are devised and adopted which would ensure due share of benefits derived from the use of TBRK.

Another important aspect of community benefits pertains to the tourism industry. It has been observed that unscrupulous tourism has detrimental effects on the community's local resources, such as land, water and energy. Even ecotourism often displaces members of local communities and erodes their cultural traditions (Hillel, 2002). It should be understood that healthy social and natural environment help and support tourism. It therefore makes common sense for tourism stakeholders to be natural allies of sustainability. All concerned persons should be sensitized to the environmental and social issues, so as to bring about conservation of resources. The present day tourism should, therefore, be multi-stakeholder in nature, should maximize local benefits, contribute to sustainable environmental management and allow cultural exchange.

Research, Public Education and Awareness: Committed and skilled people are always the key to success of any program. This is true of conservation and sustainable development of biodiversity as well. Unfortunately, there are very few institutions which give formal education and training in this field of expertise. There is already present an acute shortage of "biodiversity professionals", the people who will carry out research in various aspects of this field, such as biosystematians, curators, managers, foresters and fishery experts. These professionals need to be trained in-situ and ex-situ conservation (Kapoor-Vijay, 1992). Universities, in both developed and developing countries, along with Agriculture, Forestry and Environment Research Centers, should help train such personnel.

Training needs to be provided both at research and implementation levels. The transfer of technology for conservation and its successful implementation is sometimes adversely affected by poor communication between the theoreticians and field-oriented scientists. In addition there should be expertise available to resolve issues at political, social and even philosophical levels. There has been observed a deficiency in the development of curricula, course structure, training materials etc for subjects like Conservational Biology, Ethno botany, Herbarium Development and Management, Taxonomy and in-vitro technology etc. Thus, more training centers need to be established, or expanded, curricula updated and international co-operation and support enhanced.

RECOMMENDATIONS

The following broad based recommendations are, thus, made. If properly implemented, these should go a long way in the utilization of biodiversity in the sustainable development of this country.

- Formulate/review/revise laws which would ensure that an affective legal frame-work is in place which promoted sustainable use, establishes clear rules on jurisdiction and responsibilities among agencies and permitted users and clarifies rights of ownership to the biological resources
- Ensure that biological resources are harvested according to scientifically sound management.
- Promote community-based conservation projects in which sustainable use of biological resources can be demonstrated.
- Provide incentives/alternate means to the community, especially to the owners, to promote conservations and sustainable utilization of biological resources.
- Introduce a system of disinsentiveness to discourage unsustainable utilization and practices which deplete biological resources.
- Research and training in social and biological sciences to strengthen human capacity in biodiversity conservation and management.
- Public education and awareness about biological resources and the need for their conservation.
- Introduce appropriate environmental assessment procedures for the projects that may have significant adverse impact on biodiversity.

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BIOTECHNOLOGY FOR SUSTAINABLE DEVELOPMENT

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1. BACKGROUND

"Sometimes people ask me what field I'd be in if not computers. I think I would be working in biotechnology. I expect to see breathtaking advances in medicine over the next two decades, and biotechnology researchers and companies will be at the center of that progress". Bill Gates, New York Times, June 18, 1996.

For thousands of years, people have used biotechnology to produce foods such as cheese and bread with bacteria and yeast. The genetic manipulation of both animals and plants started in prehistoric time. Archaeological findings and suggestions from ancient writings support the view that there were rudimentary agricultural crops at least some 7,000 to 9,000 years ago, in the hills between Iran and north-western Iraq, from where they spread to the valleys between the Tigris and Euphrates. In fact, all the plants now grown had started from ancient wild relatives. Similarly, all the domesticated animals came from the genetic modification of their wild ancestors. A tremendous amount of plant science data reveals natural crossings between species and even spontaneous mutations. It is also known that new species arise from these natural hybridizations and mutations.

Since the discovery of DNA, the most important advance in Genetics has been the discovery of the restriction enzymes in 1972, which allowed DNA to be cut at specific sites and then put back together. Next came the discovery of polymerase chain reaction (PCR), which allowed fragments of DNA to multiply. The identification of specific DNA genes for desirable traits, and the transfer of those genes into another organism constitute genetic engineering. The gene transfer involves the use of a vector carrier, which can be a plasmid or a virus. The full potential of genetic engineering is still unknown and the results so far achieved are only the beginning. Such breeding methods largely accounted for the phenomenal gains in productivity during the 20th century.

Karl Ereky coined the term biotechnology in 1919. Biotechnology is the application of science and engineering to the direct or indirect use of living organisms, or parts or products of living organisms, in their natural or modified forms. It can offer enormous benefits to mankind, from an improved environment to better crop yields, from better

health to more effective healthcare.
The development and dependence on Biotechnology has largely increased in countries all over the world in the last few years. The human Genome project, production of antibiotics and improvement of crops by agricultural biotechnology are some of the major breakthroughs provided by this technology. Biotechnology is a revolutionary and accessible concept that can boost agriculture and overall economy of the country. Biotechnology and Information technology, the technologies of the new century, will reinvigorate productivity and growth in food and agricultural production and will make agriculture sector more environmentally sustainable. Enhancement of agricultural productivity should get more emphasis in developing countries where resources are shrinking and population is increasing. In short, the field of Biotechnology has the potential to increase production and productivity in agriculture, forestry and fisheries. It can lead to higher yields on marginal lands in countries that today are not self sufficient in food to meet the local needs.

2. BENEFITS OF BIOTECHNOLOGY

Biotechnology seems to be leading a sudden new biological revolution. It has brought us to the brink of a world of "engineered" products that are based in the natural world rather than on chemical and industrial processes. Biotechnology has been described as "Janus-faced". This implies that there are two sides. On one, techniques allow DNA to be manipulated to move genes from one organism to another. On the other, it involves relatively new technologies whose consequences are untested and should be met with caution. Biotechnology is also a powerful "enabling technology," which touches on our quality of life, standard of living and will increasingly drive the competitiveness of the world economy. In healthcare, for example, it is leading to more reliable health surveillance, disease diagnosis and therapies. In other areas, benefits include improved plant yields, a cleaner environment, more pest-resistant trees and crops, enhanced fish stock management and more environmentally friendly pesticides.

Some other benefits offered by Biotechnology are given below:

a) Protecting Water Quality

Reducing nutrients in farm runoff, increasing crops fertilizer efficiency and conserving topsoil are ways that biotechnology helps protect water quality. Herbicide tolerant crops promote conservation tillage, preserving topsoil and even reducing greenhouse gas effects by keeping carbon sequestered in soil. And reduced insect damage in Bt crops means healthier plants use fertilizer more efficiently, reducing harmful residues left in the soil.

b) Reducing Chemical Pesticides

The use of agricultural chemicals is an environmental paradox. On the one hand, the

runoff of agricultural chemicals into wetlands, streams, and lakes, as well as seepage of those chemicals into groundwater, can pose environmental problems. Overuse of chemical pesticides, for example, can damage biodiversity in areas adjacent to fields and kill fish or other important aquatic animals, insects, and plants. Overuse can even harm agricultural productivity itself by killing beneficial insects such as bees, other pollinators, and pest-eating insects in and around the fields. On the other hand, the failure to use such products means low productivity, which has its own adverse environmental impacts. It is estimated that up to 40 percent of yield potential in Africa and Asia, and about 20 percent in the industrialized world, is lost to insect pests and pathogens despite the ongoing use of copious amounts of pesticides. One benefit of agricultural biotechnology that has already been demonstrated is its ability to help better control insect pests, weeds, and pathogens. Among the most prevalent first generation products of agricultural biotechnology have been crop varieties resistant to chewing insects.

c) Weed Management

Among the most popular traits included in commercial bioengineered crop plants is herbicide tolerance. That feature allows farmers to apply a specific chemical herbicide spray over fields without damaging the growing crop. The trait has been developed in some plants with conventional breeding methods, but the process is more efficient and effective with gene-splicing techniques. Varieties of canola, corn, cotton, flax, rice, and sugar beet have all been bioengineered to tolerate herbicides.

d) Environmental Benefits

Biotechnology has tremendous potential to promote sustainable industrial development. For example, plantations of genetically improved trees will increase fibre availability and reduce wood costs, thus strengthening the forest sector's competitiveness. With advances in biotechnology, new biology-based techniques of waste treatment have been developed to treat contaminated soil and water, clean contaminated air flows and off-gases, and monitor changes in the environment. Other applications of biotechnology have environmentally beneficial effects. New enzymes can reduce by 50 percent the use of chlorine-based bleaching agents used in pulp and paper production. In agriculture and forestry, genetic engineering can improve disease and pest resistance. By means of crops that are genetically engineered to be insect resistant or herbicide tolerant, farmers can manage their crops more effectively and improve yields while applying fewer chemical pesticides and herbicides. Other applications can be used to clean up contaminated sites containing recalcitrant substances, to extract and process minerals in the mining industry, to develop alternatives to petroleum-based feedstocks (e.g. ethanol, biodiesel) and the next generation of pollution detection and abatement technologies.

Biotechnology can also contribute to solutions to climate change through the use of enzymes to produce cleaner burning fuels and by improving the capacity of forests to

sequester carbon dioxide.

e) Biomass Energy

'Biomass' is plant and animal material that can be used as an energy source, from the traditional wood to waste material such as bagasse from sugarcane, to specially grown energy crops that can be converted to ethanol using modern biotechnology techniques and used with petrol in vehicles.

f) Producing Healthier Foods

Advancements in agricultural biotechnology are leading to healthier, more nutritious foods. For example, a healthier soybean oil is currently being developed with reduced saturated fat content. In 25 years, the world's food production must increase by more than 75 percent to keep up with the Earth's population. Agricultural biotechnology is the safest and most efficient way to meet that demand.

g) Promising Hope in Developing Countries

Scientists have developed a type of rice that could eliminate vitamin A deficiency in the developing world, a problem that is a common cause of blindness and other health troubles in millions of children. Produced through biotechnology, scientists say the improved nutritional composition of "golden rice" could prevent 1 - 2 million deaths per year.

h) Health and Medical Care

'One of the ways in which we find out how the world works is through science'. Through science we are discovering more about the make up of human DNA and what each gene does. Moral issues of how to use the knowledge emerge as we learn more. We are moving into gene therapy, gene mapping, in vitro fertilization, monoclonal antibodies and DNA fingerprinting. These are just some of the fields in which biotechnology is challenging sensitive moral and ethical boundaries in health and civil liberties.

- Bio-sensors
- Microchip bio-sensors
- Other uses of bio-sensors
- Pharmaceuticals and bio-pharmaceuticals

i) Bio-sensors

In order to survive, living things must be able to respond to changes in the environment, to detect food or to avoid toxic chemicals. Biological sensory systems can be extremely sensitive. 'Sniffer' dogs are able to detect the trail of humans, illegal drugs or explosives, while sharks can detect small amounts of blood from hundreds of

meters away.
In a biosensor there is a biological recognition layer, which may be an enzyme or enzymes, an antibody, a membrane component, an organelle, a prokaryotic or eukaryotic cell, or even living tissues. This layer is used to recognize a particular substance by producing a biochemical signal. The biological component is the part which ensures sensitivity and is responsible for the high degree of specificity shown by biosensors. The basis of the sensor is that, when two biological molecules interact, there are measurable physical or chemical changes, which can be measured by a transducer. The biological component is immobilized on to the surface of the transducer so that these changes can be measured accurately.

The first attempt to make a biosensor was in the 1960s when a sensor was developed which allowed surgeons to monitor blood glucose levels continuously during surgery. In this sensor the enzyme glucose oxidase was used. This catalyses the reaction between glucose and oxygen in solution to form gluconic acid and hydrogen peroxide. The enzyme was associated with a platinum oxygen electrode which measured the changing oxygen concentration as blood glucose levels changed.

ii) Microchip Bio-sensors

Recently biosensors have been developed where the transducer is a microchip. One example is a biosensor, which is smaller than a ballpoint pen that has been developed to detect the level of glucose in blood. The enzyme glucose oxidase is incorporated into a disposable probe which clips into the electrical device and the tip of the probe is dipped into a drop of blood. Glucose oxidase reacts with glucose in the sample to produce gluconic acid which generates an electric current in the chip. The current is relative to the amount of glucose present. It can also give warning of low blood glucose levels (hypoglycaemia). This makes it easier for a diabetic to calculate the dose of insulin needed. Similar sensors for alcohol and cholesterol are being developed.

iii) Other Uses of Bio-sensor

Food, such as meat, may look fit to eat but may have been kept for too long in unsuitable conditions and may contain too many potentially harmful microorganisms such as Salmonella. Now, however, a biosensor probe has been developed to detect the number of microorganisms in meat for use in the food industry. It consists of a sharp metal probe containing a biosensor which can be inserted into the meat. The biosensor measures the overall concentration of a range of different sugars in the meat. There is a correlation between sugar concentration and the number of microorganisms which feed on the meat. If the reading is above a certain level, then the meat is declared unsafe for human consumption.

Biochips can also be used to monitor changes in the environment. For example microorganisms that react with heavy metals and organic toxins could be used in the biochips. It may soon be possible to produce a range of biosensors, each incorporating

a different microorganism, in order to monitor drinking water, or detect toxic gases, drugs or explosives. These would be very useful in pollution control and forensic science.

iv) Pharmaceuticals and bio-pharmaceuticals

The vast bulk of pharmaceutical drugs presently on sale are synthetic chemicals derived either directly by chemical synthesis or by chemically modified molecules derived from biological sources. Biopharmaceuticals are considered to be recombinant protein drugs, recombinant vaccines and monoclonal antibodies (for therapeutic roles).Biopharmaceuticals are becoming increasingly relevant in biological applications but are still only a small part of pharmaceutical industry. Biotechnology will also accelerate screening, producing speed bioassays and will lead to the production of new drugs. Biotechnology will almost certainly vastly reduce the huge costs presently incurred in product development of new drugs (e.g. costs of discovery, development, scale-up, clinical trials and regulatory paperwork).

New medical treatments based on biotechnology are appearing almost daily in the marketplace. These include:

a) Therapeutic products (hormones, regulatory proteins, antibiotics)
b) Prenatal diagnosis of genetic diseases
c) Vaccines
d) Immunodiagnostic and DNA probes for disease identification and
e) Gene therapy

3. BIOTECHNOLOGY AND SUSTAINABLE DEVELOPMENT

The developing countries have a vital stake in the pattern of development that the new technology will take. For it is in the developing countries that 80% of humanity resides and it is in the developing countries that all of the additional two billion persons that will be added to the world's population will come. It is in the developing countries that we will have to double food production in less than two generations with largely the same amount of land and water. It is from the developing countries that the bulk of the biological diversity has been obtained, and it is to the people of the developing countries, in their poverty and lack of health, that the new technology could bring significant and even dramatic improvements in the quality of life.

Economic prosperity, development and more so sustainable development are complex issues which are the final end result of a whole set of interacting factors. The concept of sustainable development was launched by the World Commission on Environment and Development in the report 'Our Common Future' in 1987 and reinforced by the UN Earth Summit in Rio de Janeiro (1992). The concept of the sustainable development is based on the conviction that it should be possible to increase the basic standard of living of the world's growing population without unnecessarily depleting our finite

natural resources and further degrading the environment in which we live. Emerging biotechnologies, based on new scientific discoveries, offer novel approaches for striking a balance between development needs and environmental conservation. A wider diffusion of the technology is seen as the key to directing its positive impacts onto the world's society as a whole. Biotechnology is continuously and rapidly developing in an increasing number of sectors that improve the effectiveness of the way in which products and services are provided. However, the transfer and development of biotechnology in an environmentally sound manner requires a variety of conditions, including capital inputs that, in the case of many developing countries, are not readily available.

One of the important aspects of biotechnology, is its role in the sustainable development of various sectors. Sustainability is playing a pivotal role in the economy of many countries, both developed and developing. Such a development in turn depends upon the use of new technologies, innovations, entrepreneurship and utilization of inexhaustible supply of renewable resources. Biotechnology is one such technology which has rapidly developed over the past few decades and has great potential of solving many problems pertaining to Agriculture, Industry, Environment and Health which have direct relevance to sustainable development. These features and potentials of biotechnology have generated great interest among the developing countries, many of which have embarked on various programs in biotechnology at various levels.

In majority of the developing countries, agriculture is the mainstay of the economy. Any improvement in agricultural productivity directly helps in the improvement of economy. The role of new biotechnology in agriculture has been described as a precursor to another Green Revolution that would help eliminate world's hunger. The conventional methods of genetic improvement resulted in significant increase in grain production over the past few decades.

In addition to that, industrial processes based on biotechnology are often economical as they consume less energy and use raw material more effectively. The largest contribution of biotechnology is in the pharmaceutical industry where various drugs are being produced by genetically engineered microorganisms (GEMs). The best known examples are human insulin, interferon and growth hormones.

Biotechnology has the potential to spread across a broad range of sectors and deliver more sustainable approaches to food production and security, industrial production and processing, and economic development more generally. A move to a more "bio-based" economy could create opportunities to narrow the economic divide between North and South and de-couple economic development from the environmental degradation that plagued the last century. New generation sustainable innovations in biotechnology offer much greater potential than has been delivered so far to address the needs of the South. But to realise this potential, new partnerships will be required to address the right questions in the right circumstances in order to deliver products

appropriate to needs. Public policies need to be developed that address local needs but that are set in the global context. Local decisions will need to be taken about how to reposition sustainable production with industrial and agricultural life as biological materials potentially provide more renewable resources and feedstocks for industrial manufacturing and energy production. Responses will be different in different settings, but biotechnology can only help us deliver a more sustainable future if we engage in open and inclusive dialogue with civil society, with scientists and industry and between North and South.

a) Can Biotechnology Help in Achieving Millennium Development Goals

On a global scale, biotechnology, harnessed through an appropriate regulatory and ethical framework, can play a significant role in the solution of problems identified in Sections III and V of the Millennium Declaration – "Freedom from want" and "Sustaining our future"- issues that include increasing agricultural productivity, fighting disease, conserving the soil, preserving forests, fisheries and biodiversity.

Around the world, governments, international organizations and institutions are recognizing the potential of biotechnology and calling for action to enable the realization of its benefits. Recognizing its potential for improving productivity, increasing nutrition, and reducing the environmental impact of current agricultural practices, the leaders of Asia Pacific Economic Cooperation (APEC) in October of 2001: "reaffirm[ed] the importance of safe introduction and use of biotechnology products based on sound science." The International Fund for Agricultural Development in its 2001 annual report also states that biotechnology could be essential to the alleviation of rural poverty in developing countries.

Technology transfer can only be effective when linked with integrated measures to address the complex matrix of constraints (including socio-economic, marketing, credit, land tenure, political) faced by farmers in poor countries. Public-private partnerships, (North-South, South- South) using multidisciplinary teams are an effective mechanism for ensuring value and long term sustainability for technology transfer. In reaffirming a global commitment to achieving the Millennium Goals for poverty reduction and hunger by 2015, the WSSD was a unique opportunity for all stakeholders to establish such integrated policies and measures to ensure that the world's poor are empowered to access the technologies they need to survive and compete in a global marketplace. The decisions made at this Summit resulted in many new initiatives and a climate for further development of biotechnology. Such decisions included:

- Better access for developing countries to global markets
- Increased investment for developing economies
- Resource commitment, e.g. support for the New Partnership for Africa's Development (NEPAD)
- Technology development and transfer from developed to developing countries to

facilitate the strengthening of the local biotechnology industry

- New sustainable sources of revenue for developing countries through equitable benefit-sharing schemes.

The potential of biotechnology to stimulate economic development and support sustained development – from industrial development to the development of small-scale and emerging farmers was emphasized at the WSSD. The current lack of skills and funding in biotechnology were important components of the North – South dialogue in WSSD. The debate at Johannesburg also focused on poverty alleviation, land degradation, increasing food production, providing better access to good quality water, reducing the destruction and pollution caused by mining, combating the effects of desertification, reducing the population growth rates, resolving problems of crime and civil strife and halting the loss of biodiversity. In many of these areas, biotechnology can make a positive contribution.

The appetite for biotechnology among both farmers and the general public is rising steadily in developing countries. In Africa, where population growth is at 3.5% p.a. by far outweighs food production growth (2.5% p.a.), biotechnology is being recognized as among the most promising tools for increasing agricultural productivity within a sustainable environment. Several success stories have emerged where biotechnological approaches have contributed to the solution of specific problems of small farmers who produce 80% of all food consumed. They include: the widespread adoption of tissue culture technology to propagate disease-free banana plantlets in Kenya, where small-scale farmers have increased their household incomes by up to 38%.

Documented benefits of modern biotechnology for small scale farmers have been seen in the cultivation of Bt cotton in the Makhathini area of KwaZuklu/Natal in South Africa that has resulted in lower pesticide usage, higher yields and improved net returns. The cultivation of Bt maize also promises less pesticide use and reduced mycotoxin levels in the edible product. Similar results have been documented in other countries, both developing and developed. In China, on-farm studies on Bt cotton show similar increases in yields and farm incomes, and also that the smaller farmers benefited most from the cultivation of Bt cotton.

It is hardly surprising therefore that farmers and developing countries are increasingly turning to biotechnology. The many benefits, especially to farmers and the environment- are now well-documented both for large-scale intensive farming in developed countries, and equally for smallholders in the developing world. Advances in our understanding of fundamental mechanisms in functional genomics, together with the elucidation of gene sequences for major crops, have allowed researchers to focus more precisely on traits which are important to farmers in developing countries.

b) Addressing the WEHAB Topics

The WEHAB initiative focuses on the coherent international approach to the implementation of sustainable development by outlining actions and steps to be taken in five key thematic areas of Water, Energy, Health, Agriculture and Biodiversity and Ecosystem. Management. It was proposed by UN Secretary- General Kofi Annan as a contribution to the preparations for the World Summit on Sustainable Development (WSSD) and are among the issues contained in the Summit's Draft Plan of implementation.

- Water & Sanitation

Water is essential for life. Without adequate clean water, there can be no escape from poverty. Water is the basis of good health and food production. It is used for irrigating crops, for providing hydropower, for protecting ecosystems. Despite the broad recognition of the central role of water in sustainable development, including efforts to eradicate poverty, addressing the water needs of the poor through concerted global action has not been given enough priority.

While progress has been made but on average it has been slower than anticipated. Water resources in many countries remain fragile, more due to poor demand-and-supply management than to actual water scarcity. Measures promoting sustainable use of water are far from satisfactory. Already 20% of the world's population lacks access to safe drinking water, while 50% lacks access to safe sanitation. This situation is set to worsen dramatically.

About 1.2 billion people still have no access to safe drinking water, and 2.4 billion do not have adequate sanitation services. Some 2 million children die every year from water-related diseases. In the poorest countries, one in five children dies before the age of five mainly from water-related infectious diseases arising from insufficient water availability, in both quantity and quality.

Provision of safe drinking water and sanitation services to more than 1 billion people over the next decade remains one of the most critical challenges humanity is facing today. The increasing water scarcity, combined with its deteriorating quality, will have far reaching global impacts on human health, socio-economic development potential of affected countries, freshwater and marine resources, and biodiversity, and may cause international conflicts over water rights. An estimated one-third of the world's population will suffer from chronic water shortage by the year 2025 due to increasing demand for drinking water caused by growing population, decreasing quality of the water resulting from pollution, and augmenting requirements of expanding industries and agriculture. The shortage will be particularly felt by people in arid areas and by rapidly growing coastal populations and megacities

- Energy

Energy development issues are part of the much debated sustainable development problem. The way in which these services are produced, distributed and used affects the social, economic and environmental dimensions of any development achieved. Although energy itself is not a basic human need, it is critical for the fulfillment of all needs. Beyond the biological needs of humanity, energy sources are used to enable advanced activities such as heating, cooking, transport, communication, warfare and social and leisure activities. This allows us, in general, to live under diverse climatic conditions, in great numbers and often in comfort.

Without access to energy services, people must spend a great deal of time and physical energy on basic subsistence activities rather than on earning money. In addition, lack of energy correlates closely with many indicators of poverty, such as poor education, inadequate health care and hardships imposed on women and children. Without energy, the world's entire industrialised infrastructure would collapse; agriculture, transportation, waste collection, information technology, communications and much of the prerequisits that a are required for a nations's sustainable development

All these can be produced from both conventional and renewable sources of energy. Principal fossil energy sources, such as oil and natural gas are approaching exhaustion. Closely linked to energy development are concerns about the environmental effects of energy use, such as climate changes. Energy development therefore embodies the idea of implementing increasingly effective and responsible energy harvesting and utilisation schemes.

- Health & Environment

The International Society of Environmental Biotechnology defines Environmental biotechnology as "the development, use and regulation of biological systems for remediation of contaminated environments (land, air, water), and for environment-friendly processes (green manufacturing technologies and sustainable development)".Contamination of water, air and soil, largely the result of human activity, has had an undeniable impact on human health Health is both an indicator of as well as a resource for sustainable development.

The United Nations Environment Programme's statement in this regard is as follows:

"The intensified and unsustainable demand for land, water marine and coastal resources resulting from the expansion of agriculture and uncontrolled urbanisation lead to increased degradation of natural ecosystems and erode the life supporting systems that uphold human civilisation. Caring for natural resources and promoting their sustainable use is an essential response of the world community to ensure its own survival and well being."

The idea of sustainable development did not become popular until the 1990s. It was during this decade that scientific evidence began to mount indicating that human actions were having a negative impact on the environment on a global scale, leading to outcomes such as global warming. The idea of sustainable development became a widespread concern when enough people concluded that the current path of human activity was unsustainable in the long term and changes in human society were needed.

Agenda 21, the blueprint for action adopted at the Rio Earth Summit, acknowledged the close relationship between health, the environment and development, as well as the need to improve health in order to achieve sustainable development. Poverty eradication and economic development cannot be achieved where there is a high prevalence of debilitating illnesses. And the health of the population cannot be sustained without responsive health systems, a healthy environment and an intact life-support system.

- Agriculture

Agriculture plays a crucial role in sustainable development. Some 70 per cent of poor and hungry people in developing countries live in rural areas and depend directly or indirectly on agriculture for their livelihoods. The developing world faces a deepening crisis in food security, malnutrition and food access. A better standard of living depends on increasing productivity in agriculture. Biotechnology research, together with appropriate policies, better infrastructure and traditional research methods, can bring benefits to millions of poor farmers and consumers.

Agricultural biotechnology can be used to help farmers in developing countries produce more by developing new crop varieties that are drought-tolerant, resistant to insects and weeds and able to capture nitrogen from the air. The bioengineering of plants with economic advantage can help many developing countries transform arid zones into food factories. Biotechnology can also make the foods farmers produce more nutritious by increasing the vitamin A, iron and other nutrients in the edible portion of the plant.

When this happens, it will lower overall cost of food due to higher productivity and reduce losses and provide broader array of more nutritious and safe foods. This will lead to Higher and more stable rural incomes as a result of more stable yields and healthier livestock due to increased tolerance of constraints such as drought, flooding, heat, cold, pests, diseases and weeds and reduced input costs resulting from the incorporation of pest and disease resistance in crops and animals.

With adequate and improved food supply will overall improve health of our farmers and poor people in rural areas which implies that they can now work more and be twice as productive. This will not only enhance the country's overall agriculture dependant economy as well as also save their income which will then eventually be

used to improve their living standards on the whole. Demand for other locally produced non farm products will increase creating a virtuous circle in which rural agriculture and rural off-farm income will grow and sustain each other's growth and after that of the whole economy. Such broad-based development opens up new opportunities for reducing poverty and hunger.

- Biodiversity

Biodiversity is basically the variety of life forms on earth, including genes, species and ecosystems. The immense value of this vast resource remains yet to be discovered. For instance, genetic diversity underpins the development of cultivated food crop varieties and animal breeds and also helps them to better adapt to a variety of harsh climatic and environmental conditions. Biodiversity is the very basis for sustainable development. It contributes largely in the production of goods (such as food, medicines and building materials) and the services (such as clean water and nutrient cycling) that the earth's ecosystems can provide and that make economic prosperity and human survival possible.

Biodiversity includes every form of life—from the smallest microbe to the largest animals and plants—and the interactions between them. This continuum of biological variety and interactions is difficult to imagine, let alone describe in tangible terms. Yet it is best understood as the living world's capacity to change—variability—and the wealth of biological forms and processes that derive as a result—variety.

What is important about biodiversity to humans is the prospects that it offers, from the perspective of both present benefits of variable life forms for various climatic and cultural environments and its enormous future potential associated with the capacity for organisms to adapt to for change, and develop potential for an inherent capacity to mutate and adapt in an ever-shifting environment to meet the requirements of new developments in this ever growing world.

c) Facilitating Sustainable Development Through Biotechnology

Sustainable development aims to reduce waste and environmental pollution, as well as decrease energy and resource consumption. In order to be sustainable, biotechnology-derived applications must be economically feasible and socially responsible in addition to being environmentally friendly – they must present a cost advantage, monetary or otherwise, before they may be accepted by industry. Even though biotechnology-derived applications may reduce manufacturing costs and improve profitability, there are many companies that rely instead upon traditional production methods, be it because they are unaware of biotechnology's industrial applications, or because they remain cautious of biotechnology use in industry. Biotechnology-derived applications are generally more environmentally friendly than existing industrial methods. They can also reduce production costs, promote production efficiency, and improve product quality. In industry, biotechnology-

derived applications accomplish these goals through the following methods:

- Replacing non-renewable resources with renewable ones;
- Replacing harsh chemicals with biological organisms; and
- Developing more efficient and effective technologies.

i) Sustainability of Biotechnology Applications in the Environment

Biotechnology helps the environment through the development of such technologies as bio-filtration and bioremediation. By these processes, natural bacteria are used to replace harsh chemicals in the treatment and breakdown of waste material. Natural bacteria can also be used to convert waste into useful materials or energy sources. These are not only environmentally friendly strategies for reducing waste and pollution, but they can speed up treatment processes, reduce costs, and make use of industrial byproducts which would otherwise be discarded as waste.

ii) Sustainability of Biotechnology Applications in Food and Agriculture

Biotechnology-derived applications in food and agriculture include the use of bio-pesticides and the development of genetically modified (GM) plants.

Instead of using harsh chemical pesticides, bio-pesticides derived from natural materials may be used to control insects and other pests that devastate crops, such as pesticides that contain baculoviruses, which are used to control insects like the spruce budworm. This is not only an environmentally friendly alternative, but it may also be a more effective one because bio-pesticides can control pests that conventional chemical pesticides sprays cannot. Bio-pesticides also specifically target certain pests – instead of killing organisms indiscriminately, bio-pesticides have minimal effects on other species and the environment.

The genetic modification of plants produces food crops that have improved or enhanced characteristics, such as pest/disease tolerance, improved nutrient content, better taste/appearance, or the ability to remain fresh for longer periods of time. Genetically modified (GM) crops include corn, soy, and cotton, as well as many vegetables.

Both GM plants and biopesticides support more efficient crop production methods and may decrease production costs. They are not allowed to be used unless they are first tested and approved for safety. The proper handling and labelling of genetically modified foods promotes social responsibility in producers and ensures that consumers can make informed decisions when purchasing such produce.

iii) Sustainability of Biotechnology Applications in Healthcare

Biotechnology is used in the development of vaccines, diagnostic tests, medicines, and

medical treatments. In addition to more effective treatments, biotechnology's contributions to the medical field include improved methods for illness prevention, and the ability to detect health problems earlier. Not only is this directly beneficial to human health, but it may also reduce health care costs, provide earlier disease intervention, and shorten treatment times. Biotechnology also benefits drug development by increasing the efficiency and focus of pharmaceutical research and manufacturing. More effective medicines and medical treatments could aid in lowering health care costs, which would help more people gain better access to health care. Improved medical treatments and health care access have the potential to decrease mortality rates and disease occurrence, thereby improving the overall health and productivity of the workforce and benefiting individuals, companies and the overall economy of the country.

iv) Sustainability of Biotechnology Applications in Industry

There are two main uses of biotechnology in industry. Firstly, fossil fuels and other non-renewable resources may be replaced by renewable sources of biomass. Secondly, harsh chemicals may be replaced with biological organisms, such as bacteria, to speed up the chemical reactions used in the production of industrial products.

Through biotechnology, harsh chemicals may be replaced with more environmentally-friendly natural organisms, causing a reduction in pollution and energy consumption during the manufacturing process. Biotechnology also promotes the production of more environmentally friendly products, such as biodegradable plastics made from plant raw materials. Using corn or other biomass feedstocks instead of petroleum would address economic and social concerns by reducing dependence on imported fossil fuels. Biotechnology-derived applications are sustainable because they increase efficiency in industrial production methods. Biotechnology improves industrial efficiency by reducing costs and increasing gains for both producers and consumers. This is accomplished through four main methods:

- Reducing the number of steps in a chemical process,
- Speeding up chemical reactions,
- Reducing the production of undesirable byproducts, or
- Making use of byproducts, instead of discarding them as waste.

v) Sustainability of Biotechnology Applications in Natural Resources

Through biotechnology, increasing the number of industrial processes that use renewable resources instead of petroleum based materials could lead to a mass reduction in air pollution. Non-renewable resources, such as petroleum, can be replaced by plant raw materials and other biomass feed-stocks for the production of more environmentally friendly liquid fuels. For example, gasoline blended with ethanol can significantly reduce the pollution released by cars into the environment and increase fuel energy efficiency.

In forestry, biotechnology is applied through the use of bio-pesticides to preserve and protect forests, as well as through the production of genetically modified (GM) trees. GM trees have been genetically changed to develop desirable characteristics, such as improved wood quality and pest/disease resistance. Bio-pesticides and GM trees help preserve the environment by protecting forests against diseases and pests. In the future, they could play a role in improved forest conservation methods and increased forest productivity.

d) Building Relevance Competence In Biotechnology

The development gaps and needs vary from country to country, but include longer term needs of establishing in-country capacity to educate needed expertise on the technical subjects and on the related legal, social and political issues in biotechnology sector

i) Policy and Law

Developing countries should realize that they lack laws and capacity to make and enforce the needed policies. In some cases the adoption of new technology is put on hold because the regulatory framework is not in place. The agricultural policies of developing countries should enable and facilitate safe and effective development, introduction and uptake of valuable new technologies. These would need to include aspects of bio-safety, and the protection of consumers and the environment.

Institutions that are responsible for management of genetic resources need to be guided by policies on biodiversity collection and international exchange. This includes capacity to negotiate terms, including sharing of benefits. Environment law needs to be formulated or further developed in many countries.

ii) The Lack of Capacity

Many developing countries do not have sufficient resources for research and development of their genetic and bio resources hence they are dependent on developed industrial countries for a so-called technology transfer. Countries like China, Brazil, Argentina, India and Cuba are strong in certain fields of biotechnology. This implies the need of building of in-country capacity to educate and empower expertise for the country, and to undertake independent research on strategic technology and policy issues. It will enable the country to assess technology needs and potentials in the country, use relevant technology elements in national research and development, formulate and enforce policies, laws and regulations, negotiate contracts with industries, participate on equal terms in international collaboration on research, development and policy making.

iii) Biosafety

Concerns about environment and food safety are supposed to be taken care of by procedures of testing and control elaborated in the Cartagena Protocol on Biosafety. Most developing countries have signed the protocol, but few have so far ratified it. Most developing countries and particularly the least developed countries lack the capacity to implement the Cartagena Protocol and depend on the financial and technical support that is stated as a necessity in the protocol itself.

Basic tests do not need to be repeated in all countries, but each country must be able to critically assess tests made by others and do additional testing if deemed necessary because of local circumstances. The risk of uncontrolled spread of transgenes to wild species or to local varieties of the same species depends on local flora and on the local farming and seed supply system.

Responsible decision making on requests for importation of GM-food, or the introduction GM-technology, depends on professional assessment of bio-safety issues according to the Cartagena Protocol. Short-term courses should be arranged for senior policy makers and regulators from developing countries, and on risk assessment and gene ecology for senior scientists, and on risk assessment for NGO/Civil society leaders. This kind of training is urgently needed and would be helpful for many countries

iv) Social and Ethical issues

The rapid advancement of biotechnology raises many ethical and religious issues. These technologies need to be fenced with ethical norms. Some contemporary people think that Holy Quran prohibits scientific intervention with the genetic sack of animals because it is a part of the portion marked off by Satan to lead them astray from the path of God.

Fear and concern arises on the prospective use of biotechnology in various unethical ways to increase the control of rich nations and groups over the common biological resources of the creation. Other issues can be as women dangerous and exploitative reproductive techniques and use of biotechnology to perfect military means for spreading diseases and death.

It is generally felt that the integrity of creation is damaged if biotechnology is utilized by commercial pressures to manufacture new life forms that are valued only as economic commodities. It is also a threat to mankind if proper consideration and safety measures are not taken and new organisms are created and released into the environment irresponsibly.

In short, biotechnology is more than just a scientific issue - it is seen by some as "interfering with the workings of nature and creation". In priority setting, all concerns

must be clearly balanced, respecting ethical aspects but recognizing biotechnology's potential for increasing food supplies and alleviating hunger. Many ethical issues are now being debated in the context of Intellectual Property Rights (IPR) legislation but others remain unresolved. Since such issues are largely related to cultural background and levels of public perception and awareness, decisions on the use of specific technologies should respect socio-economic realities.

4) RECOMMENDATIONS

Thirty years ago the Green Revolution transformed traditional agriculture, albeit with significant social and distributional consequences. Today, advances in biotechnology may herald a similar revolution, not only in agriculture but in health, pollution abatement, and other sectors. The unpredictable nature of the various effects of biotechnology on society and the economy presents serious concerns. There are emerging needs to promote anticipatory research and planning on the impact of biotechnology on sustainable development and optimal uses of the technology to promote sustainable development in the future while minimizing the risk of using this technology.

Following are some other recommendations for the optimal use of biotechnology for sustainable development:

i. Public awareness, dialogue, communication and understanding of biotechnology are required to ensure that end-users understand and are given the opportunity to experience the benefits of biotechnology. Collaboration among scientists, governments, international organizations, farmers, health care workers, civil society groups, and other stakeholders is key to achieving this objective.
ii. The establishment of government agencies to champion biotechnology, proactive investment in human resources development, and the strengthening of scientific and technological capabilities.
iii. Strengthen and encourage the commercialization of biotechnology based research in universities, government agencies and other institutions - this includes clarifying institutional policies on sharing royalties between researchers, research entities and students.
iv. Biotechnology is one critical tool in the quest for sustainable development. Farmers from developing countries have reported significant positive experiences with this technology. While no negative human health impacts have been reported, concerns about the safety of the technology, particularly environmental, continue to be raised. These concerns need to be addressed by scientists, government officials and others through the provision of accurate and understandable information and dialogue.
v. Biotechnology is an important tool that has the potential to play a meaningful role in poverty alleviation in developing countries. It is important to recognise the positive contribution that biotechnology can make in the alleviation of poverty in the developing world.

vi. In the move towards a bio-based economy, opportunities for investment in biotechnology need to be explored to enhance industry's productivity in a sustainable manner.
vii. The link between biodiversity and biotechnology needs to be further highlighted. Biotechnology should be seen as a tool for unpacking and enhancing biodiversity rather than a threat to biodiversity.
viii. It is important that biotechnology is used for the social benefit of developing countries and for economic development. To fulfill this vision, it has to be ensured that research and application in biotechnology is guided by a process of decision-making that safeguards both human health and the environment with adherence to the highest ethical standards. There is consensus that existing legislation, backed by science based assessment procedures clearly articulates rules and regulations that can efficiently fulfill this vision.
ix. Biotechnology today has become as important as traditional plant and animal breeding have been in the past. At the same time, it raises a number of difficult economic, social, ethical, environmental and political issues that constitute major challenges for the human society. The response to biotech products by the public has been rather mixed. In general, biopharmaceutical products seem to be better accepted than transgenic crops. Clearly it is no longer possible to assume automatic public acceptance of new products and processes that promise public and commercial benefits. Public perception and opinion have a significant influence on the direction and funding of biotechnology research. Hence there is a need to work actively and transparently to inform and engage the civic society in decision-making, and to maintain a relationship of trust and confidence. The government and the industry must actively promote access to information on the benefits and risks in a balanced manner.

To achieve this goal, several enabling factors already exist: a sound bio-safety regulatory system; well respected appellate and judicial system for redresser of grievances; cadre of willing and able scientists for effective and accurate communication of information; a large body of extension personnel in agriculture, fisheries, veterinary and human health sectors; large NGO network spread across the countries; and an effective and independent mass media.

However, several challenges to success need to be recognized while framing the strategies: diverse levels of education and literacy across the country; low understanding of biotechnology among the public; lack of simple communication material; varying quality of science reporting; inadequate inter agency coordination; insufficient dialogue between scientists, industry, policy makers, regulators, consumer for a civil society organizations and the mass media; and lack of sufficiently proactive administrative machinery.

There is a need to build public awareness about opportunities and challenges presented by biotechnology development and to inspire public trust and confidence on the safety, efficacy as well as social and ethical acceptability of products among

consumers and civil society through the dissemination of accurate information in a coherent, balanced well articulated, user-friendly and transparent manner. Several focused and well-directed measures are needed to achieve public trust and confidence in biotechnology.

5) CONCLUSIONS

Modern biotechnologies could provide key components to the solution for the problems of food insecurity and poverty if steered by a set of appropriate policies. The capacity to search, assess, acquire or develop, and utilize biotechnology is one of the most important factors accounting for differences in nations' competitiveness in the technology. It is the existence or absence of that capacity in developing countries that will determine whether they engage effectively in the application of biotechnology to address their national needs.

The need for an integrated biotech policy with concurrent attention to education, social mobilization and regulation is considered to be an essential pre-requisite for an orderly progress of the biotech sector. Synergy between technology and public policy is essential for us to achieve an effective mobilization of the tools of new biology for adding both years to life and life to years.

It is imperative that the developing countries leverage resources through partnership and build regional innovation systems. The strategy will help develop local talent for a globally competitive workforce. While it recognizes private sector as a crucial player, the strategy also visualizes government to play a major catalyzing role in promoting biotechnology. The development strategy is based on a strong innovation promotion framework in which industry, academia, civil society organizations and regulatory authorities will communicate in a seamless continuum. The perspective for biotechnology in the third world countries would be global while also concentrating on local issues. This chapter has taken into consideration all the areas that will play a leading role in utilizing biotechnology for sustainable development. There is a great need to strengthen academic and industrial biotech research capabilities, work with business, government and academia to move biotechnology from research to commercialization, foster the industrial development in this sector, inform people about the science, applications, benefits and issues of biotechnology, enhance the teaching and workforce training capabilities and establishing the third world countries as preeminent international locations for biotechnology.

Therefore, it is imperative for every country to explore solutions to their problems and come up with well-defined national plans. There is a great need to establish suitable infrastructures for acquiring, developing and managing the technology for developing local scientific and technological expertise. The urge and ambition to develop and sustain enabling conditions poses new challenges to the third world nations. These fundamental issues have to be forcefully addressed before we can genuinely hope to benefit from such cutting-edge technologies without in any way having to compromise

with any deterioration of environment.

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ROLE & IMPORTANCE OF REGIONAL COOPERATION IN SCIENCE & TECHNOLOGY

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INTRODUCTION

A "science" of some sort has always existed in every society in various periods of human history. There can be no action, whether on natural or social phenomena, without a certain amount of rational empirical knowledge of the physical, living, and social world. Such knowledge has always played an important role in the development of societies and in their material as well as in their institutional and cultural achievements. Many civilizations and societies have ignored or simply not paid attention to the notion of progress, but nevertheless have witnessed some degree of technical change that occurred over the very long term. However, it is in modern industrial societies that science and technology became the critical factors for long-term economic growth and development.

Science is a component of the organized knowledge that has existed in all societies since time immemorial. Similarly, technology, which is the blend of knowledge, organization, procedures, standards, equipment and human skills, combined appropriately to produce socially desired products, has also existed in the same fashion. The new addition in present times is the 'systematic pursuit' of scientific knowledge and its rapid use in meeting the pressing human needs.

Science and technology do indeed matter, even more nowadays. This should be self-evident. And yet in many developing countries, there is so little appreciation of this fact, (among decision makers as well as the general public), that people either do not know or do not realize the benefits that a consistent and deliberate development-strategy can derive from scientific and technical resources. Undeniably, scientific and technological progress has provided many benefits over the long term for the industrialized countries and in more recent times for developing countries. The most striking evidence of this is per-capita income of the industrialized countries, which has increased almost tenfold in the span of two centuries. This purely quantitative indicator gives little idea of the individual and collective benefits that have accompanied this enormous rise in income: longer life, lower infant mortality, eradication of certain diseases, higher level of education, more rapid means of communication, better living and working conditions, greater social protection, more leisure opportunities, etc. Whatever inequalities persist, and however large (and

sometimes growing) the pockets of poverty still to be found in the "rich" countries, the general level of material improvement is manifestly positive. This is all the more reason to try to improve the current situation of most developing countries, whose conditions are such that the benefits of scientific and technological progress do not contribute to their development in the same way, at the same level or speed as in the developed countries.

NEED FOR S&T COOPERATION

Science and Technology are now the principal tools for bringing about the changes needed to meet the ever increasing requirements of the human race. Advancement in science and technology depends on the broad sharing of information and knowledge. It is, therefore essential that the exchange and flow of information or experiences be maintained on research methods and results, so that the advancement and dissemination of knowledge maybe promoted. The population of the South represents about 80% of the humanity but has only 20% of the world's scientists and holds a very small percentage of world patents.* The developing countries of the South have entered the third millennium, facing monumental challenges hindering their efforts to advance towards economic progress and sustainable development. At the core of these challenges is the ability of the South to participate in and benefit from the rapid advances in scientific research and technological innovations driving economic and social development. These powerful forces are largely controlled by industrialized countries in the North and are mostly directed to address the problems and needs of rich countries. The South, as a whole, contributes meagerly to modern science and technology. If acquired and properly utilized, new trends in science and technology offer immense possibilities for solving many of the problems impeding economic and social progress in the South.

In this regard independent efforts are virtually impossible for the South. For instance, merely acquisition of modern technologies is not enough, unless accompanied with technologically well-equipped personnel and management required for making optimum use of these technologies and established institutes to train these personnel. Sustained supply of money, men and material is hence needed to win ultimate gains of S&T application. Here, regional cooperation is a more viable option for the Southern countries than isolated efforts. Moreover, the South cannot blindly follow the steps taken in the North for development due to environments society differences in cultures differences and priorities. Above all, developing countries have their own problems and they have their own limitations. Hence, they have to come up with their own line of action, of course, with technical assistance from the North at all stages. It would always be advisable for the South to institute joint program for their long-term goals.

[*Keynote Address delivered by Prof. M.H.A. Hassan entitled "Building critical Science and technology capacities in the South through South-South Cooperation – towards a South-South science and technology cooperation for development in the 21st Century", web-link: www.un.org/News/Press/docs/2001/dev2337.doc.htm*]

The South must intensify co-operative efforts to enhance its indigenous capacity to generate, manage and utilize science and technology in ways that address its own basic needs. For this to take place, regional efforts must be vigorously pursued. The objective behind these efforts should be to develop collaborative programmes in building-capacity for scientific education and research, and to establish new regional alliance among academia, governments and industries to address real-life problems. The ability of countries to participate in, benefit from and contribute to the rapid advances in science and technology can significantly influence their development. Efforts for Regional cooperation should be intensified and strengthened towards the developing countries' indigenous capacity-building in science and technology, including their capacity to utilize scientific and technological developments from abroad and to adapt them to suit local conditions.

The following key points indicate the growing need for large-scale cooperative agendas especially for the developing countries.

- Enabling Scientists, researchers and policy-makers to address the problems and to devise a strategy for checking them.
- To train, retain and promote native scientist and technologists in efficient numbers.
- Exploring the applications of S&T for economic development, as well as ensuring the sustainability of society and environment by striking a best mix.
- Sharing models to reduce prices and complexity of innovation and development.
- Promoting effective cooperation among governments, between public and private sectors, both within and across frontiers.
- Maintaining adequate funding for sustaining S&T, in congruence with growing economies.
- To assign responsibilities to the public and private sectors, ensuring that due roles are being played.

Successful regional or international cooperation in S&T includes:

- South-South cooperation (between developing countries),
- South-North cooperation (among developing and developed countries) and

This cooperation depends on many factors:

- **A common will and desire for cooperation**
  What lies at the core of regional collaboration is the spirit of mutual understanding, mutual support, and mutual benefit. Mutual benefit provides the motivation for cooperation and drives the mutual support. Fostering a dialogue between potential partners and developing and nurturing the intersection and balance of interests is very important and may require significant time and effort.

- **Cooperation at the institutional level**
  Favorable conditions at the institutional level are essential for cooperation. These include the assurance of appropriate and sustainable financial and political support, both nationally and internationally, effective use of the potential capacity of existing national, regional, and international research or educational institutions.

- **Development of policies promoting cooperation**
  Strengthening the cooperation among developing countries is vital. Technical cooperation currently comes from North-South programs, but great potential exists for cooperation among developing countries and regions. The cost-effectiveness of such South-South cooperation in many cases, is demonstrably higher than North-South cooperation, and triangular cooperation may produce even greater dividends from limited investment.

- **Regular Communication, Academic Exchange, and Extensive Database**
  There is a dire need to establish an information-network, connecting existing and new information-centers located in developing and developed regions. It is necessary to establish a comprehensive database on scientific personnel, scientific organizations, sources of funding, possibilities of academic exchanges, and important research subjects, including past accomplishments, current status, and future trends. It is perceived that the main difficulties for accomplishing this goal are the availability of funds and experienced personnel for the purpose of collection, synthesis, and distribution of the information. These challenges may best be met through cost-sharing among regions and countries, making use of the related professional societies to do the selection of needed information; networking institutions and existing information centers; seeking funds from industries and from local governmental and international agencies to establish proper network-systems in developing countries; distributing the information through workshops and conferences; and establishing international virtual research and development centers.

There are forums like TWAS, COMSATS, ICS-UNIDO and ISESCO already working on regional cooperation for Science and Development; however it would be long before they can achieve their true objectives. Further, grand events like "World Summit on Sustainable Development" at Rio and Johannesburg have laid great emphasis on the need of collaborative efforts for S&T developments. The real impact of their ambitious targets will take time to materialize.

CHALLENGES IN THE WAY OF REGIONAL COOPERATION

The importance of regional cooperation in order to benefit from S&T applications and to stay abreast of the rapid advancements in science and technology, although irrefutably evident, is yet a mammoth task for the South—chiefly because of the obstacles that stand in the way. These obstacles need to be overcome for arriving at this

point and some of them are highlighted here.

- **Inconsistency of Policies by Governments**
  Most of the policies designed in the South have been inconsistent, non-committal and formulated very much in isolation; a big stumbling block on the way to bilateral or multilateral collaborations.

- **Brain-Drain**
  The long-standing problem of brain-drain is a common phenomenon for developing countries. The main reasons for brain-drain stem from internal political, economic and/or social conditions. It should also be recognized that external factors can accelerate the brain drain. The most effective measures to induce scholars to return to their countries of origin are the creation of favorable working and living conditions and an attractive political and economic environment. Creating this favorable environment means improving the status of educators and scientists, as well as placing sufficient emphasis on education for social improvement. Part of the inducement for scholars to return will be the possibility for them to maintain an active collaboration with colleagues abroad. While their students are studying abroad, the home countries can encourage students and scholars to excel and effectively create a "brain trust" for their home country. These students and scholars can be encouraged to make contributions to scientific cooperation and technology transfer, personnel training, and other international cooperative activities, in accordance with their training, talents, and resources.

  Short-term return visits can be an effective beginning to acquaint scholars with the potential for longer-term cooperative projects. At the same time, developed countries have a vital role to play in encouraging foreign students and scholars to have a spirit of responsibility towards their home country. China has a traditional saying: while the trees grow, the leaves always fall onto the roots. Most Chinese have deep feelings for their motherland. Wherever they are, a part of their hearts always link with their native land. Programs and policies should be developed to facilitate students and scholars in rendering services to their home countries.

- **Lack of Communication Facilities**
  The South lacks educational institutions and research facilities, necessary to complement the efforts for joint action programs. Dearth of reliable data and information on existing and projected potentials plus mismanagement of resources is impeding the cooperative cause. Management of Information has been faulty and sloppy for most part of our history. More time is spent in searching some historic findings then putting them into use—an obstruction that needs to be removed.

- **Regional and Intraregional Conflicts**
  One of the main reasons for the discouraging progress made on international

collaborations has been the regional and intraregional conflicts. Examples can be quoted from all over the world. Even the most developed nations have had conflicts. The only difference is that either the differences have been abridged; some disputes are postponed or are well managed. A decade-long Iran-Iraq war has pushed both countries much behind in the economic race, despite having huge reserves of oil and gas. Tension between India and Pakistan denied all efforts to join hands for the common and serious goals of poverty-alleviation, harnessing health and education opportunities, reducing unemployment and promoting joint initiatives in the field of Science and Technology within the region The state of affairs in Afghanistan and Iraq is hampering formation of regional institutions in the Middle East, South Asia and Central Asia. Consequently, the advantages that could be drawn by sharing resources, funds, time and energies, fully supplemented by physical congruities, have not been outlined. In some cases, there are independent beneficiaries and in most no party has really gained anything. Ultimately, collaborations within geographic regions could not be established and possible goals have not been met.

- **Leading Misconceptions About Science & Technology**
  The dreadful outcomes of the two world wars and the concealed realities of a long cold war have raised certain misconceptions about Science & Technology. Today, perils of an expected nuclear war loom over the world since long and the race of acquiring and developing destructive technologies is on; so less attention is paid to peaceful and constructive usages of modern technology that include energy, environmental sustainability, economic development and quality of general life. Most developing countries invest large portions of their budgets on military expenses and are not left with enough reserves to combat poverty, illiteracy and many other social evils. Need for funding S&T stands lower on the priority lists. S&T itself thus was misconceived and further cooperation could not be promoted that could really serve the masses.

BENEFITS AND FEASIBILITY OF S&T COOPERATION

Despite all the difficult challenges, S&T cooperation is inevitable, particularly for developing countries. Certain assumptions have been motivating the people of South to move towards S&T cooperation. They are:

- The trends and examples set by the North are, proving that S&T is indispensable for improving the quality of life.
- The main underlying assumption that most of the developing countries have number of resources necessary to launch S&T based Industrial Development.
- Not many mega S&T projects have been launched in the South. At the same time, many countries in the South have abundant manpower and materials, employment of which can produce products at globally competitive rates. The presence of big market gaps and the prospects of cheap labor and materials make broad-based S&T cooperation viable.

- The advancement in Information and Communication Technologies has made it very easy to access the developmental ideas originating in the North very early. Bulk of information available also contains the shortcomings that various programs had in the North. In this particular regard, catching up with the North, has greatly been aided today and stands as an advantage to us; the developing nations.

PROSPECTS AND OPPORTUNITIES IN S&T COOPERATION

1. **Increased Investment in Research & Development**
   Financial and intellectual resources for S&T are scanty, especially in the South. On the other hand, the requisite knowledge-base for effective competition is expanding. This disparity presets an opportunity for South-South cooperation in the S&T arena, so that the efficient use of their resources could be possible. Of course the continued importance of North-South collaboration cannot be ignored either. Nevertheless integral activities, such as R&D, must enjoy South-South cooperation on a larger scale, as these require a critical mass knowledge and expertise for effective functioning.

   A sustained mechanism of sharing research-resources could bring developing countries much closer to their target of marinating a critical minimum of investment required. The South Centre suggest in this regard that, "with the increasing importance of economies of scale and expenditure on research and development, South-South cooperation may well become the most cost-effective means for the South to reach the new frontiers of science and technology".

2. **Changing Trends in International Policies**
   One of the most noticable features of the recent decade is the changing trend in international policies and interests. Investment and technologies are being transferred from the North to South, promoting bilateral and multilateral cooperation. Although China, India, Brazil and Malaysia attract most of the foreign investments, inflows are also taking place in countries like Pakistan, Bangladesh, Sri-Lanka, Argentina, as also countries in Africa. In China, where this collaborative trend was initiated, the stakeholders have already sensed that a parallel progress in Science is also required. The increasing foreign investments have paved their way for enhanced multi-faceted North-South cooperation. If correctly followed, these developments augur well for S&T future, especially in the South.

   Adding to these changing dynamics is the fact that the concept of alignment and dependence on a single nation is no longer valid. Social Patterns of Countries are now shifting towards multination dependence and are searching for many options available for international relationships. This shift is also promoting multilateral cooperation which is in the benefit of South. Pakistan and countries of Middle East have always been more aligned with US, ignoring the prospects of collaboration

within their immediate spheres—creating a need for regional cooperation within the South.

3. **Inter-Regional/Multi-Regional Developments**
   The wave of regional cooperation that surfaced some years back is moving further up. The talk of Inter-Nation and Multi-Nation cooperation is ever increasing. It can safely be predicted that the regions will replace nations in the near future. EU is one glaring example. Once its constitution is ratified by all its member countries, the big European community will virtually become one nation. Winning concessions from EU will mean concessions from any one or whole of its members. Since it is in building blocs, EU is extending its cooperation in various fields to other nations and regions. Important dialog is in process between EU and African Union (AU). We can thus anticipate what shape regional cooperation will assume in the years to come and what prospects it has for S&T. We are to keep on our toes as these are good signs. Moreover, it is of no surprise that interaction between regions will become a priority as compared to negotiations where there is a single nation involved. In any case, these developments will enhance collaboration and will provide gainful opportunities.

4. **The Role of ICTs for Cooperation**
   The emerging ICTs are playing a dominant role in improving performance in critical sectors of the economy and society. ICTs, being predominantly conceptualized and developed in the North, confront the South with the risk of increased and sustained dependence on the North, in terms of technical know-how and technological expertise. In order to strengthen the existing capacities related to the production of software and hardware, a close South-South collaboration is highly needed. This will consequently allow these countries to bridge the gap between them and those of the North, while simultaneously being more sensitive to the particular nature of their own needs.

   However, with the rapid progress in the field of IT, there are many examples of the rapidly industrializing countries of the South, now competing with the North in areas of software-development and adapting management techniques. Examples of India, China and Korea are well known. It can therefore, be concluded that random capabilities utilized for a single objective can prove worthwhile, while isolation reaps no results, and this is precisely what the South must not engage in.

STRATEGIES FOR FUTURE DIRECTIONS AND COOPERATION

A strategy for future cooperation, amongst the countries of the South, must be initiated resolving that they possess and will continue with, the political will to rise to face the challenges which they have identified for themselves. For this, the concerned countries must:

- Adopt and pursue policies of non-secrecy to other parts of the developing world.

- Show their willingness to propagate and further the local and regional South-South collaboration in S&T.
- Commit to solidarity in the collective augmentation of capacities and acquiring of necessary technologies.

Any cooperation thus envisioned must be founded on a medium to long term vision, based on the choice of the priority-sectors and on mutually agreed specific actions, to be taken to attain the stated objectives.

Policy of Science and Technology

One of the most critical challenges in realizing South-South collaboration is to help countries develop a meaningful and concrete science and technology policy that maybe closely tied to their overall economic goals in the broader perspective. Any such policy must include strategy of technological innovation, which should be effective and clear regarding its future goals. A sound S&T policy must lead to

- Establishment of framework for practically complimenting S&T endeavors in the country.
- Strengthening capacities and capabilities in the fields of training, research and information systems and add value to technological innovation.
- Instituting an interactive partnership between governments, R&D organizations, manufacturing concerns, financing agencies and the civil society, in order to ensure consistency in experience-exchanges and sharing of relevant documents.

Human Resource Development

For conducting scientific and technological training activities in a bilateral or multilateral framework, exchange of programs between universities and R&D institutes from the different countries of the South could prove worthwhile. It is equally necessary that womenfolk of these regions play a participative role, in the generation and utilization of technological products. Such mutual programs may offer scholarships and fellowships, and could be coordinated by the special units dealing with national expatriate expertise-exchange and regional institutions working for the development and propagation of S&T.

Strengthening Institutional Capacities

Changes in the socio-economic and political environment require specialized institutions to function on levels that are comprehensive and encompass a much wider domain of knowledge. Economies of scale can be realized through a practical approach towards partnerships, which may include national and international level partnerships alike. The centres of research of the South could come together not only in need of assistance from each other and their counterparts in the North, but essentially as *genuine research centres* who have their own objectives, competencies

and comparative merits and demerits.

Identifying Clusters of Common Interests

It seems rational for developing countries to build upon joint activities and programs, in order to strengthen their mutual ties as well as streamline their respective economic strategies. In this regard, rather than embarking on totally new initiatives, developing countries might find it more useful to focus on the existing smaller programs. South-South cooperation can get a much-required boost if some successful examples could be presented.

The following lines of action must also be laid down for establishing a prospective regional cooperation.

i. Identifying the regional potentials, resources, deficiencies and congruities.
ii. Identifying key-areas requiring immediate attention and implementation.
iii. Developing human-resources on need-of-the-day basis; building competence and skills through expert-exchange programs, joint ventures, supporting higher education and sending personnel for training when it is not possible indigenously.
iv. Involving the North in collaborative efforts.
v. Assigning roles and responsibilities to all stakeholders, particularly the governments.
vi. Monitoring and evaluating progress and keeping the cycle running. It is not a one-time activity.

A much more elaborate follow up, monitoring and evaluation-system of the cooperative activities of S&T cooperation must be introduced and assessed. Projects and programs must be practically assessed, so that reasonable clarity can be attained. Efforts must also be channeled towards the promotion of the need for regional cooperation, supported by the success-stories of various organizations, enterprises, institutions, countries ad regions.

CONCLUSIONS

Regional Cooperation in S&T is neither a liberty nor an exception. It has become imperative in the wake of global challenge put forth by WTO and the uprising new world Order. Countries in the South must increasingly acquire and adapt the stock of knowledge available in the North, and at the same time, build up their own capacities. S&T proves to be the only tool that can strike optimum balance between economic progress and socio-environmental sustainability. The need of international, regional and multiregional cooperation has also been strongly asserted, especially the South-South collaboration. Now it would be up to us to rise to the occasion, grasp the opportunities, pool our available resources together and move hand in hand towards progression and at the same time; effectively meeting ambitious targets of poverty-reduction, improved healthcare, education and sustainable environment for all.

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SCIENCE & TECHNOLOGY POLICY, A SUGGESTIVE ROADMAP FOR DEVELOPING COUNTRIES

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1. CENTRALITY OF SCIENCE AND TECHNOLOGY TO SUSTAINABLE DEVELOPMENT

The wealth of a nation is no longer determined by its physical resources. These have to be explored, extracted and manipulated to get the best gains out of them and for this purpose, Science and Technology has come to be the basic as well as the most advanced tools. The wealth of the nations, therefore, depends upon their Scientific and technological "haves" and "have-nots" [1]. Japan stands prominently in the list of developed countries, despite having very scarce physical resources, while most Middle Eastern countries are gifted with abundance of oil reserves but are only considered as developing economies. The major factors separating the developed and the developing countries are the scientific and technological infrastructure and popularization of science and technology in the two groups of countries [2]. The state of S&T in most developing countries is not very encouraging. The literacy rates are not high enough and then are the diversities of the educational backgrounds. Science and Technology foundations are few and mostly weak in structures. The South does not have enough scientists, as required by the fast changing world of today. Adding to these problems are the brain drain and migration of capable S&T professionals to advanced nations. The resultant loss of qualified and capable S&T human resource has put extra burden on the already meager technological resources available in these countries [3].

Apart from the shortage of human resources, there are other factors like general unawareness of S&T, lack of S&T institutions, neglect of S&T at corporate policy-levels and insufficient career-opportunities for the few indigenous qualified Scientists and Technologists. The biggest hindrance appears when finances come into play. The major chunks of national earnings are spent on defense and provision of general public services, thus barring adequate allocations for education, health and environment. Compounding the odds are alarming rates of inflation, population, pollution, economic disparities and unsustainable patterns of living. Due to these reasons and for the fact that S&T does not have enough representation in the ranks of governments; Science and Technology still remains far too low on priority lists, even in the modern ages.

The pleasing observation is that the things are changing. Latest developments in the fields of S&T, pace of globalization, speed of change and challenges of global competition in the wake of WTO are the main factors that are forcing these changes. Responsibilities and roles are realized by respective spheres. Governments today are more actively involved on S&T issues; public-private partnerships are developing; standards of scientific and technological education are improving; associated institutions are being strengthened and enhanced private investments are made in S&T locally as well as (very notably) from abroad. The progress made in Information and telecom Technologies is glaring to watch. Having said that, all this is but just the beginning and a lot needs to be done. The journey on the road to progress on vehicles of S&T has to be continued and the development has to be sustained. The positive impacts would obviously need time to trickle down to the masses, but that should be the basic aim of S&T development.

2. NEED OF S&T POLICY

While all the above has been discussed on account of the importance that Science and Technology bear for the world of today, it is necessary to develop proper infrastructure and promote suitable conditions for their applications. An all-inclusive S&T policy has to be put down, for proper planning, implementation, control and evaluation. A well-formulated policy makes things easy, as the purpose is defined and directions are set. The document under review is one proposal for developing countries that lays down detailed framework, according to which the Governments may play their role as a regulator as well as a facilitator for sound development of S&T. It will cover ways to cope with monumental challenges lying in the way of sustainable development and suggests measures to keep up the progress.

3. OBJECTIVES OF S&T POLICY

The detailed objectives of this S&T policy may include to:

1. Lay down a roadmap for establishing a sound and stable, self sustaining S&T base in the South.
2. Sensitize general public about the centrality of S&T to development to a level where they are ready to appreciate S&T projects.
3. Keep the current wave of development in S&T fields; chiefly those of IT & Telecommunication, up and on.
4. Develop & build indigenous capacities, while looking out for foreign investment and/or cooperation [4].
5. Pave way for medium to long term S&T plans.
6. Identify and target key S&T areas prioritized on immediate local needs, potentials and benefits and also those requiring relative by cheaper investments.
7. Promote the constructive roles of S&T, e.g. S&T for poverty-alleviation, education, health, employment-creation, environmental controls and to increase productiveness, as well as to improve the general S&T concepts and enhancing

willingness of people for their application.

8. Ensure and improve S&T educational standards at all levels.
9. Create and strengthen linkages between public and private sectors for greater cooperation in various Sciences and Technologies.
10. Set up specialized government offices for regulation and facilitation of S&T areas.
11. Devise a comprehensive yet flexible procedural framework for durable growth of S&T environment in a country.
12. Develop an extensive, effective and efficient pool of S&T personnel at all levels for meeting local needs and for responding to international challenges.
13. Arrange and promote cooperation with other countries, regions and/or blocs.
14. Encourage S&T professionals working abroad to come back to their respective home-countries and contribute to within field of expertise.
15. Establish S&T funds for gathering and allocating necessary grants for:
    - Human Resource Development
    - Funding Seminars, Workshops, symposiums, etc.
    - Small to Medium scaled projects
    - Publications
    - Research Work
16. Create more dynamic S&T environments for sustainable development [5].

4. STRATEGY & IMPLEMENTATION PLAN

The proposed strategy and implementation plan is a 21-point agenda that may form the due course of action.

4.1 Scientific and Technology Governance and Investments

Most governments of developing countries have been more regulators than facilitators. Lack of resources, facilities and encouragement led to much brain-drain. These factors, and that of widespread irregularities marred overall development, of which Science and Technology was just a part.

The positive thing, nonetheless, is that the scenarios are changing and now at least the necessity of S&T is felt with greater interest and consideration. The lead role definitely has to be played by governments and their supporting tiers. Focal points; the ministries of science and technology are to transform from mere regulating to more facilitating and more promoting functions of the Governments. Financial and administrative procedures should be simplified and long, cumbersome and unnecessary formalities must be eliminated. Encouragement of innovation, knowledge- sharing and transfer should begin from the top. Existing educational, research and industrial setups should be upgraded and new ones be established, according to the needs of the day. The syllabi, training and development programs need to be designed in accordance with local needs, but have to be standardized on global parameters. Easy access and dissemination of latest information has to be provided to the masses; public-private linkages should be developed and strengthened. Institutions need more autonomy to

carry out their projects with ease and flexibility; building of governmental and private S&T linkages with foreign countries and/or organizations should be greatly encouraged and facilitated.

One major step that countries of the South should take in this regard is to increase the number of experienced Scientists and Technologists in concerned ministries and governmental functions. Obviously they are people who can advise and plan best on such matters, so they should be given more say in all selected affairs particularly in policy and decision-making. All committees should consist of a combination of well–trained S&T personnel, administrators and specialists from other fields. The organizational structures should be devised so as to build and enhance teamwork among persons from different backgrounds. Governments and ministries should encourage sharing of knowledge and teamwork. S&T personnel should be given appropriate authority and a proper system of incentives should be designed to maintain and enhance performance. Due recognition must be given for achievements at all levels in order to promote innovation and higher development.

In the end, the South has to raise the much needed investment in S&T sector. Budgetary allocations for S&T in developing countries are depressing; these have to be raised considerably. Transparency and accountability should be ensured for proper utilization of funds. Other local and foreign investments must also be encouraged and facilitated. Proper planning and implementation can help to optimize usage of scarce resources, by allocating the funds to some key-area like education, energy and health in the beginning and then moving to higher end-technologies. Indigenous development of talent and technology has to be prioritized in order to move forward on the path of self-reliance and self confidence and the fulfillment of national goals.

4.2 Optimizing Existing Infrastructure and Competence

The existing state of infrastructures in the majority of cases is quite dismal. Number of S&T institutions and - especially those in the public sector - is faced with shortage of equipment, funds and manpower. Most of the available infrastructure is old and worn out, while the training faculties are not sufficient to meet the growing needs of preparing well-qualified and well-trained S&T human resources. Majority of the resource persons are not equipped with the latest developments in S&T fields, whereas acquiring latest knowledge will put additional burden on funds as well as faculties. Existing capacities are low and their utilization is much below optimum. Significantly, however, they have to be utilized, as the South cannot opt for wholesale-replacement.

This gray area, therefore, should be one of the top-most priority areas of S&T policy. The first step would be the identification of existing infrastructures and competencies and then laying plans for their optimum utilization. It is suggested that developing countries should generate reports based on their availabilities in following manner.

- Region-wise standard of existing Infrastructures and competencies

- Region-wise availability of excellent grades
- Region-wise availability of grades requiring a little up-gradation.
- Average-grade infrastructures
- Infrastructures and competencies totally useless (The below-average grades will be considered obsolete).
- Categorically indicate regions requiring priority attention.
- Suggestions be gathered through questionnaires from the staff of institutions investigated.
- Feedback and proposals of the program machinery.

Based on the outcomes of this report, the concerned authorities should devise detailed programs through which the utilization of excellent-grade infrastructures could be optimized. Most competent of resources (persons and faculties) be identified for key positions in S&T related affairs. They should also be involved in devising strategies, policies, curricula and other related matters in the effort to draw the best out of their competence and experience.

4.3 Building Capacity

Parallel to optimization of existing infrastructures and competence, building up the capacity of institutions and that of manpower is equally important. The plans for implementation should cover the following measures targeted at building capacities.

Regular refresher courses should be launched for faculty members during summer vacations. The participation should be encouraged by way of offering awards on performances and special incentive programs. The refresher courses should be offered in collaboration with the leading public and private-sector universities and, where possible, experts may also be invited from abroad. Training courses for technicians and support professional are also suggested. Involving technical institutes and private setups in such training schemes would be very useful.

For contingent measures, all registered institutions should be linked with central "S&T fund", from which they could collect up-gradation grants periodically subject to need and availability. Long formal matters should be shortened for ease of transferring funds, so that institutions could be able to meet their most urgent matters in easily, efficient manner.

The common dilemma with most developing countries is that majority of S&T people were discouraged on want of proper recognition and reward. Similarly the lack of competition among institutions made their authorities complacent and unimaginative. A two-faceted scheme is proposed to overcome these problems. Separate reserves should be set as "Special Incentive Program for S&T professionals" and "Leader S&T Institutions". Under the first program, the S&T organizations and educational institutions could nominate candidates for certain categories along with a summary of their contributions on specified forms. Special incentives and awards

should be announced periodically, in recognition of the accomplishments and services rendered. Under the latter, selected institutions could be graded on the administration of their S&T departments and on their compliance to set standards; the leading five be awarded through grants, souvenirs and enhanced status. It is also suggested that the selected institutions are given a time-frame over which they would be evaluated to see how well they perform in a subjected time-period and how best all their capacities; human, capital and organizational are put together to attain a higher position.

The proposed line of action will act in more ways than one to strengthen existing facilities. First it will remove the sense of deprivation observed in various S&T quarters. Secondly, it will create an atmosphere of competition among individuals and institutes who would now push for achieving some tangible results instead of being complacent.

In addition to above steps, individual organizations should be encouraged to form their own "S&T funds". These should be meant for meeting short-term requirements, identifying time-to-time long-term requirements and also, where possible, reserving finances for future needs. All these proposals should be implemented and monitored regularly, in order to ensure optimal utilization of collective existing infrastructure and competence.

4.4 Strengthening Infrastructures for S&T in Academic Institutions

Academic institutions hold the key for a prospective S&T future of any country. The State of affairs in counties of the South is not encouraging, but positive changes may be seen of late. However the task is monumental, as the majority of public institutions need total overhauling, of which S&T faculty/department is only a part. Most of the laboratories and equipments need replacement, as up-gradation will not do in the long run.

The report discussed in the preceding part can serve as the key input for this plan, as well and replacement of the low-grade infrastructures should start at the earliest for prioritized institutions and regions. Apart from this report, all registered institutes may also be required to prepare a record of their facilities. Their task would be to document availabilities and estimating the period after which they would need to be replaced.

Exclusive "S&T Acquisition and Replacement Wings" may be established to plan, organize and control all programs for Acquisition of latest Sciences and technologies on need-governing basis and for replacement of outdated sciences and Technologies. The wing can also be assigned to work out the contingent requirements that may surface during the plan and to make necessary relevant arrangements to meet them.

4.5 Sound Funding-Mechanisms for Basic and Advanced Research

Funding for basic as well as advanced research is a challenge. Most of the research in the South has depended upon governmental support or, in a few cases, some institutions were able to carry it on their own. The governments in the past have not been able to allocate adequate budgets for S&T, due to scarcity of their own resources and many other hard challenges they were confronted with. Consequently basic research could not flourish on sustainable basis.

The fact cannot be denied that all advanced applications of Science and Technology are most effective when they are backed by sound basic research. Strengthening and restructuring the existing funding mechanisms, identifying and developing newer ones and, where possible, creating new structures is important for promoting basic research in scientific, medical and engineering institutions [6]. Financial and administrative procedures also need to be simplified to permit efficient operation of research programs. The government funding should be managed by way of allocating reserves to some key-fields and then extending funds later to other areas. Funding transactions should be simplified and monitored. Computerizing the funding and record-keeping processes would be helpful. While managing the governmental funds, newer sources of funding also need to be searched for. Many international organizations and regional groupings, starting from UNO, are ready to extend monetary donations for S&T projects. Ministries of S&T should identify such sources and design programs for attracting and then properly utilizing these grants, with particular emphasis on basic research. Relevant procedures should be simplified. The universities should be linked to international and regional arrangements. Local private funding for basic and advanced research in S&T is apparently a far cry. It is however asserted here that establishment of Venture Capital Companies, incubators or other sources of funds must be supported.

4.6 Developing Human Resources

Human Resources are the key to every developmental project. Competent human resource is the foundation on which the structure of Science and Technology is built and the development of these resources is a must, to go further and further on the track of progress. Responding effectively to the dynamically changing world, Human Resource Development has to be a continuous; comprehensive program.

Unfortunately, developing countries have weak human resource bases. The basic literacy-rate is quite low, while the indicators of higher education are depressing. There have been few incentives for the personal and intellectual growth of Scientists. The weak organization of existing institutions did not extend good opportunities of training and development to personnel. Most qualified personnel and, especially the cream of the lot migrated to foreign countries for better prospects. All these factors led to brain-drain creating a large intellectual vacuum in countries of the South. This actually is the basic scarcity that is hampering the growth of Science and Technology.

There aren't enough Scientists and Technologists to train the younger lot, to launch significant programs and they do not have enough representation in corporate arenas so that practical; long-term decisions can be made. The pressures for socio-economic development are mounting and the best solution is provided by S&T. For developing countries, a lot has to be done on the very basic level of education, then on training and personal development.

Human Resource Development has therefore, got to be the top-most priority. The standards of education, particularly of S&T, have to be raised from elementary levels to post-graduation studies. A lot of restructuring is needed to accommodate the new realities of the information-age into our educational methodology and contents [7]. Well-designed programs should be launched at respective levels and for true implementation, the ministries of Science and Technology should work in close association with other functions of government concerning Education. Moreover, training and personnel development facilities must also be strengthened in career organizations. The steps that may be planned are discussed in the following points:

i. All levels of education need upgrading and that can best be designed by the teachers. Experienced resource-persons should be identified and, under their directions, other teachers and students should be trained, educated and developed on modern S&T footings. Teachers need to be given more say in policy issues, in syllabus-designing and in general administration.
ii. Existing facilities must be improved and curricula should be revised at all levels.
iii. S&T curricula should match contemporary needs, yet they must be kept as simple as possible and interesting.
iv. Governments and ministries need to pay greater attention, in the shape of care, material and funds, for education particularly of S&T that will ultimately help to achieve the targets of economic growth and simultaneously to combat the problems of poverty, disease and environmental degradation, etc.
v. Educational institutions should be linked to industries to keep the students in touch with practical life.
vi. Fields of immediate and demanding local importance and the emerging technologies should be included in wider proportions in curricula. They should include bio-technology, energy, mining, electronics, fertilizers, Information and Communication Technologies, medicine and large-scale manufacturing.
vii. Public functionalities should regularly arrange competitions, workshops, symposiums and seminars for greater dissemination of S&T information. Moreover, informative and appealing messages should also be communicated through print and electronic media, to supplement the efforts directed towards growth of S&T.
viii. The foremost reason behind low literacy rate is widespread poverty in the South. Majority of parents simply cannot afford to send their children to schools. Checking education costs and effectively managing them is, therefore, crucial. The governments should make all possible efforts to initiate free basic education. The reserves for offering scholarships and fee grants should be increased for

deserving and performing students. Measures for reducing costs of and ways for generating monetary support to education should be devised and incorporated with passage of time. Favorable long-term results can be anticipated if steps are taken on similar lines.

ix. Higher education and especially post-graduate and post-masters studies should be focused. Countries of the South do not produce reasonable numbers of PhDs. International cooperation can be utilized well for similar purposes. The bright and research-oriented personnel should be encouraged to pursue higher studies and the most competent of them should be supported to go abroad for acquiring latest education, particularly for S&T. International linkages should also be strengthened for such purposes [8].

X. While the focus is laid more on basic and higher education levels; due attention must be paid to secondary and higher secondary levels of education. The S&T syllabi should be kept interesting, that create interest for pursuing higher studies. The number of enrollments and performances should be monitored and needful should be done if drastic fall is observed.

4.7 Decelerating Brain Drain

Brain Drain is an unfortunate phenomenon in developing countries. The talent that does come up in Sciences and Technologies, despite inadequate facilities and non-conducive environments cannot find organizations where it can strengthen its concepts and deliver its best. Resultantly, the cream of the lot migrates abroad and the intellect of those who remain at home fades with time. Ironically, the brain drain has accelerated. Today, this phenomenon has to be reversed i.e. brain drain has to be decelerated. In fact, "Brain share" should be the case. Plans should be laid down for improving learning and training environments, building capacity of existing institutions, establishing new centers of S&T and increasing incentives and rewards for people performing well in S&T sectors. Various measures have been discussed for these issues under respective heads.

4.8 Transferring, Developing and Diffusing Technology

Developing countries have remained dependent on technology-transfer from abroad. However, for meeting the growing challenges of globalization, indigenous capacity bases for developing various technologies are to be widened; equally important is their diffusion in our industry.

Since the South is far behind in local technologies, Technology-transfer is and will remain an area of focused attention. On account of the obvious significance and benefit of transfer of technology, the process has to be continued on sound managerial grounds. The procedures for transfer should be made simpler. Priority should be given to sectors of local importance e.g. biotechnology, food-processing, machinery and energy. The governments need to make the general environment conducive for transfer and for furthering its results over a long term. Technological imports from

local private sector should also be encouraged, on condition that they do not pose serious threats for local industry and have visible long-term advantage. S&T fairs and seminars may be arranged in different countries to create and raise interests of foreign S&T investments in developing countries. While implementing such international campaigns, special attention must be paid to local infrastructures, as without them, no project can bear fruit. Roads, inland and overseas transport and other means of communication must be improved on top priority basis as they are a big obstacle in the way of S&T schemes, especially the transferred ones.

Irrespective of the importance of technology-transfer for countries of the South, complete dependence on foreign technologies is not advisable. In the world of today, goals of competitive and sustainable economic growth can only be achieved by deploying a suitable mix of foreign and indigenous capabilities, and efforts are to be concentrated systematically on shifting from foreign to local advancements. China, India, Malaysia and Korea are clear examples who utilized transferred technologies and developed their own in parallel. They have already outpaced other developing nations of their regions. "Indigenous Technology Development Programs" should be launched in developing countries. Under these programs, triangular linkages of ministries, existing technological centers and scientific research organizations should be developed both in public and in private. Cooperation should be extended for dissemination of quality approaches, immediate local and international needs and latest S&T advancements in the world, particularly those of concern to South and ultimately extending to joint Human Resource Training and Development programs. The formalities hindering the way of growth must be reduced. Local S&T projects should be promoted by way of special incentives and concessions. To enable indigenous technologists to gain momentum, their direct linkages with international organizations should be supported. SMEs need to be given due priority nowadays and enterprises dealing in S&T should be regularly advised on ways for promoting their activities.

Along with taking the steps discussed above, foreign technologists should be encouraged to establish their projects in developing countries. Necessary infrastructure should be built and attractive incentives be offered to the investors. This will greatly help in utilizing foreign expertise for development of technology in the South. Foreign investments in developing nations would mean low costs of production for the investors and creation of utilities for native population. More flexible, less rigid regulation roles should be played by authorities to back large-scale inland technology development.

Technology-transfer and development have no value if technology is not diffused into the industry and also into the minds. Whether it is imported or made locally, it has got to find acceptance in local industry. Only a large-scale industrialized utilization of these technologies will promote their development and only commercialization will prove their worth in the long-term. Appreciation of Sciences and Technologies is unfortunately low in the South. From industrial owners to a common man; S&T means

excessive costs. The majority also do not know its constructive uses. Science and Technology in the real world envelops nearly all aspects of life. General awareness, appreciation and openness have got to be developed among people from all walks of life. Ways should be included for S&T policies to diffuse technology into the minds of people and its applications in various facets of normal life, including industry. Mass communication techniques, seminars and private-public interactions should be promoted to push technology into most dimensions of routine life. Once technology is diffused in real life, countries can move fast forward on the road to sustainable economic development. The outcomes of these campaigns should be regularly reviewed and evaluated to make necessary adjustments from time to time.

4.9 Promoting Innovation

Innovation refers to newness; creativity, something that did not come up before. What has been found common behind every development is an innovative idea that later culminated in bigger outcomes. South lags far behind when it comes to creativity and innovation. It is probably due to this that most technologies available inland are old and outdated. Similar is the case with curricula and published material. The general culture is not encouraging for innovation. New ideas are not well appreciated by majority of the general public. Launching of projects has always been discouraged by the government machineries. The procedures and dealings involved in setting up of a project – whether innovative or not - have been so very cumbersome that the initiators mostly opted out of their schemes and this has been the case in general. One could easily include that innovative ventures were a far thought in such environment. S&T in the North, on the other hand, has primarily grown on fast; continuous innovation. Their communities have always appreciated new ideas starting from the very level of academic institutions, despite the fact that most new ideas were simply unworkable. It is, however, this attitude that has contributed most to their growth. Continuous innovation kept the vehicle of S&T growth rolling forward with staggering acceleration. As the wave of innovation moved to Asian countries of China, Malaysia, Korea and India, they emerged as new fast developing nations of the world well outpacing others in their regions.

Governments in the South should realize this reality and launch "Promotion of Innovation" in different fields, including that of S&T. Prime attention must be paid to education in order to make students more open, interactive and communicative. A few support schemes have been discussed in section no. 4.5, pertaining to human resource development. Furthermore, linkages among industries, academia and research organizations should be strengthened, for innovation through mutual cooperation and competition [9]. Experimentation and application of new ideas needs to be encouraged. Improving the state of infrastructure is another way for promoting and experimenting originality developments in research centers and the real industrial sector should be encouraged. Latest research and development undertaken at home should be publicized through print and electronic media. Significant achievements must be rewarded by Governments. Establishment of new projects must be facilitated

by removing unnecessary hindrances. Small and Medium Enterprises ventures in S&T need to be promoted, through facilitating policies. Discouraging innovation must be discouraged. There is a misconception about innovation that it is something only leading to further complexity and higher technology. In the real world, innovation may be anything like setting forth a new theory in the field of Science, deriving a new formula, introducing an altogether new idea or even eliminating a whole process for cutting the costs of a process, provided the same has not been done before. This misconception should be removed with a view to encouraging anything new of whatever sort. Talent of many capable persons wasted in the past because they were simply not recognized. Governments and ministries should make sure that all ways to appreciate, encourage, support and reward innovation are supported. Creation of a general climate conducive for promotion of innovation is a must.

Incubators and Venture Capital Companies: Incubators and Venture-Capital Funds have been the major source of initial upsurge of new technology in North. The concept is gradually flowing into developing countries. Comprehensive programs for promoting incubators and venture capital companies have to be promoted. Foreign and local incubators and VCCs should be encouraged to invest in S&T fields. Relevant regulatory guidelines must be made simpler and smooth after consultation with statutory bodies.

4.10 Research and Development

Research and Development is closely related with innovation. Since developing nations are short on innovation; large scale R&D in their countries is limited. It would be wrong to state that the South has no Scientific and Industrial Research and Development centers but it would not be wrong to state that they are quite small in number. Furthermore, their activities and findings are not adequately communicated so that they could be benefited from. The levels and standards of Scientific R&D need to be raised. The industrial sectors are generally more directed towards their production on existing facilities. Far less has been done on R&D of indigenous technology. Scientific and Industrial R&D are not interlinked and there exists an information vacuum. Surprisingly enough, S&T R&D in fields of agricultural, healthcare, food and environment are very restricted. Much more of R&D is needed to meet local and global needs.

The scattered R&D setups within and among the countries of the South may be interlinked using latest ICTs. Established S&T web-portal should provide access to Scientific R&D centers of a country and/or of a region. Information volunteered by Industrial centers may also be a part of it. Research and development already done should be made available online. The portal can assist in encouraging linkages among universities and industries that can mutually benefit from combined R&D schemes. Collaborative R&D efforts need to be encouraged and notable advancements be made public through media. Private sector should also be involved in establishing R&D centers for increasing their capacities and sharing government load. Significant

upcoming in fields of S&T must be appreciated. R&D having far reaching impacts on the country should be rewarded and governments would have to play their roles to facilitate commercialization of such findings. R&D forms the base of major S&T breakthroughs. Expanding the scale of R&D to much larger extent where R&D is considered integral part of overall business; has to be one of the priority objectives of S&T policies for countries of the South.

4.11 Indigenous Resources and Traditional Knowledge

Many developing countries are assumed to have good agricultural and mineral resources. They also have abundant cheap manpower. Unfortunately these advantages are not fully benefitted from. Majority of reserves and deposits are still unexplored. The countries especially those in Africa, spend considerable amounts for food, medicine and even for water. To worsen scenarios is the mismanagement of available resources that are more wasted and less optimized. Majority of these problems are due to the tradition of knowledge that the developing countries are carrying with them. Innovation and developments have not found their way much into old systems of knowledge. While these are all challenges to be tackled; environmental degradation has also become a burning question; something directly related with the utilization of resources.

The need is not to put an end to traditional knowledge. The real need is to integrate it with the latest developments taking place in the fields of S&T. Bio-Technology, food and fruit preservation technologies, mineral sciences, metallurgy, oil & gas exploration and utilization technologies, renewable energies, livestock sciences and environmental studies are some very useful tools for supplementing the outcomes from available resources. The costs of production can be reduced and the downsides can be avoided by making proper use of recent developments. S&T means also help in proper management of resources so that wastages can be minimized. Food and fruits can be preserved better and for longer periods of time. Latest equipment can help greatly to earn from the minerals buried below land surfaces. Special endeavors should be made to motivate people for acquiring modern knowledge. Means of improving yield and quality of livestock should be promoted and incentives be offered for investments made in poultry and fisheries. Intra-national and International cooperation should be developed to support similar schemes.

Mineral sciences and metallurgy should be triggered up. More of industries need to be established particularly in the underdeveloped parts of countries. Foreign investors must be offered lucrative incentives for exploration and for establishing industrial setups in the South. S&T institutions should be established and furnished with suitable equipment in lesser developed areas. The standard of education must be improved and comprehensive training of selected faculties is essential. Strengthening SMEs, Private sector investments and partnerships in all above-mentioned areas is recommended. Governments on their part would have to ensure spread and application of latest means of S&T knowledge.

4.12 Mitigating and Managing Natural Hazards through Technologies

Enormous loss of life and material caused by recent Indian Tsunami and South Asian Earthquake has raised voices for the need of mitigating and managing Natural Hazards. It is true that such hazards can not be predicted. Their impact is also not just restricted to the time of their occurrence; many other problems are surfaced in their aftermath like disease outbreak, problems in relief efforts and cumbersome rehabilitation process. However there must be means to keep the damages to the minimum. Again S&T provide the best tools for mitigation and management of Natural Hazards. Countries affected by these calamities were found well short of means necessary to tackle with these disasters. Actually these two were too big incidents to be coped with. In reality countries have not been as well equipped as to handle floods that are more predictable and more common in South Asian and South East Asian regions. The most painful aspect is that effective tools of S&T are not available in majority of cases that can assist in relief works, rehabilitation, medication and most essentially for safeguarding security of life. Developed nations have well trained teams for crisis management that are equipped with variety of S&T tools for all sorts of relief efforts. Such equipments include life-detecting devices, transportation and communication modes, medicines and other relief aids; all speaking of S&T cross-cutting utility. Moreover, they do not just play their role after the devastation of hazards. There are certain useful applications that can avoid, mitigate or at least minimize possible destruction of similar incidents. Countries of the South must devise long-term policies for mitigating and managing hazards on priority basis. A proposal is submitted here including following recommendations.

Tall buildings should be periodically inspected to check their ability to withstand earthquakes; thunderous storms etc. Once could easily find many old; outdated constructions in many parts of the South including houses, multi-storey buildings, educational institutions, hospitals, markets and bridges. Most of them are over-burdened with occupants who are threatened seriously by natural hazards. They should be reconstructed. Latest S&T applications should be deployed for reconstruction or renovation of buildings to ensure their long term safety and security. Ways for making them more compatible to the changing climatic conditions should also be considered. More importantly, construction designs should be suggested so as to keep the costs minimum while at the same time equipping them with most recent technological security arrangements.

Capacity building of meteorological and seismological departments should be undertaken early. Departments in the South lack adequate infrastructure, manpower and technology for carrying out their tasks. Public departments and allied functions should work together for deriving solutions of such problems. Sciences dealing in prediction of storms, floods, rains, weather severities and earthquakes must be included in syllabi and the base of existing contents enlarged. The institutions have to be restructured on global footings for achieving their high efficiency and effectiveness. National centers can be linked with foreign setups for sharing similar knowledge and

keeping abreast of advancements taking place in similar fields.

Sound risk mitigation of Natural Hazards would help safety assurance of new constructions. Consultation with local and foreign construction specialists would be advantageous. Safety arrangements in new housing societies and construction projects must be ensured by way of tight monitoring. Township form of housing needs promotion in rural areas and mountainous regions on modern footings. They would not only be able to better withstand tremors as compared to the present formation of scattered clusters but also would help in conducting proper corrective measures in crisis situation. Lightning receptors should be made mandatory for tall buildings and complexes and their private usage should be promoted. People should be urged to undertake risk management measures before constructing new residential and non-residential buildings. A scheme may be launched to inspect houses, schools and apartments to see how best S&T tools can be incorporated in existing structures to make them resistant to hazards especially quakes, storms and lightning. Public-private partnerships would well support such corrective and preventive measures, hence their development is strongly recommended.

Flooding has been the main problem of quite a few developing nations. Countries like Pakistan and Bangladesh are heavily flooded in monsoon seasons yet within these countries there are regions with acute water shortage. Availability of clean drinking water and that of agricultural water are major issues for many other developing countries also. A reason behind water scarcity is improper management of available resources and reservoirs. The S&T features of water reservation and management need promotion. These techniques would help to overcome much of water scarcity and would also help to combat flood hazards.

Up-gradation and acquisition of equipment may be the next significant feature under this head. Strong need is felt for helicopters, boats, vehicles, life-detectors, general purpose detectors, sensors, cranes, ladders, drillers and other modern preventive and corrective tools that are needed in similar circumstances. Medical supplies particularly to the public health care institutions also need to be increased that are found short even in normal days. Countries of the South should come up with a strategy to import the most important equipments as soon as possible from different countries. A reasonable portion of central and regional budgets has to be dedicated to acquisition of hazard mitigation and management infrastructure. Local development and import from private sector in this context should be encouraged. "Hazard mitigation and management units" should be formed at district levels. Each unit should be provided with appropriate materials and should be linked to divisions of armed forces and to other quarters of community. The idea of this proposal is to make public communities more capable of tackling hazards on their own and also with their support to trained personnel. The availability of equipment to underdeveloped and far flung areas should be made certain since generally, they are most affected and they are most seriously hampered by the lack of necessary facilities.

In the end, Ministries should raise adequate reserves for training of manpower for real mitigation and management of Natural Hazards. Civil communities are seldom well trained and often under-supplied with materials to support activities initiated in wake of or in response to tragedies. It has also been observed that people hit in catastrophes are not able to institute efforts on their own mainly on want of training and the time lost in waiting proves fatal. Masses should be imparted modern S&T training and the focus of the training should be school and college students. Proposed training ranges from basic First Aid to higher levels of hazard management efforts. Formation of district level "Hazard mitigation and management units" will greatly help the cause by helping to expand the circle of training to general public. Civil service organizations should be promoted and trained on advanced footings for effectively checking impacts of hazards.

4.13 Bringing Sustainability to Environment

The research conducted on natural hazards links many of them with environmental degradation. The temperature of the world is rising due to fast increasing pollution and is melting ice at poles and at high altitudes. Alarmingly increasing industrial waste is said to be one reason behind Indian Tsunami and deforestation at shores is said to have increased the impact of the disaster to much larger extents if it would have happened otherwise. Apart from this perspective; population, urbanization and industrialization are rapidly growing at the costs of plantation and forests. Unsustainable and unorganized patterns of living are seriously harming habitats that are suppliers of air, food, water, and other elements necessary for making livelihoods. Environmental debates have become vibrant internationally. Immediate measures are to be taken for making our living patterns more sustainable and friendlier to our environments. Urgent action is inevitable for developing countries where population growth rate is high, deforestation activity is unchecked and regulations on industrial wastes are not effectively enforced.

Owing to the high significance of environmental preservation; regulations on general business must be tightened with regard to their wastes. Deforestation should be strongly discouraged and stringent laws should be placed in tact to check illegal tree cutting. Masses must be sensitized to the importance of sustainable environment by various promotional campaigns. Ministries should collaborate with law enforcing agencies to check anti-environmental activities and suggest the governments on suitable legislation in this regard. Governments are urged to promote plantation and encourage private sector to come up with their role for preservation of environment. While hazards may not be totally avoided; a good environment can still withstand many negative impacts.

It is strongly asserted here that physical infrastructure especially roads, transportation and public health and educational institutions need immediate attention. It is the plight of roads and transport that hinders quick and effective works in times of hazards. The public health and educational institutions are most drastically hit by

incidents as compared to other organized constructions. Public constructions should be tightly monitored. Persons involved in mal-utilization of funds and use of inferior quality material should be brought to book. It is the human life that suffers due to these criminal acts and there is no pardon for putting it on peril.

4.14 Generating and Managing Intellectual Property Rights

"The population of the South represents about 80% of the humanity but has only 20% of the world's scientists and holds a very small percentage of world patents." [10]

In real world, holding patent means significance especially in the WTO regime. When a formula, a product, a theory, a research, a process or even a sub process is established to have something new about it; it can be provided with a legal cover of "Patent" or "Intellectual property Right". The owners of Patents and Intellectual property rights are entitled to certain privileges the chief of which is the security of the innovation from piracy. As we look at it this way, they are for the security of a new idea and actually it is the new ideas that rest at the base of every advancement be it in the field of Science and Technology. Piracy of ideas has led to gross disappointment of talented individuals in Pakistan. Research conducted by some scientists in the country was discouraged and in some cases, their ideas were stolen. Adding to their vows, research was not supported by corporate sector and consequently, interest in Sciences and Technologies is very limited. On the other hand, most of research and products utilized in the South are reserved in the name of organizations of the North that are making ominous profits out of them. To reduce the costs they pay and to gain optimum share of their own resources, it is very necessary to generate Intellectual Property from within countries of the South.

The first step should be to promote and encourage innovation of ideas and of practices. Governments have to take the lead for promoting innovation in S&T sector and detailed strategy has been suggested in section 4.7. Literature about information on winning Intellectual Property Rights must be made public. Ministries of S&T would concede and manage S&T related Intellectual Property Rights within their countries and would extend due privileges for innovation. It should be ensured that rights reserved with foreign organizations and individuals are not adversely affected. The ministries are also suggested to support efforts for global recognition of an indigenous Intellectual Property Right. Stringent measures must be taken to check piracy of ideas, publications, research and developments.

The aforementioned acts are not meant for discouraging use of information but only to prohibit its misuse. The stress should be laid on creating S&T IPRs in the South starting from basis research and then moving to higher levels of research and development. Although it may take time but once something new has been found, it must be secured. This is the way huge multinationals are securing their intellectual assets and are growing further up. In order to sustain in global world; innovation has to be promoted and it has to be safeguarded. Creation of IPRs would provide an

identity to newness and managing them will secure newness in long term and would also engage the owners to move further for even more creativity. Above all, Creation and Management of IPRs will cut down S&T costs; something most relevant and pertinent for all developing countries.

4.15 Generating Public Awareness and Interest

Scientific and Technological development critically depends upon the extent to which the general public understands science and technology [11]. Awareness of S&T is not pronounced in most parts of the South. Literacy rates are not high and majority of population has no or limited access to clean water, sanitation, energy, appropriate healthcare and educational facilities, etc. Aptitude of majority is thus naturally inclined away from S&T. Public awareness of S&T in developing nations has to be raised substantially; something which can be done by the aid of institutional infrastructure like Science centers, museums, Technology parks, science cities, exhibitions, etc. There are a very few similar institutions existing at moment. The state of the existing institutions needs big improvement on modern footings. New Science centers, museums and technology parks should be established with passage of time. Media can be involved to play a more active role in promoting S&T awareness programs. Television can play a very useful role in this regard since it reaches out and attracts a good share of public. Other means of media especially newspapers and internet may also be employed in a suitable mix for generating basic interest.

The promotion programs would disseminate basic know-how of S&T, its constructive applications, the goods it can bring to everyday life and its centrality to socio-economic development and environmental sustainability. Mass communication techniques have not been well-utilized in this context. The schemes should promote consumption of local goods and services and should cover a much wider area from basic inputs to finished products and eventually transforming into a psychological weapon for promotion of indigenous development. This scheme should also enhance the interaction between the industries and the customers where suppliers will be known of what customer really wants from them and the customers will get what they really expect. Scheme of Software parks has proved successful. Following similar lines, S&T parks should also be set starting from major cities and then gradually moving to other regions of developing countries. The aim of these parks primarily would be to share S&T information with society plus sales of S&T literature and products. The parks may be integrated with recreational facilities to attract most of general public. The idea behind the scheme is to increase general interest in S&T that would eventually support their advancement. All these are suggested components of generating awareness and interest among masses but they are not all inclusive. Few other elements are discussed in other parts of this compilation and even few more may be brought in future for furthering such endeavors.

4.16 Building International Cooperation for Science and Technology

Alleviating poverty, enhancing quality of life, increasing food yield, improving literacy, growing economy and generating employment are some major challenges that lie ahead of countries of the South. A boosted economy is needed to meet all these challenges while the environment has to be sustained at the same time to ensure safety and security of life. Development of Science and Technology is the only real time solution for managing economy as well as environments. However, it requires continuous adequate finances. Developing countries do not have enough financial reserves to launch on various S&T avenues. They also lack appropriate knowledge resources of S&T. The difficulty can be best be overcome by seeking foreign cooperation. Since developing countries share similar problems; enhanced South-South collaboration is one big need of the day to tackle them most effectively. However we also have to import knowledge and technology from North who is far ahead in these two crucial fields. Not ignoring the significance of South-North collaboration, a triangular cooperation; South-North-South is more feasible in current world [12]. All governments to date have developed collaborations with advanced countries of the world especially the USA, UK, Japan and China. The need of expanding cooperation with other countries of the developed and developing worlds and particularly those lying in geographical neighborhoods is gaining impetus rapidly. The governments in the South should work actively to enhance international collaboration at all levels. Ministries of Science and Technology on their parts, need to maximize the S&T benefits of international cooperation. Collaboration with South should be themed on developing ties for fighting poverty, disease and illiteracy and on convincing the North to cooperate in the areas more concerned with the socio-environmental development of the South. Cooperation with North should be instituted structurally for sharing and transfer of technology and knowledge primarily focusing on needs and patterns pertinent to South. Governments and relevant authorities need to work closely on developing adequate infrastructure for facilitating foreign cooperation into the South. Private initiatives in this perspective need encouragement and facilitation. In the beginning, the focus should be on developing cooperation for education, health care and sanitation. Simultaneous investments in industry must not be ignored and gradually yet systematically; efforts should shift their focus towards commercialization of Sciences and Technologies. Measurable targets should be set to make substantial gains on current S&T cooperation setups, to build strong linkages with emerging forums like EU, African Union, ASEAN and other South-South, South-North and South-North-South collaborations.

4.17 Measuring Fiscal Performances

Getting your money's worth from developmental projects is an extremely current issue [13]. Sound fiscal measures are critical for successful implementation of the policy objectives. The strategy in broad has to consider deeply the financial and fiscal sides since this functionality needs due monitoring and proper management. The fiscal measures include proper utilization of current monetary supplies, estimation of near

future needs and timely projection and preparation of contingency requirements. The job thus requires expert inputs from experienced economist(s), financial and administration managers and scientists. The finance wings of S&T authorities should comprise of people from all these ranks who are given relevant autonomy for effective fiscal management. Redundant procedures must be simplified to avoid wastage of time and hiccup in activities. Proposals for making transactions computerized may also be considered for enhancing efficiency and reducing hectic manual working. Special committees and task forces should be assigned on suggesting suitable fiscal measures at all stages to complement this implementation plan.

4.18 Monitoring

Continuous monitoring of S&T policy is a demanding issue and in fact is very much a challenge. Many projects and programs developed in the past lost their way at latter stages since they were not monitored well. Continuous monitoring is one major part of Management and when ignored, no managerial activity produces the required output. Separate "Monitoring and Evaluation units" should be set that would continuously keep a watch on all proceedings and primary focus should remain on outlines of policy documents. While monitoring would help to keep human and other resources on track, it will also generate valuable feedback. The authorities will be informed about shortcomings; loopholes, if any in basic plan and timely contingent measures can be taken. The unit may also suggest improvement measures that could be taken at any later stage of the policy work plan. This unit should be consisted of a team of experienced administrators and scientists. They would be required to liaise with other relevant setups. The suggested unit should generate regular reports. Continuous regular monitoring and evaluation should be conducted reviewing the performance in relation to the parameters set and necessary decisions be made for further course of action. Necessary powers may be delegated to the unit and facilitating procedures should be laid down for smooth proceedings. On time monitoring and evaluation must be given due significance in the working of concerned ministries to make certain that things are going on plan, funds are utilized as allocated and most importantly, improvement is made; no dull unproductive practice is observed.

4.19 Thrust Areas of Science & Technology

Science and Technology requirements differ greatly for the South than those for the North. Countries of the South are primarily confronted with the problems of massive poverty, malnutrition, lack of healthcare and education. Development of Science and Technology thus has to be directed for combating these problems while also assisting for national economic growth. The thrust areas of Sciences and Technologies that can be identified for developing countries are discussed briefly in the following.

- *Biotechnology*
  The vast potentials of biotechnology or genetic engineering are just unfolding in the world. The advanced nations predict that harvesting biotechnology will take a

few decades and it will be one of the leading technologies in coming times [14]. Biotechnology will also affect international trade and the impact will be largest on agriculture. Since many developing countries are primarily agricultural countries relying heavily on their crops and agro-based industries; applications of biotechnology could have important consequences on their economies. Brisk population growth rate, changing climatic conditions and traditional methods of cultivation are producing food crops short of local demand. Lack of research and lack of awareness about quality requirements are not helping to produce high quality yield. Better quantities and qualities are being demanded from agricultural sector; that are the two key areas addressed by biotechnology.

Recent breakthroughs in biology and chemistry enable humans to manipulate the interior of cells and derive the products they want. The cellular DNA can also be played with to produce low-water using, disease resistant, pest resistant and heat resistant agricultural outputs. Very obviously these developments augur well for the South due to which biotechnology is identified as foremost thrust area for development.

Naturally, awareness and utilization of biotechnology need promotion in the South where it has not yet made notable inroads. Greater portions should be reserved in the syllabi. The benefits of applications should be promoted through media. Public and private institutions working on it need to be strengthened, interlinked and facilitated. International cooperation for transfer of knowledge and technology from abroad has to be encouraged by all means. Starting from biotechnological techniques for larger and improved yield; advanced applications that can convert simplest of creatures into living biochemical factories of novel drugs, foods, solvents and renewable energy sources may be introduced with the passage of time.

- *Renewable Energy*

  Energy is the basic input of all socio-economic development activities. Energy is currently the burning issue for the world and its rocketing prices are of ominous concern for all developing countries. Majority of them are deficient in energy resources particularly the fossil fuels that are the major energy-resource of the world, so energy imports consumes a big percentage of import bills and still a major portion of the population has limited access to electricity and commercial fuels. Rapid population and anticipated industrial growths are exerting high pressures for exploring newer and cheaper sources of energy.

  Foreseeing these challenges, renewable energy resources are crucial for the South. The areas that can be identified in this field may include: R&D in energy resource assessment, utilization of indigenous low quality coal, development and adaptation of renewable energy resources including nuclear power, solar energy, biomass, wind energy and thermal energy technologies. Generation of renewable energy through thermal, solar, nuclear and biomass sources must be facilitated.

Proposals should be invited for commercializing these sources of energy and private sector could be involved for optimizing results. Exploring newer sources will help greatly to meet local demands indigenously and for reducing huge expenditures on imports. Investments in the sector must be encouraged and facilitated by way of easy legislation and concessions. It is a thrust area for developing countries where Scientific and Technological advancements can contribute highly over long-term.

- *New Materials*
  Many Countries of the South invest noticeable amounts on import of basic engineering goods [15]. Efforts for production of following materials in developing countries may be strengthened.
  - Foundation grade pig iron
  - Electrical, surgical and other alloy steels
  - Silicon Microchips
  - Micro Circuits and conductors
  - Ferrous alloys
  - Refined copper and its alloys
  - Aluminum and its alloys
  - Composite materials including ceramics and polymers
  - Rare earth metals
  - Computer Accessories
  - Plastics
  - Temporary storage devices e.g. floppy diskettes and flash drives

  In metallurgy, focus may be on the development for materials like sponge iron, power metallurgy, vacuum metallurgy, foundry and casting technology, composite materials such as glass fibers and carbon fibers etc. To achieve these, training of manpower in above fields is a must. Other supportive measures would include up-gradation of existing facilities, establishment of new centers and institutes specializing in the above fields, interlinking universities and the industrial sector and provision of incentives to industries to set up manufacturing units for producing the above materials.

- *Information and Communication Technologies (ICTs)*
  The current revolution that we are witnessing in ICTs will have a far reaching impact in catalyzing development in various sectors. They are cross-cutting tools that can be utilized in all aspects of human life for improvement and benefit. Modern businesses have taken full advantage of advancement in ICTs and are going further ahead on it. Their utility is however not limited. They can greatly assist in improving health, education and many other sectors. While their utilization has enhanced greatly in last five years across the world, their base has to be still to be greatly enlarged to maximize their benefits. The target in this thrust area should be to provide Internet and telephonic (both fixed and cellular) access to majority if not whole population of countries of the South.

- *Agricultural Machinery*
  Since many developing nations are agricultural countries, good potentials for developing local agricultural machinery exist there. The capacities of installed plants have to be increased along the establishment of new plants. Manufacturing of tractors, thrashers etc. would do well for augmenting local agricultural sector. Local and international cooperation should be boosted for agriculture related technological Research and Development in the South.

- *Ocean and Water Research*
  Majority of developing countries have coastlines that are capable of producing rich fisheries, mineral and oil and gas reserves. These potentials are however largely untapped. The inland water resources have also been managed inharmoniously in past due to which numerous problems have arisen. Majority of population has no or limited access to clean drinking water. Serious water deficiency is foreseen for agricultural, industrial and personal consumption in future; thus making proactive planning of our water resources necessary. R&D in marine sciences can assist much for optimizing production of fisheries, minerals and other reserves. Supplemented by reservation techniques, fisheries can result in good local and export income. Desalination techniques can be utilized for provision of drinking water near the coasts. Proper planning of inland water resources has now become a must. Latest S&T techniques make it possible for long-term reservation and appropriate utilization of water resources. Modern techniques of reserving river, surface and rain water and joint venture programs are advised herein for all developing countries. Water resources and management is a very crucial thrust area for the South and for its S&T circles. Urgent programs must be launched at earliest foreseeing immense challenges that lie ahead. Well devised, integrated action program should be launched by collaboration of government, business and general public for interest generation and promotion of water management techniques.

4.20 Strengthening Public-Private Partnerships

Public sectors of the developing countries are overburdened and tangled up in number of problems. The challenges are so big that governments can not handle them on their own. Public-private membership can be very useful to overcome this difficulty and it has been this partnership that has done things right for the North. The policies should facilitate Public-Private partnerships in all sectors including S&T. The governments could easily assume facilitator and regulator roles while in private holdings, there would be personal stakes, direction of activities and thirst for achievement. The public-private partnerships can play their role in all areas discussed in this policy. The policies hence must promote these linkages to move forward towards sustainable development goals.

4.21 The New Vision

In the existing world, the basic aim of all developing countries is to boost their economies, improve the quality of life of their inhabitants and sustain healthy, clean environments. Naturally, this is a multi-faceted task for any country and needs strong will and commitment, not just from a few but all of the people. A new vision has to be inculcated in the minds. This, the New Vision, may include the following directions:

- Encouragement of innovative ideas and open, participatory discourses for knowledge sharing and analysis
- Establishing strong R&D base for indigenous requirements
- Aligning tasks with global standards
- Shifting from Technology-transfer to Indigenous Production and Development
- Emanating and sharing an S&T culture, where people from all circles are aware of importance of S&T and play their roles effectively; if not physically, then at least by appreciating their development
- Moving with new, invigorated spirit towards the achievement of goals

5. CONCLUSIONS

Development of S&T in the South is imperative. However, it is not solely the job of the government or that of Scientists. It needs a cumulative effort, and no strategy is possible unless the general public supports it. Science and Technology Policies must be published and promoted, so that the idea is delivered to and shared with all concerned. This chapter only lays out a suggestive policy that developing countries can adopt. The proposed roadmap, once incorporated with ideas of experience personnel and molded in accordance with regional requirements, would hopefully set a meaningful direction on the road to sustainable development.

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EPILOGUE

The human society has been striving for economic development over a long period of time. This has been a serious but complex issue involving, inter alia, social as well as political dimensions. The history of this human endeavor appears to be chequerred, consisting more of black rather than white squares. The second half of the twentieth century saw a prominent emergence of the terminology "socio-economic development" on political horizon of the globe. This rapidly transcended into another interesting aspect of socio-economic development, connecting the earlier perception with another important component – sustainability.

The basic merit attached to sustainability factor with socio-economic development lies in the fact that sustainable development involves moral consideration of the welfare of coming generations. The idea implies that the present generation should not consider material benefits for itself alone but should sacrifice some of these, if it becomes inevitable, for the benefits of those who will come later in this world. Obviously the whole economic planning for development along these concepts will require entirely different perception for designing and implementation of well considered programmes. However, the stark socio-economic disparity existing on our planet comprising large segments of society suffering from acute poverty, illiteracy, disease, deprivation of the most basic human needs coupled with exploding population is forcing the world conscience to shift the priority of development goals from long term perspectives to short time emergency measures designed for rapid relief to the most afflicted world community. Clearly this aspect puts a strong retarding pressure on the schemes and programmes based on sustainable socio-economic criteria.

The sustainable socio-economic development faces another dilemma. Economic growth needed for human welfare requires growth in the energy production and utilization. There is an appreciable shortage of energy sources, particularly the clean energy sources, to meet the demands of the rapidly growing population of the world. The extensive use of carbon dioxide emitting energy sources in the future is poised with the danger of serious environmental degradation whose ill effects the world is painfully witnessing even these days. Natural catastrophes like hurricanes, floods, earthquakes, tsunamis, desertification, soil erosions and irregular weather patterns are producing havoc on human life. The major affectees of these disasters are the poor societies. The planners and policy makers of sustainable socio-economic development will have to struggle hard to find a solution for this dilemma.

The nations of the world will need clear concepts, research based knowledge, uncompromising resolve and strong moral commitment in order to meet the difficult challenges posed by the sustainable socio-economic development in the coming decades. A good reflection of these ideas is clearly visible in the world initiatives of Rio, Millennium Development Goals and the World Summit on Sustainable Development,

Johannesburg. However, the goals, objectives and time frames set out for the sustainable socio-economic progress have been too ambitions to achieve any timely benefits for the poor populace of the world. It is necessary that the programmes arising out of these initiatives are reviewed vigorously and appropriate modifications made in the light of the lessons learned so far.

The force and quality of knowledge required to achieve success for the sustainable socio-economic development in a timely manner has to be galvanized as quickly as possible. Research organizations, universities, think tanks, world intellectual forums, NGO's and other sources of quality knowledge and experience have to be brought together both from the developed and the developing world in order to provide a solid foundation on which mankind could build its future strategy and practicable action plans to achieve success. Collaboration and cooperation without discrimination and with transparency of activities should provide useful results. Creation of new ideas and their dissemination are one of the many ways by which the purpose of the ongoing world initiatives on sustainable socio-economic development could be helped and advanced.

The present attempt by COMSATS is aimed to contribute to the achievement of the objectives given in the above stated paragraphs. The subjects on which views have been expressed in the book constitute both the concepts and scientific solutions related to the sustainable socio-economic development. As stated earlier, the concepts of sustainability and socio-economic development are complex issues. However, it is hoped that the ideas presented in the various chapters of this book will provide an opportunity of combined and integrated approach for formulating relevant future strategies and activities by the designers and implementers of upcoming programmes related to the world agenda of sustainable socio-economic development.

The areas on which opinion has been expressed in this book cover a wide range of views having a direct bearing on the subject of sustainable socio-economic development. They include concepts, policies, assessments, education and training, regional cooperation and hard core branches of science and technologies such as information and communication technologies, biotechnology, nuclear power and some renewable energy technologies. Some relevant but important features of these chapters have been highlighted in the ensuing sections of this epilogue. The purpose is to convey the general idea and the flavor of the main write-ups in a brief manner. The details and in-depth analysis can be arrived at by going through the actual chapters from where the views and opinions presented in this part of the book could be amplified for more comprehension. Due to the complexity of the issues discussed the possibility of difference of opinions exist. However, it is the intention of the authors to welcome any suggestions or new ideas which could be accommodated in the text of a future but better version of this attempt. With the background of the afore-stated views, the summarized description of various chapters of the book has been given as follow:

The section on "From Rio to Johannesburg: Achievements and Failures in Sustainable

Development" touches upon the concept of sustainable development, and while reviewing the global efforts made in pursuance of sustainable development, achievements and failures in achieving some goals were identified. The chapter briefly describes the background to sustainable development, and certain landmark events, particularly the Rio Summit, which happened all along the way, till the Johannesburg Summit (in 2002). The primary focus however, remained on how successful or unsuccessful the world community has been since Rio Earth Summit.
Gaps that exist in the implementation of actions plans for sustainable development were also indicated in the section, such as:

a) A fragmented approach towards sustainable development: Policies and programmes at both national and international levels do not reflect the inextricable connections between economic, social and environmental objectives;
b) No discernible changes in the unsustainable consumption and production patterns, which are putting the natural life-support system at peril;
c) Lack of mutually coherent policies or approaches in the areas of finance, trade, investment, technology and sustainable development, particularly in the context of a globalizing world; and
d) The financial resources required for implementing Agenda-21 have not been forthcoming and mechanisms for transfer of technology have not improved.

In terms of follow up actions taken and achievements in pursuance of sustainable development, it was contended that the civil society now was relatively more informed; depletion of ozone layer had been mitigated; protocols like Kyoto were a step forward towards realization of the goals. As for failures, it was argued that poverty and healthcare situation has not improved; much is required to stop the extinction of species, loss of forests, depletion of water resources, and sufferings due to border conflicts.

It was discussed that the world surely can undo the failures that the decade after the Rio Summit witnessed, by translating their words into action and by making good on their commitments. Doubtless, the path of global negotiations to world-wide problems is a difficult one and there are no early successes. In fact, coming to a national resolve and undertaking national action is a primer to the success of international treaties. This has shifted the onus for action on most of the problems from the supra-national onto the national and even to the local level.

In the second section of the book, 'Important Aspects of Sustainable Development Based on Science and Technology', the centrality of science and technology in meeting the ever increasing requirements of human beings was underlined. It was realized that the issues facing the human-race today have global repercussions and that there was an increased recognition of interdependence. The importance of mainstreaming science and technology by strengthening international linkages also became apparent.

It was noted that there has probably never been a more opportune time than the

present time to harness all the scientific knowledge for facing complex challenges posed to humanity today. Speaking of the strategies that the comity of nations must adopt, it was stated that the global challenges that we face today demand that we be more innovative in our thinking and compassionate in our actions.

Drawing the attention of readers to one of the most important ingredients for sustainable development, i-e education, it was hoped that education can set a better and shorter course for development. The next chapter touched upon the need to sensitize the people towards the centrality of 'Education for Sustainable Development' (ESD). Education is a bridge between 'the past to the present' and 'the present to the future'. A deep recognition of the importance of education is the necessary first step if we are to achieve the level of democratic participation envisioned by a country. Infusing the concepts of sustainable development throughout our learning experiences will help foster that awareness. Involvement of educators, government, businesses, and non-governmental organizations, working toward common goals, will lead to an understanding of multiple perspectives and informed decision-making. How we meet the future is in our hands. Education for sustainable development provides an opportunity to craft the future we want for the world.

The authors while advocating this cause narrated some steps as helpful in realizing the vision of development through educated society. These included, developing fresh curriculum, educating teachers, creating tertiary level institutions to embrace and support 'education for sustainable development' and initiating practical structured training programs and related activities with a dual focus on philosophical and practical knowledge.

In order to further the cause of education for sustainable development, other bold measures that were emphasized, include: to sensitize media and publishers about the issues of education for sustainable development, associate them with all other stakeholder like non-government organizations, private sector and policy makers as well as to prepare generic training materials for policy makers, education planner, teachers and teachers' trainers.

Education for sustainable development can help prepare our society for a fast-paced world of rapid scientific, social, technological workforce, and demographic changes. It was accented that the overarching goal is to infuse the concepts of sustainable development into all learning, from structured schooling in formal education settings to life-long learning in non-formal programs. The establishment of guidelines and objectives for educational programs embracing the basic principles of sustainable development will provide a basis for the development of an integrated, holistic and interdisciplinary approach. It would also encourage the promotion and use of appropriate, as well as innovative, emerging technologies and knowledge-based alternatives.

Where education is expected to change the social and economic scenario of the world,

clean and renewable energies are promising in providing us with necessary energy-supply for development without jeopardizing the future of later generations. This book in its later two chapters advocate the role of nuclear energy as well as renewable sources of energies in meeting the growing energy demands of both developed and developing countries.

Nuclear energy, as a proven source of clean and assured energy supply, can greatly help in achieving the benefits and goals of sustainable socio-economic development and tilt the balance in favor of higher economic growth with lesser climatic degradation. It was argued that the world opinion is now shifting in support of nuclear power due to its increasing economic competitiveness, stringent safety standards and better waste-disposal solutions. It was also felt that the world is expecting a turnaround of nuclear electric power and a so-called "second wind" is in the offing. Continuously increasing fossil-fuel prices and devastations occurring due to climatic change are the main reasons for the nuclear energy to make a come back as a main source of power and energy.

Thorough discussion on 'the use of nuclear power for sustainable development' was made by taking into account both the extreme views, in favor and against the usage of nuclear energy. After careful analysis and discussion it was concluded that: Nuclear power has to play an important role as a component in the overall energy-mix during the 21st Century, as it has the potential to be a sustainable energy-source; other non green-house gas-emitters like hydro and renewables, will not yet be able to meet the growing energy-needs in an adequate and assured manner; nuclear power plants will become fairly competitive with fossil-fuel fired plants due to rapid increases in the fossil-fuel prices, technology improvements could adequately alleviate public fears about safety and waste-disposal; and an increasing need is being felt in the advanced countries to revive nuclear power, due to increasing blackouts, climate hazards and international commitments to cut down the carbon-emissions which will cost the industry heavily.

With reference to Millennium Development Goals (MDGs) it was concluded that the world initiatives to eradicate poverty through sustainable socio-economic development are positive steps in the right direction. However, the commitments made under MDGs and World Summit on Sustainable Development (WSSD) in Johannesburg are too ambitious to be fulfilled by the world-community in a timely manner, due to wide differences in political, economic and social priorities among nations and regions and also the differences in the approaches adopted to address the issues. Success of the MDGs and WSSD plan of action largely depends upon abundant availability of clean-energy. As hydro and renewables have been proved to have limited potential in the near future, the only alternative left for filling the supply-demand gap for clean-energy will be the nuclear energy which is a proven and reliable source of clean energy.

Renewable energy resources and technologies have the potential to provide solutions

to the long lasting problems being faced by the economy, the industry, the environment and the masses in the consumption of traditional sources of energy. It is only through devising such solutions that the development of nations can continue without hindrance, and in fact contribute towards sustainable development goals.

In devising strategies to approach the development and deployment of renewable energy technologies (RETs) it was emphasized that each country should devise its own renewable energy mix, customizing to its geographic features and strengths. It was agreed that a sound strategy would encourage adaptability and accessibility in accordance to its geo-graphic location, economic condition and social acceptance.

The chapter on renewable energy recommends that the policy of renewable-energy must be designed on the 3A principle of Accessibility, Acceptability and Availability to satisfy the basic needs of people and to achieve the target growth-rate in their economies. Amongst other general energy-policy guidelines for apt usage of renewable energies for meeting future energy demands included: developing of regulatory frame work to encourage development of entrepreneurship in the field; keeping all the energy options open to develop renewable energy resources and their technologies; promoting energy-efficiency tools; relaxing taxes and duties to make RETs competitive as well as encouraging RET industry with incentives.

Moving on from meeting energy demands for development through clean energies, the succeeding chapter draws attention towards achieving Millennium Development Goals (MDGs) and the pivotal role of information communication technologies (ICTs) in the accomplishment. After briefly discussing the millennium development goals, the role of ICTs and the positive impacts ICTs made so far, the application of ICTs in the field of education and healthcare was underscored. It was stressed that the provision of accessible education and affordable healthcare to every segment of society would ensure safeguarding environment, boosting economy and developing vibrant society as a whole.

Narrowing down focus on education it was observed that information and communication technologies hold great potential to help those seeking to achieve universal primary education and universal literacy in the near future. It was anticipated that even if the educational targets depicted in MDGs are overly optimistic, innovative techniques using ICTs in the educational sector should help improve access, effectiveness and quality of education.

Ensuring food security, which is the basic need of life, for the ever growing population of the world, is a mammoth task. Modern biotechnologies could provide key components to the solution for the issue of food insecurity if steered by a set of appropriate policies. The chapter on 'Biotechnology for Sustainable Development' discusses the paramount role of biotechnology in meeting this global challenge. The capacity to search, assess, utilize, acquire and develop biotechnology has been pin pointed as one of the most important factor that would result in different fortunes of

nations' competitiveness. It is the existence or absence of this capacity in developing countries that will determine whether they engage effectively in the application of biotechnology to address their national needs.

The need for an integrated biotech policy with concurrent attention to education, social mobilization and regulation is considered to be an essential pre-requisite for an orderly progress of the biotech sector. Synergy between technology and public policy is essential for us to achieve an effective mobilization of the tools of new biology for adding both years to life and life to years.

It is imperative that the developing countries leverage resources through partnership and build regional innovation systems. The strategy will help develop local talent for a globally competitive workforce. While it recognizes private sector as a crucial player, the strategy also visualizes government to play a major catalyzing role in promoting biotechnology. The development strategy is based on a strong innovation promotion framework in which industry, academia, civil society organizations and regulatory authorities will communicate in a seamless continuum. The perspective for biotechnology in the third world countries would be global while also concentrating on local issues. This chapter has taken into consideration all the areas that will play a leading role in utilizing biotechnology for sustainable development. There is a great need to strengthen academic and industrial biotech research capabilities, work with business, government and academia to move biotechnology from research to commercialization, foster the industrial development in this sector, inform people about the science, applications, benefits and issues of biotechnology, enhance the teaching and workforce training capabilities and establishing the third world countries as preeminent international locations for biotechnology.

Therefore, it is imperative for every country to explore solutions to their problems and come up with well-defined national plans. There is a great need to establish suitable infrastructures for acquiring, developing and managing the technology for developing local scientific and technological expertise. The urge and ambition to develop and sustain enabling conditions pose new challenges to the Third World nations. These fundamental issues have to be forcefully addressed before we can genuinely hope to benefit from such cutting-edge technologies without in any way having to compromise with any deterioration of environment.

Focusing on the third and equally important facet of sustainable development, the environment, this book signifies conserving biodiversity of every area and region. The author to 'Biotechnology for Sustainable Development' cautioned against the ever growing environmental and climatic problems, such as depletion of ozone layer, greenhouse effect, deforestation, desertification and gross water, soil and air pollutions. He called for taking strong measure to check the loss to natural habitat of living beings and indicated a stronger link between conserving biodiversity and slow down the environmental degradation. It was asserted that gathering knowledge of the biodiversity of the given area is essential for health and viability of the total

ecosystem operating there. The chapter presented an overview of the issue in conserving biodiversity of a country in the broader context of sustainable development with special reference to Pakistan.

In the last two chapters the role of regional cooperation in furthering the goal of sustainable development was highlighted. It called for building strategic alliances, synergies, and cooperation in various fields of science and technology and at various levels, at governmental as well as institutional levels. The directives depicted for regional cooperation included: adopting and pursuing policies of openness to other parts of the developing world, showing willingness to propagate and further the local and regional cooperation as well as to committing solidarity in the collective augmentation of capacities and acquiring necessary technologies. Besides this the need to develop human resources in important S&T fields, strengthening institutional capacities, and identifying clusters of common interests were emphasized.

The above mentioned anthology of various but interrelated ideas, views, concepts and analyses tends to depict an interesting mosaic from where a better picture may emerge to determine a road map for future journey to one of the worlds' most important destinations, i.e., sustainable socio-economic development. Mankind cannot afford to carry a blurred vision and remain ambiguous and indecisive about its future anymore. Hope for a better future for the humanity is very much alive. Let us fulfill this hope with a clean vision and with collective efforts. Sustainable socio-economic development of mankind provides a reliable path for this cherished goal.

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