STRATEGY FOR SCIENCE, TECHNOLOGY AND INNOVATION IN ISLAMIC COUNTRIES

Revised Version

Publications of the Islamic Educational, Scientific and Cultural Organization
-ISESCO- 1430H/2009

Table of Contents

CHAPTER 1

BASIC CONCEPTUAL OVERVIEW OF ISLAMIC COUNTRIES

1.1. The Growth of Science in early centuries of Islam

The contribution of Muslims to advancement of science and philosophy during a period of seven centuries from 700 A.D to 1400 A.D is well documented in the literature (Qurashi 1993). Several reports have analysed the impetus that led to the rise of Islamic science. So intense was the intellectual activity during this period that breakthrough advances were made in one branch of science after another. The names of the following Muslim scientists will always shine in the firmament of learning:

Astronomy	Abu Rayhan Muhammad al-Biruni, Nasir al-Din al-Tusi, al-Kindi (Also Metallurgy, Music, Optics, Meteorology)
Mathematics	Muhammad al-Khwarizimi, Umar Khayyam (Also poetry)
Medicine	Abu Ali al-Husayn Ibn Sina (Avicenna), Abu Bakr al-Razi (Rhazes). (Also Theology, Philosphy, Mathamatics, Chemistry, Astronomy). Haly Abbas, Ibn Rushd (Averroes)
Physics	Hassan Ibn al-Haytham, al-Biruni, Ibn Sina, al Kindi

Muslim scientists also excelled in Astronomy, Agriculture, Medicine, Horticulture, Oceanography, Physics, Mathematics, Chemistry, etc. They were men of multi-disciplinary learning who excelled in more than one field. For instance Abu Bakr al-Razi wrote 200 volumes, 100 of them on medicine alone. Umar Khayyam was not only a great poet but also a genius in mathematics and philosophy. Al-Kindi wrote 265 volumes on physics, astronomy, optics and music. One of their strong points was the inter-disciplinary character of their approach to science.

This was essentially due to the dynamic message contained in the teachings of Islam. This message expanded the world view, eliminated social contradictions, elevated the consciousness of the people and gave them a new motivation for achievement, enabling them to unravel the mysteries of nature. Their rise was accompanied by accumulation of vast quantities of intellectual knowledge, unmatched in the previous history of the world, including the Greeks. The process of knowledge expansion was further catalyzed by critical and analytical approaches let loose by the forces of accumulated intellectual capital; yet, this was the age of abiding faith.

These masters of the reservoirs of science and philosophy produced the renaissance and revival of knowledge, which enabled the subsequent generations to rise to new heights of excellence in Europe and elsewhere. However, much of the power the Muslims wielded in the period was no less a part of the knowledge-base, as that of the faith in the teachings of the Holy Quran and the Prophet (Peace Be Upon Him). As the investigations and inventions ceased, as enquiry, analysis and criticisms waned, so did the power.

The critique of Ibn-Khaldum is illuminating in this regard. The erosion continued. The economic fall was precipitated by the colonization of Muslim lands by western powers. The very edifice of knowledge-base built by Muslims shifted to the West.

For a long time now, it has not been realized that science and technology are allies of economic development. Continued neglect has stalled the 'real' development (human development) and science illiteracy persists in society.

1.2. The Present Situation and Modern Technology

The challenges to the Muslim world have become even more acute with the emergence of new technologies (microelectronics, biotechnology and synthetic materials). Their rapid diffusion, through the creation of new products, processes and services, is aggravating the "economic inequalities" between the developed and developing countries - the consumers of technology. The Islamic countries are, by and large, at the receiving end. Some countries are eager to assist in the development process but at a cost, sometimes unbearable and involving political implantations. Even technologies, not in tune with socio-economic conditions are imposed, resulting in downgrading the social values and traditions of the society. A change is required and each country should prepare the strategy for the development of area-specific technology and its application to socio-economic development.

Today, unlike the previous periods of industrialization, the ways in which economic change transforms attitudes, institutions and societies cannot be reduced to a simple linear relationship that is automatic. Considering the present S&T development in the Islamic Countries, it is convenient to divide them into three categories; (i) countries with significant scientific and industrial base; (ii) countries in which some scientific and industrial base exists, and (iii) countries with hardly any scientific or industrial base. Each category needs a different strategy and approach. This is elaborated later. In fact, it has to be understood that technology is one social process among others; it is not a question of technological development on the one hand, and social development on the other, as if these were different processes. Society is shaped by technological change which in turn is shaped by society (Solomon, 1984). This concept should receive prominence in the developmental plans of Islamic countries.

The spread of new technologies in the developed countries is dominated by the service sector, the very rapid growth of information-related activities, and the large-scale investment in education. This package is capital-intensive. The paradox, however, emerges where the basic needs of the development of Islamic countries-food, shelter, health and education - are taken into consideration. It is in these sectors where the investment priorities of these countries lie and so all efforts and resources should be channelized to provide such basic needs. The rapid spread of new technologies does not itself imply rapid social change. Other factors are involved, which are to be viewed in the context of economic, social and educational policies, the well established customs of daily life, and values and traditions of the society.

Since the later half of the twentieth century, a new techno-economic paradigm has emerged, with components that are both consistent with one another and interdependent. The earlier technological innovations were drawn from knowledge that was generally available. Presently, the new technological system is increasingly defined by innovations based to a great extent on very sophisticated science. In comparison with the previous technological systems, the characteristic features of the new one are: greater complexity of conception, close linkages with scientific institutions, greater capital-intensity, more diversified location of production, greater flexibility in application and uses, and more rapid achievement of global development and world markets. This world-view of new technological systems is further expanded in subsequent Chapters. It is, however, important to understand that the Islamic countries, which aspire for adopting new technology, will have to build up a substantial intellectual capital in their own way and in accordance with their own circumstances. And this is possible only through (a) substantial capital resource, (b) a close link between science and technology, and therefore between universities and industry, and (c) a large pool of highly qualified scientists, engineers and technicians. Deficiencies in these do exist in most of the Islamic countries and must be attended to.

The Islamic countries possess vast natural and human resources, which (if exploited judiciously with the help of scientific and technological resources) can yield very substantial gains for human development. The Newly Industrialized Economies (NIEs) have demonstrated this in the last decade. Malaysia amongst the Muslim countries is an excellent example. The country wisely chose to harness the downstream industries, achieved a level of designing, development and innovation, that, despite a relatively low scientific and technological base, brought immense economic advantage. Amongst the NIEs, several models of development are available, which can provide varying choices for the Islamic countries at different stages of human resource development. This document will, among other things, explore such choices and alternatives for general use by policy-makers in Islamic countries.

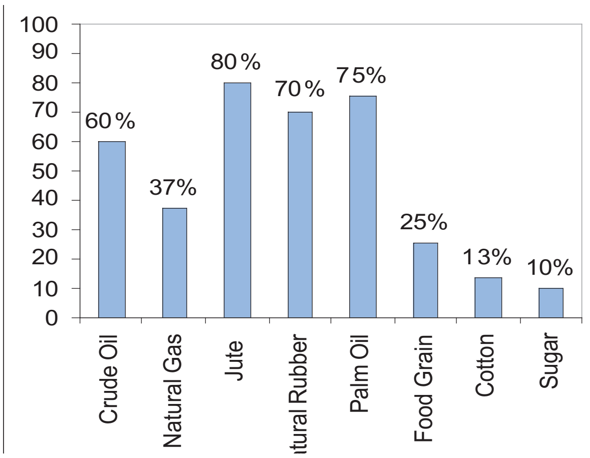

Fig. 1.1. Production of Raw Material in Muslim Countries

1.3. Some Basic Considerations

a) Introduction: The Islamic World, which has a population comprising more than 25% of the total world population, stretches from Indonesia to Algeria and from Turkey to Togo in 57 independent states, out of which twenty-one countries are producers of (see Fig. 1.1) almost 60% of the world's crude oil which amounts for almost 70% of the world's trade in oil. The Islamic countries also produce 37% of natural gas, 80% of jute, 70% of natural rubber, 75% of palm oil, 25% of grain, 13% of cotton and 10% of sugar cane out of the world's total production. A number of Muslim countries in Africa are rich in aluminum, copper, tin, lead, zinc and phosphate. Despite natural resource endowment, many countries suffer due to poverty, disease and illiteracy and are scientifically and technologically underdeveloped.

Millions of people living in Islamic countries are absolutely poor, with income of US one dollar or less per person per day, whereas the few rich ones spend as much as $600 per day. About 500 million of the people currently living in these countries suffer from malnutrition and chronic diseases, nearly three fifths lack basic sanitation. A quarter does not have access to adequate housing. Nearly two-fifth of the children do not attend school upto grade 5. Each year the global population climbs by an estimated 90 million people, most of this in Muslim countries, and there is not sufficient food to feed them, as the agricultural productivity per unit is abnormally low and finally, climatic change is turning the countries into food deficient and famine areas.

The total GDP of the 57 countries is only about US$2446 billion, less than that of a single technologically advanced European country (e.g. Germany) and one-third of that of Japan. The UNDP Human Development Report 2007/2008 points to the Human Development Index and the relevant positions of Islamic countries are summarized below.

1.3. (b) Human Development Index (HDI): The human development index measures the average progress of a country in human development. Out of 177 countries surveyed for Human Development Index (H.D.I) by the UNDP in 2007-8, there are 70 countries with high HDI ranging from 0.968 to 0.800. In this classification only 10 Muslim countries are included. In the second group, titled medium human development, there are 85 countries with HDI value ranging from 0.798 to 0.502, which include 37 Muslim Countries. And in the low human development with value between 0.499 and 0.336, it includes 22 countries, out of which as many as 10 are Muslim countries.

Further analysis of the data shows that, among these Muslim countries, life expectancy at birth varies from 78.3 for United Arab Emirates to 41.2 for Sierra Leone; adult literacy rate is 99.3% for Uzbekistan and lowest 23.6% for Burkina Faso; GDP per capita is $28,161 for Brunei Darussalam and lowest $806 for Sierra Leone. And the education index is 0.973 for Kazakhstan, 0.917 for Kyrgyzstan and lowest at 0.255 and 0.267 for Burkina Fasso and Niger, respectively. These details reflect the great possibility of improving the quality of life of the people living in the Islamic countries, through long-term sustainable application of science and technology for economic development.

1.4. Agro-Industrial or Industrial Base and Education

S&T Position in Brief: The Islamic countries spend 0.1 to 0.7 of their GNP on Science and Technology, whereas technologically advanced countries are spending 2 to 3 percent of their much larger GNP in this field. (Just for comparison, France and Germany spends 2.18%.) Furthermore,

- The Islamic countries have 8.5 scientists, engineers and technicians per 1000 population, as compared to 40.7 as world average and 139.3 for OECD countries.
- The 57 Islamic countries together contribute 1.17 per cent to the world's scientific literature, as compared to 1.66 per cent by India and 1.48 per cent by Spain. It is of interest to note that the seven Islamic countries have contributed five or less than five research papers per year.

- In all Islamic countries, there are few technical schools, colleges and universities and they have hardly any research centres of international standard.
- There is lack of opportunity for creating leadership in R&D, and for determining planning strategies. This has created vacuum for forming policy-making body for formulating national policy for individual country and multi-national policy for Islamic world as a whole.
- Most of the Islamic countries are rapidly losing traditional comparative advantage, which resided in the availability of natural resources and cheap labour.
- Lack of interest by political bodies in science, developing the educational system, inadequate R&D infrastructure and support-services and, above all, absence of scientific enquiry and activity are some of the factors responsible for the poor performance of S&T sector in their development process.

1.5. Broad Categories of Islamic Countries on the basis of Scientific and Industrial Development

Based on UNDP Human Development Report 2007/2008, UNESCO Science Report 2005 as well as ISESCO case study (2006) and COMSTECH publication on Status of Scientific Research in OIC Member States (2005), we may divide Islamic Countries in to three broad categories on the basis of scientific and industrial development. This is a broad classification, in order to further elaborate the S&T position in the Islamic Countries:

i) Countries with significant scientific and industrial base: viz Azerbaijan, Egypt, Indonesia, Iran, Jordan, Kazakhstan, Kuwait, Malaysia, Turkey, Uzbekistan

ii) Countries in which a fair scientific and industrial base exists viz Algeria, Bahrain, Bangladesh, Kyrgyzstan, Lebanon, Libya, Morocco, Nigeria, Oman, Pakistan, Qatar, Senegal, Sudan, Syria, Saudi Arabia, Tunisia, United Arab Emirates, Uganda, Yemen

iii) Countries with hardly any scientific and industrial base viz Afghanistan, Albania, Benin, Brunei Darussalam, Burkina Fasso, Cameroons, Chad, Comoros, Cote D'Ivoire, Djibouti, Gabon, Gambia, Guinea, Guinea Bissau, Guyana, Iraq, Maldives, Mali, Mauritania, Mozambique, Niger, Sierra Leone, Somalia, Surinam, Tajikistan, Togo, Turkmenistan

Thus, about half of the Islamic countries presently fall in the third category.

1.6. Some Possible Actions Needed

a) Countries with Significant Scientific and Industrial Base

Majority of these countries have approved national S&T policies and have national commission/board to supervise and review the implementation. They have well-established universities and R&D institutions, some of them of international repute. These countries spend around 0.1 to 0.7 per cent of their GNP on research and development activities. The entry into joint ventures with MNCs is benefiting in establishing consumer-goods industries, neglecting high-tech industries. It is also observed that, with the industrial achievements, there is less emphasis on basic research. These countries are progressing, thriving on the industrial base, coupled with efficient use of raw materials and technical manpower. Ample natural resources available be utilized efficiently and qualified manpower be developed to compete with newly industrialize countries. Following actions be taken in this direction.

i) Acquire world capabilities in scientific and technical research

ii) Double the total public and private allocations to sciences

iii) Generate emphasis on basic research and materials research

iv) Impose quality and productivity in industrial processes

v) More aid to universities, both scholarships for students and for research facilities

vi) Work of research institutions and development agencies be better financed and coordinated

vii) Stimulation of public interest in, and support of national initiatives in science and technology

b) Countries in which some scientific and Industrial base exists

These countries have developed educational institutions, research institutes and appropriate industries based on local and imported raw materials. These are functioning in isolation and much influenced by local geo-political situation and interventions. For instance, Pakistan has 111 universities and degree-awarding institutions, but none is listed among the highly productive universities in the region. Majority of R&D activity is concentrated on routine work and the research results are seldom applicable to industry. There is no effective coordination between university, research institutes and industry, thus encouraging trade imbalance, repetitive import of technologies and machinery and heavy dependence on imported raw materials for running agro-chemical, textile, steel and pharmaceutical industries. Although a National Science and Technology Policy was approved in Pakistan in 1984, later other relevant policies on technology and IT are operative but their role in industrialization is minimal. The scientific and industrial base has to be further strengthened, in collaboration with local industries, in order to accelerate production of quality products to compete in the international market and to reduce trade imbalances. The following proposals are submitted for consideration:

i) Development of national capabilities for the formation, implementation, and review of policies and plans concerning national S&T activities

ii) The percentage of budget allocated to basic research needs to be enhanced. The industrialized and newly industrialized countries spend from 12 to 25 percent of the R&D budget allocated to basic research in the entire R&D budget.

iii) Review of the existing system of technology transfer, to facilitate and encourage acquisition and absorption of modern technology by the industry

iv) Develop S&T scholarship programmes, to improve the qualifications of university teachers and researchers, so as to achieve national goals and improve quality of life of the people.

c) Countries with hardly any scientific and industrial base

These countries mainly survive on agriculture or forestry, and any natural calamity leads the large population to starvation, famine and migration to other countries. People suffer from malnutrition, disease and illiteracy. Foreign aid is utilized to benefit a few and these countries lack basic amenities and educational facilities. There are only a few schools and colleges and technical institutions, that too with few trained instructors and ill-equipped workshops. What is needed is:

i) Attempts to be made towards collection of statistics, on a regular basis, which may result in future planning on scientific basis

ii) Identify priority areas in agriculture-sector and utilization of agricultural products for developing agro-based industries.

iii) Increase the base of agricultural R&D to grow other food crops, instead of just concentrating on mono-crop production, and for adaptive research and extension services.

iv) As over 80 per cent of the population lives in the rural areas, integrated curriculum be developed, which may take into consideration the socio-economic situation and religious ethics, together with modern science and engineering subjects.

v) The rights of indigenous countries and national jurisdiction over biological diversity and traditional knowledge be maintained and protected, particularly from MNCs and seed companies.

vi) Enter into bilateral agreements with other Islamic countries for training of manpower, exchange of information and utilization of existing knowledge and material, instead of re-inventing the wheel.

vii) Establish a framework for the design, execution and evaluation of institution-building projects, depending upon the local endowment and expertise

Only ten countries amongst the Islamic countries fall under high development, the remaining 47, by and large, belong to low and medium development categories (Chapter 3 of the document). High development amongst Islamic countries does not necessarily indicate having proper development of S&T infrastructure. Nor does it mean that they are producers of processes and products based on new technologies. They are in fact consumers of high technology products and processes. Despite high HDI, and enviable economic indicators, especially in terms of high per capita GNP, the acceptable levels of S&T infrastructure are yet to be developed. In a majority of developing Islamic countries, the S&T infrastructure requires drastic improvement. This is limited by inherent weakness of financial resources. The three categories need a different plan for economic development, related with technological change. Certainly, a strong will for technological change is emerging in these countries.

Considering the above situation and the fact that more than half the Islamic countries have hardly any scientific and industrial base, it is proposed that the countries with established R&D institutes and universities may enter into agreements to assist these underdeveloped nations in improving S&T capability. Category one may offer scholarships for graduate and post-graduate students, in priority areas, from Category three countries. Also provide necessary expertise in formulating national science and technology policy and action plan for its implementation.

1.7. Some Thoughts on S&T Cooperation:

The future growth of S&T in Islamic Countries can best be achieved through bilateral and multilateral cooperation. The various organs of OIC, the Islamic Educational Scientific and Cultural Organization (ISESCO), the Islamic Development Bank (IDB), the OIC Standing Committee on Scientific and Technological

Cooperation (COMSTECH) and other organizations under OIC umbrella can be expected to play a very positive role in this regard, provided they are adequately strengthened through a collective effort of OIC member countries.

The document has deliberately attempted to focus on the present and the future, so that the document remains precise and succinct. Liberty has been taken in this document to reduce emphasis on classical technology so that Islamic countries should not spend unnecessary time on reinventing the 'wheel', and we can hope that new technological capability will enable the Islamic countries to adapt and use the new technological systems for accelerating growth in economic and social sectors. It is yet another matter whether to begin with downstream industries or with upstream industries. There is a possibility to go simultaneously for both upstream and downstream technological growth. This will, however, be dictated by the identification of "niche" markets, the availability of financial resources and a desirable ratio per thousand of S&T manpower (see Chapter 3).

In essence, it may be summarized from what has been stated in this overview that: (a) science, technology, intellectual capital, and innovation are historically in the genes of the peoples of Islamic countries; (b) The process of intellectual growth that led to the rise of "high science" between 7th and 14th centuries A.D. resulted from the elevation of high consciousness in men of faith which provided motivation for achievement. Power then was an accompaniment of these elements. The fall from this crest, represents a loss of these abilities, and (c) we need today to re-develop and combine these abilities.

The new technologies, their rapid dissemination, and the use of ensuing products and processes, based on intense investment in education, and combined with the fall of trade barriers, can give an unprecedented economic advantage to developed countries. The challenge for Islamic countries, the consumers of the new technology, is high but surmountable, if these countries are able to develop an implementable agenda based on the premise that technological change is an ally of socio-economic development. Indeed, plenty of natural resources are available (Chapter 2). A collective cooperative effort, integrated by ISESCO, IDB and COMSTECH, should provide the blueprint for change.

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HDI rank[a]	Human development index (HDI) value 2005	Life expectancy at birth (years) 2005	Adult literacy rate (% aged 15 and above) 1995-2005[b]	Combined gross enrolment ratio for primary, secondary and tertiary education (%) 2005	GDP per capita (PPP US$) 2005	Life expectancy index	Education index	GDP index	GDP per capita (PPP US$) rank minus HDI rank[c]
HIGH HUMAN DEVELOPMENT									
1 Iceland	0.968	81.5	..	95.4	36,510	0.941	0.978	0.985	4
2 Norway	0.968	79.8	..	99.2	41,420	0.913	0.991	1.000	1
3 Australia	0.962	80.9	..	113.0	31,794	0.931	0.993	0.962	13
4 Canada	0.961	80.3	..	99.2	33,375	0.921	0.991	0.970	6
5 Ireland	0.959	78.4	..	99.9	38,505	0.890	0.993	0.994	-1
6 Sweden	0.956	80.5	..	95.3	32,525	0.925	0.978	0.965	7
7 Switzerland	0.955	81.3	..	85.7	35,633	0.938	0.946	0.981	-1
8 Japan	0.953	82.3	..	85.9	31,267	0.954	0.946	0.959	9
9 Netherlands	0.953	79.2	..	98.4	32,684	0.904	0.987	0.966	3
10 France	0.952	80.2	..	96.5	30,386	0.919	0.982	0.954	8
11 Finland	0.952	78.9	..	101.0	32,153	0.898	0.993	0.964	3
12 United States	0.951	77.9	..	93.3	41,890	0.881	0.971	1.000	-10
13 Spain	0.949	80.5	..	98.0	27,169	0.925	0.987	0.935	11
14 Denmark	0.949	77.9	..	102.7	33,973	0.881	0.993	0.973	-6
15 Austria	0.948	79.4	..	91.9	33,700	0.907	0.966	0.971	-6
16 United Kingdom	0.946	79.0	..	93.0	33,238	0.900	0.970	0.969	-5
17 Belgium	0.946	78.8	..	95.1	32,119	0.897	0.977	0.963	-2
18 Luxembourg	0.944	78.4	..	84.7	60,228	0.891	0.942	1.000	-17
19 New Zealand	0.943	79.8	..	108.4	24,996	0.913	0.993	0.922	9
20 Italy	0.941	80.3	98.4	90.6	28,529	0.922	0.958	0.944	1
21 Hong Kong, China (SAR)	0.937	81.9	..	76.3	34,833	0.949	0.885	0.977	-4
22 Germany	0.935	79.1	..	88.0	29,461	0.902	0.953	0.949	-2
23 Israel	0.932	80.3	97.1	89.6	25,864	0.921	0.946	0.927	3
24 Greece	0.926	78.9	96.0	99.0	23,381	0.898	0.970	0.910	5
25 Singapore	0.922	79.4	92.5	87.3	29,663	0.907	0.913	0.950	-6
26 Korea (Republic of)	0.921	77.9	..	96.0	22,029	0.882	0.980	0.900	5
27 Slovenia	0.917	77.4	99.7	94.3	22,273	0.874	0.974	0.902	4
28 Cyprus	0.903	79.0	96.8	77.6	22,699	0.900	0.904	0.905	2
29 Portugal	0.897	77.7	93.8	89.8	20,410	0.879	0.925	0.888	6
30 Brunei Darussalam	0.894	76.7	92.7	77.7	28,161	0.862	0.891	0.941	-6
31 Barbados	0.892	76.6	..	88.9	17,297	0.861	0.956	0.860	8
32 Czech Republic	0.891	75.9	..	82.9	20,538	0.849	0.936	0.889	2
33 Kuwait	0.891	77.3	93.3	74.9	26,321	0.871	0.871	0.930	-6
34 Malta	0.878	79.1	87.9	81.1	19,189	0.902	0.856	0.877	3
35 Qatar	0.875	75.0	89.0	77.7	27,664	0.834	0.852	0.938	-12
36 Hungary	0.874	72.9	..	89.3	17,887	0.799	0.958	0.866	3
37 Poland	0.870	75.2	..	87.2	13,847	0.836	0.951	0.823	11
38 Argentina	0.869	74.8	97.2	89.7	14,280	0.831	0.947	0.828	9
39 United Arab Emirates	0.868	78.3	88.7	59.9	25,514	0.889	0.791	0.925	-12
40 Chile	0.867	78.3	95.7	82.9	12,027	0.889	0.914	0.799	15
41 Bahrain	0.866	75.2	86.5	86.1	21,482	0.837	0.864	0.896	-4
42 Slovakia	0.863	74.2	..	78.3	15,871	0.821	0.921	0.846	-1
43 Lithuania	0.862	72.5	99.6	91.4	14,494	0.792	0.965	0.831	3
44 Estonia	0.860	71.2	99.8	92.4	15,478	0.770	0.969	0.842	0
45 Latvia	0.855	72.0	99.7	90.2	13,646	0.784	0.961	0.821	4
46 Uruguay	0.852	75.9	96.8	89.4	9,962	0.849	0.942	0.768	16
47 Croatia	0.850	75.3	98.1	73.5	13,042	0.838	0.899	0.813	4
48 Costa Rica	0.846	78.5	94.9	73.0	10,180	0.891	0.876	0.772	13
49 Bahamas	0.845	72.3	..	71.8	18,380	0.788	0.875	0.870	-12
50 Seychelles	0.843	72.7	91.8	82.2	16,106	0.795	0.886	0.848	-9
51 Cuba	0.838	77.7	99.8	87.9	6,000	0.879	0.952	0.683	43
52 Mexico	0.829	75.6	91.6	75.6	10,751	0.843	0.863	0.781	7
53 Bulgaria	0.824	72.7	98.2	81.5	9,032	0.795	0.926	0.752	11

HDI rank		Human development index (HDI) value 2005	Life expectancy at birth (years) 2005	Adult literacy rate (% aged 15 and above) 1995-2005	Combined gross enrolment ratio for primary, secondary and tertiary education (%) 2005	GDP per capita (PPP US$) 2005	Life expectancy index	Education index	GDP index	GDP per capita (PPP US$) rank minus HDI rank
54	Saint Kitts and Nevis	0.821	70.0	97.8	73.1	13,307	0.750	0.889	0.815	-4
55	Tonga	0.819	72.8	98.9	80.1	8,177	0.797	0.926	0.735	15
56	Libyan Arab Jamahiriya	0.818	73.4	84.2	94.1	10,335	0.806	0.875	0.774	4
57	Antigua and Barbuda	0.815	73.9	85.8	..	12,500	0.815	0.824	0.806	-4
58	Oman	0.814	75.0	81.4	67.1	15,602	0.833	0.766	0.843	-15
59	Trinidad and Tobago	0.814	69.2	98.4	64.9	14,603	0.737	0.872	0.832	-14
60	Romania	0.813	71.9	97.3	76.8	9,060	0.782	0.905	0.752	7
61	Saudi Arabia	0.812	72.2	82.9	76.0	15,711	0.787	0.806	0.844	-19
62	Panama	0.812	75.1	91.9	79.5	7,605	0.836	0.878	0.723	15
63	Malaysia	0.811	73.7	88.7	74.3	10,882	0.811	0.839	0.783	-6
64	Belarus	0.804	68.7	99.6	88.7	7,918	0.728	0.956	0.730	8
65	Mauritius	0.804	72.4	84.3	75.3	12,715	0.790	0.813	0.809	-10
66	Bosnia and Herzegovina	0.803	74.5	96.7	69.0	7,032	0.825	0.874	0.710	17
67	Russian Federation	0.802	65.0	99.4	88.9	10,845	0.667	0.956	0.782	-9
68	Albania	0.801	76.2	98.7	68.6	5,316	0.853	0.887	0.663	30
69	Macedonia (TFYR)	0.801	73.8	96.1	70.1	7,200	0.814	0.875	0.714	11
70	Brazil	0.800	71.7	88.6	87.5	8,402	0.779	0.883	0.740	-9
MEDIUM HUMAN DEVELOPMENT										
71	Dominica	0.798	75.6	88.0	81.0	6,393	0.844	0.857	0.694	19
72	Saint Lucia	0.795	73.1	94.8	74.8	6,707	0.802	0.881	0.702	15
73	Kazakhstan	0.794	65.9	99.5	93.8	7,857	0.682	0.975	0.728	1
74	Venezuela (Bolivarian Republic of)	0.792	73.2	93.0	75.5	6,632	0.804	0.870	0.700	14
75	Colombia	0.791	72.3	92.8	75.1	7,304	0.788	0.869	0.716	4
76	Ukraine	0.788	67.7	99.4	86.5	6,848	0.711	0.948	0.705	9
77	Samoa	0.785	70.8	98.6	73.7	6,170	0.763	0.903	0.688	14
78	Thailand	0.781	69.6	92.6	71.2	8,677	0.743	0.855	0.746	-13
79	Dominican Republic	0.779	71.5	87.0	74.1	8,217	0.776	0.827	0.736	-10
80	Belize	0.778	75.9	75.1	81.8	7,109	0.848	0.773	0.712	1
81	China	0.777	72.5	90.9	69.1	6,757	0.792	0.837	0.703	5
82	Grenada	0.777	68.2	96.0	73.1	7,843	0.720	0.884	0.728	-7
83	Armenia	0.775	71.7	99.4	70.8	4,945	0.779	0.906	0.651	20
84	Turkey	0.775	71.4	87.4	68.7	8,407	0.773	0.812	0.740	-18
85	Suriname	0.774	69.6	89.6	77.1	7,722	0.743	0.854	0.725	-9
86	Jordan	0.773	71.9	91.1	78.1	5,530	0.782	0.868	0.670	11
87	Peru	0.773	70.7	87.9	85.8	6,039	0.761	0.872	0.684	5
88	Lebanon	0.772	71.5	..	84.6	5,584	0.775	0.871	0.671	8
89	Ecuador	0.772	74.7	91.0	..	4,341	0.828	0.858	0.629	21
90	Philippines	0.771	71.0	92.6	81.1	5,137	0.767	0.888	0.657	11
91	Tunisia	0.766	73.5	74.3	76.3	8,371	0.808	0.750	0.739	-23
92	Fiji	0.762	68.3	..	74.8	6,049	0.722	0.879	0.685	3
93	Saint Vincent and the Grenadines	0.761	71.1	88.1	68.9	6,568	0.768	0.817	0.698	-4
94	Iran (Islamic Republic of)	0.759	70.2	82.4	72.8	7,968	0.754	0.792	0.731	-23
95	Paraguay	0.755	71.3	93.5	69.1	4,642	0.771	0.853	0.641	15
96	Georgia	0.754	70.7	100.0	76.3	3,365	0.761	0.914	0.587	24
97	Guyana	0.750	65.2	..	85.0	4,508	0.670	0.945	0.636	12
98	Azerbaijan	0.746	67.1	98.8	67.1	5,016	0.702	0.882	0.653	4
99	Sri Lanka	0.743	71.6	90.7	62.7	4,595	0.776	0.814	0.639	7
100	Maldives	0.741	67.0	96.3	65.8	5,261	0.700	0.862	0.661	-1
101	Jamaica	0.736	72.2	79.9	77.9	4,291	0.787	0.792	0.627	11
102	Cape Verde	0.736	71.0	81.2	66.4	5,803	0.766	0.763	0.678	-7
103	El Salvador	0.735	71.3	80.6	70.4	5,255	0.772	0.772	0.661	-3
104	Algeria	0.733	71.7	69.9	73.7	7,062	0.778	0.711	0.711	-22
105	Viet Nam	0.733	73.7	90.3	63.9	3,071	0.812	0.815	0.572	18
106	Occupied Palestinian Territories	0.731	72.9	92.4	82.4	..	0.799	0.891	0.505	30

HDI rank		Human development index (HDI) value 2005	Life expectancy at birth (years) 2005	Adult literacy rate (% aged 15 and above) 1995-2005	Combined gross enrolment ratio for primary, secondary and tertiary education (%) 2005	GDP per capita (PPP US$) 2005	Life expectancy index	Education index	GDP index	GDP per capita (PPP US$) rank minus HDI rank
107	Indonesia	0.728	69.7	90.4	68.2	3,843	0.745	0.830	0.609	6
108	Syrian Arab Republic	0.724	73.6	80.8	64.8	3,808	0.811	0.755	0.607	7
109	Turkmenistan	0.713	62.6	98.8	..	3,838	0.627	0.906	0.609	5
110	Nicaragua	0.710	71.9	76.7	70.6	3,674	0.782	0.747	0.601	6
111	Moldova	0.708	68.4	99.1	69.7	2,100	0.724	0.892	0.508	25
112	Egypt	0.708	70.7	71.4	76.9	4,337	0.761	0.732	0.629	-4
113	Uzbekistan	0.702	66.8	..	73.8	2,063	0.696	0.906	0.505	25
114	Mongolia	0.700	65.9	97.8	77.4	2,107	0.682	0.910	0.508	21
115	Honduras	0.700	69.4	80.0	71.2	3,430	0.740	0.771	0.590	3
116	Kyrgyzstan	0.696	65.6	98.7	77.7	1,927	0.676	0.917	0.494	26
117	Bolivia	0.695	64.7	86.7	86.0	2,819	0.662	0.865	0.557	7
118	Guatemala	0.689	69.7	69.1	67.3	4,568	0.745	0.685	0.638	-11
119	Gabon	0.677	56.2	84.0	72.4	6,954	0.520	0.801	0.708	-35
120	Vanuatu	0.674	69.3	74.0	63.4	3,225	0.738	0.705	0.580	2
121	South Africa	0.674	50.8	82.4	77.0	11,110	0.430	0.806	0.786	-65
122	Tajikistan	0.673	66.3	99.5	70.8	1,356	0.688	0.896	0.435	32
123	Sao Tome and Principe	0.654	64.9	84.9	65.2	2,178	0.665	0.783	0.514	10
124	Botswana	0.654	48.1	81.2	69.5	12,387	0.385	0.771	0.804	-70
125	Namibia	0.650	51.6	85.0	64.7	7,586	0.444	0.781	0.723	-47
126	Morocco	0.646	70.4	52.3	58.5	4,555	0.757	0.544	0.637	-18
127	Equatorial Guinea	0.642	50.4	87.0	58.1	7,874	0.423	0.773	0.729	-54
128	India	0.619	63.7	61.0	63.8	3,452	0.645	0.620	0.591	-11
129	Solomon Islands	0.602	63.0	76.6	47.6	2,031	0.633	0.669	0.503	14
130	Lao People's Democratic Republic	0.601	63.2	68.7	61.5	2,039	0.637	0.663	0.503	11
131	Cambodia	0.598	58.0	73.6	60.0	2,727	0.550	0.691	0.552	-6
132	Myanmar	0.583	60.8	89.9	49.5	1,027	0.598	0.764	0.389	35
133	Bhutan	0.579	64.7	47.0	..	..	0.662	0.485	0.590	-14
134	Comoros	0.561	64.1	..	46.4	1,993	0.651	0.533	0.499	10
135	Ghana	0.553	59.1	57.9	50.7	2,480	0.568	0.555	0.536	-8
136	Pakistan	0.551	64.6	49.9	40.0	2,370	0.659	0.466	0.528	-6
137	Mauritania	0.550	63.2	51.2	45.6	2,234	0.637	0.493	0.519	-5
138	Lesotho	0.549	42.6	82.2	66.0	3,335	0.293	0.768	0.585	-17
139	Congo	0.548	54.0	84.7	51.4	1,262	0.484	0.736	0.423	16
140	Bangladesh	0.547	63.1	47.5	56.0	2,053	0.635	0.503	0.504	8
141	Swaziland	0.547	40.9	79.6	59.8	4,824	0.265	0.730	0.647	-37
142	Nepal	0.534	62.6	48.6	58.1	1,550	0.626	0.518	0.458	8
143	Madagascar	0.533	58.4	70.7	59.7	923	0.557	0.670	0.371	27
144	Cameroon	0.532	49.8	67.9	62.3	2,299	0.414	0.660	0.523	-15
145	Papua New Guinea	0.530	56.9	57.3	40.7	2,563	0.532	0.518	0.541	-19
146	Haiti	0.529	59.5	..	..	1,663	0.575	0.542	0.469	2
147	Sudan	0.526	57.4	60.9	37.3	2,083	0.540	0.531	0.507	-10
148	Kenya	0.521	52.1	73.6	60.6	1,240	0.451	0.693	0.420	9
149	Djibouti	0.516	53.9	..	25.3	2,178	0.482	0.553	0.514	-15
150	Timor-Leste	0.514	59.7	50.1	72.0	..	0.578	0.574	0.390	16
151	Zimbabwe	0.513	40.9	89.4	52.4	2,038	0.265	0.770	0.503	-9
152	Togo	0.512	57.8	53.2	55.0	1,506	0.547	0.538	0.453	-1
153	Yemen	0.508	61.5	54.1	55.2	930	0.608	0.546	0.372	16
154	Uganda	0.505	49.7	66.8	63.0	1,454	0.412	0.655	0.447	2
155	Gambia	0.502	58.8	..	50.1	1,921	0.563	0.461	0.493	-6
LOW HUMAN DEVELOPMENT										
156	Senegal	0.499	62.3	39.3	39.6	1,792	0.622	0.394	0.482	-6
157	Eritrea	0.483	56.6	..	35.3	1,109	0.527	0.521	0.402	6
158	Nigeria	0.470	46.5	69.1	56.2	1,128	0.359	0.648	0.404	4
159	Tanzania (United Republic of)	0.467	51.0	69.4	50.4	744	0.434	0.631	0.335	15

HDI rank	Human development index (HDI) value 2005	Life expectancy at birth (years) 2005	Adult literacy rate (% aged 15 and above) 1995–2005	Combined gross enrolment ratio for primary, secondary and tertiary education (%) 2005	GDP per capita (PPP US$) 2005	Life expectancy index	Education index	GDP index	GDP per capita (PPP US$) rank minus HDI rank
160 Guinea	0.456	54.8	29.5	45.1	2,316	0.497	0.347	0.524	-30
161 Rwanda	0.452	45.2	64.9	50.9	1,206	0.337	0.602	0.416	-4
162 Angola	0.446	41.7	67.4	25.6	2,335	0.279	0.535	0.526	-33
163 Benin	0.437	55.4	34.7	50.7	1,141	0.506	0.400	0.406	-2
164 Malawi	0.437	46.3	64.1	63.1	667	0.355	0.638	0.317	13
165 Zambia	0.434	40.5	68.0	60.5	1,023	0.259	0.655	0.388	3
166 Côte d'Ivoire	0.432	47.4	48.7	39.6	1,648	0.373	0.457	0.468	-17
167 Burundi	0.413	48.5	59.3	37.9	699	0.391	0.522	0.325	9
168 Congo (Democratic Republic of the)	0.411	45.8	67.2	33.7	714	0.346	0.560	0.328	7
169 Ethiopia	0.406	51.8	35.9	42.1	1,055	0.446	0.380	0.393	5
170 Chad	0.388	50.4	25.7	37.5	1,427	0.423	0.296	0.444	-17
171 Central African Republic	0.384	43.7	48.6	29.8	1,224	0.311	0.423	0.418	-10
172 Mozambique	0.384	42.8	38.7	52.9	1,242	0.296	0.435	0.421	-16
173 Mali	0.380	53.1	24.0	36.7	1,033	0.469	0.282	0.390	-8
174 Niger	0.374	55.8	28.7	22.7	781	0.513	0.267	0.343	-3
175 Guinea-Bissau	0.374	45.8	..	36.7	827	0.347	0.421	0.353	-4
176 Burkina Faso	0.370	51.4	23.6	29.3	1,213	0.440	0.255	0.417	-17
177 Sierra Leone	0.336	41.8	34.8	44.6	806	0.280	0.381	0.348	-5
Developing countries	0.691	66.1	76.7	64.1	5,282	0.685	0.725	0.662	..
Least developed countries	0.488	54.5	53.9	48.0	1,499	0.492	0.519	0.452	..
Arab States	0.699	67.5	70.3	65.5	6,716	0.708	0.687	0.702	..
East Asia and the Pacific	0.771	71.7	90.7	69.4	6,604	0.779	0.836	0.699	..
Latin America and the Caribbean	0.803	72.8	90.3	81.2	8,417	0.797	0.873	0.740	..
South Asia	0.611	63.8	59.5	60.3	3,416	0.646	0.598	0.589	..
Sub-Saharan Africa	0.493	49.6	60.3	50.6	1,998	0.410	0.571	0.500	..
Central and Eastern Europe and the CIS	0.808	68.6	99.0	83.5	9,527	0.726	0.938	0.761	..
OECD	0.916	78.3	..	88.6	29,197	0.888	0.912	0.947	..
High-income OECD	0.947	79.4	..	93.5	33,831	0.906	0.961	0.972	..
High human development	0.897	76.2	..	88.4	23,986	0.854	0.922	0.915	..
Medium human development	0.698	67.5	78.0	65.3	4,876	0.708	0.738	0.649	..
Low human development	0.436	48.5	54.4	45.8	1,112	0.391	0.516	0.402	..
High income	0.936	79.2	..	92.3	33,082	0.903	0.937	0.968	..
Middle income	0.776	70.9	89.9	73.3	7,416	0.764	0.843	0.719	..
Low income	0.570	60.0	60.2	56.3	2,531	0.583	0.589	0.539	..
World	0.743	68.1	78.6	67.8	9,543	0.718	0.750	0.761	..

CHAPTER 2

BUILDING UP AND DEVELOPMENT OF HUMAN CAPITAL IN ISLAMIC COUNTRIES

2.1. Survey of H.D.I. Report

In a world that is undergoing rapid structural changes, the importance of human capital development (relating to the nurturing and expanding of the human potential and capability) for a nation's economic growth, cannot be denied. Traditional drivers of growth and wealth-creation, for example, have changed from commodities to knowledge, from the tangible to the intangible, whereas land, labor and capital have been replaced by knowledge, technology and innovation. To achieve sustainable socio-economic development in today's world requires nations to have the ability to harness existing knowledge; to create and innovate new technologies; and to utilize productive, cost-saving technologies, such as, information and communications technologies (ICTs).

However, for science, technology, innovation to contribute effectively to sustainable development, countries require basic scientific skills and expertise. The economic success of the developed countries is largely attributed to the sustained and enduring investments that economically advanced countries have made in building their educational, scientific and technological(S&T) capacity. The ability to do so depends largely on the quantity and quality of human capital available in a country. Human capital represents the knowledge, potential, drive, skills and all other essential attributes that are embodied in individuals. Thus, the most important prerequisites to meeting the challenges of the 21st century lies in human capital development i.e. the continuous enhancement of people's knowledge, skills and values.

According to UNDP's Human Development Report (2007-2008), the countries of the globe have been categorized at 3 levels of human development:

- High Human Development
- Medium Human Development
- Low Human Development.

In the Islamic world only 10 countries have been placed amongst countries with 'high human development' (HDI equal to or greater than 0.800).These include: Brunei Darussalam, Kuwait, Bahrain, Qatar, United Arab Emirates, Libyan Arab Jamhuriya, Oman, Saudi Arabia, Malaysia, Bosnia and Herzegovina. In most of these countries, high human development is essentially due to abundant natural resources, such as oil and gas. This has enabled them to invest heavily in the social sector, and thus raise the quality of life of their populations. Yet, there is very little in these countries that exists in the form of a strong S&Tinfrastructure. Even universities and research institutes cannot claim a pervasive excellence, as in other high human development countries. They are high consumers of borrowed technology, which they can afford to purchase even at high cost. This situation is no different for Islamic countries placed in the category of "medium human development". This comprises a group of 24 countries.

Some countries that belong to this group include Kazakhstan, Turkey, Jordan, Lebanon, Iran, Pakistan, Tunisia, Algeria, Indonesia, Egypt and Morocco. Table 2.1 shows the HDI data for all Islamic countries.

The majority of Islamic countries have been placed in the category of 'low human development' (HDI less than 0.500). Since economic development is partly linked with human development, therefore, it is indicative of low economic development and marginally developed S&T infrastructure. The majority of African countries belong to this group (Table 2.1), a clear indication that these countries lack political will and commitment to improve or build up their human capital or improve S&T for science-led development. These countries need to make a serious and sincere effort to improve this situation. The countries in the middle and low human development categories have a long way to go in achieving the world average. It appears from the data of Table 2.2 that the low human development Islamic countries of Asia, Middle East and Africa have rather inadequate economies for investment in human development (see also annexed Table I). The African group of Islamic countries is amongst the most deprived, as described in the Human Development Report (2007) on the basis of Human Poverty Index (HPI).

2.2. Ways of Development of Human Capital in Islamic Countries:

Development in most Muslim countries is being hindered mainly by the low priority accorded to the development of human capital, i.e. human skills and capacities. Although some countries of the Islamic world are among the richest nations in the world, yet poverty and illiteracy still prevail in many parts of the Islamic world, thus making them dependent on foreign assistance. Serious political, economic and social problems have further worsened the situation. This is why the majority of Muslim countries continue to be technologically backward and invest little in education, especially in science and technology.

Although in some cases the need for human capital development is now more readily recognized, than before, however a lack of appropriate methods and policies to be adopted for human capital development, hinders the progress in this direction. Indeed, there is an urgent need for countries to identify appropriate strategies for human capital development in this highly competitive global marketplace. Whatever the details may be, it is generally accepted that, for real progress, these policies should be based on the triple theme of "faith, values and goals".

2.3. Human Capital Development in the Agro-based Countries:

As indicated in Table 2.2, the Human Poverty Index (HPI) for Africa is 44.38%, for Asia it stands at 20.34% and for the Arab States it is in the vicinity of 20.33%. These data do have some correlation with HDI, and per-capita GNP. For African countries these are discouraging indicators for S&T growth. In fact, one leads to the other and vice-versa. In subsequent Chapters an argument has been developed that judicious investment in S&T manpower and R&D can cause rapid economic growth and thus human development. In Islamic countries, except for the oil-rich economies, other economic indicators also show a general deprivation in health, education, and literacy-ratios, as well as women's development. These imbalances are reflected in the low human-development of African countries and a number of Asian Islamic countries. Inspite of several negative indications, there are a number of choices available to Islamic countries for accelerating the process of economic development. The data given in Table 2.3 provides information about the vast natural resources of arable, "irrigable" land and the percentage of its utilization for production. The African Islamic countries have a land area of 840 million hectares. Of this, 14.35% (2003) only 3.5% is used for agricultural production. On the whole, the contribution of agriculture to national income in these countries is 36.37% (2005). This is a significant portion of GDP in these countries, and the best results can be obtained by the application of biotechnologies of farming and food-systems to their agriculture.

2.4. Applied Research and Technology as a Tool for Development

This aspect, with other alternatives, is discussed in Chapter 5.For these Islamic countries, the imperatives are obvious, namely, economic planning for development, combined with technological advancement in those "niche" areas that are relevant to (a) basic needs area of food (biotechnology), health-services, and (b) to industrial production sector, preferably in the downstream sector, which may enable them to build further on technology-capability.

In doing so, essential elements of applied research must be identified, and developed carefully, either from within or in collaboration with sister Islamic countries, for maximum economic utilization of natural resources. The existing natural resources in the Islamic countries are in abundance. The case of oil rich countries calls for re-examination for investment in energy-related S&T research, defense R&D, and even in some new technologies. These aspects are discussed elsewhere.

References:

1. Human Development Report, UNDP, 2007 / 2008
2. http://www.studentsoftheworld.info/infopays/rank/PNB1.html
3. www.sesrtcic.org (Special Reports of Selected Indicators) Data is Latest by 2002

Table 2.1: Values of Human Development Index (HDI) and HDI Rank of Islamic Countries

Countries	HDI Rank	H.D.I Value	HDI Rank	H.D.I Value
African Countries	**1997**	**1997**	**2005**	**2005**
Benin	155	0.421	163	0.437
Burkina Faso	171	0.304	176	0.370
Cameroon	134	0.536	144	0.532
Chad	162	0.393	170	0.388
Comoros	139	0.506	134	0.561
Gabon	124	0.607	119	0.677
Gambia	163	0.391	155	0.502
Guinea	161	0.398	160	0.456
Guinea Bissau	168	0.343	175	0.374
Mali	166	0.375	173	0.380
Mozambique	169	0.341	172	0.384
Niger	173	0.298	174	0.374
Nigeria	146	0.450	158	0.470
Senegal	153	0.426	156	0.499
Sierra Leone	174	0.254	177	0.336
Uganda	158	0.404	154	0.505
Zanzibar(1)	156	0.421		
				0.453
Arab Countries				
Algeria	109	0.665	104	0.733
Bahrain	37	0.832	41	0.866
Djibouti	157	0.412	149	0.516
Egypt	120	0.616	112	0.708
Iraq	125	0.586	-	-
Jordan	94	0.715	86	0.773
Kuwait	35	0.833	33	0.891
Lebanon	69	0.749	88	0.772
Libya	65	0.756	56	0.818
Mauritania	149	0.447	137	0.550
Morocco	126	0.582	126	0.646
Oman	89	0.725	58	0.814
Palestine	-	-	106	0.731
Qatar	41	0.814	35	0.875
Saudi Arabia	78	0.740	61	0.812
Somalia	-	-		
Sudan	142	0.475	147	0.526
Syria	111	0.663	108	0.724
Tunisia	102	0.695	91	0.766
UAE	43	0.812	39	0.868
Yemen	148	0.449	153	0.508
Average				

Asian Countries				
Afghanistan	-	-		
Azerbaijan	103	0.695	98	0.746
Bangladesh	150	0.440	140	0.547
Brunei Darussalam	25	0.878	30	0.894
Indonesia	105	0.681	107	0.728
Iran	95	0.715	94	0.759
Kazakhstan	76	0.740	73	0.794
Kyrgyzstan	97	0.702	116	0.696
Malaysia	56	0.768	63	0.811
Maldives	93	0.716	100	0.741
Pakistan	138	0.508	136	0.551
Tajikistan	108	0.665	122	0.673
Turkey	86	0.728	84	0.775
Turkmenistan	96	0.712	109	0.713
Uzbekistan	92	0.720	113	0.702

MISSING DATA: 1. Zanzibar(1), 2. Palestine, 3. Somalia, 4 Afghanistan, 5. Iraq

Table 2.2: Population, Gross National Product (GNP) and Human Poverty Index (HPI) of Islamic Countries - 2005

Countries	Population (in million) 2005		Human Poverty Index (HPI-1)	
African countries	Rank	Value	Rank	Value in %
Benin	163	8.5	100	47.6
Burkina Faso	176	13.9	106	55.8
Cameroon	144	17.8	64	31.8
Chad	170	10.1	108	56.9
Comoros	134	0.8	61	31.3
Gabon	119	1.3	49	20.4
Gambia	155	1.6	94	40.9
Guinea	160	9.0	103	52.3
Guinea Bissau	175	1.6	99	44.8
Mali	173	11.6	107	56.4
Mozambique	172	20.5	101	50.6
Niger	174	13.3	104	54.7
Nigeria	158	141.4	80	37.3
Senegal	156	11.8	97	42.9
Sierra Leone	177	5.6	102	51.7
Uganda	154	28.9	72	34.7
Zanzibar(1)	-	-	-	-
Average				**44.38**
Arab Countries				
Algeria	104	32.9	51	21.5
Bahrain	41	0.7	-	-
Djibouti	149	0.8	59	28.5
Egypt	112	72.8	48	20
Iraq	-	-	-	-
Jordan	86	5.5	11	6.9
Kuwait	33	2.7	-	-
Lebanon	88	4.0	18	8.5
Libya	56	5.9	-	-
Mauritania	137	3.0	87	39.2
Morocco	126	30.5	68	33.4
Oman	58	2.5	-	-
Palestine	106	3.8	9	6.6
Qatar	35	0.8	13	7.8
Saudi Arabia	61	23.6	-	-
Somalia	-	-	-	-
Sudan	147	36.9	69	34.4
Syria	108	18.9	31	13.6
Tunisia	91	10.1	45	17.9
UAE	39	4.1	17	8.4
Yemen	153	21.1	82	38
Average				**20.34**

Asian Countries						
Afghanistan	-	-	-	-	6.96	222
Azerbaijan	98	8.4	-	-	10.4	1241
Bangladesh	140	153.3	93	40.5	66.2	467
Brunei Darussalam	30	0.4	-	-	8.54	21675
Indonesia	107	226.1	47	18.2	282	1279
Iran	94	69.4	30	12.9	187	2771
Kazakhstan	73	15.2	-	-	44.4	2942
Kyrgyzstan	116	5.2	-	-	2.29	445
Malaysia	63	25.7	16	8.3	126	4963
Maldives	100	0.3	42	17	0.79	2401
Pakistan	136	158.1	77	36.2	107	689
Tajikistan	122	6.6	-	-	2.18	335
Turkey	84	73.0	22	9.2	342	4704
Turkmenistan	109	4.8	-	-	6.63	1371
Uzbekistan	113	26.6			13.5	508
Average				20.33		
Total Islamic Countries		1328.4			2446.85	188140

MISSING DATA: 1. Zanzibar(1), 2. Somalia, 3, Afghanistan, 4.

Source:

Human Development Report, UNDP, 2007 / 2008 page 243-246 (**Population**)

Human Development Report, UNDP, 2007 / 2008 page 238-240 (**HPI**)

http://www.studentsoftheworld.info/infopays/rank/PNB1.html (**GNP US$ Billion**)

http://www.studentsoftheworld.info/infopays/rank/PNBH1.html (**GNP PER Capti US$**)

Table 2.3: Arable and Irrigated Land and Agricultural Production in Islamic Countries

Countries	Land					Agricultural Production as % GDP 2005	Products and Services Imports as % GDP 2005
	Area (1,000 Ha)	Arable as % Area		Irrigated as % Area			
African Countries		1970	2003	1970	2003		
Benin	11 262.00	12.7	23.53	0.70	0.35	36	26.11
Burkina Faso	27 400.00	13.00	17.66	0.60	0.23	27	--
Cameroon	47 544.00	12.50	12.54	0.40	0.28	22	25.38
Chad	128 400.00	2.50	2.80	0.40	0.06	34	39.49
Comoros	223.00	35.00	35.87	--	--	40	34.72
Gabon	26 767.00	1.10	1.21	1.40	0.14	8	22.89
Gambia	1 130.00	15.90	27.88	8.30	0.26	32	65.39
Guinea	24 586.00	2.5	4.47	15.20	0.76	24	30.42
Guinea Bissau	3 612.00	8.30	8.31	5.70	1.53	57	50.78
Mali	124 019.00	2.00	3.87	3.10	0.60	36	37.99
Mozambique	80 159.00	3.70	5.43	4.00	0.24	22	41.48
Niger	126 700.00	2.80	11.43	1.80	0.19	44	24.27
Nigeria	92 377.00	32.30	33.02	3.20	0.39	33	35.93
Senegal	19 672.00	11.80	12.50	3.00	1.47	15	41.65
Sierra Leone	7 174.00	6.80	7.94	6.00	1.05	51	41.83
Uganda	24 104.00	21.40	21.57	0.20	0.07	33	27.16
Zanzibar(1)	94 509.00	3.20	--	5.00	--	--	--
Total	839,638.00	11.03	14.38	3.47	0.51	32.12	36.37

Arab Countries							
Algeria	238 174.00	3.10	3.17	7.60	1.42	8	23.6
Bahrain	68.00	1.50	2.94	--	40.00	1	--
Djibouti	2 320.00	--	0.04	--	0.06	4	53.5
Egypt	100 145.00	2.40	2.90	--	100.00	13	32.61
Iraq	43 832.00	12.00	13.12	48.60	35.18	8	78.30
Jordan	8 921.00	3.50	1.97	20.00	7.47	2	93.40
Kuwait	1 782.00	0.30	0.84	40.00	8.44	0	30.35
Lebanon	1 040.00	20.80	16.35	39.80	31.61	6	45.12
Libya	175 954.00	1.00	1.03	25.90	3.04	5	--
Mauritania	102 552.00	0.20	0.48	23.90	0.12^	21	95.71
Morocco	44 655.00	20.70	19.00	13.60	4.76	16	44.33
Oman	21 246.00	0.10	0.17	--	6.67	2	--
Palestine	--	--	--	--	--	--	68.19
Qatar	1 100.00	0.60	1.64	--	18.31^	0	33.45
Saudi Arabia	214 969.00	1.70	1.67	11.90	0.93	5	26.39
Somalia	63 766.00	1.60	1.64	18.00	0.45	60	1.68
Sudan	250 581.00	5.10	6.78	15.10	1.38	46	27.61
Syria	18 518.00	27.60	25.16	17.70	9.20	25	--
Tunisia	16 361.00	18.30	17.05	12.90	4.03	13	50.64
UAE	8 360.00	0.30	0.76	17.20	13.60	3	76.31
Yemen	52 797.00	2.60	2.91	26.20	3.10	14	--
Total	**1 367**	**6.49**	**5.98**	**22.56**	**14.49**	**14.00**	**48.82**
Asian Countries							
Afghanistan	65 290.00	12.10	12.11	37.90	7.15	35	55.6
Azerbaijan	8 660.00	18.50	21.23	62.50	30.60	10	52.87
Bangladesh	14 400.00	65.60	55.37	32.80	52.39	22	23.05
Brunei Darussalam	577.00	0.50	2.25	33.00	4.17	3	27.29
Indonesia	190 457.00	9.90	12.08	24.30	9.45	13	28.63
Iran	164 800.00	10.00	10.24	56.50	12.14	11	30.16
Kazakhstan	271 730.00	12.70	8.30	6.40	1.71	8	44.63
Kyrgyzstan	19 850.00	3.50	6.77	7.10	9.89	34	56.78
Malaysia	32 975.00	3.20	5.46	32.70	4.64	8	99.86
Maldives	30.00	3.30	13.33	10.00	--	9	111.44
Pakistan	79 610.00	26.10	27.10	82.30	66.95	22	19.32
Tajikistan	14 310.00	5.70	6.50	78.90	16.97	28	72.77
Turkey	77 945.00	31.40	29.98	15.00	12.83	10	33.98
Turkmenistan	48 810.00	2.90	4.51	92.90	5.46	23	47.79
Uzbekistan	44 740.00	9.20	10.50	97.60	15.70	33	28.66
Total	**1,034,184.00**	**14.31**	**15.05**	**44.66**	**17.86**	**17.93**	**48.85**
Grand Total (Islamic Countries)	**3,240,963.00**						

Source:

www.sesrtcic.org (Special Reports of Selected Indicators)

^ Data is Latest by 2002

CHAPTER 3

PRESENT STATUS OF S&T IN ISLAMIC COUNTRIES

3.1. Introduction

Economic development rests mainly on an S&T base and its application to the major sectors of Agriculture, Transport, Industry, Education, Health and Environment. The genesis of this recognition is easily traced to the existence of a world-wide distinction between the developed and the developing nations, based largely on the state of their S&T and technical manpower development. It, however, is also a practical reality that, given the political will and ingredients of optimum S&T inputs, the developing countries can initiate and then strengthen their economic growth. In this connection, the examples of Germany in Europe and of Japan and Korea in Asia can be cited.

Inspite of this, however, it is another stark reality that the Muslim countries belong to the slowly developing region of the world, although they have been trying to implement their development plans for the past one or two decades, but with little success. Because, of this, considerable concern has been shown in recent years and these countries now have started, though late, to take stock of the situation. For obvious reasons the realization is a welcome sign, but the task ahead is gigantic. The two important elements of this "prosperity prescription", the skilled manpower (particularly the R&D manpower) and the expenditure for R&D are unfortunately in short supply throughout the Muslim world.

3.2. S&T Components

The Islamic countries comprising 57 independent states and stretching from Indonesia to Morocco, have a total population of over 1.2 billion, out of 6.176 billion of the world population. On an average, only 55% of this population is fully literate, although in the individual countries this figure will be variable.

The world devoted 1.7% of its gross domestic expenditure to research and development (GERD) in 2002 and GERD per inhabitant is $134.4. The United States spends 2.8% of GDP on R&D and GERD per inhabitant is $ 1005.9; for developing countries this percentage is less than one and per inhabitant it is only $42.8. Just for comparison, Egypt spends 0.2 of GDP and GERD per inhabitant is $6.6. (Table 1 for 2002, from Unesco Science Report 2005, page 4). This shows a wide range of funding level for research and development in different countries. Particularly, it is very low in the Islamic countries, with hardly any scientific and industrial base. The recommendations put forward by various UN agencies and the OIC organizations to allocate at least 1% of GNP for spending on scientific and technological development has not been achieved by any of the Islamic countries.

The researchers per million inhabitants are 894.0 on the world basis, whereas for developed countries the figure is 3272.7, for developing countries it is 374.3 and for least developed countries it is as low as 4.5 (for USA it is 4373.7). For Bangladesh it is 51 while for Egypt, it is 493 per million population. Average for

Arab states is 116. This shows that the S&T base in Islamic countries rests on relatively few numbers of S&T manpower. (Table 2 for 2002 from UNESCO Science Report 2005 p.6)

Further the private-sector industries are contributing lion's share to national R&D in the developed countries. For instance the US industry funded 66% and performed 72% of R&D in the year 2000. The newly industrialized countries now spend 40-60% of total expenditure on R&D, the rest being shared by the private-sector industries. In the Islamic countries, the major burden is still on the governmental R&D institutions and public sector organizations.

It is evident that the developed countries are advancing and making further progress through engagement of large numbers of researchers and investing higher percentage of GNP on research and development. Review of these facts and figure reveals that most of the Islamic countries have a weak R&D base that needs considerable strengthening for R&D, in order to become the basis of indigenous development.

3.3. Comparative Study of S&T/R&D Manpower

Some of the selected Muslim countries, which are at various stages of industrial development, include Bangladesh, Egypt, Indonesia, Iran, Iraq, Jordan, Malaysia, Nigeria, Pakistan, Sudan and Turkey. Considerable data about these countries is available from various sources, including UNESCO Year Books. The S&T and R&D statistics for these countries are summarized in Table 3.3 and 3.4. Inspite of some visible improvement in the numerical strength during the last two decades, the whole infrastructure is still grossly inadequate and not commensurate with the internationally recommended standards for a desirable economic and technological growth. The researchers per million inhabitants are extremely low in all the Islamic countries, as compared to advanced countries, e.g. USA - 4,373, Germany - 3,208.5 and Japan 5,084.9

3.4. R&D Culture and Environment

R&D culture and appropriate environment is lacking in most of the Islamic countries. This is evident from the small number of research publications in international journals coming out from these countries. This is also due to lack of Government support for the research scientists. The expenditure on R&D as percentage of GNP in Islamic countries is also much smaller than the world average (Table 3.5). It varies from 0.1 to 0.7% of GNP, whereas advanced countries are spending over 2.5% of GNP on R.D. The civil and military servants have much better status than the scientists and engineers, as against the advanced countries where respect for research and scholarship is very high among the Government, and even the common man has a very high esteem for a Professor. Of course, the output of research publications is much higher for the advanced countries and all this stems from a conducive culture for research in these countries. It is an eye opener to see that the share of journal publications from all the Muslim countries put together is less than the share of journal publications of only one small European country - Belgium.

Another indicator of advancement in the science and technology sector is the number of scientific publications. The total scientific publications worldwide was 598,447 in 2001 as compared to 455315 in 1991. The developed countries shared 92.31% of total publications. USA contributed 32.79 of total scientific publications, Japan 10.8%, UK 9.3% and Egypt 0.3% of world share of scientific publications (Figure 3.1. for 2001 from Unesco Science Report 2005 p.9. and Status of Scientific Research in OIC member states 2005, COMSTECH). The total number of scientific papers published in few selected Islamic Countries for ten years passed (1995-2005) is given in Table 3.5. Turkey published largest number of papers numbering 82,407, followed by Iran (19,114) and least number of papers published during the ten year period is assigned to Somalia (22) and Afghanistan (55)

There is a clear dependence of the economic prosperity of a country on the state of development of S&T of that country with, of course, the exception of those few countries where the natural resources (oil) are excessive. This in turn shows the importance of R&D manpower in the realm of S&T, as well as the expenditure on R&D in Science and Technology sector related to the economic welfare of the people.

3.5. Trained S&T Manpower

A quick look at the data provided in the annexed Table II shows that most of the Muslim countries have sub-critical levels of S&T manpower. The Muslim World, with a population of over one billion, has only 650 universities, some of which are at the initial stages of their establishment and are no more than upgraded colleges. Taken together, the universities of the Islamic World do not produce more than 4,000 Ph.Ds per year. The number of scientists per million of population is far below the average of developed countries (3,270 or more) and even those of some developing countries.

A number of studies have been carried out by various authors on the basis of available data on S&T manpower, R&D expenditure, S&T publications and S&T institutions. Although the figures are dismally low, when compared with western countries, the situation has in some ways improved during the last 20 years. On the basis of the developmental needs of the Islamic World upto the year 2020 AD, it has been recommended that the Islamic World should have at least 10 million scientists and engineers, of whom 10% should be engaged in R&D activities.

3.6. Scientific and Technical Education

Scientific and technical education is by far the most important factor that influences growth and development of a country. However, in the majority of Islamic countries the quality of education imparted at various levels (primary, secondary and tertiary and university) is abysmally weak. The teaching of science should aim at developing a rational and critical aptitude for observation of natural phenomena; to inculcate mental skills to develop theories of natural phenomena based on the observed data; and to enable persons to build on previous knowledge and work collaboratively for unraveling the laws of nature.

It is necessary to make primary education compulsory and free, as far as possible so as to achieve universal enrollment by the years 2020. Integrated curricula (including Islamiyat and Science) be introduced and teachers be trained, with emphasis on new methods, practical work and group approach.

Large numbers of students in the rural areas are well versed in indigenous learning including Quran and Sunnah, and the only have to be trained in basic science education.

While primary and secondary education should be compulsory for all, college and university education should be highly selective, so that the most talented are allowed higher education. Vocational and technical disciplines, such as electronics, refrigeration, carpentry, motor mechanics, computer, should be made compulsory at matriculation and intermediate college levels, so that persons after passing matric or intermediate are capable of earning their living. For example, Pakistan has 28 Polytechnics and 7 mono-tech with a combined capacity of training about 17500 sub-professionals in diploma courses and 17000 in B.Tech. courses. There should be further increase in these institutions with improvement in instruction.

The Islamic countries with hardly any scientific and industrial base may establish contact with other advanced Muslim countries, for assistance in the following areas:

1. developing integrated curricula, with emphasis on science education and Islamic teaching
2. revision of curricula to make compatible with demands of new knowledge.
3. establishment of vocational training institutes for producing qualified technicians
4. exchange of students and teachers program
5. training of teachers in vocational subjects, according to the area-specific needs.

3.7. University Education

Universities are fountains of knowledge, education, scholarship, research and technology development, but in the majority of Islamic countries, they are concentrating to impart education only and that too on a limited scale. For instance, there are 111 universities and degree-awarding institutions in Pakistan (57 in public sector and 54 in private sector) but none ranks in the world-class institution. The widespread malaise of our universities is directly attributable to the poor preparation for both teaching and research, which adversely affects the quality of instructions, as well output of research. The teachers and researchers must be provided with more working facilities and incentives to improve educational qualifications. University teachers should be encouraged to actively participate in research activity and devote at least 1/3rd of their time to research. It is also important that the technical colleges and professional universities, as well as scientific and technical departments in general universities, be closely linked with the specialized research institutes and the industry, so as to help develop improved technologies and products. New science and technology facilities be created to provide appropriate opportunities for continuing higher education. By creating attractive conditions for highly trained personnel, Muslim countries can incite their human capital to stay home, or return, and contribute to the development of their country or region. Islamic countries, with significant scientific and industrial base, may provide the following facilities to other Islamic countries.

1. Provide post-graduate education in selected fields of interest to the less developed countries
2. Embark on joint research programme, utilizing the expertise and research facilities.
3. Take long-term assignment for teaching in new and emerging technologies.
4. Invite the researchers to present papers in the international conferences/ seminars.
5. Provide work-place, to utilize the highly sophisticated equipment for research.

From the Unesco Publication, where literacy and enrolment data is given, it appears that at least a fourfold increase will be required to catch up with the present position of the industrialized nations in a reasonable period of say twenty years. The culture of merit must be enforced in all disciplines. The university level should then be judged, in addition to the internal meritable assessment, with high international-level assessment of the students particularly the Ph.D awardees. To produce such quality R&D manpower, we need to make judicious calculation for the number of Ph.D's required. In the advanced countries the number is about 3,000 Ph.Ds per million population and it is quite logical that we in the Islamic countries should aim at the same number if we need to develop to those standards. With this number per million for the Ummah we would need about 3.5 million Ph.Ds and we should aim at producing this manpower in say 15 to 20 years. For producing this manpower we shall need more universities and we may aim at about 1 university per million population. Most of the Muslim countries, particularly with larger population have much lesser universities.

3.8. S&T Education for Women

Scientific and technical education for women is another significant aspect of this problem. Higher education for Muslim women in Science and Technology could provide productive or economic benefit to society as well as other long-term benefit. It could ensure that these members of the Ummah, forming half the adult population, who spend so much time with children, should be able to instill in the younger generation not only the usual qualities of character but also genuine and sound respect for knowledge and learning, together with the necessary motivation for acquiring such knowledge. Efforts should be made to train and induct a larger number of women into S&T occupations, particularly in R&D establishments. Scholarship programmes be introduced for talented women to obtain scientific and technical education and training.

3.9. Brain Drain

While brain-drain is a phenomenon affecting the developing countries in general, by a continuous loss of technical and scientific manpower to the developed countries, this phenomenon has been affecting the Muslim countries very seriously. During the last 20 years, countries like Pakistan, Egypt, Iran, Syria, Bangladesh, Turkey, Algeria, Lebanon and Jordan have lost a considerable number of high-level highly trained personnel, including scientist and researchers, to the industrialized world which can mean losses in economic terms of many billion of dollars. Other less developed Muslim countries are being added to this list, and sooner or later the phenomenon will affect almost all the Muslim world.

One can estimate the number of people with high-level competence that have migrated from the Third World to the industrialized world, during the last two decades, at about 1000,000. The majority has gone to the USA, and a great many to Western Europe, Canada and Australia. Asia has contributed 55% of this loss. Among the biggest losers of the Muslim World in Asia are three countries: Iran, Pakistan and Turkey; while the three biggest losers in the Arab group are: Syria, Jordan and Lebanon. Pakistan, for instance, has been losing about 60% of all medical practitioners from every year's graduates, while Iran and Syria have been losing about 40% and 30% respectively. The losses of the African group have been directed more specifically towards Western Europe. Starting in 1975, about one-third highly competent North African manpower has migrated to France. For example, it is noted that in African countries, most science teachers are white French, while the majority of indigenous engineers and scientists have left to work abroad.

There is a gross misperception that higher salaries offered to high-level educationists, and scientists is the motive force to make them migrate to the advanced/industrialized countries. A favourable research-environment, recognition of achievements and proper career-structure are all favourable factors pertaining to the performance of scientific work, by having excellent engineers and scientists, in both quality and quantity, by expanding quality of education at universities has contributed greatly to the development of the Japanese and Korean hi-tech technologies.

The continuous out-flow of highly skilled workers is a phenomenon that cannot be ignored by policy-makers. The relevant apex organizations in the OIC should identify areas where quality manpower is deficient and where the manpower of requisite quality is available in the Islamic countries. Instead of migrating to the West, the qualified scientists, engineers and educationists should be induced to work in other Islamic countries, with hardly any scientific and industrial base.

3.10. Technology Transfer and Development

Technology transfer is increasingly becoming a large-scale market-oriented activity, with the ancient trade-secrets, guilds training methods being replaced by modern intellectual-property systems, chambers of commerce, technological training and research centers. Few, if any, of the industrialized countries themselves can be said to be completely autonomous in meeting their needs for technological know-how. Even the USA, long considered to be the world's technological leader, is dependent on external sources for much of its technological advancement. Developing countries are proportionately far more dependent on external sources or new technical knowledge than the industrialized countries.

The acquisition of technology from advanced industrialized countries requires the realization of the best possible terms and conditions for its use and securing the possession of the necessary skills and resources for its optimal utilization. Effective transfer and utilization of technology-imports requires that the countries concerned simultaneously develop, domestically, other critical ingredients that go with the transfer and utilization process. The development of an efficient institutional and economic policy framework, which stimulates technological innovation and is conducive to the development of human resource, is fundamental to achieve the objective of technological transformation.

The technology-transfer (TT) process is multilateral. Technology is continuously generated through inventions and innovations, and is absorbed, applied, utilized, adapted, diffused, exchanged, bought, sold and further developed and enhanced by a variety of means and entities. The acquisition of foreign technology and services must be considered against the background of technological needs and requirements, and must be related to the selection of suitable technology and suppliers of technology, on the one hand, and to the negotiation and determination of acceptable terms and conditions for technology supply, on the other.

Those countries which have been considered as already developed, have witnessed unprecedented growth of their Gross National Products (GNP) and, subsequently, their export and import volumes, whereas the performance of developing Islamic countries during the same period, due to the low impact of lower technology transfers (as well as due to numerous other reasons), has not been so encouraging. In table 3.7 the data on population, GNP per capita and percentage of GDP devoted to export and import trade, for the selected Islamic countries, is presented. It shows that Saudi Arabia with highest GNP per capita has devoted more percentage of GDP to trade, in terms of export and import compared to countries with small GNP per capita, like Mali and Niger are spending more percentage of GDP towards imports. Countries like Malaysia, Indonesia, Saudi Arabia and Egypt have little imbalance in trade and more shifting toward exports. This is mainly due to availability of natural resources, core of technical manpower and fairly established basic industries.

Human Development Report

The data pertaining to important factors affecting the economic conditions has been extracted from UNDP Human Development Report (2007/2008) for the four randomly selected countries belonging to the three Categories of the Islamic Countries, as mentioned in Chapter I and the data is presented in Table 3.8. Beside large variation in GDP and GDP per capita, the adult literacy rate also varies from 99.5 in Kyrgyzstan to 39.3 in Mauritania. The expenditure on education as percentage of GDP varies from 7.1 in Senegal to 2.3 in Maldives.

In 2005, the GDP per capita in Muslim countries ranged from US$ 213 in Burkina Faso to US$ 28161 in Brunei Darussalam. In the OECD group, the lowest per capita income was US$ 32119 in Belgium, and the highest was US$ 60,228 in Luxemburg. The average per capita income was US$ 6716 for the Arab States and US$ 29,197 for the OECD Group. The world average is $9543 GDP per capita. The average values are computed by eliminating the widely diverging lowest and the highest figures. (UNDP HD Report 2007/2008). In majority of Islamic countries, the GDP per capita is less than US$ 5000, indicating poor economic activity as well as S&T capability. These countries are characterized by scant natural resources and an equally meager supply of trained human resources.

The new world trends that have taken place during the last two decades are moving towards establishing large regional economic blocks for cooperation in term of policies, trade, technology transfer, R&D and other technological components that make technical progress possible for all cooperating countries. Muslim countries have recently realized the need for further cooperation among themselves and instituted several OIC Standing Committees to promote cooperation in the field of "economy and trade", "science and technology", and "information and culture". Each of these Committees drafted cooperation plans in their respective fields and these plans were approved at the various OIC Summit meetings. Some useful work has indeed been done to promote cooperation, but the policies and resources made available so far for implementing the approved cooperation plans fall short of actual needs and requirements.

3.11. Islamic Science and Technological Centre of Excellence

One of the prime objectives of ICPSR is to coordinate with research institutions and centers of excellence in the Member States to promote effective scientific liaison among them as well as to establish new joint Islamic Centers of Excellence in various important fields in different regions of the Islamic Countries. This initiative needs to be supported by the Islamic countries. (COMSTECH) also has formulated excellent and realistic S&T cooperation programs that include the establishment of a number of S&T centers of excellence. These include R&D centers to serve Muslim countries in areas such as technology transfer, physical standards, S&T information, computer technology, oceanography space science and biotechnology. Among the proposed centers, the Islamic Centre for Technology Transfer needs to be given a high priority.

It is not out of place to mention that the economy of majority of Islamic countries is based on agriculture and that they have established a large number of agricultural teaching and R&D institutes, but even then import million tons of food grains and other agricultural product to feed the growing population. Pakistan has a large number of agriculture institutes located all over the country and over 70% of population is engaged in agriculture and agro-based industries, but it has been importing wheat, edible oil, tea milk and other dairy products year after year. This is a serious problem and must be tackled on regional basis.

3.12. Areas of Cooperation

Cooperation between Islamic countries in industrial R&D and in other S&T fields is not a matter of convenience, but a condition for breaking out of the vicious circles of economic ad technological dependence. Therefore, full support should be given for S&T cooperation programs particularly those already prepared by ISESCO, COMSTECH and other OIC organizations.

The changed nature of new technologies, requires continuous training, service and further development which has affected the concept of technology transfer. Technology transfer, which in the past could be considered as a self-contained transaction from producer to consumer, has become an ongoing process. The concept of technology transfer has been superseded by that of joint technology-development. Developing countries, including Islamic countries, should bear this in mind while identifying the technology needs and setting up their technology-transfer systems. Concrete proposals on this and plans of action can be jointly prepared, with the assistance and association of regional and international organizations.

Considering the technological position of Muslim countries during the last few decades, it becomes clear that these countries were mainly `buyers' of technology and acquired the technologies needed for their development and industrial programs through technology transactions from international market. Experience has shown that acquisition of technology by Muslim countries through technology-transaction often approximated the turn-key or other packaged types.

Furthermore, as a result of the stronger negotiating positions of technology suppliers, technology transactions to Muslim countries were usually accompanied by many unfair terms and restrictive clauses. These restrictive clauses seriously limited the capacity of countries to absorb, adapt and diffuse the imported technology. The direct costs, in terms of payments for royalties, licensing-fees, and salaries for foreign consultants were usually high. Similarly, hidden costs in the form of imported capital equipment, starting materials, intermediate after-sale services were also unfair in many cases. Other malpractices, such as supply of outdated technologies, incompatibility with environment, etc., were also frequently encountered. It seems plausible to assume that very little absorption and diffusion has taken place. In other words, technology was more easily traded than absorbed and/or diffused in Muslim countries.

Muslim countries are at a great disadvantage in selection of technology to be acquired because the conditions prevailing there are different from those in the developed countries. *Moreover, the majority of Muslim countries do not usually have the necessary human and institutional infrastructure for studying and evaluating the various technologies available*. Sometimes, they do not have the necessary information concerning what technologies are available for a particular job.

The design and engineering capabilities in the majority of the Muslim countries are still very weak, and need to be upgraded and strengthened. The importance of R&D institutions for technological development has been recognized during the last few decades in most Muslim countries. However, very little relationships between these organizations and industry have been developed. As a result, the contribution of local R&D in technology generation, absorption and diffusion has been very limited.

3.13. Islamic Economic Community

One of the major items of importance is the economy of a country. Therefore to benefit from the strength areas of Islamic countries mutually, there could be a mechanism in the form of an organisation known as Islamic Economic Community whose functions may be devised on the lines of the European Economic Community, which has proved of immense benefits to the countries of Europe. The Islamic Economic Community will certainly be a very useful enterprise for the economy of the Islamic countries.

While this community manages the sharing of experiences on multi-national level the individual countries should be encouraged to share each others experiences on bilateral level wherever it is more useful in that manner. All approaches should be tapped for reaping the benefits of cooperative efforts. The educational and scientific benefits in S&T should however be shared through ISESCO and COMSTECH which should be strengthened in their activities.

3.14. S&T based Models of Economy Development

For the economic development of a country by the use of science and technology, different models have been used in various countries. The advanced countries of the west, developed high level S&T as a priority and made effective use of it to achieve economic benefits as well as political strength and dominated the world affairs.

In countries like Singapore, Korea and Malaysia, the economy was developed by making use of technology through multi-national investment and generating wealth in the country. The emphasis on the indigenous development of high level S&T was then taken by allocating larger funds generated through the economic development. This model is also successful, but the dependence on the advanced countries is an uncertain parameter which can be used to accept dictation of policies of the advanced countries unless a stage is reached where this dependence has been minimised by indigenous development of R&D capabilities.

The third model is where there are large natural resources and the standard of living is high, through the exploitation of these natural resources with the help of the advanced countries and use of their S&T. However the heavy dependence on the S&T of the advanced countries is an uncertain factor and the absence of indigenous S&T is a great weakness.

A better policy for countries lacking natural resources is the initial stress on education and development of Human Resource in S&T as well as generating wealth through investment and help of the multi-nationals and following a systematic and a balanced programme of economic development through a "mix" of these models.

3.15. The Example of Singapore

Singapore a tiny country with a population of four million only has developed educational institutions of world repute and knowledge-based industries. With the fall in margin of profitability in semi-conductor industry, which was the base of economic success in Singapore, it develops plans to move-up the value-chain with focus on high-value industry in areas of bio-medical sciences, nanotechnology and energy. The government adopted a two-core plan viz attracting highly qualified research scientists to work in Singapore through establishing state-of-the-art research laboratories and to focus on graduate education programme to supply highly skilled scientists and engineers for research and development-oriented industry. Since 2000, Singapore has pumped more than $2 billion into developing the bio-medical research industry alone and over one billion dollar in development of qualified manpower. The world-class research laboratories manned by dedicated research scientists has accelerated research activities within the country. It is evident from registering patents obtained in Singapore from 800 in 2000 to 2100 in 2006. And the graduate programme is aimed at getting 1000 PhD researchers by the year 2015. In the words of Dr. Philip Yeo Adviser to economic development, :the economy of Singapore sequentially passed through the phases of labour intensive, skill intensive, capital intensive to technology-intensive. The last phase is passing through knowledge-intensive which translates into creating new products and services". There are many lessons to learn from the rapid development of this tiny country with not much of natural resources except oceanic water.

3.16. Brain Drain and Expatriates Resources

In developing countries (Islamic countries included), there are not enough academic opportunities as well as facilities for higher education and training, particularly at Postgraduate. research level. The scientists have, therefore, to be sent to the advanced countries. A fair number of these students do not return to their home countries particularly the good ones who can compete well with the standards of those countries. Such people settle in those countries even if they feel strong association with their home countries. This brain drain is a considerable loss of human resource for the Islamic countries. To minimise this brain drain special efforts are required on the part of these countries to devise means of attracting them back home by higher qualification incentives of salaries and better jobs. An international effort in the field of Physics to prevent brain drain was made by the Pakistani Scientist, Professor A. Salam (Nobel Prize in Physics 1979) by setting up, the International Centre for Theoretical Physics (ICTP) at Trieste in Italy. The ICTP was set up in 1964 and over the years it has followed various schemes to minimise the brain drain. One of the important practical aspect to achieve this end was to institute short term Fellowships at ICTP for bright Ph.D. scholars who were finding it uneasy to breathe science in their home countries after return. During the Fellowship at ICTP a scientist could do research of his own choice and collaborate with other scientists of his specialization particularly from the advanced countries and could then return to his home country. ICTP has benefitted thousands of scientists, particularly physicists, from developing countries including many Islamic countries. It has acted well to prevent brain drain to a large extent.

As a complimentary step, various ways have been used to draw the benefits from those expatriates who remained settled abroad. For example, Pakistan Government has a scheme where expatriates can make shorts visits to Pakistan for a few weeks lectures, seminars and advisory discussions. The daily allowance and the air ticket is paid by the Government. The main objective of the TOKTEN programme was to utilize the services of highly qualified expatriate consultants and to transfer the latest know-how and cutting edge technology from developed countries to Pakistan. TOKTEN assignments are implemented through a process of need and supply. It is the UNDP funded programme operating in 37 developing countries since 1977. Egypt and Turkey have also benefited from this programme. Other Islamic countries may enter into agreement with the UNDP to avail services of their applied scientists and engineers presently working abroad. Pakistan (HEC) successfully launched foreign faculty hiring programme with higher salaries for short and long term contract.

3.17. Concluding Remarks

The current failure of S&T in the Islamic countries can be attributed to lack of interest in science by political leaders, minimal funds to education and science, inadequate R&D support system and deteriorating educational standards. In the present state of technological advancements, all countries are making efforts to improve the economy through application of science and technology for development. However, no country can achieve substantial progress in isolation. The world is a global village and survival hinges on competitiveness and better performance in the world trade.

The Islamic countries shall have to lodge cooperative programmes to strengthen the R&D organizations/institutions, to improve faculty of education, exchange of experts and academics. The launching of collaborative programmes for training of high-level manpower and R&D projects is to be made priority areas of national and regional interest bearing in mind the essential aspect of sustainable development.

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10 Pages of Tables and Charts: It may be noted that as usual the data in the latest report is 3 to 4 years old.

Table 1

KEY INDICATORS ON WORLD GDP, POPULATION AND GERD, 2002

	GDP (in billions)	% world GDP	Population (in millions)	% world population	GERD (in billions)	% world GERD	% GERD /GDP	GERD per inhabitant
World	47 599.4	100.0	6 176.2	100.0	829.9	100.0	1.7	134.4
Developed countries	28 256.5	59.4	1 195.1	19.3	645.8	77.8	2.3	540.4
Developing countries	18 606.5	39.1	4 294.2	69.5	183.6	22.1	1.0	42.8
Less-developed countries	736.4	1.5	686.9	11.1	0.5	0.1	0.1	0.7
Americas	14 989.2	31.5	849.7	13.8	328.8	39.6	2.2	387.0
North America	11 321.6	23.8	319.8	5.2	307.2	37.0	2.7	960.5
Latin America and the Caribbean	3 667.5	7.7	530.0	8.6	21.7	2.6	0.6	40.9
Europe	13 205.0	27.7	795.0	12.9	226.2	27.3	1.7	284.6
European Union	10 706.4	22.5	453.7	7.3	195.9	23.6	1.8	431.8
Comm. of Ind. States in Europe	1 400.0	2.9	207.0	3.4	17.9	2.2	1.3	86.6
Central, Eastern and Other Europe	1 119.4	2.4	134.4	2.2	12.4	1.5	1.1	92.6
Africa	1 760.0	3.7	832.2	13.5	4.6	0.6	0.3	5.6
Sub-Saharan countries	1 096.9	2.3	648.0	10.5	3.5	0.4	0.3	5.5
Arab States Africa	663.1	1.4	184.2	3.0	1.2	0.1	0.2	6.5
Asia	16 964.9	35.6	3 667.5	59.4	281.5	33.9	1.7	76.8
Comm. of Ind. States in Asia	207.9	0.4	72.6	1.2	0.7	0.1	0.4	10.3
Newly Indust. Asia	2 305.5	4.8	374.6	6.1	53.5	6.4	2.3	142.8
Arab States Asia	556.0	1.2	103.9	1.7	0.6	0.1	0.1	6.2
Other Asia	1 720.0	3.6	653.7	10.6	1.4	0.2	0.1	2.1
Oceania	639.5	1.3	31.6	0.5	8.7	1.1	1.4	274.2
Other groupings								
Arab States All	1 219.1	2.6	292.0	4.7	1.9	0.2	0.2	6.4
Comm. of Ind. States All	1 667.9	3.5	279.6	4.5	18.7	2.2	1.1	66.8
OECD	28 540.0	60.0	1 144.8	18.5	655.1	78.9	2.3	572.6
Selected countries								
Argentina	296.6	0.6	36.5	0.6	1.6	0.2	0.5	44.0
Brazil*	1 300.3	2.7	174.5	2.8	13.1	1.6	1.0	75.0
China	5 791.7	12.2	1 280.4	20.7	72.0	8.7	1.2	56.2
Egypt*	252.9	0.5	66.4	1.1	0.4	0.1	0.2	6.6
France	1 608.8	3.4	59.5	1.0	35.2	4.2	2.2	591.5
Germany	2 226.1	4.7	82.5	1.3	56.0	6.7	2.5	678.3
India*	2 777.8	5.8	1 048.6	17.0	20.8	2.5	0.7	19.8
Israel	124.8	0.3	6.6	0.1	6.1	0.7	4.9	922.4
Japan	3 481.3	7.3	127.2	2.1	106.8	12.9	3.1	839.6
Mexico	887.1	1.9	100.8	1.6	3.5	0.4	0.4	34.7
Russian Federation	1 164.7	2.4	144.1	2.3	14.7	1.8	1.2	102.2
South Africa	444.8	0.9	45.3	0.7	3.1	0.4	0.7	68.7
United Kingdom	1 574.5	3.3	59.2	1.0	29.0	3.5	1.8	490.4
United States of America	10 414.3	21.9	288.4	4.7	290.1	35.0	2.8	1005.9

* GERD figures for Brazil, India and Egypt are all for 2000.

Note: For Asia, the sub-regional totals do not include China, India or Japan in any of the tables in the present chapter.

Source: UNESCO Institute for Statistics estimations, December 2004.

Table 2
WORLD RESEARCHERS, 2002

	Researchers (thousands)	% world researchers	Researchers per million inhabitants	GERD per researcher (US$ thousands)
World	5 521.4	100.0	894.0	150.3
Developed countries	3 911.1	70.8	3 272.7	165.1
Developing countries	1 607.2	29.1	374.3	114.3
Less-developed countries	2.1	0.1	4.5	152.7
Americas	1 506.9	27.3	1 772.4	218.2
North America	1 368.5	24.8	4 279.5	224.5
Latin America and the Caribbean	138.4	2.5	261.2	156.5
Europe	1 843.4	33.4	2 318.8	122.7
European Union	1 106.5	20.0	2438.9	177.0
Comm. of Ind. States in Europe	616.6	11.2	2 979.1	29.1
Central, Eastern and Other Europe	120.4	2.2	895.9	103.4
Africa	60.9	1.1	73.2	76.2
Sub-Saharan Countries	30.9	0.6	48.0	113.9
Arab States Africa	30.0	0.5	159.4	40.9
Asia	2 034.0	36.8	554.6	128.5
Comm. of Ind. States in Asia	82.9	1.5	1 155.0	8.9
Newly Indust. Asia	291.1	5.3	777.2	183.7
Arab States Asia	9.7	0.2	93.5	66.6
Other Asia	65.5	1.2	100.2	20.9
Oceania	76.2	1.4	2 396.5	114.4
Other groupings				
Arab States All	39.7	0.7	136.0	47.2
Comm. of Ind. States All	700.5	12.7	2 505.3	26.7
OECD	3 414.2	61.8	2 984.4	191.9
Selected countries				
Argentina	26.1	0.5	715.0	61.5
Brazil*	54.9	1.0	314.9	228.0
China	810.5	14.7	633.0	88.8
France	177.4	3.2	2 981.8	198.4
Germany	264.7	4.8	3 208.5	211.4
India*	117.5	2.1	112.1	176.8
Israel*	9.2	0.2	1 395.2	661.1
Japan	646.5	11.7	5 084.9	164.5
Mexico*	21.9	0.4	217.0	159.7
Russian Federation	491.9	8.9	3414.6	30.0
South Africa	8.7	0.2	192.0	357.6
United Kingdom*	157.7	2.9	2 661.9	184.2
United States of America*	1 261.2	22.8	4 373.7	220.0

* India 1998, Israel 1997, United States 1999, United Kingdom 1998, Brazil 2000, Mexico 1999.

Source: UNESCO Institute for Statistics estimations, December 2004.

Table 3.3: S & T Manpower in Eleven Muslim Countries

Countries	[illegible]			[illegible]			[illegible]			[illegible]			[illegible]			[illegible]			[illegible]		
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bangladesh	[illegible]	—	—	[illegible]	[illegible]	[illegible]	[illegible]	—	—	[illegible]	—	—	[illegible]	[illegible]	[illegible]	[illegible]	—	—	[illegible]	—	[illegible]
Egypt	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	—	[illegible]
Indonesia	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	[illegible]	—	[illegible]
Iran	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	—	—
Iraq	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	[illegible]	—	—	[illegible]	—	—	[illegible]	—	—	—	—	—
Jordan	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	[illegible]	—	[illegible]
Malaysia	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	—	[illegible]
Nigeria	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	[illegible]	—	—
Pakistan	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	[illegible]	—	[illegible]
Sudan	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	[illegible]	—	—
Turkey	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	[illegible]	—	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	[illegible]	—	[illegible]

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Table 3.4: R & D Manpower in Eleven Muslim Countries

Countries	[illegible]			[illegible]			[illegible]			[illegible]			[illegible]			[illegible]		[illegible]		
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bangladesh	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Egypt	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Indonesia	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Iran	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Iraq	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Jordan	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Malaysia	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Nigeria	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pakistan	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sudan	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Turkey	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Source:

UNESCO Statistical Year Books, 1971-91 & 1998

Human Development Report, UNDP, De Boeck University, 1999, pp. 197-200

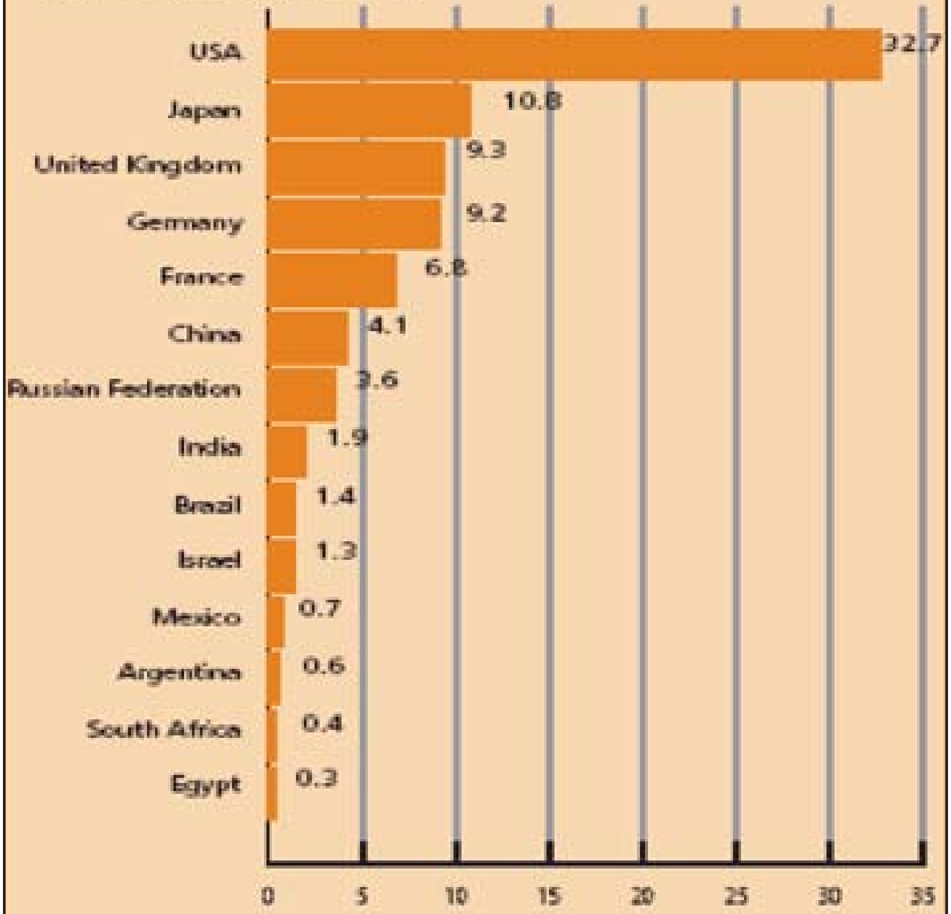
www.sesrtcic.com, 2005

Table 3.5: R&D Expenditure, Percentage of GNP, in Eleven Muslim Countries
(R&D Expenditure in Japan, U.S.A. and Brazil is given for comparison)

Countries	1970	1975	1980	1985	1990	1995	2005
Bangladesh	—	0.1	0.2	0.2	0.2	—	0.6
Egypt	0.6	0.8	0.6	0.1	0.3	0.5	0.2
Indonesia	0.2	0.1	0.3	0.5	0.4	0.1	0.1
Iran	0.2	0.3	0.4	0.3	0.4	0.5	0.7
Iraq	0.2	0.1	0.2	0.3	0.3	—	—
Jordan	0.3	0.4	0.3	0.6	0.6	—	—
Malaysia	0.2	0.1	0.3	0.3	0.4	0.4	0.7
Nigeria	0.4	0.4	0.3	0.3	0.4	—	—
Pakistan	0.2	0.1	0.3	0.4	0.4	—	0.2
Sudan	0.5	0.6	0.2	0.3	0.4	—	0.3
Turkey	0.5	0.7	0.6	0.7	1.0	0.6	0.7
	1.7	1.9	2.1	2.7	2.8	2.9	3.1
	2.0	2.2	2.4	2.6	2.7	2.5	2.7
	0.4	0.8	2.6	0.4	0.6	0.6	1.0

Source:
UNESCO Statistical Year Books, 1971-91 & 1998
Human Development Report, UNDP, 2007 / 2008 page 273 - 276

Figure 2
WORLD SHARES OF SCIENTIFIC PUBLICATIONS, 2001
Selected countries (%)



Source: see Table 5.

Table 3.6: Share of Mainstream Journal Articles (1995-2005)

Country	Total Paper Published (1995-2005
Egypt	22723
Turkey	82407
Malaysia	10684
Saudi Arabia	17475
Nigeria	9105
Pakistan	7832
Morocco, Algeria, Libya, Tunisia	10113
Iran	19114
Kazakhstan	2386
Jordan	6384
Bangladesh	4745
Indonesia	5118
Bahrain	853
Mali	588
Niger	611
Sudan	1107
Somalia	22
Cameroon	2343
Uganda	1975
Yemen	387
Oman	254
UAE	4389
Afghanistan	55
Iraq	819
Syria	1348

Table 3.7: Population, GNP/capita, and Volume of Merchandise Trade in Selected Muslim Countries, 2005

Country	Population (Million)	GNP/capita US$	Export (Million) US$	Import (Million) US$
Sierra Leone	5.53	218	158.5	344.69
Ouganda	--	--	--	--
Chad	9.75	396	3032	1117
Bangladesh	141.82	467	9297	13889
Guinea Bissau	1.59	177	99	119
Burkina Faso	13.23	396	347	1280
Niger	13.96	240	500	805
Mali	13.52	379	1135	1632
Nigeria	141.36	564	42276.9	17702
Benin	8.44	514	569	894.03
Pakistan	155.77	689	16051	25357.3
Muritania	3.07	560	564	750
Egypt, Arab Republic	74.03	1255	10654	19819
Indonesia	220.56	1279	86179	74935
Senegal	11.66	708	1535.83	3197.04
Cameroon	16.32	1009	2829	2890
Morocco	30.14	1694	11190	20790
Jordan	5.41	2426	4301.76	10506.1
Tunisia	10.03	2889	10493.6	13177
Turkey	72.07	4704	73476.41	116774
Algeria	32.85	2727	46001.4	20357
Iran, Islamic Republic	68.25	2771	56252	38238
Malaysia	25.35	4963	140949	114603
Gabon	1.38	5007	4860	1370
Oman	2.57	8999	18691.8	8815.58
Saudi Arabia	23.12	11764	180737	59409
United Arab Emirates	4.53	24213	115453	80822.33

Source:

www.sesrtcic.com

http://www.studentsoftheworld.info/infopays/rank/PNBH1.html (**GNP PER Capita US$**)

Table 3.8: Important Indicator for Science and Technology Development in Selected Islamic Countries

	Countries and Categories	Total Population in Millions	GDP US $ Billion	GDP per Capita $	Adult Literacy rate	Expenditure on Education % of GDP	Research and Development Expenditure % of GDP	Researcher in R&D / million
I	Countries with Significant Science & Industrial base							
	Egypt	72.8	92.4	4337	71.4	5.9	0.2	493
	Malaysia	25.7	130.3	10882	88.7	6.2	0.7	299
	Turkey	73.0	362.5	8407	87.4	3.7	0.7	341
	Saudi Arabia	23.6	309.8	15711	82.9	6.8	–	340
II	Countries with Science and Industrial base exists							
	Algeria	32.9	102.3	7062	69.9	5.1	–	–
	Oman	2.5	24.3	15602	81.4	3.6	–	–
	Syria	18.9	26.3	3808	80.8	5.9	–	29
	Kyrgyzstan	15.2	2.4	7857	98.5	4.4	0.2	457
III	Countries with hardly any Science & Industrial base							
	Chad	10.1	5.5	1427	25.7	2.1	–	–
	Maldives	3.0	1.9	2234	51.2	2.3	–	–
	Mauritania	11.3	8.2	1792	39.3	5.4	–	–
	Senegal	8.3	0.8	5261	96.3	7.1	–	–

Source:

UNDP Human Development Report 2007/2008
www.sesrtcic.org (S&T OIC member Countries)

CHAPTER 4

ACQUISITION OF TECHNOLOGICAL CAPABILITY FOR THE FUTURE

4.1. Technological Capability

It has been discussed in the previous chapters that Islamic countries vary considerably in the extent of their socio-economic development. The argument is reinforced when the economic and S&T data are further examined. Amongst the groups of Islamic countries, three distinct categories can be recognized: (a) those with high human development, but with inadequate S&T infrastructure, (b) those with medium or low human development but with somewhat advanced S&T infrastructure, and (c) those with low human development and an inadequate S&T infrastructure. The majority of African Islamic countries belong to the last category.

While the Arab States, except Djibouti, Mauritania and Somalia, enjoy a comfortable rank on the human development index scale (Table 2.1, Ch.2), the data brings out higher levels of economic deprivation in the Asian and other African Islamic countries, the African states being least developed, (HDI 0.32). The same is true of science and technology. The overall deficiencies are apparent in weak S&T infrastructures, distorted policy-implications, inadequate allocation for S&T research, lack of attention on enterprise development and absence of linkages between research institutions and industry. All this adds up to under-utilization of even the available scientific and technological capability.

On top of all this, it is not realized that scientific and technological research employed judiciously, in tandem with judicious economic plans, can bring about remarkable economic development, the advantages of which, if allowed to filter down, can bring about equally remarkable human development. It is high time that this deficiency in economic planning is rectified. To be able to do so, effective strategic measures for building technological capability must be initiated by each country. For this purpose, no single document can serve the purpose of all the countries. Each country, necessarily, has to develop its own plan of action and carve out their own blueprint for development. This may be seen in the differences that lie in the choices, both for choosing technology and for capability building (Table 4.1). According to a UN study (1987), three main aspects of Technology Capability Building are listed below:

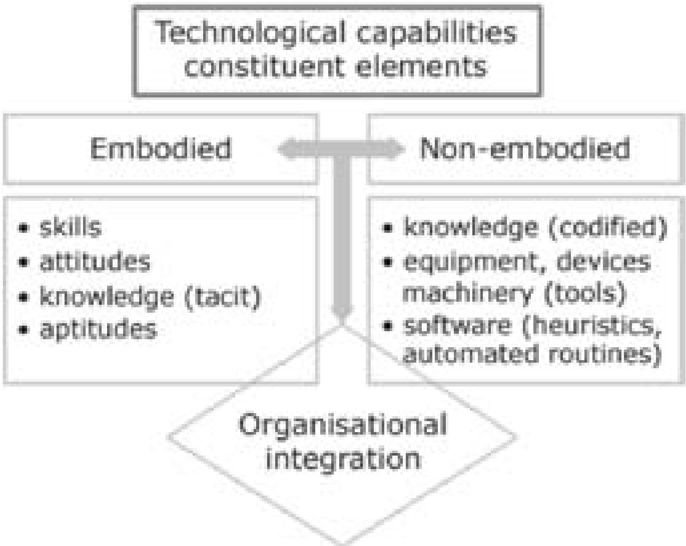
(a) The selection of machinery and equipment for producing specific goods and services;

(b) The assimilation and diffusion of those technologies in the host economy; and

(c) The development of indigenous capacities for innovation.(Huq,1999)

Those countries in which, for example, agriculture is the mainstay of national income, the technologies of choice would be biotechnologies in farming and food-systems (this is discussed in detail in a subsequent section). Alternatively, countries that have strong economies, and depend only marginally on agriculture income, may like to plan for further acquisition of such technologies for value-addition on agro-products and produce, packaging and marketing, which may enable them to enter downstream industries, as has been the case with Malaysia.

Table 4.1



The elements of technological capability

Source:
(Technology acquisition and domestic learning, 2007)
http://www.scidev.net/en/policy-briefs/technology-acquisition-and-domestic-learning.html

4.2. Obstacles and Barriers to Building Scientific and Technological Capability

Most of the Islamic countries, be they in high, medium or low development mode, need to examine carefully, the obstacles that can impede S&T development. The obstacles can take various forms, such as:

- **Lack of Knowledge-sharing**: It is not advisable to draw comparisons with developed countries. They are leading the third technological revolution. In the process a new technical paradigm has developed - which means that this knowledge is not available for sharing with developing countries.

- **Highly capital-intensive technologies**: If the Islamic nations at this stage think of "high technology", then it must be realized that these are highly capital-intensive. The National Science Foundation of USA has categorized those technologies as high-tech in which R&D expenditure represents 10% of the value added per product. In 1990, the expenditure on these industries (pharmaceuticals, office equipment, electrical and electronic equipment, aerospace, missiles and satellites) in the US was 23% of their revenues (as against 7.5% for industry as a whole).

- **Lack of Investment on Human Capital**: The development of S&T manpower has a long gestation-period and requires high amounts of public and private finance. This obstacle, however, disappears, if investment on education is considered as the building up of human capital, with high private and social rates of return, the added advantage being the building up of technological capability, if the quality of education is right and at the tertiary level is enterprise-directed.
- **Lack of International Cooperation**: Whereas building up a national technological capability is important, yet not much can be achieved without international cooperation. Even within Islamic countries, such opportunities are abundant and are rapidly on the increase. This may call for integrating research-development plans under the umbrella of the OIC organizations.
- **Lack of Funding**: In some Islamic countries, very substantial amounts of money are used for the purchase of Defense equipment (annexed Table IV). Technological capability building demands that a portion of these funds is diverted to R&D in public and private sector. Defense research has significant technological spin-off for use in other upstream or downstream industries.
- **Lack of Enterprise Development**: The development of enterprises may not be left unattended. A conscious effort should be made to introduce directional incentives for promotion of enterprise-functions in desired areas of technology. This would be facilitated if linkages of enterprises with research institutes and universities are assured.

4.3. Some Guidelines for Building Technological Capability

The paragraphs that follow are only illustrative and provide choices which, as the circumstances permit, may be used as guidelines:

Devising a coherent S&T policy that promotes the role of science and technology: The first and foremost step in building scientific and technological capabilities is to identify the national needs and thereafter strengthen the S&T base, in the light of those identified needs.

Human Capital development: High quality S&T education and training at all levels that helps to build a sustained and sustainable workforce for addressing national needs is essential. Efforts are required to attract, develop, and retain the scientific and technological talent of the nation. **This effort should be made from grass-roots to higher education. Special attention should be given to high-quality technicians (vocational training), as well as higher education and indigenous research**.

Ensuring Regional and International Collaboration: Virtual networks of centres of excellence should be created, which link professionals from different locations, working on similar problems, through information and communication technologies (ICTs).This can multiply the potential effectiveness of individual centres and provide equitable access to currently available knowledge. Also, regional cooperation between countries in the form of South-South cooperation and exchange systems needs to be developed. North and South cooperation should also be utilized effectively.

The Public-Private partnership: The private sector is now a primary global force in research and development for S&T, but it will not be possible to depend entirely on the private sector. Funding needs to be given to encourage public-private partnerships that will get the major partners together and promote joint research.

Financing: Funds are needed to sustain the financing of high-quality indigenous research and development in sectors of strategic importance. To complement national efforts, innovative and creative new mechanisms are needed to ensure adequate funding for Technological capability-building internationally.

4.4. Education and Research

The importance of education and research for development of technological capability cannot be overemphasized. Investment in building human capital is, in fact, investment in building technological capability. This brings high social rates-of-return. The African group of Islamic countries is struggling hard to raise the literacy ratios and participation-rates at the primary and secondary levels. However, much remains to be achieved at the tertiary levels, especially in areas of research in science and technology. The Asian group of Islamic countries is investing in school education, and has also been able to develop a substantial intellectual pool in disciplines of S&T.

These Islamic countries that rank amongst high human-development nations have set up good tertiary-level institutions, but the excellent teaching programs are generally not accompanied by high-quality basic or applied research. The universities have, by and large, failed to serve as engines of development. Considering the invasion of new technologies, the demands on universities have increased tremendously.

It calls for a number of pervasive reforms in (a) budgetary allocation to education, (b) budgetary allocation to research in universities and in research institutions, (c) budgetary allocation to R&D institutes, (d) curriculum development at different levels of education, especially science education, keeping room for the use of information-technologies. Scientific and technological research at higher education (M.S & PhD studies at universities) has to be supported by the industry, as its end user.

Funding: Appropriate budgetary allocations are the key to success at tertiary education level and research. The actual allocations will vary from country to country, but a minimum percentage of GNP must be identified. An effort may also be made to establish funding-ratios for basic and applied research. Quality is of the essence. It must assert itself at all levels of education and research. Mere production and certification of a vast number of under-prepared manpower would be of little avail. Each country will be well advised to implement its own national plan for education and research.

If capability for this is inadequate, then cooperation at regional and international level through OIC - S&T organs, such as ISESCO, Islamic Development Bank, COMSTECH and Inter-Islamic Network of S&T centres, may be invited. These organizations may implement a plan for strengthening of institutions for countries in the African setting with limited economic capability.

4.5. Identification of Technologies

Concept of Sustainable Development:

Since the introduction of the concept of sustainable development in 1987, by the Brandtland Commission, much emphasis has been laid on achieving a sustainable socio-economic environment for all of the world's population. Despite various comprehensive and far-reaching efforts and recommendations, unfortunately the Islamic countries have still not been able to achieve an acceptable level of human welfare. The indiscriminate use of limited natural resources has further led to environmental degradation in the form of climate change, soil-erosion, desertification, declining agricultural productivity, causing negative sustainable development.

Considering the growing importance of sustainable development for economic progress, Islamic countries need to collectively work on identifying appropriate mechanisms for achieving sustainable socio-economic development, which includes prioritizing R&D areas, setting targets and thereafter translating these targets into concrete policies.

Much has been written in the literature on issues involved in developing a general capability for science and technology. This aspect, therefore, is not being emphasized further. In the present context, because of the rapid expansion of new technologies, possibilities that need to be considered are the acquisition of these technologies by Islamic countries. The identification and the harnessing of new technologies should begin with a search for the manufacturing of products which have 'niche' markets. In such cases, production-processes can be accelerated through the use of national technological capability and /or through international collaboration (preferably within the Islamic countries). A step-by-step approach may start with basic tasks and progress steadily towards the more complex. The technology development phases are linear and are represented in the following manner:

Table 4.1: Phases of Technology Development

Upstream	Downstream
Basic Research, Innovation	Product, Process, Production, Marketing, Design Engineering, Development

The choice will lie with the country, whether to enter upstream or downstream. This in turn depends on research and technology capability. Recently, amongst the newly industrialized economies (NIEs), Malaysia has made a successful entry at the downstream level. Highly qualified S&T manpower and efficient research-institutes will remain necessary prerequisites. The choice for such countries may be microelectronics, biotechnologies, material sciences and engineering goods.

Even if the industrial production sector receives minimal attention, because of limitations of technological capability as, for example, in low-income Islamic countries of Africa and Asia, then the technology-focus should be on farm and food-technologies. These countries have vast areas of arable land, and depend heavily on the contribution of agriculture to national income. Notwithstanding this, the information and communication technologies (ICTs) should receive high consideration in the development plans of any country. ICTs have demonstrated all-pervasive impact on industry, commerce, business, education and services. These can play a role for bridging the gap between South and North, and improve the economic condition, provide job-opportunities, increase per-capita income, and ensure intellectual export with highly trained manpower.

4.6. Initiatives for Building Technological Capability

Some Examples from Developing Islamic Countries

In the process of building technological capability, technology should not be considered as an end in itself. Technology is a means to achieve a set of economic and social development goals. A country need not necessarily be an innovator and producer of advanced high technologies to achieve economic growth. Building technological capability will involve three levels, in increasing complexity: (a) application capability, (b) production capability, and (c) innovation capability. The first crucial element is the building up of investment-related capabilities. Even if technologies are to be acquired from abroad, it is necessary to possess in-house capabilities in investment functions. For instance, even though many investment-functions are carried out by the experts and consultants, in-house capabilities are necessary to evaluate the recommendations of consultants, select the right type of equipment, participate in process-design, to ensure that the specific needs are met, and to understand the plant operation.

Boxes 1 and 2 illustrate indigenous technological development efforts in some developing countries of Asia and Africa.

Box 1: Examples of technological capability-building in Asia

In 1990, Malaysia created the Advanced Manufacturing Technology Centre (AMTC) to assist local SMEs in the application of advanced manufacturing technologies, such as CAD/CAM, to enhance their international competitiveness. The Standards and Industrial Research Institute of Malaysia (SIRIM) has played an active role in the industrial development of Malaysia by coordinating and promoting technology transfer, standardization, industrial research and consultancy, technical support services and other related activities.

In Indonesia, the government-owned enterprise, P.T. Len. Industry (PERSERO), is actively involved in applied research, especially in engineering, manufacturing and electronics. Based on the result of its own R&D, the company produces electronics components.

Source: UNCTAD, "Technology transfer arrangements: study tour to Malaysia, Indonesia and Republic of Korea and working in Kuala Lumpur, Malaysia", 4-16 May 1992 (UNCTAD/ITD/TEC/Misc.5)

Box 2: Technological capability-building activities in Africa

The case of Saume Magazine, a grouping of about 500 craftsmen who make spare parts for repair of vehicles in small garages and workshops in Kumasi, Ghana, is a good example of such efforts. In this case, the efforts of local mechanics to develop manufacturing skills are supported by the Government through technical service, training and credit. Such support includes government funding for the intermediate Technology Training Unit of the Technology Consultancy Centre at the University of Science and Technology in Kumasi, and an extension of the training-unit concept throughout the country through the Ghana Regional Appropriate Technology

Industrial Services, which provides on-site training in product development. In addition, as part of the Intermediate Development Association-supported Transport Rehabilitation Project, the Government, through Kumasi Technical Institutes, is providing training to upgrade the skills of mechanics in informal workshops and to teach them basic accounting and management methods. It has also helped to establish a pilot program to provide credit to small operators and a mechanics' cooperative to purchase and share machinery, such as lathes and crank-shaft grinders.

Apart from enterprises in the informal sector, technological capabilities in Africa are mainly accumulated in public research institutes. For instance, the International Institute for Scientific Research for the Development of Africa (IISDA) is a newly established centre located in Ivory Coast and supported by Canada, France and the Ivorian Government. Its current research program is concentrated on the improvement of yam varieties and the treatment of malaria. The institute has research links with the International Institute for Tropical Agriculture in Nigeria, which is active in tissue-culture for germ-plasm conservation and the in-vitro distribution of disease-free planting material for yams and other crops. In Ethiopia, biotechnology research is being carried out by the Plant Genetic Resources Centre, which coordinates the Genetic Resources Network of the African Ministerial Conference on Environment (AMCEN). However, the contribution of these research activities to economic development has been limited, due to the poor linkages between the research institutes and production.

Sources: World Bank, Sub-Saharan Africa: from Crisis to Sustainable Growth (Washington, D.C. World Bank, 1989; L.K. Mytelka, "Rethinking development: role for innovation in the other two thirds", Futures, vol.25, No.69,1993), pp.694-712: UNIDO, Genetic Engineering and Bio-Technology Monitor, No.40 (December 1992), pp. 19-27; J.H. Dunning, "Multinational enterprises and the globalization of innovatory capacity" Technology Management and International Business: Internationalization of R&D and Technology, O. Granstrand, L. Hakanson and S. Sjolander, eds. (United Kingdom, John Wiley & Sons, 1992); P. Vitta, "Utility of research in Sub-Saharan Africa: beyond the lead of faith", Science and Public Policy, vol. 19, No. 4, (August 1992), pp.221-228.

The building up of production capabilities begins with assembly activities. In the export-oriented countries, building technological capability can start with assembling capabilities. Some studies indicate that assembly of semiconductors may not be useful for technology acquisition and dissemination of technology to other fields. On the other hand, production of consumer electronics embodies certain skills and technical know-how that can be applied to other areas of the electronics industry. Countries that achieve mastery over manufacturing techniques for components of consumer-electronics products will be able to transfer their experience to the production of peripheral equipment for computers. For building up innovative capabilities, a number of approaches are needed within the Islamic countries. This can be best promoted by (a) partnership between enterprises of various countries, (b) the supportive role of government with regard to innovation in international competition, and (c) technological accumulation through linkages between enterprises and universities.

Promoting Exchange Programmes: Criss-cross training within Islamic educational and research institutions, and even enterprises is likely to cause rapid manpower-development in downstream and upstream technologies. Excellent university departments in substantial numbers are available in the Arab, Asian and African Islamic countries. This potential remains to be fully harnessed. The OIC specialized agencies are best suited to undertake this task, if the funds are specially allocated for this purpose. With relatively small sums of money, a large number of technologists can be trained within Islamic countries in specific technology-capability tasks, the maximum advantage accruing to the least developed countries. No international program of cooperative development can afford to ignore the utility of such exchanges at a bilateral level. This is already happening, though to a limited extent, between many countries. The oil-rich countries, with strong economies, may like to take a lead in pooling financial resources for human resource development programs. Any nation that has a per-capita income of less than 300 US$ and human development measure (HDM) of more than 51 should receive high priority. The same programmes can bring about technology cooperation for downstream and upstream industries.

Vocational training: In the economic plans of Islamic countries, technical/ vocational training should receive separate treatment. A well-trained technician is always at the hub of technological activity. More than the quantitative numbers, the quality of technical training is important. In most of the countries, the technicians have a poor career structure. The examples of South Korea in this regard may be emulated, where a capable technician can rise to the same salary-level as, for example, a university Professor. The technical training curricula need to be matched by market-demand, especially in countries that are in the process of new technology acquisition. Again, in this area, considerable advantage can be taken from the available facilities in a number of advanced countries which are at the 'take -off' stage. It can be a task for ISESCO to identify the right type of curricula and keep them under constant review. The introduction of new information-technologies has implications both for science education and technical education. The process of technological acquisition will remain incomplete without building up a strong pool of well-trained technicians for participation in upstream and downstream technologies.

Promotion of Science in the Society: Society is constantly changing with the time. Rapid advancements in science and technology in one part of the world have direct impact on the societal behaviour and outlook in a country for remote and under-developed. It is imperative that the strategy for promotion of science and technology must provide safeguards and appropriate mechanisms whereby the inputs into the society through S&T can be translated fully into socio-economic gains, with no loss to social values and traditions. It is necessary that people are informed regularly of the advances in S&T as well as their applications. The science awareness in the society can be achieved through various activities, such as Mobile science exhibitions/fairs, science film shows, science centres/clubs, science museums, planetaria, scientific publications and panel discussions on T.V and in electronic media including demonstration of improved agro-based technologies in the rural areas. Popularization of science and technology at the gross-root level should be one of the major objectives of the national S&T Policy. Science has to be nourished and promoted in the society, so as to mobilize people in all sections of the society to innovate, adopt and apply scientific knowledge in practical fields and for its own welfare. Promotional activities in science and technology will provide platform to the younger generation to choose science as profession/career and inculcate spirit of innovation and sharing of traditional and new knowledge. Scientists, engineers, educators and journalists should be encouraged to propagate the benefits of science and technology, popularization of new technologies in the society and the protection of traditional knowledge and genetic plant resources.

Strengthening the Research Institutes: Research institutes obviously play an important role in technology acquisition and innovation. In a number of Islamic countries (at least eleven), excellent research institutes have been developed. These should be strengthened, both for basic and applied research. The difficulty is that most of these institutes work in isolation from industrial enterprises. For a long time, the ratio of applied to basic research has been debated. There is no rule-of-thumb to determine the ideal ratio. Much, of course, will depend on the state of preparation of the country for entry into the mainstream of industry and the sophistication level of this industry. Those countries which intend to enter the industrial production sector, where knowledge-intensive technologies are involved, would need to invest more in basic research. *Clearly, basic research constitutes a steel-frame, on the edifice of which applied research can be mounted. The priority of the research institutes and universities should not be only to train manpower but also to serve as engines of development*. This would require a change in the mission-statement written for these institutions. The governments of Islamic countries, in devising policies for building technological capability, must carefully choose programs which may help develop linkages of these institutes with industry. A better prepared private entrepreneur can provide the much-needed financial support to institutions involved in "innovations and development" research. An equally positive role can be played by venture-capital (private or public). To begin with, the initiative should originate in the public sector with, an eye on knowledge-intensive industries.

The "Silicon Valley" in the USA and huge software engineering complexes in India and China have thrived on venture-capital. Interestingly enough, the rise of management-sciences, coupled with the tools of information and communication technology, have created a new paradigm of efficiency. This is of the essence for the internal and external efficiency of the research institutions and enterprises. The planning process and policy measures should recognize this.

Establishment of Science Parks and Technology Incubators: A new initiative, which has been successfully used in the UK, is the establishment of "science parks". These were established at the university campuses jointly by the universities and private-sector companies, in the decades of 1980s. The sublimation of the technological expertise of academics in solving developmental problems has been beneficial for both the universities and the industry. This useful initiative can be taken up in countries where universities have high research-outputs in various branches and the private enterprises are fully motivated.

Technology incubators facilitate economic development, technology commercialization, as well as entrepreneurship. They play an important role in strengthening cooperation between public and private sectors for regional economic development. Technology incubators serve the purpose of job creation through development of new businesses such as technology-based forms is a main underlying concern of. They foster entrepreneurship and training in the local community.

The "Silicon Valley" in the USA and huge software engineering complexes in India and China have thrived on venture capital. Interestingly enough, the rise of management sciences coupled with the tools of information and communication technology have created a new paradigm of efficiency. This is of essence for the internal and external efficiency of the research institutions and enterprises. The planning process and policy measures should recognize this.

Initiatives such as technology parks, technology incubator schemes and self-entrepreneurship can integrate a number of new concepts in technological capability building.

4.7. Thrust Areas

The future development in three categories of Islamic Countries would hinge essential on; the concept of sustainable development, the specific stage of science and education and industry in specific group of countries and finally available resources in terms of manpower, funds and cooperation. Bearing these in mind the following seven thrust areas are being proposed:

1. **Biotechnology and Agro-based Industry**
2. **Healthcare**
3. **Micro-electronics**
4. **Nano-Technology**
5. **ICTs**
6. **Renewable Energy**
7. **Environment and Climate Change**

There is a need for new initiatives, aimed at building technological and social capabilities in these key areas. The information and communication technologies (ICTs), for example, have created a technological revolution affecting the life of individuals in all countries of the world. Advanced information and communication technologies (ICTs) are playing an increasingly important role in the development process Acquisition of knowledge and establishing R&D in the information-related technologies may have far-reaching effects on technological capability needed for entering into downstream industries.

The biotechnologies can have meaningful application in all types of economies. It has been suggested, for instance, that cheaper versions of biotechnology, like the tissue-culture techniques, or the production of animal vaccines, can easily be adapted to local needs through indigenous capability-building. This should not be capital intensive. Similarly, software engineering, and other areas of microelectronics, though knowledge intensive, may not necessarily be capital-intensive.

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CHAPTER 5

POLICY IMPLICATIONS

5.1. Basic Considerations

There are wide differences among developing Islamic countries in their capacity to apply, absorb and use technologies. The experience of developing countries that have been successful in fostering faster economic growth shows the importance of three main factors: (a) endogenous capability-building, particularly human-resource development at different levels; (b) introduction of advanced technologies from abroad; and (c) stimulation of national R&D activities through institutional support. These three are ultimately dependant on the indigenous educational base in each individual country.

To be able to take advantage of the opportunities opened up by new technologies, enterprises from developing Islamic countries and economies in transition should develop strategic business-partnerships within and outside the Muslim World and be able to define niches. This requires market-intelligence and participation in global marketing networks. To develop these capabilities, enterprises must be encouraged to enter into strategic partnerships with firms from other countries. Such strategic partnerships are usually characterized by: (a) a two-way relationship; (b) a deliberate effort to cooperate, whether induced by government incentives or as a result of market functioning.; (c) the sharing of technological knowledge, through a variety of forms that may involve collaborative R&D, training, manufacturing and marketing; and (d) a strategy aimed at long-term mutual benefits, rather than just short-term financial success. Based on the concept of long-term of sustainable development (see *Annex-1&2*)

5.2. Building the Educational Base

Most of the Islamic countries have neither a high science-base nor a modern technology-base. Therefore, the policy should first focus on building up a science and technology infrastructure. **The first step would be to develop the indigenous educational base, so as to create a critical minimum capability through technical training programs for workers and common utility facilities for enterprises using the guiding principles of development, viz-faith, values and goals**. This would require applications of new technologies. Institutions such as "service bureau" could play a vital role in the application and diffusion of new technologies. For example, the “service bureaus” working in the garment industries of relatively advanced countries offer services of micro-electronics-based equipment, which carries out all functions of garment-making procedures, thereby reducing their investments, maintenance and managerial costs. The manufacturer only needs to supply the bureaux with a sketch of the garments to be produced. Such a bureau in Boras, Sweden, handled 200 customers in 1995 out of a total of 300 firms in the region; these were mainly small firms which could not afford to install such equipment. Similar bureaus are in operation in several countries, including Japan and USA.

The Islamic countries today can be broadly divided into three categories viz:

a) Those that have strong industrial base as well as a good S&T structure; these are 8 or 9 in number.

b) Those countries that have a fair Industrial base, but a weak S&T structure, numbering perhaps 20 or so;

c) Those that have poor Industrial base, being essentially agrarian or forest-based economies, with hardly any S&T structure; these constitute one half of the Islamic countries.

Clearly, we need to have separate S&T development policies for each of these three categories. The principles of upgrading the indigenous educational system, through bi-lateral support and help (within the O.I.C) would have to be a corner-stone of any Policy guideline.

5.3. Technology Development

For technology capability-building, policy interventions may be needed in three interrelated aspects: (a) to provide incentive structures that induce enterprises to build up and upgrade capabilities; (b) to develop complementary capabilities for these incentives (education, training and research); and (c) to provide a variety of institutions that support the efficient functioning of markets (especially to diffuse information and promote inter-industry linkages, for example). The objectives of policy instruments should be to diffuse technological innovations throughout the domestic industrial sector, assist in the creation of a core of generic technologies with multiple industrial applications, and develop an infrastructure for establishing technical norms and quality-control patterns.

The success of domestic enterprises depends on the availability of complementary assets in the economy. Governments should focus on creating complementary assets involving: (a) creation of specialized centres, to carry out development work on the basic research results produced by universities; (b) entrepreneurial promotion schemes; (c) venture-capital funds; and (d) research and training facilities in manufacturing technologies. Based on these complementary assets of a general nature, the enterprises will be able to develop specific assets and capabilities.

The policies should also aim at the full exploitation of the existing technology and infrastructure, by reforming the institutions and gearing them towards innovation. The policies should address, among other things, the issue of incorporation and enforcement of international standards, for products, processes and services, into domestic industrial setups.

Industry - Education Linkages: As new technologies are science-based, there is now a greater need to establish as well as strengthen the linkages between universities/research institutes and industry, especially in more advanced Islamic countries and economies-in-transition, where certain technological capacity already exists in both the academic and business sectors. Such linkages can be strengthened in several ways. Among them, two approaches appear to be particularly relevant:

(a) government should encourage their national research institutes/ universities to raise the funding for research projects - at least a certain proportion - from industry or other external foreign enterprises; this would induce research institutes to take up research projects that are of relevance to enterprises; and

(b) government should establish science research parks, close to reputed academic establishments and industry. Such parks would not only increase university-industry linkages, but firms engaged in similar activities, located at one place, would also have "agglomeration" effects, resulting in a collective benefit. Such parks should be thematic, as exemplified by electronics, biotechnology or software parks. Foreign enterprises should also be encouraged to invest in such parks, as the presence of the international technology-development activities could have a positive effect on domestic enterprises.

To sustain the university-industry linkages and to enable the academic sector to contribute to enterprise-development, the university systems in Islamic countries need to reorient their activities. Such reorientation includes: (a) **adaptation of curricula**, particularly in the engineering and science fields, to the changes and advances in science and technology; (b) strengthening basic training and continuing education; (c) **establishing closer linkages between research and teaching**; (d) **establishing a mechanism for the contracting of studies and research** in the form of collaborative university-industry ventures.

To build up technological capabilities and compete successfully in new technologies, large pools of scientifically and technically trained personnel are necessary. While investing in the building up of such manpower pools, it may be necessary to involve industry in manpower-planning exercises, education and R&D policies. Representatives from industry could be appointed to the governing boards of national research institutes/universities, as well as to the advisory councils of relevant ministries. More advanced Islamic countries and economies in transition need to make special efforts to strengthen their technology-base by upgrading their manufacturing capabilities. This may initially require acquisition of technologies from abroad. The policies need to focus on building technology-capability in applied sciences and technology and on complementary assets that can help to transform their strength in scientific knowledge into tangible products and processes. In most of these countries, technologies also tend to be concentrated only in a few segments of the economy. The policy needs, therefore, to address the issue of diffusion of technologies throughout the economy and in society. Special incentives should be given to upgrade their technologies. Seven thrust areas are identified namely: Biotechnology and Agro-based Industry, Healthcare, Micro-electronics, Nano-Technology, ICTs, Renewable Energy, Environment and Climate Change.

NIEs (Newly Industrialized Economies) have successfully mastered the downstream activities of production engineering. This is helpful in product-designing and in making improvements to process technologies. NIEs need to strengthen these capabilities further, specially in more complex and higher value-added activities, such as system-designing and manufacturing. Simultaneously, they also need to get started on the upstream activities of research and innovation, if they wish to advance their goal of catching up with the industrialized countries. This implies producing not only more engineers, as they do now, but also producing scientists in both natural and physical sciences.

As new technologies are increasingly introduced and adopted, there is a dire need that the general public is made aware of new developments in science and technology through science exhibitions, science programmes and panel discussions on the electronic media and establishment of science museums/ parks. This would encourage the younger generation to adopt science career and to aspire for innovations.

5.4. Outline Plan for Education, Science & Technology

This outline plan is built on the broad guiding principles of development viz. faith, values and goals, and has been drafted in the light of the strategy of Integrated Curricula and the needs for education at the various levels, as introduced in Malaysia and Indonesia two decades age. Due emphasis has been placed on the scientific and technological components of education at the primary, secondary, vocational as well as tertiary levels. These curricula have the merit of building on the indigenous socio-cultural base, right from the primary level. (A.Q.Kazi; T.Hussain & M.M. Qurashi (2006) J. Sci & Technology Policy and Scientometries, Vol.5, pp.3-21, also M.D Shami, "Education Science and Industry in the Muslim World", published by Institute of Policy Studies, Islamabad, 2003, p.82).

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The first and second rows in the Outline Plan deal with the progressive development and gradual implementation of integrated curricula at (i) Primary Schools and Technical Schools and (ii) Secondary, Vocational and Technical Schools. An effort has been made to divide the Plan, as far as possible, into successive five-year periods, with smaller sub-divisions of two years where needed. The integrated curricula can probably be fully made operational in the third five-year period.

In the third and fourth rows, the corresponding process has been outlined for the case of (i) Degree and Technical Colleges, and (ii) Universities and Institutes of Higher Learning. The success of this process will largely depend on two major factors: (i) the quality as well as quantity of the inputs from the first two educational levels, and (ii) the extent to which the college and university teachers can be made to accept and adopt the somewhat radical concepts and suggestions given above.

The last row gives a rough picture of the essential interactions required between Universities R&D and Industry, which would lead to technology-development, cooperation between industry and R&D institutes, ultimately resulting in the establishment of operative R&D groups within selected industries. This interaction would hopefully set the stage for the development of sound industrial policies, with special emphasis on technology development/transfer and Regional Cooperation in the long-term perspective.

Table A&B: Schematic Outline for Fifteen-Year Action Plan (2010-2023) in 3 phases

Table A

Phase – I			Phase – II		Phase – III
2010 – 2013			2014 – 2018		2019 – 2023
Framing/Development of integrated Curriculum Textbooks	Teacher Training at Primary Level	Integrated Curriculum Teaching at Primary Schools	Dialogue for Coordination between Madrasah & Traditional & Western type Education	Plan for Coordination on between Madrasah & Traditional & Western type Education	Integrated Curriculum made operational at Primary Schools and Madrasah & Traditional
Curriculum and Textbooks Development with emphasis on Practical in Secondary and vocational schools		Introduction of Group Activity in Secondary Schools and Vocational Schools	Training of Teachers for integrated curriculum at Secondary and Technical Schools Levels		Integrated Curriculum made operational at Secondary and Technical Schools level

Table B

Phase – I			Phase – II		Phase – III	
2010 – 2013			2014 – 2018		2019 – 2023	
Development of Curricula for Degree and Technical Colleges	Plan for Training of Teachers for Scientific Methodology at Degree and Technical College Levels, including a component of Social Sciences and Humanities		Cooperative Research Activity in Degree and Technical Colleges in emerging fields, e.g., Bio-Tech, Electronics, etc	Training of Teachers for integrated Curricula at Degree College Level	Training of Teachers for integrated Curricula at Technical College Level	Integrated Curricula to be made operative and Scientific Methodology at Degree & Technical Colleges
Plan for Curriculum Updating and Practical Activity at University Level		Plan for Research at University Level	Establish Practical and Group Activity at University Level	Establish R&D Groups in Universities and Institutes	R&D Groups to be made fully operational progressively at various Universities and Institutes	
Initiate Dialogue for University R&D Institute, Industry Cooperation	Initiate Proposals for Technology Development and Industrialization	Plan for University – R&D Institute-Industry Cooperation	Establish Operative R&D Groups in Selected Industries Outline Plan for Industrial Policy	Plan For Inter-Islamic S&T Policy Development of Industrial Policy	Undertake preliminary Technology Transfer and Development	Develop bilateral and international cooperation; Technology transfer and development

5.5. Schematic Base of Action Plan for Typical Islamic Countries

A basic plan to achieve the aims described above needs to be developed for various Third-World countries. It can be outlined as follows, with **four major thrusts**:

1. Sustained efforts shall be made to develop the creativity of the students by coordinated re-awakening of the latent moral & social values, emphasizing the cooperative, balanced and just way of life which had been the base for the early civilization's progress in knowledge and science. The foundation for this should, in fact, have been laid at the primary level, as in case of Indonesia and Malaysia, where the primary curriculum for classes I-III has been integrated into two books only; one integrating language, religion and science, and the other dealing with mathematics & its branches.
2. At each appropriate level, books on Traditional Studies should be included, presenting the religious/moral view, in coherent juxtaposition with the scientific and technological worldview, and recognizing that moral reformation has to precede the scientific and technical uplift of the community.
3. During the learning/teaching process, it should be incumbent upon the teacher to present himself as an exemplary person and to explore practical Religion-Science relationship;

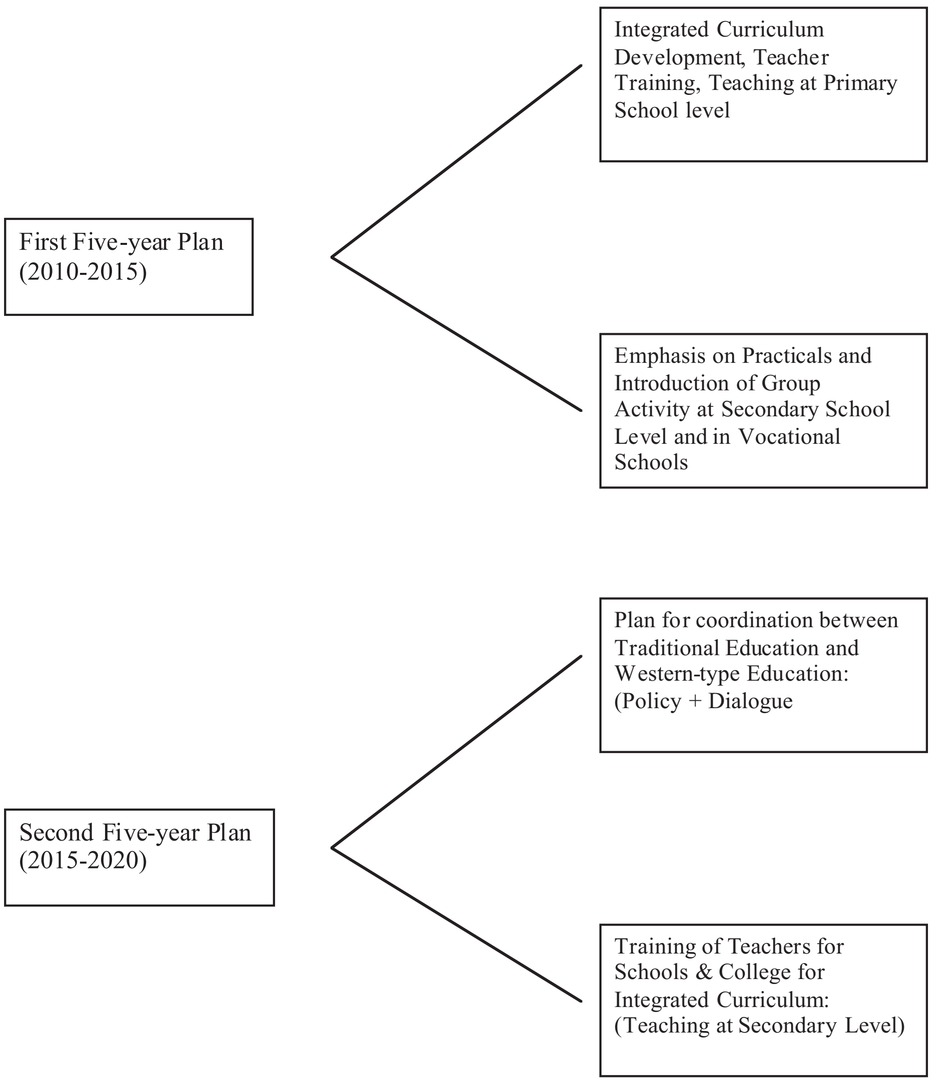
4. Teaching of Science should have three main aims:

a) To develop a rational and critical aptitude for observation of natural phenomena;

b) To inculcate mental skills to develop coherent theories of natural phenomena based on the observed data;

c) To enable persons to build on previous knowledge and work collaboratively for unraveling the laws of nature and using science for the benefit of mankind.

Chart 1-C
2010 - 2020



The effective dialogue between the leaders of Traditional and Western-type education would have a crucial role in the successful implementation of the above plan. An attempt has been made in Indonesia, Pakistan; other countries may follow the mentioned outline in selected modern and traditional schools.

In order to achieve these aims, it is imperative to make the history and philosophy of science during the last two millennia, an essential part of the curriculum of the science subjects. Philosophy of science helps to develop a holistic view of the universe and the interactions between culture and science. History of a particular science-subject should underscore the element of never-ending continuity of the scientific activity and the contributions made by the scientists from various civilizations in the pre-modern period. The lessons derived from this would translate into a fuller and integrated effect for the future of the Islamic Countries.

Indicated here Table 1(C) is a Ten-year plan base for the secondary level, broken up into two successive five-year periods, indicating the above-mentioned basic features. Individual countries would hopefully develop the details independently, bearing in mind the outcome indicated earlier for the third five-year period.

5.6. Some Concluding Thoughts on Technology Development in the Islamic Countries

Mytelka (1993) suggests that in African countries the focus should be on: (a) the process of technological innovation within enterprises rather than on scientific research in educational and research institutes; (b) involving users in the initiation, design and R&D phases of all projects, thereby assuring that users needs are being met; (c) estimating the formation of consortia within and across the countries, reducing costs and building the multidisciplinary needs for the innovation process; and (d) building competitiveness in African industry as one element in a broader integration of Africa into the world economy. Mytelka, L.K. (1993). *Rethinking development: role for innovation in the other two thirds*. Futures, Vol. 25, No. 69.

While such a task is underway, the overall S&T policy should aim to attract investments in downstream activities of production, such as assembling of parts or producing minor components (assembling TV or making TV cabinets, for example), which will also add to the learning process. In countries with small domestic markets, specially African countries, it may be difficult to attract such activities. Regional cooperation in the form of free-trade among the countries in the region may overcome such limitations of market size and foreign enterprises may be induced to use these countries as export platforms. The existing research-capacity in universities in the area of new description, such as biotechnology, may need to be exploited fully in developing tangible products and processes using local natural resources. Since natural resources are available in these countries for biotechnology products, it may also be easier to attract research-collaboration from industrialized countries.

In the case of certain African and other Islamic countries, the adoption of concept of "technology missions" may be an effective way of achieving Technological Capability Building (TCB) and competitiveness. Technology missions involve setting specific economic goals to be achieved in a given time-frame. The goals may be to achieve a certain share of manufactured goods exports as part of total exports or increase industrial production to a targeted figure by a targeted year. Once such a goal and the time-frame are specified, the selection and application of technology becomes important in achieving the goals in a cost effective and sustainable manner. It is important to remember that the modern research in necessary important fields is so expensive that only the funds from big industry can carry these through effectively. Therefore it is essential to foster and develop the effective linkages between industry and science established on all levels for enhancing the process of sustainable development.

CHAPTER 6

RECOMMENDATIONS

1. Development of education and S&T for economic welfare, to a large extent can only be achieved through a serious political will and Government's full financial support; planning for nearly 100 percent literacy in about 20 years.
2. For this purpose, different strategies would be needed for different levels of education, to be tailored so as to utilize the vast pool of manpower being educated in the indigenous system,
3. Better and more attractive careers and opportunities for teachers, scientists, engineers and technicians are to be created, so as to get the best out of S&T utilization. Appreciation and national honours should be given to R&D personnel in the area of S&T.
4. Emphasis on indigenous R&D, at international standards, on relevant topics through systematic interaction with advanced countries, sharing and mutually benefiting from the strengths of the OIC countries through extensive use of ISESCO, COMSTECH and I.D.B., etc.
5. Systematic use of indigenous S&T in the local industry, in improving quality and production in industrial units. This should include special attention to the development of a working cadre of "quality-conscious" Technicians at various levels, within the individual specializations.
6. An organized effort should be made to foster and fully develop the essential interactions between Industry, Technical Training Institutes, Universities and R&D Institutes, including representation on each other's governing boards and setting up science parks and Technology Incubators.
7. Creating means to spread culture of science in the public, through science exhibitions, media (TV) programmes, science prizes and regular "scientists-public' forums, with open discussions on TV. Use of media channels to spread the culture of S&T and its benefits to the people.
8. Constant liaison and communication with the political leaders, to keep them aware of the use of S&T for public welfare. A special fund should be created for developing and implementing "Integrated Curricula", especially in the lesser developed of the Islamic countries. This fund should be administered by the proposed Scientific Advisory Board.
9. Proper coordination and effective communication among various S&T organizations within the country and between countries, to make best use of the total S&T potential in the country.
10. The Consultative Council established for review of the Implementation of the Strategy for Promotion of Science and Technology in the Islamic countries need to give special attention to oversee long-term development and coordination of (a) Human Resources Development, and (b) Technology Development, for the various existing and upcoming industries, including: (i) Biotechnology and Agro-based Industries, (ii) Healthcare, (iii) I.C.T's, (iv) Microelectronics and Nanotechnology, (v) Renewable Energy, Environment and Climate Change.

ANNEXURES

Annexure 1(a)

A note on biotechnologies

Traditional and Modern Biotechnology:

Biotechnology is a collection of processes that involve use of advanced scientific techniques to alter and ideally improve characteristics of animals, plants and other forms of life. In brief, biotechnology is the application of science and engineering to the direct or indirect use of living organisms. Biotechnology has made possible the selective breeding of plant hybrids, as a result corn production in the United States quickly doubled and yields substantially increased in the rice and wheat growing countries. More recently, IRRI scientists developed "Golden Rice" through fortification of rice with vitamin A, which is now responsible for reducing blindness in Africa and Asia. Biotechnology allows faster and more accurate production of new and more useful microbes, plants and animals. Traditional breeding has had inconsistent results but biotechnology is precise. Biotechnology is a useful tool in combating food shortages, undernutrition and diseases. However, mechanisms have to be developed in the Islamic countries to safeguard and to protect from exploitation and eroding the existing biodiversity by the transnational corporations. The TNC are the greater gainer in the process of biotechnology development and the poor countries has become poorer by loosing their genetic resources. in the traditional method of plant breading, still followed in most of the Islamic countries, farmer used to plant seed generation after generation (at least 3 to 4 plantings), but the seed obtained through modern biotechnology, he can plant the seed only for one generation. (it is called terminated seed) and for next planting he has to buy seed from one of the four world companies. Thus dependence on his quality seed is eroded.

Traditional and Modern Biotechnology:

There are

Some uses of Biotechnology for improvement of agriculture, industry and health:

Agriculture:

Biotechnology has emerged as a new tool for the genetic improvement of crop using genes from diverse biological organisms. This has resulted in commercial release of soybeans, corn, cotton and other, crop varieties since 1996. Globally biotechnology has registered an unprecented 60 fold increase during 1996-2006 decade, and in 2006, the area under biotech crops stood at 102 million hectares. Presently the leading countries in biotechnology crop plantings are United States (68%) Argentina (22%) Canada (7%) and (China and Australia each one percent. The prime reason for adoption of biotech crop is that biotechnology offers more environmentally free solutions for increasing yields and shelf life, for improving tastes and avoiding plant diseases as compared to traditional agricultural practices. Biotechnology is useful in production of biofertilizer for commercial crop so as to avoid dependence on hazardous chemicals. Biotechnology is also utilized to identify useful genes for different quality traits to improve crop production. Increase in population, the continual loss of prime agriculture land to housing and industry, loss of quality soil shortage of wood based materials and quality timbers, low crop germination potential; all points towards biotechnology and its potential for plant improvement worldwide. Application of biotechnology to agriculture aims at accelerating the production of food and other agriculture products for industries and for export.

Industry:

Recent advances in mutagenesis and recombination DNA technology have permitted enzymes working parameters to apply for commercial production of enzymes for use in textile, feed, starch and detergent industries. Biosulfrization of furnace oil is an attractive process as it enhances quality and price of furnace oil by about 30%. Genetically engineered bacteria and fungi can provide hydrogen energy as an alternate to other sources of energy.

Health:

Biotechnology has improved molecular diagnostic tests for infectious and genetic disorder diseases and bulk production of therapeutic agents. Also has improved and made possible production of monoclonal antibodies for the diagnosis and treatment of malaria, typhoid, tuberculosis and hepatitis B&C (these diseases causing millions of deaths in Islamic world.). Gene therapy and stem cell therapy are being used for treatment of diabetes, cancer and other diseases.

Research Groups in Biotechnology:

There are several research groups in the Islamic countries working on various aspects of biotechnology, including ISESCO's expert panels and COMSTECH's Inter Islamic Network on Genetic Engineering and Biotechnology. There are 3 or more research groups on Biotechnology working in the ten countries under Category 1 including Pakistan but their effort is isolated and uncoordinated. But they need necessary support facilities, adequately trained manpower and finances for productive research with time targeted objectives. The concentration of research should be in areas like insect and disease, resistance in major crops, drought resistance, fermentation and enzymes production, fast growing trees, bacterial desulphurization of coal and petroleum, utilization of tissue culture techniques in flowers, fruits and vegetable crops, preparation of kits for early detection of cancer and other deadly diseases and improving animals production and health. These tasks need regional cooperation and precautions so as not to disturb the ecosystem. Supporters of biotechnology research are as concerned about its benefits as opponents are of the risks.

Management of Biotechnology:

Earth Summit 1992 document has a separate chapter dealing with environmentally sound management of Biotechnology dealing with increasing availability of food, feed and raw materials, improving human health, enhancing protection of the environment, enhancing safety and international mechanisms for cooperation and establishing enabling mechanisms for the development of the environmentally sound application of biotechnology. Some of the recommendations are still valid and applicable to our situations. They are summarized below:

- Increase the yield of major crops, livestock, and aquaculture species by using combined resources of modern biotechnology, including more diverse use of genetic material resources.
- To expend the use of biotechnology in forestry both for increasing yields and more efficient utilization of forest products.
- To promote the use of biotechnology, with emphasis on bio-remediation of land and water, waste treatment, soil conservation reforestation and land rehabilitation.
- Using the new tools provided by biotechnology, develop, inter alia, improved diagnostics procedures, new drugs and improved treatments and delivery systems.
- Evaluate the various biotechnology techniques to improve the yield of livestock, poultry, fish and other aquatic species.
- Exchange and compile information about the safety procedures in biotechnology.
- To strengthen the endogenous capacities to support research in order to speed up the development and application of biotechnologies and conservation.
- Raising public awareness regarding the relative beneficial aspects and risks related to biotechnology, and its contribution to sustainable development.

Annexure 1(b)

ENVIRONMENT AND CLIMATE CHANGE

Climate-change is different from other problems facing humanity and it compels us to think differently at many levels. Climate-change is a global challenge and requires a global solution. Climate-change is already having significant impacts in certain regions of the Islamic world, particularly the least developed countries, and will affect the ability of developing countries' of Islamic world to achieve the Millennium Development Goals (MDGs).

Climate-change threatens to erode human freedoms and the limit choices. The warning signs of the impact of climate-change are already visible. Today, we are witnessing, at first hand, what could be the onset of major reversal of human development in our lifetime. Across the Islamic world, millions of the poorest people are already facing the impacts of climate-change. How the Islamic community deals with climate-change today will have a direct bearing on the human development prospects of a large section of humanity. It will increase the inequalities within countries and it will undermine efforts to build a more inclusive pattern of globalization, reinforcing the vast disparities between the 'haves' and the 'have nots'.

The source of climate change is the “blanket” of greenhouse gases that occurs naturally in the atmosphere and serves the vital function of regulating the planet's climate.

Combatting the Greenhouse Emissions

Since the start of the industrial revolution some 250 years ago, emissions of greenhouse gases have been making this blanket thicker at an unprecedented speed. This has caused the most dramatic change in the atmosphere's composition since at least 650,000 years ago. Unless significant efforts are made to reduce emissions of greenhouse gases, the global climate will continue to warm rapidly over the coming decades and beyond.

The future rate of accumulation in greenhouse gases will be determined by the relationship between emissions and carbon sinks. There is bad news on both fronts. By 2030, greenhouse gas-emissions are set to increase by 50 to 100 percent above the levels of year 2000. Meanwhile, the capacity of the Earth's ecological systems to absorb these emissions could shrink. This is because feedbacks between the climate and the carbon- cycle may be weakening the absorptive capacity of the world's oceans and forests.

The first phase of the Kyoto Protocol calls for a 6-7% reduction of greenhouse-gas emissions below the 1990 levels by 2012, while the IPCC calculates that a 60-70% reduction in emissions is needed to stabilize atmospheric concentrations of greenhouse gases. It is necessary that only that amount of CO_2 be emitted into the atmosphere which can be absorbed by natural processes and, at present, we are overloading this capacity by 10 and 50.

Role of Developed Countries and Worsening Situation of the Poor, Due to Climate-Change

Developed countries have to take the lead. They carry the burden of historic responsibility for the climate-change problem, and they have the financial resources and technological capabilities to initiate deep and early cuts in emissions. Putting a price on carbon, through taxation or cap-and-trade systems, is the starting point. But market-pricing alone will not be enough. The development of regulatory systems and public-private partnerships for a low-carbon transition are also priorities.

Across the developed world, public concern over exposure to extreme-climate risks is mounting. With every flood, storm and heat-wave, that concern is increasing. Yet climatic disasters are heavily concentrated in poor countries. High levels of poverty and low levels of human development limit the capacity of poor households to manage climate-risks. With limited access to formal insurance, low incomes and meager assets, poor households have to deal with climate-related shocks under highly constrained conditions. What is saddening is the fact that the poor are already suffering, and will suffer more, as a result of climate change.

Need for Immediate Action

The Islamic world needs to act now! Only then will it be possible to keep 21st Century global temperature-increase within a 2°C threshold above pre-industrial levels. Achieving this future will require a high level of leadership and unparalleled international cooperation. Yet climate-change is a threat that comes alongwith an opportunity. Above all, it provides an opportunity for the world to come together, in building a collective response to a crisis that threatens to halt future progress.

With climate-change, every year of delay in reaching an agreement to cut emissions adds to the greenhouse-gas stocks, locking the future into a higher temperature. It should also be kept in mind that greenhouse-gas emissions have the same impact on the atmosphere, whether they originate in Indonesia, Saudia Arabia or Sudan. Consequently, action by one country to reduce emissions will do little to slow global warming, unless other countries act as well. **Collective action is imperative**, as no one country can win the battle against climate-change acting alone.

Adaptation is a process, through which societies make themselves better able to cope with the risks associated with climate-change. These risks are real and already happening in many systems and sectors essential for human livelihood, including water-resources, food- security and health. Delay in adaptation by Islamic countries will mean increased costs and greater risks to humanity in the future.

Governments of Islamic countries can play a major role by constructing policies and measures that address climate-change, including regulations and standards, taxes and charges, tradable permits, financial incentives, research and development programs, and information instruments.

Discussions on climate-change are moving with a new sense of urgency and openness, all around the world. Climate-change has been included in the agenda of several important international and regional meetings. The Islamic world needs to realize the importance of collaborating with the rest of the world, and moving ahead, to resolve the issue of climate- change.

Summary

The average global temperature has risen by 0.74°C during the last century, which is the fastest warming-trend in history. This trend is expected to rise in the future, as predicted by the climate projections. This situation needs to be addressed urgently by the Islamic world, in collaboration with the rest of the world. Climate-change has the potential to create human disasters, ecological collapse and economic dislocation on a far greater scale than we see today. It has direct impacts on our environment, such as more floods, pest infestations in forests; damage to agriculture and marine systems, and threat to one of the essential resource, water. Climate-change also indirectly affects all sectors of human activities.

The impacts of climate-change are having numerous adverse affects, one of which includes the worsening situation of the poor people. Disastrous events, such as tsunami in 2004 and 2006 earthquake in Pakistan, need to be countered proactively. Islamic countries should develop an action-plan encompassing precautionary measures to avoid such devastating damage. The problem of climate-change has to be resolved at present, or else the consequences will be unavoidable in the future. **Intermediate action is imperative**.

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Annexure 2(a)

Nano-technologies

What is Nano-technology

Nanotechnology is the technology where small-size materials are handled, used and products made out of these. How "Small" is the size of materials that are handled and controlled is the "real question" to understand its implications. The sizes handled and controlled are in measures of a few nano-meters, a nanometer being "one billionth" part of a metre. In terms of common understanding, a nanometer (nm)is about 10,000 times (one lakh) thinner than the "human-hair and, in terms of scientific understanding, it is the size of a few atoms or molecules: about 10 atoms make the size of 1nm. This obviously means that we, today, have such precise instruments that now we can handle molecules and atoms. When atoms and molecules can be seen, handled, and controlled in the laboratory, the smallness of the products and devices made out of these can be well imagined!

For a student of physics it is easy to understand when we say that bulk laws of Newton fail when we apply them for atoms and nuclei. The quantum theory is the one which then deals better with atoms and nuclei, rather than the classical (bulk) theories in Physics. In terms of bulk aspect the "human-hair" is indeed considered as bulk. Therefore when the sizes used for investigating the physical properties are of such **smallness**, which is thousands times smaller than the diameter of human hair, one can understand the type of high technology required, particularly when we try to catch a human-hair lying on a paper and we try to pick it up by using a tweezer or, for that matter, we try to pick up one particle of talcum powder with a tweezer. It is interesting to mention that today, in a laboratory or a factory, we have available a "laser-tweezer" (two beams of laser light) which can displace atoms and molecules within a solid. On the other hand, we have an instrument called Atomic Force Microscope (AFM), which can handle one atom or a molecule and put it at another place wherever we want. The Atomic Force Microscope is a power instrument, frequently used today to handle atoms and molecules for the experiments using materials at the nano-scale size. In biological materials proteins (the important items for our food & life) are being studied and handled using these precise instruments.

This small-scale handling of proteins in the range of nano-meter sizes, holds great promise for bringing a revolution in the areas of medicine and healthcare, so that the complete diagnostics and treatment of terrible diseases like cancer and AIDs is in sight. With laser technology we are already able to detect objects the size of a few millimeter or about the thickness of match-stick, but body-cell is several thousands times smaller; the detection of cancer at cell-size could enable complete cure at the cell-level. Similarly, mew drugs are being invented which will attack only the cancer cell as soon as it is produced and destroy it, then and there. This is the shape of the revolution in the field of medicine - at hand through nanotechnology, may be in the next 5 - 10 years!

Important Features of Nanotechnology:

Here are a few noteworthy aspects of Nanotechnology, which show the urgent need for Islamic countries to go into this, along with the advanced and developing countries. The time, however, is running out fast, and will not wait for us.

(i) It is the technology of manufacturing items of small size at the nano-scale i.e. the individual molecules and atoms. The engines and rivets of small size are being built. The engines of bio-chemical molecules have been built and recently in Japan (Osaka University) a robot of a "bull" of the size of 1 micron (as thick as a "human hair") has been built through atom-by-atom construction (just like a "brick by brick" construction or Lego game) and this robot is intended to go into the blood-cells and deliver pharmaceuticals for treatment of diseases. The bricks here are molecules of a plastic resin.

(ii) It is a highly precise technology, dealing with precision at atomic and molecular dimensions, and

(iii) It is highly multidisciplinary; having the intimate involvement of Physics, Chemistry, Biology, Engineering, Art and even the Social Sciences. Never before has a technology got so much inter-subject involvement.

(iv) It is highly commercial and economic oriented, so that the business community is coming to regard nanotechnology as one of the leading industries of the 21st century, competing with the telecom and fuel industries. By 2012, it is likely to be a trillion $ industry.

(v) The central thesis is that, within the realm of any researcher (of science or art) he would find his own way to use nanotechnology and improve the extent of his current knowledge or improve his existing product. "He does not need to go out of his main field, but search within it, going deeper and interacting with others who may matter for him". For example, a surgeon may have to interact with a materials physicist or materials engineer in order to understand the mechanical and corrosion properties of an implant (may be artificial hip joint, or parts of artificial heart, etc.) and know the precise details of its mechanical properties.

The spread of Nano-Industries:

A recent survey revealed that, out of 1500 companies doing Nanotechnology business in the world, over 700 companies are in USA alone. In academics about 300 Nano-laboratories are working in the universities and other centres of research in USA and, even at one compus, various departments are having separate Nanotech labs concentrating on separate areas of specialization in order to cover its different areas. Even the universities have set up Nanotechnology degree courses. So much so, that the first Ph.D. in Nanotechnology has come out at State University of New York in Albany, proudly advertised by this university on the web. The National Institute of Health (NIH) of USA has set up a specific centre, called Nano Cancer Centre (NCC), with about 144m $ allocated to the centre, for treatment of cancer and AIDs on cell - level in the next 5 - 10 years.

In China, over 300 organizations are involved in Nanotechnology and producing Nano-Materials of various kinds, be it metallic elements, compounds, alloys carbon-nabes, wires or nano-Porous materials.

Japan, where the term "Nanotechnology" was evolved as such, is spending more than 800m $ as government grant for Nanotech R&D.

Private companies of course invest heavily in Nanotech. In European countries, apart from individual country's own Nanotechnology programme, a collective European strategy for Nanotechnology has been prepared in detail recently in December, 2004.

With the interest on counter-terrorism and home-land security the US Government further involved ministries to invest in Nanotechnology apart from the open prospects of great commercial future of this technology.

Summary: Nanotechnology:

1. Nanotechnology: Small-scale study, use, and fabrication of extremely small-scale devices through control and manipulation of atoms and molecules.
2. A Nano-size (or a Nano-meter a unit of size at Nano-scale) is one billionth of a meter and is about 100,000 times smaller than the thickness of "Human Hair".
3. Highly strategic, Technical, Commercial Economic and Public Utility [1500 companies doing business]. Trillion Dollar by 2020.

Features:

- Making of Materials:

Particles and coatings: extremely hard (artificial diamonds), antibacterial, antiviral smooth coatings for industrial tools and medical use. Enhanced paints and glass, body implants, nano-pore membranes, energy storage, pollution control, cosmetics and sunscreens, textile coatings etc.

- Nano-biotechnology:

Human-device market, implants (biocompatible materials in prosthetics and reconstructive surgery, biosensors detection and analysis, drug delivery, etc.

*Energy and Environmen*t: Efficient energy storage, efficient batteries, efficient fuel-cell, energy distribution, solar-cells technology, insulating materials, photovoltaic cells, nanotubes, nano-filteration, nano-porous sorbants, pollution-control, efficient building-materials.

- Medicine:

- Prolong human life.
- Biotechnology, pharmaceuticals, biosensors.
- Treatment of Cancer/Aids at cell-size level.
- Nano-Crystals for tracing anti-bodies.
- Long life and biocompatibal implants (surgery and dentistry).
- Small-size machines, robots, to move in the blood cells and arteries etc.

- Computer Tech:

- More powerful computer fasten than all computers on earth put together.
- Data storage: all libraries of the world can be stored in space of inches.

- Nano-art:

Microscopically small sculptures - Osaka University has made smallest "bull" 10 micron long, the width of a human hair, atom by atom.

- Electronics and Photonics:

Infrared detectors, integrated optical circuits, Si-based photonics, optical integrators for increasing speed of computers LEDs, fibre optic applications, ultra-high - bandwidth devices for communication, thin-film fabrication.

- Quantum Computing:

- Use of single photon in optical fibres, to encode quantum information.
- Information Technology, storage of information.

- Other Uses:

Exotic Building Materials; Antiterrorism; Water Purification.

Annexure 2(b)

Mechatronics

Definition

Mechatronics is "the synergistic combination of precision mechanical engineering, electronic control, and systems-thinking, in the design of products and manufacturing processes."

The purpose of this interdisciplinary engineering field is the study of automata from an engineering perspective and serves the purposes of controlling advanced hybrid systems. The word itself is a portmanteau of 'Mechanics' and 'Electronics'.

Description

A Japanese engineer from Yasukawa Electric Company coined the term "mechatronics" in 1969, to reflect the merging of mechanical and electrical engineering disciplines. Until the early 1980s, mechatronics meant a mechanism that is electrified. In the mid-1980s, mechatronics came to mean all engineering that is at the boundary between mechanics and electronics. Today, the term encompasses a large array of technologies, many of which have become well known in their own right. Each technology still has the basic element of the merging of mechanics and electronics, but now also may involve much more, particularly software and information-technology. Compared to the traditional methods, the mechatronics approach is a more holistic approach to product-design, where the trade-offs between functional components are carefully considered for their impact on overall performance. Mechatronic principles have been successfully deployed in numerous applications, such as, hard drives, robotic manipulators, temperature control, and automotive systems.

Applications of Mechatronics

The following fields are believed to lie under the general category of mechatronics:

- Modeling and design
- System integration
- Actuators and sensors
- Intelligent control
- Robotics
- Manufacturing
- Motion control
- Vibration and noise-control
- Micro-devices and optoelectronic systems
- Automotive systems, and

- Other applications (Mechatronics is also used in animal production)
- This became feasible with the advancement of micro-electronics such as bio-sensors etc.)

Mechatronics in Islamic Countries

Mechatronics and its applications can enhance industrial productivity in developing countries. Its multidisciplinary approach is well-matched to the design of complex micro-positioning devices. Some universities in Turkey, Iran, Malaysia and Pakistan and other countries have already introduced this subject. However, there is dire need to build-up capacity and implement the technology in the industry of the Islamic world, over the coming decades.

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Annexure 2(c)

Sustainable Development

1. The Concept of Sustainable Development

The concept of sustainable development was launched by the Brndtland Commission on Environment Development in the report "Our Common Future' in 1987 and it was reinforced by the UN earth Summit in Rio de Janeiro (1992), further followed and developed by the announcements and recommendations by other regional and international conferences. The Brantland Commission defined sustainable development as the process to meet the needs of the present generation without compromising the needs of future generations. It is important that meeting the needs of the poor in this generation is an essential aspect of sustainability, meeting the needs of subsequent generations. There is no difference between the goals of development policy and appropriate environmental protection. Both must be designed to improve welfare.

Many Islamic countries have not yet achieved acceptable living-standard for their people. Economic growth that improves human welfare is urgently needed. The World Development Report 1992 suggested a threefold strategy for meeting the challenge of sustainable development viz:

- **Build on the positive links**: Policies that are effective in reducing poverty will help reduce population-growth and will provide the resources and knowledge to enable the poor to take a long-term view.
- **Break the negative links**: Rising incomes and technological advances make sustainable development possible, but they do not guarantee it. Effective environmental policies and institutions are essential.
- **Clarify and manage the uncertain links**: Investment in information and research and the adoption of precautionary measures, such as safe minimum standards, where uncertainties are great and there is a potential for irreversible damage or high costs in the long run.

The sustainable development hinges on proper balance of actions of a few rich people, on one end and the millions poor people at the other end. The advanced countries, with high per-capita income, spend more lavishly on home comforts, communication, more & nutritious foods, liberal use of energy resources, fighting new diseases and, in turn, causing air, water and environmental pollution; the poor in the developing countries suffer for want of minimum daily-food, diseases, poverty and natural disasters often due to their own actions like soil erosion, deforestation, etc. The meetings, workshops, TV programmes, newspapers and other electronic media can play an important role to educate the people on the street about interactions between environmental and economic development and the consequent effects on sustainable development.

1. Human Activity and Negative Sustainable Development

The indiscriminate use of limited natural resources has continuously led to environmental degradation, unsustainable development and human miseries.

For instance, the process of desertification causes severe soil-erosion, declining agricultural productivity, increased cost of food production, reduced rural income, flight of population to towns and cities, ultimately leads to social and political instability. Another area that needs immediate attention is climatic change, which is damaging human development. In drought-prone countries of the Islamic world, children aged five or less are respectively 36 and 50% more likely to be malnourished if born during a drought. In Niger children aged two or less born in a drought-year where 72 % more likely to be stunted. Climate change will effect rainfall, temperature and water-availability for agriculture in vulnerable areas. Changed run-off patterns and glacial melt will add to ecological stress, comprising flows of irrigation water and house settlements in the process. Sea level could rise rapidly, with accelerated ice-sheet disintegration. Global temperature increase of 3-4oC could result in 330 million persons being permanently or temporarily displaced, through coastal flooding (e.g. Bangladesh, Maldives, Pakistan). Around one half of the world's coral reef systems have suffered as a result of warming seas. Increased acidity in the oceans is another threat to marine ecosystems. Climate change is providing avenues for major killer-diseases to expand, additional millions of people are exposed to malaria and dengue fever. The human activity in the process of development leads to disaster and unrepairable damages, if not properly managed.

3. Actions Required Toward Sustainable Development

The Islamic countries shall cooperate in the exercise for utilizing natural resources and traditional plant and animal species in order to produce and conserve the energy and reduce carbon emissions. Setting targets for sustainable development is a first step. Translating targets into policies is politically more challenging. Some of the priority areas for R&D at national and regional levels are mentioned below:

1. Multidisciplinary approach to forecast, monitor and maximize natural hazards, like floods, storms and earthquakes
2. Determination of the carcinogenic, mutagenic and tetragenic effects of various known pollutants and control of communicable diseases
3. Industrial research on processes for reducing solid, gases and liquid wastes, and ensuring better waste utilization.
4. Intensive experiments to determine effects of sea and river pollutions on growth and planktons of fish and plankton.
5. Development of salt-tolerant crops, adapted to withstand the arid environment, and introduction of species to check the desertification process.
6. Pool the resources and expertise to conserve the ecosystem and to utilize the biodiversity for the beneficial purposes (e.g. biotechnology in improving agricultural productivity)
7. Identification of appropriate and legitimate mechanisms for the monitoring and regulation of actions that affect the environmental process.

The comprehensive and far-reaching program of actions for sustainable development is given in Agenda 21, adopted in 1992. It has not been implemented in Islamic countries. Regional cooperation and coordination activities within the ISESCO system are crucial for economic development. And, above all, the Islamic countries should collectively participate in the programs launched by various organs and institutions of the United Nations.

Considering the importance of sustainable development and its daily effects on all section of the population in the Islamic countries, it is proposed to create a separate Authority for Sustainable Development to identify appropriate and legitimate mechanisms for the monitoring and regulations of actions that affect the environment and development process.

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