UNITED NATIONS

E

Distr.
LIMITED
E/ESCWA/TECH/2002/WG.1/28
15 July 2002
ORIGINAL: ENGLISH

Economic and Social Commission for Western Asia

Forum on Technology, Employment and Poverty Alleviation in the Arab Countries
and
Consultative Committee on Scientific and Technological Development
First meeting
Beirut, 16-18 July 2002

TECHNOLOGY AND INNOVATION IN THE ARAB COUNTRIES; STATUS, TRENDS AND FUTURE NEEDS

Note: This document has been reproduced in the form in which it was received, without formal editing.

02-0439

TECHNOLOGY AND INNOVATION IN THE ARAB COUNTRIES; STATUS, TRENDS AND FUTURE NEEDS

by

Technology Section
Sectoral Issues and Policies Division
ESCWA
Beirut, Lebanon

Disclaimer

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, on concerning the delimitation of its frontiers or boundaries.

Mention of firm names and commercial products does not imply the endorsement of the United Nations.

Bibliographical and other references have, wherever possible, been verified.

This document is reproduced without formal editing.

02-.....

Abstract

Very few would dispute the risks of further marginalization awaiting the developing countries unless they harness new technologies for socioeconomic development. Few would also contest the fact that new technologies will need to be properly assimilated with due care to their environmental, social and cultural implications in order for the developing countries to achieve concrete benefits in improved competitiveness, productivity, and environmental amelioration.

The present paper briefly discusses the state of science, technology and innovation in the Arab countries and outlines recent trends and future prospects for their development as essential prerequisites in dealing with the multitude of social, economic and cultural challenges they face.

In reviewing relevant policy approaches, emphasis is placed upon the formulation of national policies that address the totality of issues that face capacity building in science, technology and innovation. Specific issues are considered in reference to future capacity building within selected areas of technological development, namely, information and communications technologies (ICTs), biotechnology, new materials technologies and environmentally sound technologies.

The conclusions and recommendations of this paper are presented in the form of a regional agenda for action on "Technology, Employment and Poverty Alleviation," providing a framework for collaboration between concerned national, regional and international organizations. This initiative is designed to help harness new technologies for achieving the objectives of the Millennium Declaration and a host of other more specific social, economic and cultural goals

CONTENTS

OUTLINE

Very few would dispute the risks of further marginalization awaiting the developing countries unless they harness new technologies for socioeconomic development. Few would also contest the fact that new technologies will need to be properly assimilated with due care to their environmental, social and cultural implications in order for the developing countries to achieve concrete benefits in improved competitiveness, productivity, and environmental amelioration.

The present paper briefly discusses the state of selected new technologies in the Arab countries and outlines current trends and future prospects for their development as essential prerequisites in dealing with the multitude of social, economic and cultural challenges they face.

In reviewing relevant policy approaches, emphasis is placed upon the need to formulate national policies to tackle the full range of issues facing capacity building in science, technology and innovation. Specific issues are considered in reference to future capacity building within selected areas of technological development, namely, information and communications technologies (ICTs), biotechnology, new materials technologies and environmentally sound technologies.

The conclusions and recommendations of this paper are presented in the form of a regional agenda for action on "Technology, Employment and Poverty Alleviation," providing a framework for collaboration between concerned national, regional and international organizations. This initiative is designed to help harness new technologies for achieving the objectives of the Millennium Declaration and a host of other more specific social, economic and cultural goals.

PART I - GLOBAL TRENDS IN TECHNOLOGY DEVELOPMENT AND DIFFUSION

Greater reliance on science, technology and related innovation is being manifested in all spheres of human endeavour. The accelerating pace of new technology-based innovations poses both challenges and opportunities for resolving a variety of problems that face humanity in combating environmental pollution, land degradation, water scarcity, food production, poverty and social unrest.

The volume of world output in science, technology and innovation continues to grow at an exponential rate. This growth rate is, however, largely due to S and T institutions in the public and private sector in the developed countries.

I.1 Research and Development Activities:

By and large, research and development (R and D) activities aimed at the creation of new technologies are presently carried out in the developed countries, by multinationals and other private sector concerns, university laboratories and major research centers. Many process development activities are carried out in response to the needs of industry, agriculture and services in the these countries. A good deal of product development, on the other hand, is geared and high-income consumers. As a result, only 10% of global health research, for example, focuses on illnesses that constitute 90% of the global disease burden. Agricultural and energy research may also be demonstrated as focusing on specific needs by the developed countries while those of the developing countries continue to be neglected.

International and inter-institutional collaboration in R and D have witnessed significant strides during the past two decades, in particular. Prominent examples include a host of international programmes undertaken by

regional groupings such as the European Union. Collaboration in science and technology has even become widespread between commercial enterprises, including multinationals, with focus on pre-competitive research.

Additionally, the future of R and D activity in many of the world's leading universities often hangs in the balance pending availability of research grants from industry. The future will probably witness even wider R and D collaboration spurred by recent developments in information and communications technologies (ICTs) and the rise of new institutional forms leading to the creation of "virtual research and development centres."

I.2 Diffusion of Technologies:

Global diffusion of technology has been anything but even. Thus, around 80% of the world's Internet users inhabit OECD countries. Bandwidth possessed by the city of Sao Paulo in Brazil exceeds the total international bandwidth available to all African nations. Even some of the more obsolescent technologies have not yet reached the world's poor. Electric power and traditional antibiotics are yet to reach one third of the world's population.

I.3 Public Support for Technological Innovation:

Support by governments in the developed countries has been massive. Public involvement in support of technology development and dissemination in the developed countries has been maintained at between 2-3% of GNP in most developed nations, while most developing countries are yet to break the 1% barrier.

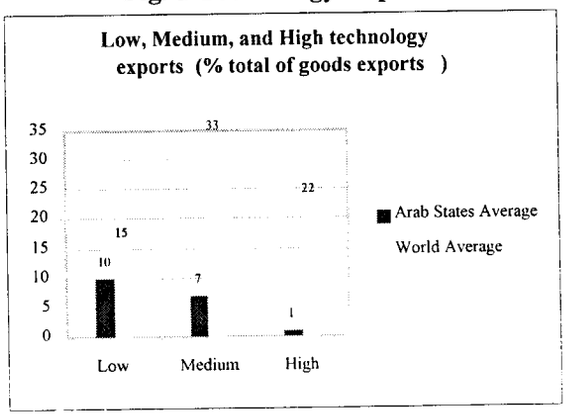
Public funding and incentives for endogenous technology development, adaptation and dissemination are planned so as to create legislative, regulatory and investment frameworks that support STI activity. A good deal of spending in the developed countries is designed to compensate for market failures. This, has not taken place to any substantial degree in the developing countries in general, the Arab countries included.

I.4 Measuring Progress in Technology and Innovation:

Progress in technological development and innovation is measured with reference to a variety of indicators:

- input indicators that refer to expenditure on R and D and higher education etc.;
- output indicators such as published papers, registered patents;
- technology implementation and innovation-related indicators that highlight licensing agreements and the ratio of high to low technology exports versus corresponding and imports. Refer to Figure 1. below.

Fig. 1 Technology Exports



Source: HDR 2001

In general the developing countries, including the Arab countries, have yet to address the need for the collection and analysis on information leading to appropriate use of these indicators in guiding effective decision-making in technology development and innovation.

I.5 Lessons for the Developing Countries:

Recent experiences of numerous developing and newly industrialized countries have repeatedly demonstrated that reaping the benefits of new technologies is contingent upon astute policy design, the presence of coherent infrastructural capabilities and an environment that is conducive to innovation, supported by close observation of current global trends in science and technology development. The following are issues that need to be taken into account in providing better bases for harnessing new technologies for sustainable development with emphasis on enhancing national and enterprise performance as well as employment creation.

Another important lesson based on recent developments in the developed and industrializing economies is the need for novel strategies and new institutional modalities often involving as yet untested partnerships between governments and private enterprise at the national, regional and global levels. Such partnerships are likely to play an important part in addressing the numerous threats and challenges facing future socioeconomic development efforts in the Arab countries.

PART II - AN OVERVIEW OF S AND T PERFORMANCE IN THE ARAB COUNTRIES

II.1 Science and technology policies:

It is often that S and T policy directives formulated in the Arab countries are dispersed in a multitude of public statements, declarations and recommendations, rather than a single coherent document that has been subjected to public and specialist debate.[1] This, naturally, leads to inadequate implementation strategies and end results.

At any rate most documents produced with the intention of furthering scientific and technological capabilities in the Arab countries have often tended to adopt general and somewhat modest goals.[2][3] Furthermore, there are no indications that even some of the more limited policy goals could be met with currently existing implementation strategies and resource levels.

Nevertheless, change is underway, with Egypt, Jordan, Kuwait, Lebanon, Saudi Arabia and Syria having taken significant steps to formulate more self-consistent S and T policies. Other Arab countries will most likely follow suite.

New and revised S and T policies will be required to address the challenges of globalization, environmental degradation and socioeconomic development, in general. The experience of a number of developing countries clearly show that integrating innovative practices in all aspects of socioeconomic activity may only be addressed through appropriate policies, adroit implementation strategies coupled to new modalities for cooperation among national, regional and international partners. The importance of including well-defined social goals in the formulation of the above policies, strategies and cooperation schemes cannot be overemphasized.

II.2 S and T orientations:

---

[1] Such comprehensive efforts have been carried out with support from international organizations as well as agencies of the United Nations system.

[2] Thus, a good deal of policy frameworks presently in place essentially address national S and T development rather than the creation of coherent systems of innovation.

[3] For example, in terms of institution building, research and development (R and D) activities, and the number of S and T graduates.

Information and communications technologies (ICTs), biotechnologies, new materials technologies capture a sizeable proportion of resources in the developed countries. By comparison, the majority of developing countries, including many of the Arab countries dedicate most of science and technology expenditure in traditional technology areas and scientific disciplines. In sectoral terms, a good deal of public expenditure on science and technology in the developing countries, is dedicated to agriculture, engineering and medicine.

II.3 S and T output:

S and T output in the Arab countries is also growing but at a very modest rate. An indication of this growth is provided by Table 1, which presents a view of the growth of patents registered in the United States by some Arab countries in comparison with a few other countries for reference purposes.[4] It should be mentioned that at least in some cases, some of the patents filed in the United States from ESCWA member countries originate from institutions and individuals working for multinationals and other foreign firms.

However, the level of patenting activity in all the countries for which data is available is still exceedingly small, even when compared with developing countries such as Chili. It is noteworthy that patents produced by all of the Arab countries during the period covered by Table 1 is less than one twentieth the number of patents produced by Israel.

II.4 Arab countries' performance in the acquisition and use of new and conventional technologies:

Table (A.1) ranks countries in terms of a "Technology Achievement Index (TAI)," developed by the United Nations Development Programmme (UNDP) and computed on the basis of eight indicators relating to activities in technology creation, diffusion of both recent and old innovations and human skill formation.[5]

Only four Arab countries, for which data is available, namely Algeria, Egypt, Syria and Tunisia, are included in the 2001 TAI ranking.[6] One of the most glaring features of these, and similar other tables on S and T development in the Arab countries, is the lack of information about major features of the S and T scene in the Arab countries without which reliable decisions aimed at in STI capacity building would be impossible.

Dearth of information aside, available data present a rather dim picture of STI capabilities in the Arab countries. Arab countries are missing out on new technologies and lag behind even in some conventional technologies. Thus, the Arab countries are lagging behind with respect to PC and Internet host and user densities, and other relevant indicators. Figures (2-6) present a graphic view of the position occupied by the Arab countries in comparison with country groupings and world averages. Indicators used in these comparisons are based on new technologies, such as PC dissemination, Internet use and top-level domain name density as well as traditional technologies, e.g. fixed telephone line density, use of tractors and fertilizers in agriculture.

---

[4] A review of patents registered in Arab countries would need to be carried out in order to obtain the full picture. However, information about such patents is generally not readily available. Additionally, registering a patent in the United States is often taken as an indication of the commercial importance of the patent in question and the intention to defend its infringement.

[5] Table is excerpted from a large base of data presented in last year's Human Development Report produced by the United Nations Development Programme. The report introduces a "Technology Achievement Index (TAI)," that is computed on the basis of indicators relating to the level of "technology creation", diffusion of both recent and old innovations and human skill formation.

[6] This is out of a total of seventy-two countries ranked using TAI.

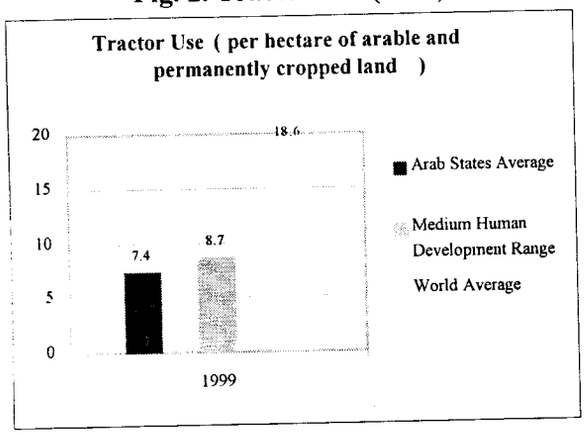
Table 1: Patenting activities.

Country	No. of US Patents			
	1986-1990	1991-1995	1996-2002	Total
Algeria	1	3	6	10
Bahrain	0	1	5	6
Egypt	14	23	49	86
Iraq	5	0	0	5
Jordan	2	2	19	23
Kuwait	17	7	43	67
Lebanon	0	0	0	0
Libya	0	1	3	4
Mauritania	0	1	0	1
Morocco	14	8	20	42
Oman	0	1	4	5
Qatar	0	0	1	1
Saudi Arabia	33	47	119	199
Sudan	1	0	0	1
Syria	3	2	9	14
Tunisia	4	5	4	13
UAE	5	9	23	37
Yemen	0	1	2	3
Arab Total	**99**	**111**	**307**	**517**
Chile	21	47	92	160
China	217	357	1422	1996
Israel	1476	2072	5637	9185
Korea	9	12	12	33

Source: uspto.gov updated through May 21, 2002

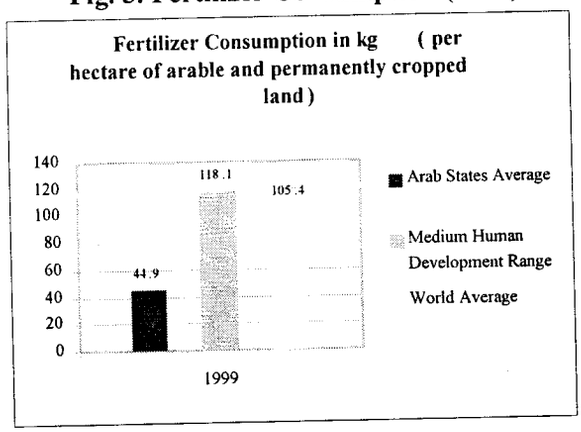
Key: ESCWA member countries
Arab countries
Other countries

Fig. 2. Tractor Use (1999)



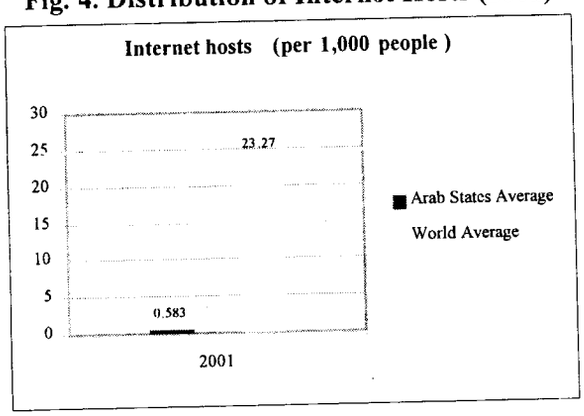
Source: HDR 2001

Fig. 3. Fertilizer Consumption (1999)



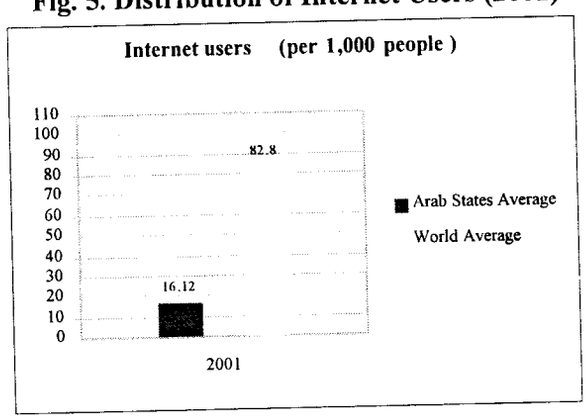
Source: HDR 2001

Fig. 4. Distribution of Internet Hosts (2001)



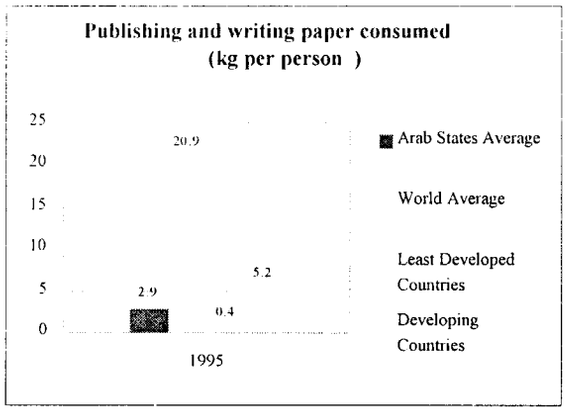
Source: ITU 2002

Fig. 5. Distribution of Internet Users (2001)



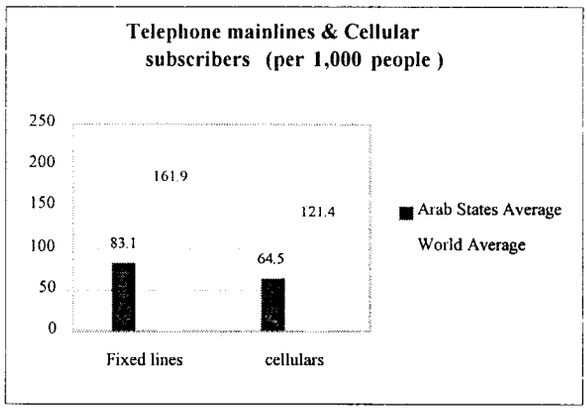
Source: ITU 2002

Fig. 6 Publishing and writing paper consumed (1995)



Source HDR

Fig. 7. Telephone and Cellular Use (2001)

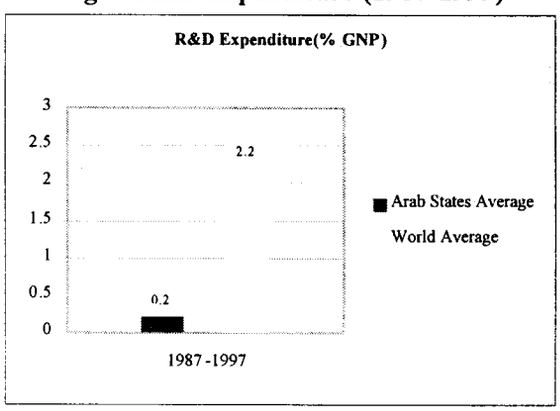


Source: ITU 2002

II.5 Research and development expenditure and manpower:

Expenditure on R and D activities in the Arab countries remains exceedingly low by international standards and even in comparison to industrializing and some developing countries. Most Arab countries spend around 0.2% of their respective GNP values on R and D activity. This is less than one tenth the ratio in the developed countries and 1/12 of R and D expenditure by Israel. This is to be contrasted with spending by other developing countries such as Chili, which spends around 0.7 of its GNP, Turkey and Iran, each spending around 0.5 of their respective GNP. Refer to Fig. 7 below

Fig. 8 R&D Expenditure (1987-1999)



Source: HDR 2001

R and D indicators covering the period 1987-1997, Table (A1.c) provide ready comparison of R and D expenditure as a percentage of GNP, and R and D expenditure in business as well as the number of scientists and engineers engaged in R and D activities. R and D expenditure as a percentage of GNP in the Arab countries listed in this table is the lowest among all countries included.

The number of scientists and engineers engaged in R and D activities is highest in Egypt in comparison to other Arab countries quoted in this table. Indeed this figure is rather high in comparison to a number of other countries in the medium human development category. See Table A1.

II.6 Human resource development:

Chart (A1.b) provides a view of growth of mean years of schooling for five Arab countries for which data is available. A rather disturbing feature in human resource development is the fall in the rate of growth of mean years of schooling in all five countries starting in 1990. Statistics on net enrollment of girls in secondary schools provide another troubling feature on human resource development in the Arab countries. Thus, out of the only twenty-seven countries in the world in which the enrollment of girls dropped by more than 5%, between the mid-1980s and 1997, five were Arab countries.7

II.7 Summary:

Creating technological capacity in a given country may proceed through a number of modalities. Three of these modalities generally account for the largest contributions. These are, firstly, contributions from national R and D activities, as well as activities conducted though collaboration with concerned foreign institutions or regional and international organizations. There is, secondly, direct acquisition of new technology inputs, often carried out by private sector concerns in the developed and industrializing countries. There is, thirdly, the "trickling effects" of foreign direct investment (FDI).

The picture in the Arab countries is not promising on all three fronts. The above paragraphs have alluded to the low R and D funding levels that are virtually ubiquitous in all Arab countries. Difficulties in tapping new technologies from FDI activities are practically legendary. Direct technology acquisition remains the main conduit through which new technology may be accessed and disseminated in the Arab countries. This modality is not without its problems for reasons that fall beyond the scope of this paper. Suffice it to say that a good deal of technology acquisition takes place at the behest of public and joint public/private institutions in areas relating to the extractive and industries and in infrastructure building, that lack the dynamism and the incentive to replicate successes when these occur. Furthermore, technology acquisition occurs for the most part through "black box" modalities in which minimal or no involvement by local STI professionals is evident.

The cause of technology transfer and dissemination in the Arab countries would be well served, should these countries choose to coordinate their strategies and arrive at a common stand in negotiations on crucial issues impacting efforts to help the developing countries bridge the technology divide, such as R and D in new technology areas, differential pricing and support for intellectual property rights (IPRs), protection of traditional knowledge and new means for compensating the developing countries for their genetic resources and for losses due the brain drain.

When insufficient resources are taken together with losses due to "brain drain" and inadequate linkages between S and T institutions and end users in the production and services sectors, little wonder remains that S and T systems in the developing countries perform inadequately.

---

7 Namely, Bahrain, Iraq, Kuwait, Qatar and the Syria.

While the picture drawn by the above statistics, is certainly not encouraging, signs of some improvement in certain areas are discernible. Thus, there are moves to improve new technology infrastructures and enhance access to the Internet in countries such as Egypt, Tunisia, Morocco and Jordan.

Efforts aimed at setting up new R and D facilities and revamping old ones have also been taking place for over a decade. New specialized centers have been set up by countries such as Saudi Arabia and Egypt. Yet, with the exception of a few cases the private sector's contributions to R and D activities remain minimal and its support for national STI capacity building limited.

PART III - SELECTED NEW TECHNOLOGY TRENDS AND FUTURE DIRECTIONS

III.1 INFORMATION AND COMMUNICATIONS TECHNOLOGIES; SOME RECENT TRENDS:

What is frequently referred to as the "ICT revolution" in the past decade is mainly due to advances in hardware and software technologies enabling modern networking technologies, particularly as embodied in the Internet. Current developments in mobile technologies should lead to further and more profound transformations with wide implications for socioeconomic development and enterprise competitiveness.

III.1.1 Advances in microelectronics and the manufacture of electronics: Advances in microelectronics have permitted:

- quadrupling microprocessor power every three years;
- rapid increases in personal computer (PC)storage capacity;
- improvement of ICT systems' reliability;
- drastic lowering of ICT systems' cost/performance ratios.

Approaches to the manufacture of electronics equipment, including ICT devices, is changing drastically, fueled at least in part by technical change. Emphasis is on the need to innovate, attain rapid market access and achieve competitive edge on quality and price bases. Designers of electronic systems are no longer also their manufacturers. For example, electronics-manufacturing service providers (EMSPs) can produce products under contract and may even help in the design of customized manufacturing facilities. This presents start-ups in Arab countries with opportunities to develop and produce quality goods without the need to acquire costly machinery and the expertise that goes with it.

III.1.2 Software technology: Software technology advanced at a breathtaking pace during the past decade. This was undoubtedly due to the ever-increasing power of the PC and the rapid expansion of the Internet. Sophistication, user-friendliness and "intelligence" that are presently integrated in modern software will undoubtedly be of great benefit in allowing interfacing with new ICTs by poor and illiterate populations. Mass production of software packages for a large spectrum of applications at affordable prices has also increased business reliance on ICTs and stimulated software production with considerable promise for improvements in enterprise competitiveness and growth.

III.1.3 The Internet: Launching the World Wide Web (WWW), a user-friendly application has simplified Internet use, rendering it an extremely popular medium for a variety of personal and commercial applications. The Internet holds enormous promise as a universal platform for global applications such as telework, e-commerce, distance learning and training, IP telephony, and videoconferencing, playing the role of a global virtual computer.

III.1.4 Developments in mobile technologies: Mobile technology, with its Global System for Mobile (GSM) communications standard, demonstrated a natural evolution path towards multi-media services. The introduction of third generation wireless networks heralds a global revolution in high-speed visual and verbal communications, at offers high-speed voice, data and video communications all the power they need, on a single device, with a single contact address or number.

The implications of these and other new ICTs will be nothing short of phenomenal. Given appropriate policies and an environment that is supportive of technology-based innovation they will contribute greatly to improved enterprise performance and employment creation.

III.2 ICTs IN THE ARAB COUNTRIES; STATUS AND FUTURE PROSPECTS

Data presented in section ... above focused on the diffusion of, or access to new ICTs. Information on activities pertaining to ICT policies, and other activities aimed at ICT system's development and manufacturing in the Arab countries is presented below.

III.2.1 ICT policies in the Arab countries:[8]

High level governmental bodies, including ministries and ministries of state, and non-governmental institutions have recently been set up to promote ICT policy formulation and the development and dissemination of ICTs in the Arab countries. Some Arab countries have already embarked upon the formulation of national ICT policy/strategy documents.[9] Thus, Saudi Arabia and Oman, for example, are engaged in formulating ICT policies and related strategies. The focus of many such policies has been on infrastructure building and extension, on the one hand, and administrative development, on the other. ICTs in education and training have so far received limited interest in comparison.

Tackling future ICT development in the Arab countries will require action on a number of related fronts. In particular, the need to set national and sectoral ICT policy objectives that are firmly based on actual demand considerations and established needs in balance with demand creation and expansion, has to be emphasized. Another crucial issue is enabling alliances, national, regional and international to accelerate capacity building.

III.2.2 Linguistic and cultural obstacles facing ICT development in the Arab countries:

While linguistic and cultural obstacles may play an important retarding factor in the diffusion of certain ICTs, they should, on the other hand, galvanize more effective cooperation among the Arab countries. Fostering such cooperation will need to be taken into account in national ICT policy design with wide scope for private enterprise contributions.

III.2.3. ICT legislation, standards and regulatory arrangements:

Despite urgent needs, serious efforts in ICT-related legislation are yet to materialize in many of the Arab countries. Particular attention must be drawn to the need for accelerating deregulation of the telecommunication sector with a view to promoting competition and providing a wider range of services at lower costs. Issues to be singled out for priority attention in the design of new legislative and regulatory frameworks include:

---

[8] Social and economic aspects relating to ICT policies and strategies in the Arab countries are further discussed in the companion document (TEP ppr. 1).

[9] Some of these activities have been conducted with the help of the United Nations Economic and Social Commission for Western Asia (ESCWA), the United Nations Development Programme (UNDP) and other international and regional organization.

- formulating intellectual property rights regimes and corresponding regulations as well as means for their enforcement;
- enacting laws to regulate transactions over the Internet, including commercial exchange, with particular attention to consumer protection and fraud prevention;
- legislating incentives for ICT industries comparable to other industrial sectors;
- allowing enterprises and individuals affordable access to the Internet and to international telecommunication with emphasis on promoting e-commerce;
- adopting common standards and protocols for Arab language ICT applications.

III.2.4 ICT manpower in the Arab countries:

While some Arab countries have been relatively late in catering for their own skilled manpower needs in ICTs, most have sought to create university faculties and departments since the late seventies. The number of relevant intermediate technical training and support institutions is meager but on the rise in most Arab countries. Often, training offered in many such institutions has tended to proceed without the necessary national regulatory and accreditation frameworks and without sufficient reference to market needs. Furthermore, it is seldom that participants in such training are offered hands-on experience in practical situations. All of this, naturally, reflects negatively on training quality.

III.2.5 ICT industrial activity in the Arab countries:

The Arab ICT industry is still in its infancy. In effect, most activities undertaken by enterprises in the Arab countries are directed towards: software development, limited hardware assembly and related services.

Software development: Software development (SWD) is its most prominent component. The private sector is the main contributor to software development with some firms[10] carrying out R and D in Arabisation and development of indigenous application software with Arabic interface. Limited activity in Arabisation is also undertaken by a small number of public sector institutions.

The fact that SWD does not enjoy recognition as an industry in its own right in most countries, and the lack of quality standards for its operations tend to reduce competitiveness and future prospects. More recently, however, Egypt and Jordan embarked on national initiatives, sometimes jointly with TNC partners, to promote development of quality software for export and succeeded in reaching reasonable levels of exports estimated to be around US$500 million for Egypt and US$150 million for Jordan in 2001.

Hardware assembly: Understandably, the manufacture of microelectronics components, has not shown any significant penetration in the region, despite timid efforts in Iraq, Egypt and Syria. A full-fledged industrial cycle in the manufacture of ICT equipment may, however, become economically feasible provided significant market integration is achieved. Manufacture of infrastructural components, such communication equipment including fiber optic cables, telephone exchanges and control equipment is expanding in several Arab countries, mainly to satisfy local needs. Export activity is emerging in a small number of cases.

PC assembly lines exist in many Arab countries. Many existing facilities may be uncompetitive, with costs sometimes exceeding international prices for similar equipment and with technologies evolving, at a lightening pace that local assemblers cannot keep up with. Some ICT applications are infiltrating as feeder industries to other segments.

ICT services: Expansion in Internet and mobile telephony is spearheading growth in an ICT service industry in most of the Arab countries. In particular, private ISPs are present in most Arab countries, and are growing in number with the increase of Internet users. Mobile telephony is also expanding in all Arab countries leading to an expansion in the private GSM operators and offered services.

[10] Particularly Al-Alamieh (Sakhr) with R and D being carried out in Kuwait and Egypt.

III.2.6 Alliances and partnerships in the ICT industry:

Alliances and partnerships in technology development and dissemination have acquired added importance during the past few decades. For the most part these alliances have been with TNCs rather than with other Arab operators. Internal alliances and partnerships, i.e. within the Arab countries themselves will help, not only in reducing costs and catalyzing the creation of larger demand, they will also help promote more effective alliances with international operators. The latter issue is particularly important if the Arab countries are to keep up with rapid advances in ICTs.

D. III.3 Biotechnology and genetic engineering; trends, opportunities and challenges

Biotechnology constitutes another one of the most important technological development of the past quarter century. While most industries that new discoveries in biotechnology have helped create are in their infancy, several have demonstrated significant economic impact. In particular, medical and agricultural biotechnologies have made considerable progress during the past two decades.[11] Multinationals active in pharmaceuticals and in agricultural production and food processing have been leading champions, supporting and financing of new discoveries in biotechnology.

The future promise of biotechnology may safely be predicted to exceed its recent achievements. Developments in the biological sciences have recently culminated in the capacity to transform and regenerate living organisms. Scenarios in which ever-green deserts, with plants able to modify their metabolic functions enabling them to withstand extreme environmental stresses of heat and aridity, are the subject of development work in numerous laboratories. Unicellular organisms may already be genetically changed and cultivated in bulk quantities to produce food ingredients and pharmaceuticals. Medical applications including cures for diseases such as cancer are being developed on the basis of advances in monoclonal antibody technology, as well as genetic techniques.

The question of whether the developing Arab countries will be affected, with benefits as well as threats and challenges, is no longer pertinent. Questions as to how biotechnology will impact developing economies, societies and physical environments and what measures could be taken to enhance benefits and reduce negative implications are far more relevant. Answers to such questions are essentially contingent upon policies and strategies they implement and research alliances they may be able to forge with concerned partners in both the developed and developing countries.

Biotechnologies are essentially multidisciplinary in nature. Numerous scientific disciplines and technologies from a variety of fields are involved in the manipulation of living tissues, cells and their parts. Success in developing and implementing biotechnologies in the Arab countries will require coordinated action at several levels, policy, implementation strategies, institution building, legislative and regulatory instruments, etc.. The following paragraphs address a number of recent developments in capacity building in biotechnology in the Arab countries. Issues addressed below are dealt with in much greater length in a relatively recent ESCWA publication.[12]

---

[11] For example, around nine out of every ten patents in biotechnology are related to medical applications. See "Biotechnology and the Future of Agriculture and Natural Resources;" D. D. parker and D. Zilberman,

[12] This study, entitled "Biotechnology in the ESCWA Member Countries: Sectoral Issues and policies" (E/ESCWA/TECH/1997/1). was undertaken with support from the Dutch Government. Summaries of the study in Arabic and English were also produced (E/ESCWA/TECH/1997/3). Two conferences were also held by ESCWA in the nineties on prospects for biotechnology in the region.

Biotechnology research is a costly enterprise. Enormous funds have been pumped into the biotechnology industry in the developed countries, particularly in the United States.[13] For the fifteen main agro-biotechnology companies operating in the United States, the average ratio of R and D expenditure in relation to revenues is 106%.

III.3.1 Status of biotechnology in the Arab countries:

Only a few Arab countries are on record as having established facilities dedicated to biotechnology research. Thus a total of eight institutions only are active in microbiology and genetic engineering among the ESCWA member countries. Several institutions in Arab countries, including Egypt, Iraq and Kuwait, have undertaken genetic engineering research with the aim of crop improvement. However, available information indicates that only Egypt has succeeded in genetically transforming a plant by installing virus resistance into potato varieties.

The International Centre for Agricultural Research in Dry Areas (ICARDA) has established the use of molecular biology as a tool for plant breeding by developing genetic markers. There are no private initiatives in genetic engineering of plants reported in the region.

On account of the smaller relative cost and simplicity of PCTC techniques, a larger number of both research and development as well as commercial production facilities have been set up in a number of Arab countries. Research and experimental production using PCTC techniques have been taken up by numerous university and research facilities only a few countries appear to have commercial PCTC enterprises. Examples include commercial production of potato tubers in Syria and Jordan as well as micro-propagation of date palms in Morocco and Saudi Arabia.

As indicated above, R and D in biotechnology and genetic engineering are costly enterprises requiring sustained investments while predicted results may not always be realized. This is especially the case in research areas of interest to the Arab countries, e.g. crop improvement aimed at installing plant tolerance to drought or salinity. This highlights the need to enhance cooperation in research, particularly in the development of more specific and advanced preparative, diagnostic and analytical tools, both within the region as well as with outside partners.

III.3.2 Strategies for capacity building in biotechnology:

Despite reasonable expectations of important contributions from a number of biotechnology applications in that the medicine, industry and pharmaceuticals, there may be a strong case for placing more emphasis, in Arab biotechnology policies and subsequent research, development and pilot dissemination activities, on agro-biotechnologies for the a number of reasons, of which the following three stand at the forefront, taking into account the high prices that TNCs would be likely to impose on the products they are developing.

Firstly, the Arab countries are keen to achieve a measure of food security.[14] Since certain biotechnologies promise improved compatibility of crucial crops to climatic conditions, then it would make sense for these countries to invest heavily in building their own capacity in selected areas of agricultural and related biotechnologies.

Secondly, on a related issue, R and D activity on crop improvement must be conducted locally in order to directly relate to specific crops and ecological conditions predominant in the Arab countries.

---

[13] Thus, the United States government provided support private and public biotechnology research to the tune of more than US$4 billion annually (i.e. half of the total budget spent on biotechnology research) for much of the eighties and nineties.

[14] While high population growth rates abound, total arable land area in the ESCWA countries, for example, was limited to around 4% of total land area in the mid nineties, (23) with additional constraints imposed upon agricultural production due to limited water supplies and poor soil fertility in many parts of the region. Water problems are related to inadequate groundwater resources, erratic rainfall, water logging and salinity. Especially in the Gulf countries, owing to the depletion of groundwater resources, soil salinity imposes an increasing problem for crop cultivation.

Thirdly, available data seem to indicate that a significant human resource base is already available in agricultural biotechnology research, rendering further support cost effective.

This is not to say that, biotechnology applications in industry and human health are to be neglected. Rather, since work on such areas may be of a more universal nature, it is likely that many willing partners and contributors with whom the Arab countries could collaborate, while relegating a position of priority to agricultural biotechnologies.

Multidisciplinary and multisectoral approaches are required for the development of viable capabilities in agricultural biotechnologies. New methodologies, institutional forms, alliances and cooperation modalities are more important here than in other areas.

The benefits of agricultural biotechnologies will not come without considerable risks for the Arab countries. In particular, the Fertile Crescent, spanning parts of Jordan, Lebanon, Syria and Iraq, is where the earliest varieties of wheat and barley were first harvested. The value of the genetic resources involved is enormous and prompt action will be necessary for their preservation.[15]

Two components should stand out in biotechnology strategies:

- astute linking of national and regional biotechnology and biodiversity strategies;
- judicious partnering with multinationals and international institutions in developing and implementing specific biotechnologies.

Both points are related to topical issues raised by the development of genetically modified organisms, in view of which, there is strong need for more research into the long-term impacts of GMOs. At any rate, a good deal of effort is required in order to reap the benefits that GMOs present for the creation of pest resistant and drought tolerant crops with enhanced nutritional content.[16] Benefits for the poor farmers working marginal lands are expected to outweigh negative effects but only if appropriate national and regional frameworks are evolved to aid negotiations with multinationals and developed countries having such ends in sight.

III.3.3 Regional R and D collaboration:

Direct collaboration on specific biotechnology research topics of interest to the region's countries should be possible among concerned institutions in the Arab countries. Alternatively, collaboration, in promoting genetic engineering research and technology transfer in areas relevant to Arab country needs, may also be revived through the International Center for Genetic Engineering and Biotechnology (ICGEB), an autonomous international research institute, and the Agricultural Genetic Engineering Research Institute (AGERI) of the Agricultural Research Center in Egypt.

Collaboration with crop breeding programmes undertaken with the research centres of the Consultative Group on International Agricultural Research (CGIAR) is another possibility. Through such collaboration, it should be possible to address all three stages of crop breeding, including genetic engineering options for crop improvement. On account of its proximity and research agenda, ICARDA might be the most appropriate among

[15] This was amply illustrated in the eighties, when American wheat and barley production suffered losses, owing to infestation by Russian aphids. No resistant varieties available in the United States were available for crossbreeding to impart resistance against this pest. In was only through the use of several Middle Eastern strains of wheat in extensive crop-breeding programmes over many years, that it was possible to manage the pest effectively. However, while none of the countries in the region received reward for the use of its germ plasm, they will all have to pay for the seeds of the improved pest-resistant varieties with genes originating from that same germ plasm. Similar considerations will naturally apply in the case of many other resources, such as Egyptian cotton varieties. Such considerations should constitute important items in agenda aimed at devising policies for biotechnology development as well as regional coordination in relevant international negotiations in relevant fora.

[16] "Human Development Report 2001," the United Nations Development Programme.

the CGIAR centres. Other forms of collaboration may be available through the intermediacy of international research programmes such as those promoted by the European Union.

III.4 NEW MATERIALS TECHNOLOGIES: STATUS AND FUTURE POSSIBILITIES

New materials technologies offer the Arab countries enormous opportunities for creating added value to petrochemicals they produce or process, giving rise to a range of associated employment opportunities. Thus, modern organic polymers, fiber-reinforced composites, polymer blends and polymeric membrane materials for water treatment poser remarkable benefits in terms of petrochemicals and plastics enterprise competitiveness and profitability. In deed, it is likely that current successes made by several enterprises in countries such as the Kingdom of Saudi Arabia and Kuwait in establishing themselves as regional, in some cases international, operators on the basis of their new materials activities would be boosted by moves to access new materials technologies as bases for downstream production activities.

III.4.1 Recent trends in new materials technologies:

Innovation taking place in new materials technologies owes its origins to fundamental improvement in understanding the factors governing performance characteristics and links between molecular structure and macro properties. Important developments have also been due to improvements in processing methods. Innovations based on new information technology (ITs), computer simulation in particular, have been responsible for significant advances, with consequent gains in product performance and profitability. Similarly, improved understanding of the biology of materials degradation has contributed to the development of materials that enjoy higher compatibility with environmental regulations, in packaging applications, for example.

III.4.2 Research and development activities in new materials:

While considerable R and D activity throughout the world is being directed towards IT- and biotechnology-based innovations, significant efforts are also being made on the basis of "traditional" areas of science and technology i.e. chemical and mechanical engineering as well as solid state physics and chemistry. Recent examples of such innovations include the development of new varieties of high-impact polystyrene (HIPS)[17] and advanced linear low-density polyethylene (LLDPE).[18] On the other hand, numerous process technology innovations have been due to new catalysts. Thus, recent innovation in polyolefin manufacturing has been due to the advent of metallocene and other transition-metal complexes. [19]

Other innovations in new materials are aimed at improving the performance characteristics of existing polymeric materials. This is often achieved through new formulations that make the most out of existing polymer systems, either through blending[20] and reinforcement[21] of current polymers and through improvements in processing methods and the development of new additives to improve special attributes, e.g. fire-retardancy, resistance to UV radiation, etc.

---

[17] "Breakthrough technology increases performance of Dow's high-impact PS;" P. Mapleston (Ed.), Modern Plastics, May 2000, p. 111.

[18] "Blow film processors reap big gains with advanced LLDPE;" R. D. Leversuch, Modern Plastics, May 2000, p. 63.

[19] See, for example, "Novel, highly active iron and cobalt catalysts for olefin polymerization;" A. M. A. Bennett, Chemtech July 1999, The American Chemical Society, pp. 24-28.

[20] See Chapter III of this Review on polymer blend technologies.

[21] See Chapter II of this Review on fiber-reinforced composite materials.

Cost reduction has also been one of the main tasks of multidisciplinary R and D activities carried out, mainly by polymer manufacturers, in branches of science and technology such as chemical engineering, polymer chemistry and solid state sciences.

Improved compatibility with environmental regulations, in general reducing the industry's impact on the environment, have also been targeted with considerable R and D activity. In general, it is possible to look at two classes of activity in this domain:

- Efforts to improve the safety of the industry's operations; an example of such activities is provided by recent work directed at improving the environmental profile of nylon manufacturing.[22]
- Activity aimed at the development of new methods for recycling used plastics and creating new application areas for the recycled products.

Success in both areas is considered essential if recycling is to achieve environmental protection while at the same time creating savings and giving rise to new industrial activity.

In effect, large manufacturers and suppliers, of both commodity, and specialty polymers, undertake an immense proportion of R and D activity in the industry. Processing machine manufacturers also carry out a significant proportion of R and D, with help, especially in pre-competitive activity from university laboratories and specialized materials research centers.

[22] To grasp the environmental impact of the production of such materials, it may be useful to mention that around 4.4 million tons of this intermediate chemical are annually produced worldwide.

III.4.3 Adaptation and implementation of new materials technologies in the Arab countries:

Immense opportunities reside for enterprises, both small and large, in the field of new polymeric materials, their processing, marketing and distribution. Given appropriate technology acquisition policies and practices as well as conditions that are conducive to partnership with established and emerging downstream operators, the Arab countries are essentially well placed to reap enormous advantages. In this, they would be aided by advantages due to their intermediate geographical position as well as labour and raw material availability. Expected developments in the integration of regional markets should contribute positively.

Additional opportunities for the creation of new employment opportunities are also posed by new and emerging demand for new materials created by developments in sectors such as telecommunications, transport construction and water treatment and transportation. Such opportunities should create plenty of room for future expansion of both conventional and more modern polymer production and composite materials processing capabilities with subsequent opportunities for small and medium enterprises.

New materials technologies, based upon modern organic polymers, should be of particular interest for the petrochemicals firms and plastics processors in the Arab countries. These include fiber-reinforced composites, polymer blends, polymer modified cements and polymeric membrane materials. All could be subjects of considerable promise for near- and long-term enterprise activity. Additionally, these new materials technologies hold promise for established operators as well as new entrants with benefits for new employment opportunities in these countries.

III.5 Environmentally Sound and Water Treatment and Desalination Technologies

Environmentally-sound technologies (ESTs) are basically, those technologies which produce little or no pollution, utilize resources "sustainably", and/or affect adequate treatment for wastes and effluent produced by other production or service technologies. ESTs encompass a broad and an extremely heterogeneous range of medium- and high-technology inputs. New technology inputs can play an important part in environmental amelioration both directly and through utilization of renewable energy resources, end-of-pipe treatment, etc.. Thus, ICTs can contribute to the design and operation of renewable energy devices, such as wind and solar conversion systems. Biotechnologies, on the other hand, present useful possibilities for soil and wastewater treatment.

Implementing new technologies for renewable energy conversion, environmental protection and water desalination/treatment is particularly valuable in improving living conditions in the Arab countries. Poor populations, especially vulnerable to problems such as water contamination, land degradation, and air pollution, would be most helped by such developments.

Progress is taking place in the all Arab countries in many of the above domains. Nevertheless, certain crucial weaknesses are manifested in existing infrastructural arrangements required to render efforts in the acquisition, adaptation, development and dissemination of ESTs of lasting benefit. Many of the obstacles to the introduction, adaptation and dissemination of ESTs may be overcome through enhancing local and relevant scientific and technological capabilities.

III.5.1 Promoting ESTs in the Arab countries:

Promoting environmentally sound technologies in power generation, in water desalination, utilization and treatment and in a variety of manufacturing industries in the member countries has to be awarded considerable attention by the Arab countries.

Ideally, implementation of ESTs should be based upon a holistic approach towards technology transfer, development and utilization; i.e. one that takes into account raw-materials considerations, technological know-how, economic, as well as social and environmental effects of production and service activities. This calls for harmonization and coordination in a number of development areas and at a number of levels, i.e. policy, legislative frameworks, enterprise promotion, etc..

Technologies now termed environmentally unsound were introduced, in the first place, with the aim of "profitable" operation under particular socioeconomic conditions, legislative environments, and support systems. It follows, therefore, that the introduction of ESTs in a particular region will have to take into account the constraints imposed by prevailing socioeconomic factors, endogenous technological capacity, the possibilities for inducing change in the socioeconomic setting, and the prospects for enhancing local legislative and regulatory climates.

Ultimately, the attainment of appropriate conditions for the successful acquisition, adaptation, development and dissemination of ESTs necessitates well-orchestrated action on several fronts. Firstly, sufficient resources, both human and financial, have to be made available. Secondly, appropriate mechanisms should be introduced for disseminating and utilizing information about ESTs and the procedures required for their acquisition and dissemination. This would undoubtedly involve building solid capabilities in technology assessment and risk evaluation. Thirdly, legislative and legal frameworks, as well as systems of incentives used to manipulate and influence the acquisition of production and service technologies, have to be reviewed and drastically amended.

PART IV - FUTURE OF SCIENCE, TECHNOLOGY AND INNOVATION IN THE ARAB COUNTRIES

A comprehensive future vision for the science, technology and innovation in a given country is essential to help unify objectives and approaches adopted by the variety of concerned stakeholders and institutions. Such a vision will have to be incorporated by policy makers within the country's broader view of its own future aspirations from several viewpoints. Economic, social, political and demographic issues will need to be considered with the same care and attention to detail as the purely scientific, technological and innovation-related questions. Achieving a reasonable measure of success in any area of future activity targeting capacity building in science, technology and innovation is contingent upon adequate policy designs and implementation strategies.

IV.1 Policy priorities:

Formulating national policies for science, technology and innovation (STI) is of the essence. To be effective, polices aimed at promoting a given STI system will require political will, resource commitments as well as implementation of evaluation and follow-up modalities. means of forging and reinforcing input and output links to their socio-economic environment. Furthermore, they need to be able to effectively interact with other national and international STI systems engaged in the creation, dissemination, transfer and utilization of knowledge in the region and worldwide. Establishing such systems requires the formulation of a number of specific "policy packages." The following paragraphs provide a few notes on their purpose and contents.

IV.2 Developing required human resources:

The need to mobilize human resources and enhance their performance, thus, competitiveness, within the context of a digital and knowledge-based global economy must come at the top of the list of priorities.

While this may well be a daunting task for emerging economies, it should be kept in mind that it is an area where recent developments in technology itself, e.g. in new ICTs, will play a vital part. Developing human resources to support continued innovation is closely linked to the emotive issues of the brain drain and making better use of expatriate S and T manpower abroad.[23]

In developing human resources, it will be important to take into account language and cultural issues. Linguistic and cultural difficulties could break or make the dissemination of certain technologies.

IV.3 Establishing new and revitalized institutional forms:

Reform and revitalization of existing institutional structures and the establishment of new as yet missing institutional components[24] stand out among the numerous policy priorities. Policies to facilitate the creation, reform and revitalization of a variety of institutional forms are urgently required. An important point that need be kept prominently in view by policy makers is that STI institutions of the future may take on novel forms, e.g. networks of institutions and experts rather and virtual centers of excellence rather than the traditional institutional forms with their established hierarchies and relationships.

---

[23] These and other issues are more amply discussed in companion ESCWA paper submitted in the first session of the Forum.

[24] For example, policy research as well as sectoral and national policy coordination bodies, whose activities are often conducted by "councils" in some of the industrialized countries.

IV.4 Infrastructure building:

Infrastructural arrangements are essential for the introduction, dissemination and implementation of all new technologies. While ICTs attract most attention where infrastructure is concerned, other new technologies such as biotechnologies, new materials technologies and modern environmentally sound technologies also require specific infrastructural arrangements. Thus, hardware, software, human and organizational infrastructural components are required to foster relevant developments and to establish specific regulations, standards and quality regimes.

IV.5 Funding for science, technology and innovation:

Spending on STI activities in the Arab countries has tended to compete with other, seemingly more pressing areas of concern. This will continue to pose special problems for increasing funds available for STI activities and institutions. Breaking the vicious circle of dependence will require close attention to increasing both funding for national STI systems as well as improved absorptive capacity of these systems.

Involving the private sector in endeavours that ultimately help enhance expenditure on STI activities is one such approach. Naturally, contributions to funding national STI systems need not be through direct monetary contributions by the private sector. Other forms of collaboration, e.g. in on-the-job training and education, on the may be equally, if not more, effective.

Other approaches include entry into international STI partnerships and alliances in areas of mutual interest, e.g. international coastal and marine pollution, common water resource management, desertification.

IV.6 Catering for specific functions of NSTI systems:

Policy interventions are required with focus on specific targets pertaining to one or more of the principal functions of NSTI systems, namely:

- local creation of scientific and technological knowledge;
- adaptation of scientific and technological knowledge, whether local or international, into local innovative applications;
- acquisition of innovative scientific and technological inputs from external sources;
- dissemination of innovative scientific and technological inputs by end users and putting this knowledge to effective utilization.

In most instances, securing effective functioning of national STI systems will require an intricate web of polices and implementation strategies. It is advisable, particularly in the case of the smaller Arab countries to capitalize on selected areas where "policy action" may be supported by comparative advantage(s). Nevertheless, it will be essential for new STI policies to maintain a high level of coordination and interaction among the functions performed by the national STI system.

IV.6.1 Addressing special STI requirements:

Acquisition and adaptation of new technologies for application in priority areas, for a given country or group of countries, are both a policy priority and catalyst for STI capacity building.

An example, for almost all Arab countries is provided by a long list of STI activities relating to water desalination, treatment, use, reuse and storage. Other national policy domains may be involved. In agriculture, for instance, where water resources are involved. This simultaneously places constraints for STI policy making as well as adds purpose and coherence to national socioeconomic policy frameworks.

IV.7 Revising legislative and regulatory instruments:

The role of legislative and regulatory instruments in promoting innovative change is most clearly manifested in the impact created by environmental protection legislation in the developed countries during the last three decades of the twenty-first century. Private enterprise was clearly prompted by legislative changes to develop and implement innovative and competitive practices based upon new environmentally sound technologies.

Legislative and regulatory instruments in place in the Arab countries are based upon centralized and compartmentalized socioeconomic development models. The need to introduce appropriate legislative and regulatory instruments and to institute mechanisms for their continual adaptation is of the utmost importance.[25]

IV.8 Promoting an innovation-friendly culture:

An innovation-friendly culture is never decreed or voted in. It can only be promoted through creation and harmonization of appropriate policy frameworks and related implementation measures covering activities in a variety of areas. The impact of these policies should encompass the entire educational systems, research and development institutions, the business community, government departments and underlying regulations that determine their responses to innovative change as well as the public at large.

In particular, creating a business environment that is supportive of, and conducive to, continuous innovation and its wide dissemination must become a national policy objective. Establishing lasting organic and functional linkages between the principal actors on the science, technology and innovation scene lies at the very foundations of an innovation friendly culture.

An innovation-friendly culture is predicated upon openness to the world at large. In particular, enhancing the ability of a country or an institution to participate in forging solutions to global problems, even in areas that are closer to the basic sciences. Some room must be kept for international collaboration, even in areas of basic science that do not possess any clear and immediate applications. This will permit entry into international science and technology circles with immense consequences for human resource development capabilities at home.

IV.9 Promoting R and D and collaboration on mutual priorities:

Promoting R and D and relevant alliances, both within and outside the region is a long-term priority in the Arab countries.[26] Future efforts in this domain will need to be directed towards improving linkages between suppliers and users of scientific and technological knowledge within the Arab countries and enhanced networking among peer institutions and individuals within the Arab countries and abroad. Emphasis on special initiatives targeting mutual priority areas, including those shown in frame (4) will need to be emphasized.

---

[25] A forthcoming ESCWA activity will be entirely dedicated to issues addressed here.

[26] This was a principal feature of ESCWA activities in the late nineties. Thus, studies and expert group meetings were conducted in 1997, and earlier in 1995 on the assessment and revitalization of R and D in the member countries. See, for example, the study "Assessment of Research and Development in the ESCWA Member Countries;" E/ESCWA/TECH/1997/5, 28 August 1997. See also the following reports:

- Report of the Expert Group Meeting on the "Assessment and Promotion of Research and Development in the ESCWA Member Countries;" 1-3 December 1997. E/ESCWA/TECH/1998/2, 27 January 1998.

Report of the Expert Group Meeting on the "Revitalization of Research and Development in the ESCWA Region;" September 1995. E/ESCWA/TECH/1995/3/Rev.1, 17 January 1996.

Frame (4); A few research priorities for collaboration in the Arab countries

Research priorities outlined in the work of several recent conferences and symposia in the Arab countries have emphasized activities in the domains:

- water desalination, treatment and reuse technologies;
- high-yielding and drought-tolerant plant varieties for alimentary and industrial applications through new biotechnologies;
- low-cost computers, wireless connectivity, broadband and accessibility for poor and illiterate people and for rural and isolated communities;
- wider access to "high-technologies" in education and health, including diagnostic and screening techniques;
- new materials' technologies in hosing, irrigation and agriculture;
- renewable energy systems, including solar and wind power devices, to bring electricity to people currently with expensive or limited access to it.

E. Part V - Frameworks for Future Action

Effective implementation of national science, technology and innovation strategies will need to take into account specific requirements dictated by a variety of national settings. In particular, manpower, natural resource and technology infrastructure considerations are often central to rational policy implementation.

Strategic action would have to address the following tasks:

- acquiring, adapting and absorbing new technologies into production and service activities;
- developing technologies for the amelioration and treatment of natural resources, including water treatment and desalination;
- blending mature technologies being used in traditional sectors with new technology inputs, in order to enhance quality, economic performance and environmental compatibility.[27]

In turn, strategic action in these domains will need to be coordinated with activities targeting:

- human resource development: through introducing new technologies, and supportive cultural practices, into school and higher education with the aim of enhancing dissemination, relevance and quality;
- institution building: with focus on setting up new institutional forms, e.g. technology parks incubators and high-technology clusters and on networking new technology end-users with various actors in technology development and adaptation;
- research, development and engineering: emphasizing R and D funding, public-private partnerships and alliances, tax rebates.

The regional Agenda for Action on Technology, Employment and Poverty Alleviation is designed by ESCWA and ILO with such strategic objectives in mind. Frame () presents highlights of this agenda and a summary of proposed implementation modalities.

[27] Due to the importance of technology blending for many ailing sectors in Arab country economies, further more focused attention will be dedicated to it in future ESCWA activities.

Frame (5); The ESCWA/ILO Regional Agenda for Action on Technology, Employment and Poverty Alleviation

The Agenda for Action on Technology, Employment and Poverty Alleviation (ATPA) is conceived in support of the Global Employment Agenda launched by the International Labour Organization (ILO). It is intended as a vehicle for fulfilling the goals of the Millennium Declaration. As such, it is designed to create bases for national, regional and international cooperation over an extended period ending in 2015.

ATPA will act as an umbrella to a host of initiatives and programmes, national, and regional, aimed at harnessing selected new technologies for employment creation and poverty alleviation. It seeks to promote social and economic development policies conducive to creation of decent work opportunities and poverty alleviation including activities aimed at the formulation of sectoral development and related technology policies taking into account: national trade development strategies, labour policies and social protection measures and implementation modalities.

Other programmes implemented within this agenda will be aimed at:

- facilitating access by poor populations to educational and training material on the basis of new technologies, emphasizing ICTs, with a view to allowing them new opportunities for gainful employment;
- enhancing the competitiveness of small and medium enterprises through access to new technologies so that they may compete, grow and provide a wider scope of employment opportunities;
- promoting technology-based local and national projects to help promote "social insertion" of poor and disadvantaged populations
- establishing new institutional forms, e.g. technology parks and technology incubation schemes, designed to catalyze the implementation and dissemination of new technologies for employment creation and poverty alleviation;
- coordinating well-defined cooperative activities among regional and international agencies with emphasis on the role played by new technologies and small and medium enterprises in poverty alleviation.

ATPA will run parallel to, and support, rather than replace, or compete with, other existing initiatives and programmes designed by other international and national organizations with a view to employment creation and poverty alleviation. In fact, ATPA will actively seek to coordinate its own activities with those of concerned international and regional organizations as well as recent initiatives aimed at technology dissemination for development, e.g. the United Nations Task Force.

The Agenda is designed to accommodate four three-year operational phases, each consisting of a core initiative incorporating a number of activities with specific objectives. Feasibility and planning studies will precede establishment of pilot facilities in selected countries, local settings and sectors. Consecutive phases will aim at developing successful pilot projects from the first phase into full-fledged projects as well as the initiation of pilot activities in new settings and sectors. The third phase will seek to expand initiatives launched in the second and first phases and the dissemination of results in the countries of the region.

CONCLUSIONS

Throughout history, technology has been a powerful tool for human development. The challenge today is to harness new technologies to bridge the income divide between the developed and developing countries as well as within the latter. To achieve significant results it will be essential to recognize the following points:

- Market forces may provide powerful motives of technological progress, yet, they are not capable on their own to create and diffuse the technologies needed to eradicate poverty and create employment in the developing countries. Government involvement in coordination with private sector commitment is of the essence. Additionally, more regional international cooperation will be necessary.

- While, the developing countries may gain high rewards from implementing new technologies, they also face especially severe challenges in managing possible risks. Such risks will need to be faced in cooperation with partners on an international scale.

- Domestic policy still matters even in the age of globalization. Even the poorest and the least developed countries will need to implement policies that encourage innovation, access to new technologies, the development of advanced skills and organize national and international collaboration.

- A variety of issues will need to be addressed in the quest for improving competitiveness, productivity and integrating the Arab economies within the knowledge-based global economy. Short-, medium and long term policies and implementation strategies will need to be designed for the acquisition of selected new technologies and harnessing them for the benefit of Arab societies. There is also a strong need for the integration of such policies within national development plans.[28]

- One of the main objectives of new STI policies and associated strategies would be to create an environment and a culture that is conducive to continuous innovation.

- National policies will not be sufficient, on their own, to compensate for global market failures. New ways in which technology is created and diffused are largely disseminated, and fashioned, by global networks. Hence, the importance of being ready to cooperate and collaborate, in short, to network.

- With the latter issue in mind, there is also a pressing need for creating novel national institutional forms that foster links between the variety of institutional forms and stakeholders in STI capacity building. In particular, new policies and novel modalities often involving as yet untested partnerships between governments, private enterprise and nongovernmental organizations at the national, regional and global levels.

- While resources will need an enormous boost in many directions, so will the ability to assimilate and utilize such additional resources.

Ultimately, only the most ambitious vision of science, technology and innovation in the Arab countries will allow them reasonable chances of meaningful socioeconomic development in the global knowledge-based economy. Urgent action based on such a vision and on many fronts is of the essence. Above all, the new vision of science, technology and innovation will require novel coordination and cooperation strategies as well

[28] An earlier ESCWA Expert Group Meeting addressed a number of these issues: "Integration of Science and Technology in the Development Management Process in the ESCWA Region," 1994. E/ESCWA/NR/1994/12. Due to important recent developments on many fronts special ESCWA activity will be dedicated to addressing issues enumerated in this paragraph in a future ESCWA activity.

as new implementation modalities seeking to capitalize on local as well as expatriate brainpower, to reform existing institutional forms as well as create new ones.

Last but not least, the role of enterprise, properly orchestrated and coordinated with sustainable development objectives will be instrumental.

Annex

Indicators of technology achievement, investment in technology creation, and technology diffusion in selected countries

Table A.1. Technology achievement index (TAI) and other indicators relating to investment in technology creation for selected countries

	HDI rank	TAI rank	Country	TAI	Mean years of schooling (age 15 and above)				R and D expenditure (as % of GNP)	R and D expenditure in business (as % of total)	Scientists and engineers in R and D (per 100,000 people)
				2001	1970	1980	1990	2000	1987-97	1987-97	1987-97
High human development	6	2	United States	0.733	9.5	11.9	11.7	12	2.6	59.4	3676
	10	1	Finland	0.744	6.1	7.2	9.4	10	2.8	57.7	2799
	18	13	Ireland	0.566	6.8	7.5	8.8	9.4	1.6	63.4	2319
	21	19	Spain	0.481	4.8	6	6.4	7.3	0.9	40.3	1305
	22	18	Israel	0.514	8.1	9.4	9.4	9.6	2.4	35.7	
	25	33	Cyprus	0.386	5.2	6.5	8.7	9.2		13.1	209
	27	5	Korea, Rep. of	0.666	4.9	7.9	9.9	10.8	2.8	84	2193
	35	25	Slovakia	0.447			8.9	9.3	1.1	60.4	1866
	39	37	Chile	0.357	5.7	6.4	7	7.6	0.7	15.2	445
	40		Bahrain		2.8	3.6	5	6.1			
	43		Kuwait		3.1	4.5	5.8	6.2	0.2	64.3	230
	45		UAE								
	48		Qatar								
High human development average					7.6	8.9	9.4	9.9	2.3		2827
Medium human development	59		Libya								
	65		Lebanon								
	68		Saudi Arabia								
	71		Oman								
	82		Turkey		2.6	3.4	4.2	5.3	0.5	32.9	291
	88		Jordan		3.3	4.3	6	6.9	0.3		94
	89	51	Tunisia	0.255	1.5	2.9	3.9	5	0.3		125
	90	50	Iran	0.26	1.6	2.8	4	5.3	0.5		560
	97	56	Syria	0.24	2.2	3.7	5.1	5.8	0.2		30
	100	58	Algeria	0.221	1.6	2.7	4.3	5.4			
	105	57	Egypt	0.236		2.3	4.3	5.5	0.2		459
	112		Morocco								
	115	63	India	0.201	2.3	3.3	4.1	5.1	0.7	24	149
Medium human development average						4.1	5.1		0.6		
Low human development	133		Yemen			0.3	1.5				
	137		Djibouti								
	138	71	Sudan	0.071	0.6	1.1	1.6	2.1			
	139		Mauritania				2.4				
Low human development average						1.8	2.8				
World average						5.2	6		2.2		959
Arab states average											

Key: ESCWA member countries
Arab countries
Other countries

Table A.2. Diffusion of technology in agriculture and manufacturing for selected countries

	HDI rank	TAI rank	Country	Fertilizer consumption (kg per hectare of arable and permanently cropped land)		Tractors in use (per hectare of arable and permanently cropped land)		Low-technology exports (as % of total goods exports)		Medium-technology exports (as % of total goods exports)		High-technology exports (as % of total goods exports)	
				1970	1998	1970	1998	1980	1999	1980	1999	1980	1999
High human development	6	2	United States	81.6	110.5	27.7	26.8		10		34		32
	10	1	Finland	188.8	140.6	60.2	89.7	19	9	21	24	4	27
	18	13	Ireland	306.7	519.9	61.1	123.3	15	10	17	12	12	42
	21	19	Spain	59.3	110.4	12.7	44.1	23	16	31	43	5	10
	22	18	Israel	140.1	277.1	40	56.1		12		16		29
	25	33	Cyprus	120.9	143	27.2	118.9	32	24	12	11	2	12
	27	5	Korea, Rep. of	245	457.6		82.7	47	18	25	34	10	33
	35	25	Slovakia		66.3		15.6		24		42		7
	39	37	Chile	31.6	194.6	8.3	23.5		3		5		1
	40		Bahrain		100		2		4		5		
	43		Kuwait		300	9	11.7		1		6		
	45		UAE		390.1	11.7	3.4						
	48		Qatar		58.8	25	4.4						
High human development average				97.1	114.6	28.7	40.2	17	13	36	37	10	22
Medium human development	59		Libya	6.2	23.8	1.9	16.1		2		2		
	65		Lebanon	135.4	196.4	7.7	18.2						
	68		Saudi Arabia	3.3	84.1	0.4	2.5		1		5		
	71		Oman		95.2	0.9	2.4		3		11		2
	82		Turkey	15.7	80.9	3.8	32.4		47		20		7
	88		Jordan	8.7	60.1	8.8	12.3						
	89	51	Tunisia	7.6	24.7	4.7	7.2	20	52	10	16		3
	90	50	Iran	6	66.6	1.3	12.1		5		2		
	97	56	Syria	6.8	60	1.5	17	4	6	2	1		
	100	58	Algeria	16.3	11.7	5.9	11.4				1		
	105	57	Egypt	131.2	337.2	6.1	27.3		24		7		2
	112		Morocco	11.7	35.1	1.4	4.3	11	22	3	12		
	115	63	India	13.7	99.1	0.6	9.1	33	38	10	11	3	5
Medium human development average				24.4	118.1	2.2	8.7		21		19		19
Low human development	133		Yemen	0.1	13.5	1.2	3.6	10		32		2	
	137		Djibouti										
	138	71	Sudan	2.8	2.2	0.4	0.6		2				
	139		Mauritania	1.1	4.2	0.4	0.8						
Low human development average				4.5	28.8	0.5	2.6						
World average				50.1	105.4	12.3	18.6		15		33		22
Arab states average				16.6	44.9	2.6	7.4		10		7		1

Key: ESCWA member countries
Arab countries
Other countries

Table A.3. Diffusion of information and communications technologies for selected countries

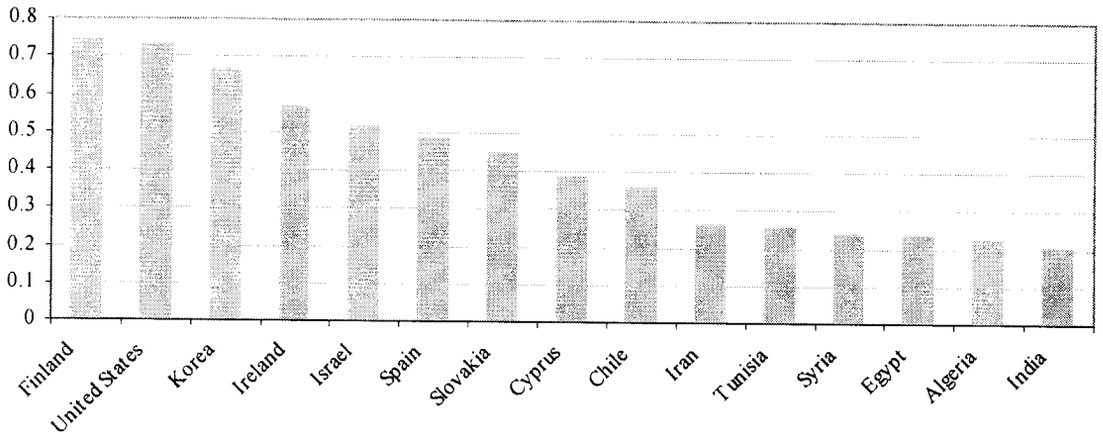
	HDI rank	TAI rank	Country	Telephone mainlines (per 1,000 people)		Cellular mobile subscribers (per 1,000 people)		Internet hosts (per 1,000 people)		Cost of a three-minute local call		Waiting list for mainlines (per 1,000 people)	
										PPP US$	Index (1990=100)		
				1990	1999	1990	1999	1995	2000	(1999)	1999	1990	1999
High human development	6	2	United States	545	682	21	312	21.1	179.1			0	0
	10	1	Finland	534	552	52	651	42.2	200.2	0.12	93	0	0
	18	13	Ireland	281	478	7	447	4.2	48.6			1	
	21	19	Spain	316	418	1	312	1.8	21	0.11	221	7	
	22	18	Israel	343	459	3	459	5.4	43.2			4	
	25	33	Cyprus	428	545	5	190	0.6	16.9	0.03		35	6
	27	5	Korea, Rep. of	310	438	2	500	0.8	4.8	0.06	94		0
	35	25	Slovakia	135	308	0	171	0.6	10.2	0.35		21	13
	39	37	Chile	66	207	1	151	0.7	6.2			24	
	40		Bahrain	192	249	11	205	0.2	3.6				
	43		Kuwait	247	240	15	158	0.7	4.4				0
	45		UAE	206	407	17	347	0.2	20.9			1	
	48		Qatar	190	263	8	143	0				1	
High human development average				416	542	11	347	9	80.5				
Medium human development	59		Libya	48		0		0				54	15
	65		Lebanon	118		0	194	0.1	2.3				
	68		Saudi Arabia	77	129	1	40	0.1	0.3			8	
	71		Oman	60	90	2	49		1.4			3	
	82		Turkey	121	265	1	119	0.2	2.5			25	7
	88		Jordan	58	87		18	0.1	0.2	0.06	197	15	5
	89	51	Tunisia	38	90		6			0.07	27	15	9
	90	50	Iran	40	125	0	7			0.03		9	18
	97	56	Syria	40	102	0		0	0	0.02	35	124	179
	100	58	Algeria	32	52		2					27	
	105	57	Egypt	30	70		7		0.1	0.07		22	19
	112		Morocco	16	53		13		0.1	0.22		8	
	115	63	India	6	27	0	2		0.1	0.09	45	2	4
Medium human development average				28	79		28		1				
Low human development	133		Yemen	11	17	0	2	0		0.04	318	4	7
	137		Djibouti	11	14	0		0	0.1				0
	138	71	Sudan	3	9	0		0	0	0.1			12
	139		Mauritania	3	6	0	0	0		0.37	84		18
Low human development average				4	9		2						
World average				102	158	2	85	1.7	15.1				
Arab states average				34	69		17		0.4				

Key: ESCWA member countries
Arab countries
Other countries

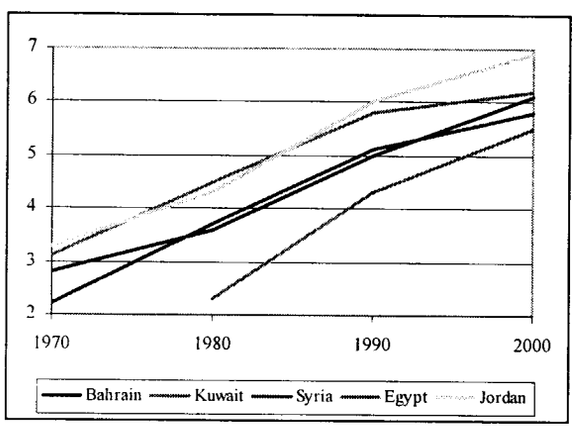
Note: PPP = purchasing power parity

Frame A.1. Position of Arab countries with respect to indicators of technology achievement, investment in technology creation, and technology diffusion

(a) Technology achievement index



(b) Mean years of schooling



(c) R and D indicators (1987-1997)*

	R and D expenditure (as % of GNP)	R and D expenditure in business (as % of total)	Scientists and engineers in R and D (per 100,000 people)
Kuwait	0.2	64.3	230
Syria	0.2		30
Egypt	0.2		459
Israel	2.4	35.7	
Cyprus		13.1	209
Chile	0.7	15.2	445
Turkey	0.5	32.9	291
Iran	0.5		560
India	0.7	24	149

* Data refer to the most recent year available during the period specified.

Key:

ESCWA member countries
Other countries