Research for Development in the South:
The Case of the Middle East and North Africa (MENA) Region

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Contents

Acronyms

ERF	Economic Research Forum for the Arab Countries, Iran, and Turkey
EU	European Union
FDI	foreign direct investment
FTA	Free Trade Area
GCC	Gulf Cooperation Council
GDP	gross domestic product
GERD	gross expenditure on research and development
GTZ	German Agency for Technical Co-operation
ICTs	information and communication technologies
IDRC	International Development Research Centre
IPR	Intellectual Property Rights
ISI	Import substitution industrialization
ITP	Index of Technological Progress
KISR	Kuwait Institute for Scientific Research
MENA	Middle East and North Africa
MSF	multistage flash
MSME	micro, small and medium enterprise
NGOs	nongovernmental organizations
OECD	Organisation for Economic Co-operation and Development
R&D	Research and Development
RHWG	Reproductive Health Working Group
S&T	science and technology
SMEs	small and medium enterprises
SOEs	state-owned enterprises
SSA	Sub-Saharan Africa
STAs	Science and Technology Activities
TRIPS	Trade-Related Aspects of Intellectual Property Rights
TTGV	Technology Development Foundation
UAE	United Arab Emirates
UNDP	United Nations Development Programme
Unesco	United Nations Educational, Scientific and Cultural Organization
USAID	US Agency for International Development
WTO	World Trade Organization

Executive Summary

The environment of research

The Arab countries have some of the lowest levels of research funding in the world, according to the *World Science Report* (Unesco 1998). Expenditure on research and development (R&D) as a percentage of gross domestic product (GDP) was only 0.4 percent for the Arab world in 1996, which although comparable to Latin America and the Caribbean, is lower than other developing regions, with the exception of sub-Saharan Africa (SSA).

However, the region is experiencing an expansion of R&D, as measured by the number of papers published in refereed and international journals (previously at a rate of 10 annually in 1967). In 1990-95, the Arab region experienced a sixfold increase of science and technology (S&T) papers published in international journals in comparison with the period 1970-75. The most dramatic increases (50 times the output in 1970-75) were in the United Arab Emirates (UAE), Oman, Somalia, and Saudi Arabia.

Large disparities exist, however, between countries in the region, with Egypt and Saudi Arabia publishing the highest output in refereed international journals (12,072 and 8,306 papers in 1990-95, respectively), while the remaining countries account for around 2,000 papers published.

Analysis shows that the quantity of scientific and technical articles published in the Middle East and Africa (MENA) region is quite meager when compared to that of the developed countries. On a per capita basis, however, some Arab countries claim a much higher status when compared to three of the leading developing countries (i.e., Brazil, China, India) (Zahlan 2000). The UAE publishes at the same per capita basis as a science-based economy such as South Korea.

Generally, publications in the region suffer from two main drawbacks. The first is a paucity of articles on engineering and technology. The second is related to outreach since much of this output does not appear in "reputable" journals. Concerning quality, two problems seem to prevail: the absence of peer reviews which normally emanates from a conducive research environment and ethic, and the absence of support for incentives for high standards of quality control and competition rules.

Research and development (R&D) in the Arab world has been concentrated (more than 90%) in applied science, especially in the Gulf states. The lion's share is in medicine, agriculture, and applied chemistry, including chemical engineering; together these streams account for three- quarters of research output. The region suffers from weaknesses in research on information sciences, molecular biology, genetics, informatics, and mathematics (Djeflat 2002). Environmental research in the region tends to be scattered and has achieved limited research results in crucial areas such as solar energy and water desalination. In addition, there is a lack of linkages between S&T and the needs of industry in the region.

Between 1992 and 1996, the number of R&D personnel in the region grew at an annual rate of 6 to 7 percent, more than twice the rate of population growth (ERF 2002). The region has also witnessed a considerable increase in higher education and in women's enrolment at the tertiary level. In 1996, about 66 percent of R&D personnel were employed in government, 31.6 percent in universities, and a mere 2.1 percent in the private sector (Djeflat 2002). Examining the distribution by sector shows that 44.2 percent of R&D personnel were in agriculture, 8.5 percent in industry, 8 percent in basic sciences, and 6.3 percent in engineering.

Government funding remains the most significant source of R&D in most Arab states. Although a large portion of R&D budgets goes to personnel (Djeflat 2002), the incentive system for researchers in the region does not promote the production of high quality output. In addition, the participation of Arab scientists in international scientific meetings is low.

With regard to the strength of science and technology activities (STAs) in the region, Algeria and Egypt have a well-established record since the 1970s in integrating S&T into economic development. Morocco, Tunisia, Jordan, and Kuwait experienced greater difficulties in linking S&T to economic development policy despite their more market-driven growth and the contribution of foreign direct investment (FDI) to industrialization. S&T policies and their reflection in economic development has been quite weak in Libya and Mauritania.

Most S&T institutions in the region are inherited from the import substitution industrialization (ISI) era, which means most of them are publicly funded with limited exposure to competition and state-of-the-art technology. Nevertheless, from 1960 to 1996, R&D institutions in the region increased at the rate of eight institutions per year (Djeflat 2002). To date, there are more than 600 institutions in the region involved in R&D activities. Models for best practices in the region include the Kuwait Institute for Scientific Research (KISR), in terms of promoting innovation and applying R&D for development.

Scholarly activity on the part of scientific and professional organizations in the Arab region tends to be low. Restrictions on the establishment of nongovernmental organizations (NGOs) in the region limit the potential role such institutions can play in bridging the research-policy divide. The private sector is somewhat reluctant to finance R&D activities because of the lack of a long-term vision and the uncertainty associated with R&D outcomes.

Nevertheless, the rate of international collaboration of Arab scientists is higher than the average in well-established scientific communities.

The environment for research

While the market plays a large role in influencing STAs, the interplay of social, political, and economic policies also has a significant impact on the outcome (Djelflat 2002).

In MENA, the huge variation in per capita income levels is reflected in the state of research institutions. At one end of the spectrum, one finds modern and technologically advanced research institutions in the Gulf countries such as Kuwait and Saudi Arabia. At the other end, the region is host to some of the poorest countries in the world, such as Yemen. In addition, the political environment in MENA has had a significant impact on the research environment. The region is one of the most conflict-ridden regions in the world. This has influenced research activity in multiple ways.

Many countries in the MENA region have a large informal sector that is heavily centred on families and households. Understanding this cultural context helps to better adapt development programs and agendas to fit the specific needs of a country or region.

Most countries in the region have undertaken liberalization measures (trade liberalization, privatization, institutional reform, etc.) after periods of state intervention and import substitution policies; however, the region still lags behind other developing regions on various fronts in terms of liberalization.

Domestic markets in most countries in the region are subject to a number of constraints, especially with respect to anticompetitive practices and market failures in labour and capital markets. Despite the transition process into market-based economies in MENA, countries in the region carry the legacy of decades of state monopolies over major resources and/or high levels of intervention by the state in key sectors of economic activity.

Introduction

In light of globalization, competitiveness and development are largely a function of the dynamism of research and development (R&D) activities and the level of technological innovation. Knowledge acquisition through education and R&D and its effective use is crucial for development whether through its impact on good governance, achieving better heath outcomes or in providing other prerequisites for material and moral well-being (UNDP AHDR 2002, p. 32).

Middle East and North Africa (MENA) countries are faced with the challenges of competition on a global scale, reduced trade barriers, more stringent intellectual property regimes, and deeper concern for the environment (Djelflat 2002, p. 2). On the developmental side, the region suffers from high rates of unemployment and illiteracy, a deficit in women's empowerment, and escalating rates of population growth and poverty. Political instability acts as a brake on developmental efforts in the region by negatively affecting growth, damaging infrastructure, hindering participatory governance, and diverting needed resources to military expenditure.

All these challenges pose a heavy burden on the region's research agenda in terms of bridging the gap between research and research needs that are policy-oriented and development-driven. Connectivity between researchers and policymakers through knowledge networks is an integral component in bridging this gap in order to apply knowledge for development. One of the current problems plaguing the MENA region is the distance between those who generate knowledge and those who can use it in the policy, professional, and business communities.

Only through innovation and creativity can MENA countries aspire to achieve their socioeconomic goals and objectives while at the same time ensure their proactive participation in the global economy. In the region, there tends to be a strong correlation between the development process and inadequate technological policies. Three elements, according to Lundvall's integrated approach, are integral components of a national innovation system: the productive sphere, the training and education sphere, and the research sphere. This paper will focus on these elements in various degrees.

The paper will also describe the environment of and for research in the MENA region. The former describes the current state of research in the region, the actors on the supply and demand side, and identifies the gaps and strengths that characterize the environment of research. An analysis of the environment for research outlines the broader contextual factors that constitute the elements of an enabling environment for research, such as the socioeconomic and political environment, and the macroeconomy and market openness. The paper aims to discern from the above examination future directions for research in the region, as well as pinpoint some of the region's best practices in terms of the institutional infrastructure for research.

Notably, the MENA region is not a homogenous group but is considerably diverse. This is reflected in the extent to which the research infrastructure in the various countries is developed. Countries in the region are often classified into three categories: those that are oil-rich, labour scarce, and enjoy high per capita incomes, mainly the Gulf Cooperation Council (GCC) countries; those that are diversified, labour abundant, and enjoy middle-level per capita incomes, such as in the Maghreb and Mashreq countries; and those that are low per capita, subsistence economies such as the Sudan, Mauritania, and Yemen. Most of the GCC countries have been able to use oil revenues to develop a reasonably advanced and dynamic setting for R&D. Other countries that are more diversified have been able to exploit their advantage of human capital to develop their research infrastructure.

Since the majority of the countries in the region are Arab countries, throughout the paper figures and data will be used on the Arab region and MENA region interchangeably. Wherever data is available for the broader Middle East region, the coverage will typically include Iran, Turkey, or both countries, as they share several of the features of upper middle-income countries of the region especially on the cultural, social, and demographic levels.

The Environment of Research

Research and development

To provide an updated assessment of the performance of R&D in the Arab region is a difficult task, as there have been no updated figures on the level of R&D expenditure in the region since 1996. There is also an absence of systematic surveys on the level of innovation in the region.

Nevertheless, the Arab countries possess some of the lowest levels of research funding in the world, according to the *World Science Report* (Unesco 1998). Research and development expenditure as a percentage of gross domestic product (GDP) was only 0.4 percent for the Arab world in 1996, which although comparable to the Latin America and Caribbean region is lower than other developing regions with the exception of sub-Saharan Africa (SSA). Table 1 compares R&D as a share of GDP for nine regions for the period 1992-97 (Rodriguez and Wilson 2000). The ratio of scientists per million inhabitants in the Middle East to those in OECD (Organisation for Economic Co-operation and Development) countries is only 1:5 and this ratio is 1:3.5 when compared to Eastern Europe and the transition economies. However, the Middle East has a similar level of scientists per million inhabitants to those in Latin America and exceeds those in South Asia and sub-Saharan Africa.

Indicators of scientific output, such as the number of science and technology papers published in refereed journals and patents granted, can provide information on the status of R&D in a region. Based on this measure, MENA is experiencing an expansion of R&D, as measured by the number of papers published in refereed and international journals (previously at a rate of 10 annually in 1967). In 1990-95, the Arab region experienced a sixfold increase of S&T papers published in international journals over the period 1970-75 (Annex Table 1). All countries throughout this period, with the exception of Lebanon, experienced an increase in S&T papers published in refereed journals. The most dramatic increases (by more than 50 times the output in 1970-75) were in the United Arab Emirates (UAE), Oman, Somalia, and Saudi Arabia. However, large disparities exist between countries in the region with Egypt and Saudi Arabia publishing the highest output in refereed international journals (12,072 and 8,306 papers published in 1990-95, respectively), and the remaining countries not exceeding 2,000 papers published (except for Morocco which published 2,418 papers).

Table 1. Regional technological and science input (1992-97).

	R&D as % GDP	**Technicians per million**	**Scientists per million**	**GDP per capita**
OECD	1.8	1326	2649	20114
Middle East	0.4	178	521	89412
East Asia	0.8	236	1026	6271
Latin America and the Caribbean	0.5	205	657	5636
Eastern Europe and transition economies	0.9	577	1841	4027
Sub-Saharan Africa	0.2	76	324	1972
South Asia	0.8	60	161	1764

Source: Rodriguez and Wilson 2000.
Note: Technicians and scientists are per 1 million persons.

In the region, there are now about 30 organizations which publish 50 or more publications annually (Djeflat 2002). In 1995, a total of 26 institutes in Saudi Arabia, Kuwait, United Arab Emirates, and Bahrain issued 50 or more papers, compared to only seven institutes in 1977 (Annex Table 2). In the social sciences, Egypt, Lebanon, and Morocco are the three principal sources of research publications (Unesco 1999b).

The World Development Indicators provide figures on scientific and technical articles published in MENA, which is quite meager when compared to those in developed countries (World Bank 2001a). On a per capita basis, however, some Arab countries rank higher when compared to three of the leading developing countries (i.e., Brazil, China, India) (Zahlan 2000). The UAE publishes at the same per capita basis as a science-based economy such as South Korea (Zahlan 2000). One can argue that the Arab region's publication productivity relative to the gross expenditure on R&D (GERD) is above average (ERF Trends 2002). By this indicator, the Arab region ranks higher than North America, Western Europe, and Asia (Zahlan 2002).

Furthermore, the number of citations is considered a measure of the quality of scientific publications (Hopkins et al. 2001). Table 2 shows the extent of the disparity between countries such as the USA and Switzerland and other selected Arab countries in terms of the number of frequently cited papers per million people. Notably, Kuwait outperformed the rest of Arab countries on this measure.

Publications in the region suffer from two main drawbacks. First, there are fewer articles on engineering and technology; articles on chemistry and physics are much more common. Of the 1,229 articles published in the period 1981-86, only 5.1 percent were related to engineering and technology (Djeflat 2002). Fergany (2000) stated that the interest in science in the publications produced by Arab authors is minimal, not to mention the quality of work. Arab scientific output throughout the period of study (1978-98) was erratic, with no cumulative pattern (which is a prerequisite for advancement in scientific research). Second, there are concerns related to outreach, since most of the publications do not appear in "reputable" journals. Barriers to externally produced research also exist due to a combination of political, linguistic, and financial constraints (Unesco 1999). Concerning quality, two problems seem to prevail: the absence of peer reviews, which normally emanates from a conducive research environment and ethic, and the absence of support for incentives for high standards of quality control and competition rules.

Table 2. Active research scientists, frequently cited articles, and frequently cited papers per million inhabitants, 1987.

Country	Research scientists	Articles with 40+ citations	Number of frequently cited papers per million people
United States	466,211	10,481	42.99
Switzerland	17,028	523	79.90
Australia	24,963	280	17.23
Israel	11,617	169	38.63
Republic of Korea	2,255	5	0.12
India	39,509	31	0.04
China	15,558	31	0.03
Egypt	3,782	1	0.02
Saudi Arabia	1,915	1	0.07
Algeria	362	1	0.01
Kuwait	884	1	0.55

Source: UNDP Arab Human Development Report 2002.

R&D activity by discipline

Zahlan (2000) argues that R&D in the Arab world has been concentrated (more than 90%) in applied science, especially in the Gulf countries. The lion's share was in medicine, agriculture, and applied chemistry, including chemical engineering, which together account for three-quarters of research output. Annex Table 3 shows that in 1992, the majority of institutions in R&D were in agricultural production and health, followed by industry.

However, the region suffers from weaknesses in research on information sciences, molecular biology, genetics, informatics, and mathematics (Djeflat 2002). In addition, environmental research in the region tends to be scattered and has achieved limited research results in crucial areas such as solar energy and water desalination. (UNDP AHDR 2002).

The analysis of poverty and income inequality in the region suffers from a lack of standardized, comparable, and comprehensive data sets. In addition, reliable information is limited by irregular patterns of data collection and publication at the level of individual Arab countries (UNDP AHDR 2002, p. 90). The result is partial evidence in some cases, and contradictory results in others. What is most serious is the inability to compile reliable trends on poverty indicators over time for a large number of MENA countries.

Furthermore, the lack of linkages between S&T and the needs of industry tends to be an obvious weakness in the region. The industrial infrastructure dates back to the 1970s at the time of import substitution industrialization (ISI) policies. For instance, even in Tunisia, only 20 percent of the spinning machines in the textile sector are fully automated, with the remaining 80 percent using mechanical and usually obsolete technologies (Djeflat 2002). The critical need for technological innovation to support industry and improve competitiveness in MENA is underscored by the fact that the region will in the near future be facing challenges of opening its markets under the European Union (EU)-Mediterranean partnership agreements that set 2010 as a target for establishing a Free Trade Area (FTA). There are also countries that have already or are seeking to sign an FTA with the USA.

The weak linkages between S&T and industry are mainly related to limited diffusion of R&D output and the lack of institutions and bodies that link producers of knowledge with the end user (Djeflat 2002). For example, Tunisia's School of Engineering produces about 500 student projects annually, of which only two or three are put into use in industry (Djeflat 2002). Another cause is the current incentive and reward system of research centres which characterizes promotion and tenure according to academic rules that emphasize publishing in scientific journals as opposed to the practical value of applied research, which is the case of Egypt. In addition, the role of the state in promoting industry restructuring and technology acquisition is a clear example of what is missing from the research agenda.

In Turkey, the Technology Development Foundation surveyed 1,297 Turkish manufacturers to determine their level of innovation in the period 1989-93 (ERF Trends 2002). Systemic and regular surveys of this type in other countries in the region are required to understand the needs of industry. In Tunisia, only two out of 10 of the most innovative firms have tried to assess the impact of their innovation on output by calculating their ratio of R&D expenditure over turnover (Djeflat 2002).

In an attempt to promote linkages between industry and research, the Turkish Technology Development Foundation (TTGV) provides incentives to support the commercialization of academic and R&D studies in Turkish industry. It awards academic research that has been applied to industry, thus promoting applied research and university-industry collaboration.

The pharmaceutical industry in the region is one of the largest industries with a market of more than US$6 billion and employing 50,000 people (ERF Trends 2002). However, Arab countries still remain net importers of medicine. Competent research and development is highly demanded in this industry to improve quality and competitiveness in the wake of implementation of Trade-Related Aspects of Intellectual Property Rights (TRIPs).

Furthermore, the large size of the micro, small and medium enterprise (MSME) sector is a characteristic of the MENA region. This sector has the potential to make a major contribution to the creation of productive employment and equitable growth. Over the past three decades, this sector has been responsible for creating a substantial share of jobs in MENA economies, with estimates ranging from 85 to 95 percent of total employment in the nonagricultural private sector, despite an institutional framework that has been hostile and discriminating (ERF 2000a).

Small and medium enterprises (SMEs) in MENA face competition both from the domestic market and from SMEs from both developed and developing countries that enjoy effective support systems. Low wages in the South are no longer a competitive advantage. The high failure rate of SMEs in the region limits the potential gains from accumulated experience and know-how (Djeflat 2002). In addition, limited innovation and technological transfers act as a setback. In Lebanon, only 8.4 percent of enterprises are equipped with new technologies and only 4.6 percent of enterprises with fewer than five workers introduced new technologies in 1996 (ERF 2000b). Research and development that is targeted to the needs of SMEs is badly needed in the region, given the poor technological support system. In addition, further investigation on the impact of traditional and informal innovation needs to take place.

Box 1 Addressing key issues in economic research in MENA.

A survey of the literature produced over the past few years both inside and outside the region shows great promise in terms of tackling some of the key issues of economic policy. However, there is a great need for support of independent research that is subject to quality control through peer review, discussion, and evaluation. Continuity of research on individual topics can only be ensured by providing financial support for medium and long-term research projects that utilize the skills of the region's elite researchers. Dissemination and public debate are also essential in order for the policy reform process to be enlightened, well-informed, and responsive to those who stand to gain or lose from economic transition. Some topics that are presently being addressed by researchers include:

- Macro stability
- Assessing the impact of globalization, regional integration, and stabilization and structural adjustment policies
- Advancement of economic theory and econometrics
- Water scarcity
- Environmental economics (mainly on a microlevel)
- Gender and employment, as well as child labour

Specific topics that deserve more attention are macroeconomic management, institutional reform, private sector development (competition policies, trade and investment regimes, regulation of privatized utilities, micro-enterprise promotion), labour relations (unionization and labour rights, compensation for redundancy, training, and retraining), employment, poverty alleviation, and human resource development (education and training systems, sectoral productivity measurement and monitoring, microcredit, interdisciplinary gender-focused assessment), promotion of exports, and FDI (information technology, access and dissemination of information, market analysis, industrial free zones, public/private roles in promotion), industrial strategy (innovation, R&D, cluster promotion, managerial and skills upgrading), and the political economy of reform (governance, democratization, ethics, decentralization). On governance, there is a need to compare and contrast legal frameworks for economic reform in the region, identify best practices of bureaucratic reform, and compare and contrast judiciary reform processes. Research on the legislative environment in MENA should focus on the process of lawmaking in terms of the proposing, drafting, and reviewing of legislation, as well as in its discussion and dissemination.

With regards to economic reform, the question of what comes after structural adjustment is seldom asked. Issues of implementation are also disregarded, as well as those of helping various sectors adapt to the liberalization context.

In the area of SMEs, it is imperative to set up an analytical framework depicting the internal and external factors affecting SME development in the region. A second research challenge is to come up with proxies that both quantitatively and qualitatively measure the different dimensions of the business environment.

Little comparative analysis is pursued, so there is a need to consider lessons learned from inside the region and outside and to adapt successful models to the specificity of regional economies.

Source: ERF 1997 & 2003; Ozar 2001.

R&D personnel

Between 1992 and 1996, the number of R&D personnel in the region grew at an annual rate of 6 to 7 percent, more than twice the rate of population growth (ERF 2002). Countries that outperformed the average include Oman, UAE, Tunisia, Iraq, Jordan, Bahrain, Egypt, and Libya (ERF 2002).

The distribution of R&D personnel by institution shows that in 1996 about 66 percent of R&D personnel were working in government, 31.6 percent in universities and a mere 2.1 percent in the private sector (Djeflat 2002). Examining the distribution by sector shows that 44.2 percent of R&D personnel were in agriculture, 8.5 percent in industry, 8 percent in basic sciences, and 6.3 percent in engineering (Djeflat 2002).

Currently, there are roughly 50,000 PhD professionals in S&T in the Arab world (Hopkins and Carr-Hill 2001) and in 1990 there were more than 600,000 Arab engineers (Djeflat 2002). Annex Table 4 shows that in 1992, the largest number of PhD holders in the Arab region were mainly in agriculture, engineering and basic sciences, and health nutrition and biotechnology. However, the lowest number of PhD holders were in industry and were exceeded by those in humanities, social sciences, and energy. In 1996, about 65 percent of PhD students were in the S&T field. In Egypt, Algeria, Iraq, Bahrain, Morocco, and Qatar more than 60 percent of the students were in S&T, while in Jordan, Kuwait, and Saudi Arabia about 60 percent of PhD students were in humanities and social sciences. Furthermore, the PhD staff to student ratio suggests that for the Arab region, PhD holders who are teaching staff are concentrated in science and technology.

Egypt has the overall edge in science inputs, with close to 60 percent of R&D personnel in the region, which is twice its population share (ERF Trends 2002). Kuwait is distinguished by higher levels of R&D personnel to population. On the other hand, Saudi Arabia has spent a considerable sum on R&D but has a small base of R&D personnel (ERF Trends 2002). However, the correlation between quantity (size of personnel) and quality of R&D is obviously very weak as is shown in the figure of Saudi Arabia's output of research that is published internationally (Table 2).

The region has also witnessed a considerable increase in higher education and in women's enrolment at the tertiary level (Annex Tables 7 & 14). The Arab Human Development Report (AHDR) shows that the mid-1990s witnessed a higher total enrolment rate for tertiary education which was 13 percent, as compared to the 9 percent average for developing countries (UNDP AHDR 2002). In the Maghreb countries, participation at the tertiary level has multiplied by 2.5 between 1980 and 1995 with Tunisia witnessing the highest increase (Djeflat 2002). The graduate rate on average reaches 120 to 220 per thousand for the whole subregion, compared to France which scored 246 in 1994 (Djeflat 2002). According to the *World Education Report* (Unesco 2000), most Arab countries have a higher level of enrolment in the fields of law and social sciences, followed by humanities. The same report shows that global trends in higher education indicate a concentration of enrolment in the humanities fields (about two-thirds of world enrolment), while around one-third are in the natural sciences.

In 1996, 164,118 students from the Arab world pursued their studies abroad (Unesco 2000). Arab students studying abroad represented 20 percent of the total number of foreign students from the developing countries, surpassing all developing regions with the exception of Eastern Asia/Oceania. Morocco by far has the largest number of Msc students in S&T studying abroad (Annex Table 6). The number of PhD students studying S&T abroad from Egypt, Morocco, and Algeria exceed those PhD students studying abroad from other Arab countries. In the field of humanities and social sciences, Morocco and Jordan have the highest number of Msc and PhD students studying abroad.

The Arab region has achieved significant strides in women's education by raising women's literacy rates threefold since 1970 (Doraid 2002). In addition, female primary and secondary enrolment rates have more than doubled, from 32 percent in 1970 to 74 percent in 1997 (Doraid 2002). In 2000, most countries, and those for which data is available, have experienced an increase in women's enrolment at the tertiary level (Annex Table 7). Turkey experienced a dramatic increase in enrolment levels, up by 62 percent from the previous year. It also has a notable presence of women scientists and researchers. To a lesser extent, Oman and Iran experienced an increase of 15 percent in levels of enrolment from the previous year. Annex Table 7 shows the participation of women by field of study, which is mainly in education followed by humanities and medical sciences. UAE and Kuwait had the highest percentage of women students in the field of education at 95 and 74 percent, respectively. In Jordan, Djibouti, Palestine, Saudi Arabia, and Syria there are over 50 percent female students in the field of education. In humanities, Kuwait, Tunisia, Jordan, UAE, Oman, Lebanon, Iran, Egypt, and Algeria have over 50 percent female students. In addition, more young women in the region are entering engineering, medicine, law, commerce, and finance (Moghadam 2002). There are growing numbers of female graduates in the fields of mathematics and computer sciences. In 1994-95, a significant number of women received bachelor degrees in mathematics and computer sciences in Iran (33 percent), Jordan (45 percent), Saudi Arabia (28 percent), Tunisia (22 percent), and Turkey (45 percent) (Moghadam 2002). Most Gulf Cooperation Council (GCC) countries have the highest percentage of female students in natural sciences, engineering, and agriculture. In Turkey, between 1968 and 1990, women graduates in the fields of engineering, mathematics and natural sciences and in agriculture and forestry increased significantly from 7 to 22 percent, 22 to 46 percent, and 10 to 33 percent, respectively (Moghadam 2002).

Trends show that employment in the MENA region has increased in favour of construction, manufacturing industries, and services at the expense of S&T specialists and managerial professional groups (Hopkins and Carr-Hill 2001). Failure to absorb highly qualified professionals has exacerbated the brain drain from the region. However, states in the region are trying to reverse this process by offering scholarships that stipulate that recipients must return to their country of origin on graduation (Hopkins and Carr-Hill 2001).

Despite the fact that a large portion of R&D budgets go to personnel (Djeflat 2002), the incentive system for researchers in the region does not promote the production of high quality output. Most research institutions are publicly funded which means public sector wage scales are applied. As a result, researchers spend a large share of their time applying for research grants, conducting consulting activities, and taking on other jobs (Hopkins and Carr-Hill 2001).

According to Varsakelis (2001), R&D investment is greatly affected by the system of intellectual property rights protection[1] in any given country as well as the national culture.[2] Findings of this study show that R&D investment intensity is quite low in countries such as Iran (1994), Egypt (1995), Tunisia (1992), Jordan (1989), and Turkey (1995) due to factors such as the system of patent protection and national culture (Varsakelis 2000).

A comparison of MENA countries with successful Asian countries such as Korea and China shows the low level of patenting and trademarking in the former (Annex Table 9). In 1996, Korea and China had over 40,000 patent applications each from nonresidents and over 68,000 and 11,000, respectively from residents. Among MENA, Turkey has the highest number of patent applications from nonresidents (19,668), which is even higher than those filed in Israel and Hong Kong. With regards to patent applications filed by nonresidents, Egypt outperforms the rest of the MENA countries listed in the table but comparisons with other developing countries reveal a large gap.

Intellectual property rights (IPR) protection is a function of having domestic laws and enforcement mechanisms that protect intellectual property. MENA countries that are members of the World Trade Organization (WTO) are committed under the TRIPs agreement to protect intellectual property. Egypt has recently issued a new intellectual property law. Jordan has witnessed a strengthening of intellectual property legislation (EIU 2003). On the other hand, Algeria, in its negotiations of accession to the WTO, has achieved little progress with regards to intellectual property rights and copyright protection against piracy (EIU 2003).

[1] For measurement of patent rights, the Ginrate and Park patents Right Protection Index is used.

[2] National culture is measured using the Power Distance Index which is a measure of the interpersonal power or influence between the superior and subordinate as perceived by the subordinate.

Financial support for R&D

With regards to sources of funding, there are three main sources for R&D activities in the Arab states: government budgets; domestic industries or other production and service enterprises; and foreign grants and technical assistance. Roughly 89 percent of R&D funds come from government, 8 percent from foreign grants and technical assistance, and 3 percent from industry (Djeflat 2002).

Government remains the most significant funding source in most Arab states (Qasem 1995; Unesco 1999); however, it remains low in absolute terms when compared to other regions and major disparities still persist among the Arab states. In many Arab states, there is a gap between budgeted R&D funding and funds actually spent. When budget cuts are made, R&D operational funds are usually hit the hardest (Qasem 1995). A large portion of these funds are allocated to wages and salaries of research personnel. In Morocco, 95 percent of the R&D budget goes to wages (Djeflat 2002). This is also a key problem in Egypt.

Governments have been confronted with difficult tradeoffs. On the one hand, there is pressure to reduce deficits, which might result in pressure to drop the required investments in research and human accumulation and in the generation of knowledge, especially in the longer-term (Rodriguez 2000, p. 28).

Government national expenditure on R&D (which is not entirely divorced from the per capita income levels in society), has also suffered from limited resources which have been channeled to other "priority" sectors or wasted on inefficiency rather than being channeled to better higher education, R&D, etc. It is argued that "despite the existence of numerous research institutes, meager state funding (and the almost complete absence of private funding) has kept scientific output to a minimum" (Rodenbeck 2000).

There is a lack of reliable data on resource flows from the private sector or public service institutions. However, Qasem (1995) stated that "R&D activities financed and managed by private sector sources came to less than one percent of total R&D expenditure in the Arab states in 1992."

As for donor support for research in the MENA region, such support peaked in the early and mid-1980s but declined before the onset of the 1990s. It is worth highlighting that there is currently no available data on donor support for research activities in the region. However, in the mid-1980s, Egypt, Jordan, Morocco, Yemen, and Tunisia were the largest recipients. The notable donor institutions in the region are: USAID, GTZ, CIDA, and IDRC, French technical assistance agencies, UNDP, and EuropeAid (Us Agency for International Development, German Agency for Technical Co-operation, Canadian International Development Agency, International Development Research Centre, UN Develoment Programme). Priority research areas were agricultural production systems, water resources, environment, renewable energy sources, and health (Qasem 1995).

Availability of and needs for research

The MENA region can be divided into three categories with regards to the strength of their science and technology activities (STAs) and their ability to integrate them into socioeconomic objectives. Countries such as Algeria and Egypt have a well-established record since the 1970s in integrating S&T into economic development. Egypt has a particular strength in agricultural research (Djeflat 2002).

A second category of countries includes Morocco, Tunisia, Jordan, and Kuwait which face more difficulties in linking S&T to economic development policy despite their more market-driven growth and the contribution of foreign direct investment (FDI) to industrialization. These countries had no clear bodies responsible for designing and implementing S&T policies and the level of awareness on the linkages between S&T and development was quite low (Djeflat 2002). Technological dependency was the case in these countries.

A third category of countries, including Libya and Mauritania, comprises both small economies in terms of markets and populations and a thin presence of S&T policy in economic development (Djeflat 2002).

It is argued that the region's capacity in social sciences is hampered by the lag in research methodologies. Much of the analytical work is undertaken in isolation from front-line methods. For instance, in economics, not only do researchers suffer from the absence of adequate training, but also from a lack of exposure and exchange with best practice economists. In addition, when individual researchers with sophisticated academic training do emerge, they usually prefer to work in the high-prestige/high-salary academic research and development institutions of the North (ERF 1997).

On the other hand, the strengths of social science research in MENA relate to the ease of conducting cross-country comparisons due to the availability of comparable indicators on a wide range of issues, the spread of public-policy research since the mid-1980s in a number of Arab states, and also the relative strengths of economic research in the Arab world (Ibrahim 2000). Research organizations in the region are also revising their research agendas. There is an increased awareness among social scientists of the need to adopt a multidisciplinary approach, as well as to design research programs that are closer to the concerns of development practitioners (see Box 2). Research results over the past decade are key to understanding the intimate relationship between the many variables and development challenges inherent to globalization and its technological ramifications, poverty and its socioeconomic determinants, and sustainable growth and protection of the environment. However, the extent to which practical research results and policy options translate into a comprehensive reform agenda is the ultimate measure of successful policy-relevant research (Handoussa 2000).

Box 2
Gender concerns in research: the case of the Reproductive Health Working Group (RHWG)

A network that has been particularly strong in reproductive health research in the region is the Reproductive Health Working Group (RHWG). Established in 1988 by the Population Council, the RHWG consists of a multidisciplinary group of researchers, including professionals with specializations in anthropology, biostatistics, demography, medicine, public health, and sociology, who are interested in quality and relevant reproductive health research.

Researchers in the RHWG have proposed an ambitious conceptual framework for analyzing the relationship between social, cultural, and economic determinants and reproductive health outcomes. Research projects in Egypt, Jordan, Lebanon, and Tunisia stimulated local and international discussion on the need for holistic and interdisciplinary approaches to understanding women's lives, and in addition, the need for comprehensive responses.

The RHWG research on reproductive morbidity in the Giza Governorate in Egypt has become an international classic in the field of reproductive health, and a model of interdisciplinary approaches to research. Recently, the American University in Cairo Press published a monograph summarizing the study methods and results. The results of the Giza study have stimulated discussion among funding agencies and Egyptian health authorities about needed policy and program changes. For instance, the Giza study led to a pilot project in three health centres to test the feasibility of improving reproductive health care within the government system. Members of the RHWG replicated the Giza study in Jordan, Sudan, and Lebanon, leveraging funds from other sources, including the Mellon Foundation and the World Health Organisation.

Furthermore, the presence of anthropologists and sociologists in the RHWG has encouraged the exploration of new research areas such as women's and physicians' perceptions on reproductive health issues. For example, the research on physicians' perceptions has been carried out by members of the RHWG and the Obstetrics and Gynecology Department of the Al-Azhar Medical School in Cairo. The project has examined the role of medical education in constructing physicians' perceptions of women's health. This research has had a profound impact on the individual department members of Al-Azhar who participated, and has brought to their attention the many nonscientific factors affecting the reproductive health care they offer.

RHWG's future research agenda includes challenging new topics such as childbirth practices (i.e., common practices such as midwives and recommended practices) and hospital policies; the relationship between health sector reform and reproductive health care; and how sexual behavior can influence fertility and morbidity.

The RHWG, like many research institutes and networks in the region, faces major challenges in terms of dissemination of research results and evaluating its impact on reproductive health care programs in the region. With regards to dissemination, the group will begin a series of interviews with the potential users of their research with the aim of understanding how they make their decisions and to what extent it is based on research results. This information will serve as the foundation for a strategic plan for dissemination. Concerning the evaluation of the RHWG performance, a participatory internal evaluation coupled with an independent external consultant review is planned.

The RHWG's commitment to quality research and interdisciplinary methods has made it one of the region's success stories.

Source: RHWG 2000.

Actors on the supply side

The role of nongovernmental organizations (NGOs) and civil society organizations in research is becoming increasingly important. However, restrictions on the establishment of NGOs in the region tends to limit the potential role such institutions can play in bridging the research-policy divide. Five of the organizations listed in Table 3 were originally founded as for-profit companies as opposed to nonprofit organizations. The main explanation for this transference is the prohibitively cumbersome procedure that requires nonprofit organizations in many of these countries to be certified (CIPE 1997, pp. 45-6). For example, in an effort to closely monitor NGO activities, many governments in the region require that applicants pass through a highly bureaucratic screening process that includes the relevant Ministry of Interior.

Furthermore, there tends to be a low level of scholarly activity on the part of scientific and professional organizations in the Arab region (Zahlan 2000). However, exceptions do exist; for example, the medical profession has had a greater impact than that of the engineering profession. The former enjoy a more established history than the latter. The inadequate incentives system and the budgeting for travel grants to attend scientific meetings has acted as a brake on professional societies reaching their potential. It has been suggested that public funding could play an important role in developing these scientific societies to maximize their impact (Zahlan 2000).

Table 3. Think tanks in the MENA region.

Name	**Country & year of establishment**	**Research themes**
Al Urdun Al Jadid Research Center	Jordan 1990	Civil society and democracy, human rights, water and environment, gender, social history, governance, and security
Association Maroc 20/20	Morocco 1995	Governance, democracy, civil society and gender
Association for Liberal Thinking	Turkey 1992	Democracy, governance, and human rights
Arab Planning Institute (API)	Kuwait 1972	Development, economic management, and planning
Bahrain Center for Studies and Research (BCSR)	Bahrain 1981	Industrial, technological, scientific, and environmental research
Center for Palestinian Research and Studies	Palestine	Economic policy and sectoral studies
Center for Strategic Studies	Jordan 1984	Regional conflicts, international relations and security, democracy, political pluralism,

		development, the economy and the environment
The Center for Economic and Financial Research and Studies	Egypt 1984	Human resource development, growth-oriented policies, poverty alleviation and capacity-building and integration with the global economy
Egyptian Center for Economic Studies	Egypt 1992	Economic development in Egypt and issues of chief concern to Egypt's economic reform schedule
Economic Research Forum for the Arab Countries, Iran & Turkey	Egypt 1993	Macroeconomic management, role of the state, governance, trade, regional integration, and EU-Med Partnership Agreements; financial sector performance, globalization, and FDI; labour markets, human resource development, population and poverty; and sectoral economics
Emirates Center for Strategic Research & Studies	UAE	International politics, security studies, labour economics, macroeconomic planning, petroleum and energy economics, Gulf security, and other areas
Kuwait Institute for Scientific Research	Kuwait 1967	Environment and urban development, water resources, food resources and marine sciences, petroleum research, and industry
Lebanese Center for Policy Studies	Lebanon 1989	Democracy and governance, civil society, economic policy, international relations, education, and environment.
Royal Scientific Society	Jordan 1970	S&T, industry, and environment
Social Science Research Center (SRC) at American University of Cairo (AUC)	Egypt 1953	Population and fertility, poverty, political participation of women, the effects of economic liberalization, urbanization, social epidemiology, maternal and child health, and the environment
Turkish Economic & Social Studies Foundation (TESEV)	Turkey 1961	Governance, democracy, civil society, globalization, and EU relations

Source: Compiled by ERF 2003.

National and regional institutions of scientific and technical learning

A national system of innovation is considered an essential prerequisite for a successful S&T policy (Djeflat 2002). However, implementation of such a system has faced numerous constraints as evidenced by the basic indicators of innovation and the impact on economic development and social welfare (Djeflat 2002).

Most S&T institutions in the region are inherited from an ISI era, which means most of them are publicly funded with limited exposure to competition and state-of-the art technology.

Most countries in the region have managed to establish some kind of S&T policy, even if implicit (Djeflat 2002). Yet, according to Lall, there is no institutional mechanism for evaluating and setting science and technology priorities in the region. Many countries suffer from the lack of an S&T plan while coordination between the various ministries and institutions is inadequate (Hopkins and Carr-Hill 2001). Another limitation is related to the fact that there are few complete and reliable records of accumulated experience in industry, university, and research centres which limits opportunities for information exchange (Djeflat 2002). Furthermore, connectivity between Arab scientists on the national and regional level is poor (UNDP AHDR 2002).

The absence of well-conceived, financially supported national research plans, and the weak link between policy and research (Ibrahim 2000), as well as the divorce between research agendas of national research organizations and the applied needs of industry, agriculture, and other sectors of the economy further impedes the efforts of research institutions in narrowing the gap between research and its developmental impact.

Nevertheless, from 1960 to 1996, R&D institutions in the region increased at the rate of eight institutions per year (Djeflat 2002). To date there are more than 600 institutions in the region involved in R&D activities. At the same time, the region is witnessing high rates of expansion in universities where the number of universities has reached 200 as compared to eight in 1950 (Zahlan 2000). About 80 percent of Arab R&D activities are conducted in universities (Djeflat 2002). In 1996, 91 percent of total expenditure on institutes of higher education in the Arab region went to universities as opposed to 6 percent received by technical institutes and 3 percent allocated to ministries of higher education (Annex Table 10). Only in Bahrain and Tunisia did technical institutes receive more than 20 percent of budget allocated to higher education.

Moreover, best practices exist in the region with regards to the state of technological and scientific infrastructure. A country like Tunisia stands out in the region with regards to technological and scientific infrastructure. The UNDP's 2001 *Human Development Report Making New Technologies Work for Human Development* stated there are 46 locations worldwide that served as technology growth hubs[3] and that El-Ghazala in Tunisia was one of them.

In addition, the Kuwait Institute for Scientific Research (KISR) represents a case of best practice in the region in terms of promoting innovation and applying R&D for development. This well-established institution (since 1972) has pioneered R&D in the field of the development of water resources. As a result, Kuwait is one of the first countries in the world to have used seawater desalination for fresh water supply (Djeflat 2002). In addition, it is also considered one of the most experienced countries in the use of the MSF (multistage flash) technology (Djeflat 2002). It has also adapted water desalination technology (i.e., reverse osmosis technology) to suit local conditions.

[3] Technology growth hubs are centres that bring together research institutes, business start-ups, and venture capital.

The success story of KISR suggests that the opportunities for catching up on the technological frontier through leapfrogging are real for the region.

State-owned enterprises (SOEs)

The Algerian experience shows that limitations in funding do not necessarily act as a brake on building innovative capacities that serve developmental purposes. SAIDAL, a state-owned enterprise (SOE) established in 1998 in the pharmaceutical sector has successfully brought self-sufficiency in many types of drugs by producing local generic products that substitute imported products (Dejflat 2002). Through a viable strategy and the use of international standards, SAIDAL has had a major impact on the growth of domestic production and improving competitiveness of Algerian pharmaceuticals. Domestic production has increased from 18 percent to 40 percent of the Algerian market. Exports of pharmaceuticals have expanded in developing and even developed country markets (Dejflat 2002).

SAIDAL's success can be attributed to benefits accrued from joint ventures and partnerships with international companies as well as its extensive training of personnel in information communication technologies (ICTs) (Dejflat 2002).

The role of private firms

The legacy of socialist policies and state-dominated economies has taken its toll on the level of private funding of R&D activities which did not exceed 1 percent of total R&D expenditure in the Arab states in 1992 (Qasem 1995). There is a growing awareness of the need to tap this important funding source for R&D, given the existing budgetary constraints and the increasingly important role played by the private sector in MENA countries. Often, though the private sector is somehow reluctant to finance R&D activities because of the lack of a long-term vision and the uncertainty associated with R&D outcomes.

In Tunisia, a private enterprise, POULINA, which consists of a group of enterprises involved in various fields of industry, agriculture, agrofood, and services has a noteworthy record in promoting technological innovation. Its success lies in its dynamic technological policy and a sizable R&D department with a significant budget. It has managed to adapt technology to the needs of the agrofood industry. POULINA achievements have included the design and marketing of a new exhaust pipe that suits the need of the European automobile industry and a new automated procurement and management system (Djeflat 2002).

Extent of North-South collaboration

The extent of North-South collaboration between scientists can take the form of joint research programs between nationals and their international counterparts. The rate of international collaboration in the Arab countries is higher than the average in well-established scientific communities (25%) (Zahlan 2000). This collaboration has increased in the 1990s, from 32 percent in 1990 to 39 percent in 1995. In the same year, of the 2,716 papers published by scientists from the GCC in refereed journals, about one-quarter were coauthored with scientists from foreign institutions. One can also make a distinction between the Maghreb and Mashreq countries where the former witnessed higher rates of collaboration with international scientists. In 1995, Algeria, Morocco, and Tunisia published a total of 1,264 papers of which 65 percent were in collaboration with either regional or international scientists with greater collaboration with the latter (Zahlan 2000).

The success of KISR in Kuwait in using R&D to pursue developmental goals can also be linked to the strategic alliances it has developed with local, regional, and international research institutions that have enabled access to state-of-the-art technology that has been adapted to the local environment (Djeflat 2002). The same approach has recently been recognized as an effective mechanism in regional and national R&D institutes and university research departments which are now forging joint programs and other forms of collaboration activities.

Research dissemination

The MENA region suffers from an insufficiency of recognized journals. The quantity is meager, as is the quality. Most of the journals are in Arabic and their quality tends to be uneven.

Research and scientific meetings are an important forum for research dissemination. According to Zahlan (2000), participation of Arab scientists in international scientific meetings is low. Of the 18,000 scientific meetings which occur annually around the world and result in published proceedings, less than 50 take place in the Arab world. Arab scientists contributed to only about 200 of these 18,000 meetings.

Networking and coordination between the various MENA think tanks is essential to create channels for disseminating and sharing research results. Even simple electronic networks can provide a useful means to disseminate and publish research.

The Internet is supposedly a cheap and simple mechanism for research networking. A 1999 comparison of MENA with other developing regions shows that some Arab countries score favourably with regards to personal computers per 1,000 people (World Bank 2001a). The best performers on this indicator are the GCC countries, particularly Bahrain, Qatar, Kuwait, and UAE (Table 4). However, regional disparities are wider with regards to indicators such as the number of Internet users in 1999, where MENA exhibited the lowest number of users among developing regions. Also, the indicator of hosts per 10,000 people in 2000 for the region was very low. The divide is all the more glaring when compared with developed countries.

On the other hand, some states in the region restrict access to ICTs for ideological and political reasons, primarily out of fear of threats to stability (Rodriguez 2000, p. 30). For example, both Syria and Iraq restrict public Internet access, while Saudi Arabia permitted public use of the Internet in 1998. Although the estimated number of Internet users was expected to reach 140,000 in Saudi Arabia, high tariffs and access restrictions have resulted in an actual number of 100,000 users (Hopkins and Carr-Hill 2001). Iraq's telecommunication network in general has been negatively impacted by the embargo imposed for over a decade.

Table 4. Selected ICT indicators in a number of Arab countries,

Country	Internet hosts per 10,000 inhabitants	Internet users per 10,000 inhabitants	Estimated PCs per 100 inhabitants
Egypt	0.3	92.0	1.5
Jordan	4.2	409.1	3.3
Kuwait	17.4	1,014.7	13.2
Lebanon	19.9	858.0	5.6
Morocco	0.8	131.5	1.3
Oman	17.8	457.5	3.2
Saudi Arabia	5.1	134.4	6.3
Syrian AR	0.01	36.1	1.6
UAE	288.5	3,392.4	15.8

Source: World Economic Forum 2003.

The Environment for Research

Social, cultural, and political environment for research

While the market plays a large role in influencing STAs, the interplay of social, political, and economic policies has a great impact on the outcome (Djelflat 2002). Several existing features of the MENA region in the social, economic, and political context influence and shape the environment for research.

One of MENA's features is the huge variations in income levels across the region that are reflected in the state of research institutions. At one end of the spectrum, one finds modern and technologically advanced research institutions in the Gulf countries such as Kuwait and Saudi Arabia. At the other end of the spectrum, the region is host to one of the poorest countries in the world such as Yemen (Unesco 1999). In Yemen, the R&D infrastructure is shackled by its lack of resources. In between, there exists the middle-income countries that do have a well-established research infrastructure but are experiencing deterioration in terms of funding and quality of research. The impressive community of researchers in countries such as Egypt, Morocco, Tunisia, Lebanon, and Turkey attest to the gap between potential and actual research output of those countries.

However, it should be highlighted that the low level of expenditure on R&D in MENA should not be perceived as an obstacle to the use of knowledge for development. Traditional knowledge and technology that is easily transferable and understood can have an influential impact on any economy (Hopkins and Carr-Hill 2001). Issues such as the free flow of information, intellectual property rights, and sharing of primary data are ultimately governed by the research culture and how knowledge acquisition is perceived (ERF 1995). Countries accomplish greater technological strides when they produce:

- A climate of democratic rights and civil liberties (including freedom of expression, and transparency of institutions) that is conducive to innovation and adaptation of ICTs
- Respect for the rule of law and security of property rights
- Investment in human capital
- Lower levels of government distortions (Rodriguez 2000, p. 10)

The above elements deemed necessary for technological progress tend to be influenced by the overriding problem of political instability. The political environment in MENA has had a significant impact on its research environment. The region is one of the most conflict-ridden areas in the world. This has influenced research activity in multiple ways. One significant manner in which research has been affected is that several governments in the region tend to limit access to information. Concern for regime stability has partly sacrificed the existence of an environment with a free flow of accurate and reliable information. A measure of voice and accountability[4] in the region shows that Arab countries rank below the mean of the world distribution (UNDP AHDR 2002). There are also restrictions on establishing professional organizations and NGOs in the region. Control of civic associations through bureaucratic constraints and tight surveillance of their activities stifles any efforts at creating a vibrant and proactive civil society.

On a positive note, academics in the region are often perceived as public intellectuals whot have a high level of input in public debates to the extent that they are much more influential than their Western counterparts. Areas such as the environment, human rights, economic development, and political reform are highly influenced by researchers' input (Unesco 1999). In fact, a high proportion of cabinet members in MENA countries are drawn from the academic and research fields. At the regional level and over the past 10 years, the Economic Research Forum (ERF) community of 143 research fellows and associates has seen the appointment of some 12 members into ministerial positions in eight ERF countries.

Many countries in the MENA region have a large informal sector that is heavily organized around families and households. Social capital plays an important role in

[4] This is a measure of the extent of free and fair elections, press freedom, civil liberties, political rights, military involvement in politics, transfer of power, transparency, and business kept informed of developments in law and politics. Business can express its concern over changes in law and politics (UNDP 2002).

development in this region. This sense of community has resulted in the lowest incidence of poverty in the world. A study by Page and Gelder (2003) showed that over the last 30 years, the region has shown remarkable progress in addressing extreme poverty compared to other regions in the world. Throughout the 1990s, MENA stood out amongst the developing regions with the lowest incidence of extreme poverty, measured as those living on less than $1 per day (Page and Gelder 2003). In spite of the harsh impact of structural adjustment programs in more than half of the countries of MENA, strong social responsibility, family, religious establishments, and charitable NGOs provide an effective mechanism for income distribution.

Understanding the cultural context helps to better adapt development programs and agendas to the specific needs of a country or region (World Bank 2001b). Sustainable development also requires that sociocultural knowledge be used in key processes for inducing development (i.e., policy formulation, planning, financing, institutional mobilization (World Bank 2001b).

Macroeconomic policies affecting STAs

Most countries in the region have undertaken liberalization measures (trade liberalization, privatization, institutional reform, etc.) after periods of state intervention and import substitution policies; however, the region still lags behind other developing regions on various fronts in terms of liberalization. For instance, transition economies, despite adopting the liberalization drive at a later period, have outperformed most MENA countries. Furthermore, there are disparities between countries' performance within the region. Egypt, for example, adopted an open door policy in 1974, but the pace of liberalization has been slow. On the other hand, Tunisia and Turkey were committed to faster and more serious liberalization measures, in spite of starting their liberalization in the 1980s.

Trade liberalization has become increasingly interrelated with the ability of domestic firms to innovate. There is evidence that Turkey's trade liberalization — which started in the early 1980s — had a positive impact on innovation. It seems to have been driven more by imitation through the import of technology-intensive products (reverse engineering) than by spillover effects from FDI (ERF Trends 2002). As for Tunisia, liberalization policies have been accompanied by a strong innovative drive reflected in the increase in patent applications especially in three fields: mechanical and electrical industries; chemical industries; and various manufacturing industries. Between 1984 and 1994, Tunisia deposited about 1,720 patents, three-quarters of which where awarded to firms, 21 percent to individuals, and 1.6 percent to research centres (ERF Trends 2002). It is worth noting that most of the firms awarded patents in Tunisia were foreign firms, while most individuals were Tunisian, which makes it hard to evaluate the true inventiveness of the economy because most patents awarded to individuals have little chance of being transformed into an application unless there is a prior investment commitment (ERF Trends 2002).

With the exception of the Gulf countries, economies in the region still enjoy high protection in terms of high average tariff rates and also high effective rates of protection in certain sectors due to escalation and distortions in the tariff structure. This has provided a disincentive for the private sector to engage in advanced R&D activities to improve productivity, product quality, or design. The outcome is a general anti-export bias, especially in high-tech exports. The share of high-tech exports is still very low[5] as compared to other developing economies, which again reflects the fact that R&D activities carried out by public research institutions and university-based centres are not demand-driven and have not catered to the needs of private firms. The figures indicate that Bahrain, Egypt, Tunisia, and Turkey were able to increase the share of high tech exports in their total exports during the period 1985 to 1997. On the other hand, the performance of Jordan and UAE has declined markedly during the same period (ERF Trends 2002).

On a related front, corporate tax rates are generally high in the region with the exception of some Gulf countries. For instance, corporate tax rates in Iran and Egypt are in excess of 40 percent. Tax rates in other countries range between 30 and 35 percent with the exception of Lebanon and Oman with rates of 15 percent and 12 percent, respectively. Kuwait, Bahrain, and UAE do not tax corporate activities (WEF 2003). Most countries offer tax holidays and tax incentives for targeted sectors, however, the incentives mainly target export activities, with no special incentives for R&D activities.

Privatization has also slowed down in the region; however, its pace is not expected to have a significant effect on the minute role of the private sector in STAs as most R&D institutions are not affiliated to state-owned enterprises, but rather to university-based centres and independent public R&D institutions. For example, the share of private sector in R&D expenditure is close to zero in all Arab states, with the exception of Jordan and Morocco where the share is 11 percent and 4 percent, respectively (see Annex Table 11).

With respect to protection of intellectual property rights, most countries in the MENA region have not been able to institute a reliable system for intellectual property rights (IPR) protection. This, coupled with high protectionism, has acted as a disincentive for the private sector to expand its already modest R&D activities in order to develop indigenous capacities, reduce cost, or improve product quality. The pharmaceuticals industry is the most sensitive in this context as policymakers are keen to control prices and maintain protection for domestic producers. However, they are likely to face immense pressures due to the TRIPS agreement, and the challenge will be accentuated in the case of Egypt, Jordan, Iran, and Saudi Arabia where the sizable pharmaceutical sector will need to be reoriented and repositioned to face such challenges (ERF Trends 2002).

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[5] Jordan had the highest share at 5.9%, followed by Turkey and Tunisia recording 4.1% and 3.3%, respectively.

Market constraints

Domestic markets in most countries in the region are subject to a number of constraints especially with respect to anticompetitive practices and market failures in labour and capital markets. This has created a market structure characterized by lack of competition as well as discrimination against small and medium-sized firms. "Both high market concentration and low import penetration are significant indicators of potential impairment of the competition process" (Lahouel 2000). Evidence from Tunisia and Morocco suggests a high degree of market concentration in domestic industries (Lahouel 2000), which is suggestive of oligopolistic structures. In the case of Egypt, there is evidence of market dominance in the case of steel production, and also high concentration in the cement industry (Ghoneim 2002). This low degree or lack of competition has adverse effects on R&D activities and STAs due to lack of incentive to innovate, reduce costs, improve operational practices as well as product quality design. In addition, "the absence of competitive pressures in the domestic sector would reduce the incentive of firms to adopt new technologies either to increase economic efficiency or to gain foreign market shares" (Mohtadi 1999).

Despite the transition process to market-based economies in MENA, countries in the region carry the legacy of decades of state monopolies over major resources and/or high levels of intervention by the state in such key sectors of economic activity as energy, infrastructure, banking, or manufacturing. For the majority of MENA countries, and in comparison to other developing regions, the government and the public sector still account for a large share of GDP generation, employment, and aggregate investment (Handoussa et al. 2000). In services, state control is still pervasive and is another obstacle domestic firms face, coping with poor services at high costs. Bureaucratic intervention is often cited as one of the major problems in the region. In Algeria, bureaucracy and red tape has stood in the way of the valorization by industry of an innovative process developed by a university laboratory in biochemistry that fabricates paper by using local plants (Djeflat 2002).

Information communication technologies

Information communication technologies (ICTs) require education, infrastructure, and institutions, the three resources that lag behind in many Arab countries (Rodriguez 2000, p. 10).

The weight of Arab countries represented in the UNDP's Technological Achievement Index (TAI), is very slim indeed. The index was established using the data of only five Arab countries: Algeria, Egypt, Sudan, Syrian Arab Republic, and Tunisia, an indication of the shortage of data that is available on knowledge acquisition in Arab countries. "In spite of significant internal variability and compared to leaders in the world, Arab countries in general clearly lag behind in technology creation (measured by patents granted to residents) and diffusion of recent innovations (measured by the share of high and medium-technology exports in total goods exports). On the other hand, Arab countries fared relatively better on diffusion of old innovations (measured by telephone lines relative to population)" (UNDP 2002).

Rodriguez and Wilson (2000) have constructed an Index of Technological Progress[6] (ITP) that measures the extent of information technology advancement in 110 countries. Annex Table 12 shows the level of ITP for selected MENA countries and compares the ITP growth in MENA with other regional groupings over the 1994-96 period. Surprisingly, Yemen, which is a low-income country, performs better than Algeria and Egypt. This confirms the overall findings reached by the authors that having a high GDP per capita does not necessarily translate into superior technological progress (Rodriguez and Wilson 2000). Having a S&T policy and necessary institutional support are also important. In terms of ITP growth, the Middle East's performance, although comparable with other developing regions, trails developed countries and Asia. However, Tunisia shows a favourable ITP growth rate which places it among the developed countries with regards to this indicator.

There are three sets of MENA countries that have pursued the track of ICT development. The first group with relatively fast-track performances includes Kuwait, and UAE. The second group of countries is still emerging and includes Egypt, Jordan, Lebanon, and Saudi Arabia. The third and last group is still developing but is in a lagging position relative to the rest, and includes Morocco, Oman, and Syria (World Economic Forum 2003, p. 183).

Despite the improving access of developing countries to ICTs, the gap between the rich OECD countries and the poor developing countries is growing both in terms of ICT products as well as in terms of income (Rodriguez 2000, p. 2). A problem lies in that most technology in the region is acquired through turnkey contracts, which limits local innovation and deepens technological dependencies. Addressing these concerns will help stimulate R&D activities by improving access to information and data.

Education

Education and training are considered essential elements in any national innovation system. MENA countries face a dilemma in terms of reforming their educational systems. The problem does not lie in expenditure levels on education since governments in the region have been spending a significant share of their budget resources in this sector. For instance, in 1996, MENA countries allocated 5.2 percent of their GNP to education which surpassed any developing region's expenditure levels, with the exception of Eastern Europe and Central Asia (Billeh 2002).

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[6] The ITP is calculated by using principal component analysis. Through this statistical technique, information on five indicators of technological output (personal computers, mobile phones, Internet hosts, fax machines, and televisions) are combined and the extent to which variations in the five variables are due to a single phenomenon that differs across countries is measured. The ITP ranges from 0 to 100, the higher the number, the more technologically advanced a country.

The quality of education is a main problem area.

In MENA, there tends to be an emphasis on tertiary education at the expense of basic education. Public spending on education has been concentrated on higher education (Billeh 2002). In three countries, Egypt, Jordan, and Kuwait, about one-third of the education budget is spent on the tertiary level (Billeh 2002). Annex Table 13 shows that in 2000, public expenditure on education at the tertiary level as a percentage of GDP per capita exceeded 80 percent for Morocco, Tunisia, Saudi Arabia, and Iran. As a result, the MENA region enjoyed one of the highest rates of enrolment at the tertiary level, surpassed only by Europe and Central Asia (Annex Table 14).

Despite the fact that higher education is the most relevant level of education for R&D, basic education is the building block on which skills necessary for the 21st century are built. Again, the quality of the educational system strongly affects output at this level. For instance, the region suffers from high dropout and repetition rates (Billeh 2002). Teaching forces in the region have expanded to meet the growing enrollment levels, resulting in a decline in average compensation levels and quality of teaching (World Bank 1998). Triple- shift primary and secondary schools exist in Egypt, Iran, Jordan, and Gaza (World Bank 1998).

There is also a serious mismatch between educational output on the one hand, and the labour market and development needs on the other. This tends to be most glaring in the case of Egypt as compared to Tunisia; however, the region as a whole suffers from this mismatch. There is nearly a total absence of quality accreditation systems that test knowledge, skills, and competence related to different jobs (Billeh 2002). University curricula usually emphasize theory while neglecting the changing requirements of technology, industry, trade, and the economy (Billeh 2002). There is also a lack of coordination within the training system which has resulted in a supply-driven approach. In Tunisia, there are 411 training centres with 26,000 students which offer 50 different specializations that are not relevant to the labour market (Tzannatos 2002). Furthermore, there are 120 publicly run training centres in Egypt that serve 36,000 students with weak links to the private sector (Tzannatos 2002).

Part of the problem lies in the fact that educational systems in most of the countries in the region are publicly financed and centrally administered (Tzannatos 2002). Populist strategies have eliminated private tuition, created access for all to education, and guaranteed employment to university graduates who lack the necessary skills and qualifications needed by the market (Unesco 1999). Private sector participation in the provision of educational services has been hindered by the lack of facilitating legal, regulatory, and accreditation frameworks, particularly for postgraduate education (Tazannatos 2002).

Nevertheless, if this mismatch persists, education loses its power to achieve socioeconomic development objectives, particularly poverty alleviation (UNDP AHDR 2002b). The risk of isolation from global knowledge, information, and technology is quite high; especially at a time when the accelerated acquisition of knowledge and information of human skills are the tools for progress (UNDP AHDR 2002b, p. 51).

The deficient capacity of Arab educational systems and institutes produce graduates who possess the knowledge and skills required for effective participation in both the economy and society has been evident in many Arab countries. According to the UNDP *Arab Human Development Report*, “The objectives of the education process should be derived from the global vision of the 21st century education. Education should integrate the Arab people into the age in which they live, an age governed by the exactness of science its causality, rigor, and method” (UNDP AHDR 2002b, p. 55).

The MENA region also suffers from a paucity of research on the quality of education. The few studies available show that educational outcomes point to a low level of knowledge attainment and inadequate analytical and innovative capacity (UNDP AHDR 2002b).

Nevertheless, case studies of Egypt, Lebanon, and Iran illustrate how recent educational research is disseminated and how educational reforms may have benefited from insights gained through research (Galal 1999; Farah-Sakiris 1999; Bazargan 1999). These case studies looked at the educational information system and the ways in which it influences the decision-making process as well as the various links between providers of educational information on the one hand, and the recipient institutions such as the administrative and political authorities, on the other. A common feature of these case studies is that the quality and dissemination capacity of educational information systems is limiting educational research and that there is room for improvement.

There is much room for improvement of the Arab educational systems through cooperative efforts between Arab countries in the areas of graduate studies, research, and publications (UNDP AHDR 2002b). Building networks of Arab educational institutions through ICT and the creation of knowledge networks is considered an effective means for cooperation (UNDP AHDR 2002b). This avenue has had extremely high returns in the case of the ERF initiative, which has allowed the formation of a flexible but cohesive critical mass of specialized experts in economics and related development sciences.

Box 3 Best case study of establishing a database on research institutions.

Scientific and cultural exchange program between Iranian and international researchers December 2000

The scientific and cultural exchange program between Iranian and international researchers was launched by the Population Council in 1999 with Ford Foundation funding and technical support from Columbia University. The program aims at facilitating networking opportunities between Iranian researchers and international counterparts to identify mutual areas of interest, promote cooperation, and expand the scope of research in Iran though multidisciplinary research.

The project covered five sectors:

- Health and population
- Environment
- Children and youth
- Women and development
- Socioeconomic development

The program has successfully established a database of Iranian researchers, scientists, research centres, and scientific institutions in the five sectors. It has also created a database on international and expatriate Iranian researchers, scientists, research centres, and scientific institutions active in the five areas. Besides using information available from the Ministry of Science, Research and Technology and various publications, the methodology consisted of surveys and consultation panels which brought together scientists and civil society to provide critical and objective insights into the status of science and research in Iran.

The program is considered a model in terms of the detailed information on the state of research in Iran. It provides data on research institutions based on their affiliations, scientific disciplines, geographical location, distribution of researchers by specialization and educational level, and major bottlenecks in the research environment in general and the five focus areas in particular.

Source: Namazi and Mohebtash 2000.

Food for Thought

The state in MENA has a major role to play in the promotion of scientific and technological innovation, well-established market-driven competition, and more efficient allocation of resources supported by an efficient information system. There also needs to be a greater role for the private sector, which can create investment opportunities that are based on innovation and competition (Djeflat 2002). Providing the right incentives for private R&D is crucial. Very few developing countries have been able to provide the right conditions, such as Korea, Singapore, Taiwan, and China (World Bank 1998).

There is also plenty of room for cooperation between countries with different resource endowments. The analysis in this paper highlights the importance of cooperation and building partnerships between the public and private sector, as well as between the various universities, ministries, and research institutions involved in R&D. Cross-border cooperation is needed for experience and knowledge exchange.

Information gathering and access to data is the first stage that, if organized, develops into a higher stage of ability to research and acquire knowledge that may then translate into policy and development (UNDP AHDR 2002b). In MENA, access to accurate and reliable data tends to be a major problem for researchers. This paper has highlighted limitations in data access and data availability. Efforts to close this information gap must be undertaken (see Box 3 on a successful data gathering initiative in Iran).

Important priority areas for research in the region are only identified under broad fields like water, land, and environment; social issues relating to poverty, unemployment, and SMEs; the production and sharing of knowledge; macroeconomic issues; and governance issues (Rodenbeck 2000). There is a need to conduct in-depth studies on the research needs in the region, either by sector or by topic. Also, literature surveys are still lacking in the region. For example, in 1995, IDRC, in collaboration with ERF, conducted a detailed literature survey on economic cooperation and integration in the Middle East, with particular reference to Egypt. It consisted of some 674 entries classified by author on all publication and conference papers that have appeared on this topic since 1979. Literature surveys can be beneficial in terms of creating an inventory on the state of research in any particular research area.

A performance analysis of existing research is as vital as the proliferation of research (Ozar 2001). The research community needs to assess how its results are being translated into useful information for those policymakers in designing and implementing policy priorities, and whether decision-makers actually use research in designing policies (Ozar 2001).

Furthermore, identifying and assessing best practice research networks in the region is important in narrowing the gap between research and its policy implications. One important result of assessing the elements of success of such research networks as ERF is that the formula can apply to several other areas of research in the MENA region, or indeed to any other developing region. There are four ingredients to success. The first element is quality control. The second element is organization of regular meetings where the research agenda is discussed and revised in light of research results achieved to date and user demand. A third element of success is the continuous emphasis on collaborative research between senior and junior researchers, research from various countries in the region, and researchers from inside and outside the region. Finally, the element of dissemination via meetings, publications, and Internet/websites is the means by which local researchers are kept abreast of frontline methodologies, are encouraged to seek their own research niches, and seek guidance and support for their own research proposals.

Nevertheless, progress in the research environment in the past decade includes the successful entry of researchers into domains previously considered the sole preserve of governments. The symbiosis of technical research with policy-relevant issues has produced several cases of better policy-making, especially when there has been cooperation between these two stakeholders. The past 10 years have also witnessed a trend of the absorption of former researchers directly into the policy-making circles of many MENA governments, further ensuring a sustainable interest in bridging the research-policy divide.

Annex Tables

Table 1. Arab science and technology output.

NATIONALITY OF PRINCIPAL AUTHOR	ARAB SCIENCE AND TECHNOLOGY OUTPUT, PAPERS PUBLISHED IN REFEREED INTERNATIONAL JOURNALS (NUMBER OF PUBLICATIONS)	
	1970-75	**1990-95**
Algeria	338	1,431
Bahrain	-	453
Comoros	-	-
Djibouti	-	-
Egypt	3,261	12,072
Iraq	380	931
Jordan	61	1,472
Kuwait	148	1,936
Lebanon	743	500
Libyan Arab Jamahiriya	96	348
Mauritania	-	27
Morocco	96	2,418
Oman	1	466
Occupied Palestinian Territory	-	51
Qatar	-	377
Saudi Arabia	126	8,306
Somalia	1	79
Sudan	426	690
Syrian Arab Republic	38	471
Tunisia	145	1,832
United Arab Emirates	1	579
Yemen	4	155
Arab Region	**5,865**	**34,594**

Source: Based on Zahlan 1999.

Table 2. Arab institutions that publish 50 papers or more and appear in the Institute for Scientific Information (ISI)

UNIVERSITY	1977	1983	1986	1989	1990	1995
Egypt						
National Research Center	105	123	174	156	134	158
Institute of Atomic Energy	-	-	(40)	56	(42)	(40)
University of Alexandria	105	163	232	213	237	179
Cairo University	107	203	338	304	359	230
Assiut University	(40)	86	100	162	160	195
Ain Shams University	81	101	157	203	190	211
Azhar University	-	-	71	93	77	70
Menoufeya University	-	-	(13)	53	(42)	54
Mansoura University	-	-	125	176	164	177
Menya University	-	-		57	(37)	69
Tanta University	-	-	69	59	(44)	92
Zakazik University	-	-	80	54	84	69
Iraq						
Baghdad University	53	50	66	60	82	(43)
Mousel University	-	-	50	54	(30)	(23)
Basra University	-	-	51	54	(44)	(19)
Council of Scientific Research	-	-	61	57	(38)	(10)
Jordan						
Jordan University	-	-	106	91	80	81
Yarmouk University	-	-	77	63	50	(46)
Jordan University for Science & Technology	-	-	-	79	73	70
Gulf Cooperation Council						
Bahrain						
Bahrain University	-	-	-	-	(45)	90
Kuwait						
Kuwait University	(22)	119	299	356	374	217
Kuwait Academy for Scientific Research	-	-	(31)	50	56	50

Saudi Arabia						
King Faisal Hospital	-	-	127	130	146	91
King Abdel Aziz Uni. (Jeddah)	(3)	73	97	84	86	84
King Saud Uni (Riyadh)	(18)	107	227	254	365	422
King Faisal Uni. (Eldamam)	-	-	(34)	50	57	(26)
King Fahd University for Petroleum and Minerals	(19)	121	123	119	168	317
United Arab Emirates						
Ain University	-	-	-	-	-	150
Algeria						
Hawary Bou Madeen Uni for S&T	-	-	-	-	-	71
Morocco						
Science College, Rebat	-	-	-	-	-	55
Alkadee Ayad University	-	-	-	-	-	65
Tunisia						
Tunis University	-	-	53	68	62	67
Lebanon						
American Uni in Beirut	59	78	127	50	(29)	(49)
Khartoum University	51	55	104	83	58	63
Other Sources						
Int’l Center for Agric Research in Dry Areas ICARDA, Aleppo	-	-	-	-	-	57
TOTAL	663	1,279	3,032	3,288	3,413	3,810
No. of entities that have issued 50 or more papers	7	12	23	29	21	26

Source: Zahlan 1999.
Note: Figures in brackets indicate they have been published in the Institute for Scientific Information (ISI).

Table 3. Distribution of R&D Institutions in the Arab States, 1992.

Research area	Number of institutional units		
	Autonomous and ministry-governed institutions	**Universities**	**Total**
Agricultural products and related areas	94	15	109
Health	23	10	33
Industry (excluding petroleum)	23	1	24
Environment and natural resources	11	3	14
Atomic and nuclear energy	13	1	14
Engineering	6	7	13
Renewable energy	12	0	12
Petroleum and petrochemicals	9	2	11
Basic Sciences	5	4	9
Geology & minerals	8	1	9
Space & remote sensing	7	1	8
Biotech	5	1	6
Others	28	6	34
Total	244	52	296

Source: Qasem 1995.

Table 4. Distribution of research staff by research area and academic degree, 1992.

	Distribution of research staff by research area and academic degree for autonomous & Ministry governed universities											
	Agric. products and allied resources		Health, nutrition and biotech		Industry		Engineering and Basic Sciences		Energy including petroleum		Humanities and Social Sciences	
	PhD	MSc	PhD	MSc	PhD	MSc	PhD	MSc	PhD	MSc	PhD	MSc
Algeria	37	119	25	68	14	32	100	168	25	134	46	98
Bahrain	1	8	2	7	0	0	7	4	1	4	8	9
Djibouti												
Egypt	2523	1152	846	576	218	225	546	259	460	325	287	129
Iraq	161	408	51	52	8	27	78	41	14	29	130	55
Jordan	46	45	33	24	21	32	45	13	12	4	36	20
Kuwait	41	33	24	10	13	6	50	71	21	20	27	7
Lebanon	18	42	17	22	4	12	22	16	4	7	20	6
Libya	17	49	12	16	4	12	10	10	10	26	22	10
Mauritania	7	39	1	10	0	0	4	1	2	16	12	2
Morocco	152	475	36	49	18	64	57	99	38	157	94	60
Oman	8	13	4	5	0	0	3	1	1	3	2	1
Palestine												
Qatar	1	5	1	1	0	0	5	4	1	2	7	5
Saudi Arabia	71	66	52	47	33	17	121	87	49	69	114	39
Somalia												
Sudan	169	123	37	25	9	31	47	14	19	75	26	18
Syria	60	72	8	11	24	19	68	11	12	8	29	8
Tunisia	50	130	16	42	1	7	51	25	5	14	41	40
UAE	25	40	4	6	0	0	5	1	0	0	5	7
Yemen	136	39	12	4	0	0	9	6	0	0	24	30
Total	3523	2858	1181	975	367	484	1228	831	674	893	930	544

Source: Qasem 1995.

Table 4 continued

		Indicators of R&D in the agriculture sector						
	Ratio of PhD Holders to total research staff	Total research staff in agric.	Agric. GDP in million US$	Agric labour in force in thousands	Researcher per 1,000 agric. Labour	Researcher per 10 million of agric. GDP	R&D expnd. in agric. in US$ million	Expnd. percent ratio of agric. GDP
Algeria	0.29	156	5441	1391	0.11	0.3	4.9	0.1
Bahrain	0.37	9	39	0	0	2.3	0.9	2.3
Djibouti	0	0	0	0	0	0	0	0
Egypt	0.65	3675	6510	5880	0.62	5.6	58.6	0.9
Iraq	0.42	569	27488	1049	0.54	0.3	32.6	0.1
Jordan	0.55	91	300	48	0	3	2.6	0.9
Kuwait	0.54	74	76	0	0	9.7	4.3	5.6
Lebanon	0.45	60	299	72	0.83	2	1.9	0.6
Libya	0.38	66	1845	155	0.43	0.4	3.8	0.2
Mauritania	0.28	46	276	417	0.11	1.7	1.5	0.5
Morocco	0.3	627	4132	2824	0.22	1.5	31.5	0.8
Oman	0.44	21	3.74	164	0.13	0.6	1.9	0.5
Palestine	0	0	0	0	0	0	0	0
Qatar	0.47	6	67	0	0	0.9	0.6	0.9
Saudi Arabia	0.58	137	7714	1596	0.09	0.2	26.9	0.4
Somalia	0	0	0	0	0	0	0	0
Sudan	0.52	292	3633	4923	0.01	0.8	3.5	0.1
Syria	0.61	132	3752	746	0.18	0.4	4.6	0.1
Tunisia	0.39	180	2196	655	0.27	0.8	6.3	0.3
UAE	0.42	65	667	0	0	1	2.2	0.3
Yemen	0.7	175	2010	1554	0.11	0.9	2.8	0.1
Total	0.545	6381	66819	21468	0.3	1	191.4	0.3

Source: Qasem 1995.

Table 5. Stock of graduates, 1996.

	Number of PhD students	% distribution of PhD students by discipline		Number of colleges and universities offering MSc and PhD programs		PhD holders staff /student ratio		
		S&T	H&SS	MSc	PhD	S&T	H&SS	Total
Algeria	4660	68	32	57	15	49	114	64
Bahrain	46	67.4	32.6	10	0	12	17	14
Djibouti	19	42.1	57.9	…	…	0	38	38
Egypt	20522	71.9	28.1	191	185	10	97	35
Iraq	3546	68.4	31.6	73	44	25	40	34
Jordan	2043	39.4	60.6	40	9	22	37	29
Kuwait	140	39.3	60.7	7	0	14	28	22
Lebanon	590	44.4	55.6	46	31	23	57	41
Libya	326	53.9	46.1	19	8	42	91	63
Mauritania	93	50.5	49.5	…	…	23	50	40
Morocco	3955	67.9	32.1	50	45	33	179	82
Oman	152	51.9	48.1	3	0	9	22	14
Palestine	421	58.9	41.1	16	0	33	80	58
Qatar	57	64.9	36.1	…	…	15	21	19
Saudi Arabia	2226	39.7	60.3	62	41	14	40	31
Somalia	0	0	0	…	…	26	38	32
Sudan	1373	41.5	58.5	42	39	39	145	72
Syria	495	68	32	27	17	29	173	60
Tunisia	1754	60.3	39.7	16	16	19	74	40
UAE	294	55.4	44.5	4	0	17	41	28
Yemen	159	56.6	43.4	6	0	41	223	152
Total	42871	65	35	669	450	20	78	42

Source: Qasem. 1998.
Note: S&T = Science and Technology, H&SS = Humanities and Social Sciences

Table 6. Distribution of MSc and PhD students inside each state & abroad by field of study, 1996.

	Number of MSc & PHD Students inside each state and abroad - S&T					
	MSc Students			**PhD Students**		
	Inside	Abroad	Total	Inside	Abroad	Total
Algeria	1629	185	1814	248	268	516
Bahrain 1994	10	30	40	0	5	5
Djibouti	2	4	6	2	1	3
Egypt	4387	163	4550	1967	342	2309
Iraq 1995	498	47	545	406	23	429
Jordan 1994	355	61	416	0	132	132
Kuwait	41	62	103	0	8	8
Lebanon	97	191	288	2	41	43
Libya	86	36	122	0	0	0
Mauritania	0	54	54	0	8	8
Morocco 1995	0	756	756	0	310	310
Oman	0	7	7	0	13	13
Palestine	3	334	337	0	42	42
Qatar	0	9	9	0	6	6
Saudi Arabia 1994	356	78	434	40	95	135
Somalia	0	0	0	0	0	0
Sudan 1994	198	22	220	112	19	131
Syria	154	280	434	11	46	57
Tunisia	394	124	518	88	100	188
UAE 1994	0	31	31	0	27	27
Yemen	4	8	12	3	14	17

Source: Qasem 1998.

Table 6 continued

	Number of MSc & PHD Students inside each state and abroad - Humanities and Social Sciences					
	MSc Students			**PhD Students**		
	Inside	Abroad	Total	Inside	Abroad	Total
Algeria	1661	130	1791	154	114	268
Bahrain 1994	18	19	37	0	3	3
Djibouti	8	9	17	3	2	5
Egypt	1405	29	1434	965	147	1112
Iraq 1995	63	44	107	271	9	280
Jordan 1994	693	215	908	44	215	259
Kuwait	43	59	102	0	17	17
Lebanon	131	247	378	32	41	73
Libya	236	33	269	0	0	0
Mauritania	0	61	61	0	9	9
Morocco 1995	0	355	355	0	175	175
Oman	0	20	20	0	14	14
Palestine	19	339	358	0	34	34
Qatar	0	14	14	0	4	4
Saudi Arabia 1994	769	77	846	225	90	315
Somalia	0	0	0	0	0	0
Sudan 1994	433	17	450	80	12	92
Syria	35	26	61	14	19	33
Tunisia	2036	45	2081	111	50	161

UAE 1994	10	16	26	0	26	26
Yemen	17	10	27	3	11	14

Source: Qasem 1998.

Table 7. Enrolment levels in higher education.

	Enrolment in tertiary education: both sexes	Enrolment in tertiary education: female		
Country	**2000**	**1999**	**2000**	**% females enrolled 2000**
Algeria	[a] 456,358	...	...	…
Bahrain	11,048	...	...	…
Djibouti	496	(a) [a] 89	207	41.7
Egypt	[a] 2,447,088	...	...	…
Iran, Islamic Republic of	733,527	299,333	346,342	47.2
Iraq	288,670	98,306	98,306	34
Jordan	142,190	73,098	73,098	51.4
Kuwait	[a] 32,320	...	...	…
Lebanon	134,018	60,007	69,557	51.9
Libyan Arab Jamahiriya	[a] 287,172	141,041	[a]138,632	48.3
Mauritania	9,033	...	1,517	16.8
Morocco	310,258	116,898	135,641	43.7
Oman	19,297	...	11,180	57.9
Palestinian Autonomous Territories	80,543	33,123	38,194	47.4
Qatar	7,808	...	5,718	73.2
Saudi Arabia	404,094	225,995	225,995	55.9
Somalia	...	...	...	
Sudan	200,538	94,654	94,654	47.2
Syrian Arab Republic	[a] 94,110	...	...	…
Tunisia	207,388	...	[a] 100,146	48.3
Turkey	1,607,388	404,032	656,005	40.8
United Arab Emirates	[a] 21,000	...	...	…
Yemen	164,166	...	...	…

Source: Unesco database, 2002.
Notes: [a] Unesco estimates for 1998.
… Indicates missing value

Table 8: Percentage of students by field of study.

Country or Territory	Percentage of students (& graduates) by field of study					Percentage of female students in each field of study					
	Education	Humanities	Law and Social Sciences	Natural Sciences, engineering & agric.	Medical Sciences	All fields	Education	Humanities	Law and Social Sciences	Natural Sciences, engineering & agric.	Medical Sciences
Algeria	1 (1)	13 (16)	25 (25)	50 (52)	10 (6)	44	26	65	47	36	50
Bahrain	… (23)	… (8)	… (27)	… (25)	… (17)	…	…	…	…	…	…
Comoros	… (…)	… (…)	… (…)	… (…)	… (…)	…	…	…	…	…	…
Djibouti	28 (…)	_ (...)	72 (…)	_ (…)	_ (…)	47	61	.	42	.	.
Egypt	16 (24)	19 (16)	41 (33)	15 (15)	7 (10)	42	54	53	36	29	43
Iran, Islamic Rep.	14 (14)	13 (9)	21 (14)	36 (34)	12 (29)	37	49	58	31	21	58
Iraq	… (…)	… (…)	… (…)	… (…)	… (…)	…	…	…	…	…	…
Jordan	12 (14)	18 (20)	32 (28)	27 (24)	11 (11)	47	65	64	38	36	54
Kuwait	31 (…)	8 (…)	34 (…)	23 (…)	4 (…)	62	74	70	60	43	72
Lebanon	1 (1)	26 (23)	52 (52)	17 (19)	3 (6)	49	38	54	51	37	53
Libya	… (…)	… (…)	… (…)	… (…)	… (…)	…	…	…	…	…	…
Mauritania	… (12)	… (23)	… (50)	… (16)	… (-)	…	…	…	…	…	…
Morocco	0 (0)	67 (62)	./. (./.)	29 (33)	3 (3)	41	31	46	./.	28	49
Oman	39 (./.)	19 (51)	6 (16)	31 (26)	5 (6)	45	42	66	43	33	58
Palestine	24 (26)	11 (30)	30 (16)	10 (20)	4 (7)	44	57	57	31	32	54
Qatar	… (41)	… (35)	… (./.)	… (19)	… (./.)	…	…	…	…	…	…
Saudi Arabia	36 (39)	19 (19)	23 (17)	18 (21)	3 (3)	48	62	37	43	44	37
Sudan	… (…)	… (…)	… (…)	… (…)	… (…)	…	…	…	…	…	…
Syrian Arab Rep.	2 (4)	55 (39)	./. (./.)	31 (41)	12 (16)	39	53	43	./.	31	35
Tunisia	2 (10)	24 (18)	32 (35)	27 (23)	8 (10)	45	42	61	44	32	55
Turkey	10 (13)	5 (6)	53 (32)	22 (30)	10 (18)	38	42	47	37	29	64
UAE	31 (47)	27 (15)	14 (13)	27 (23)	2 (2)	72	95	84	56	42	67
Yemen	26 (...)	20 (…)	44 (…)	6 (…)	4 (…)	13	23	20	4	17	5

Source: Unesco 2000.

Table 9. Number of patent applications for selected MENA countries, 1996.

Country	**Patent applications/ nonresident**	**Country**	**Patent application/ residents**
Korea, Rep.	45,548	Korea, Rep.	68,446
China	41,016	China	11,698
Turkey	19,668	Israel	1,363
Israel	12,172	Egypt	504
Hong Kong	2,059	Turkey	367
Saudi Arabia	810	Morocco	90
Egypt	706	Iraq	68
Morocco	237	Algeria	48
Algeria	150	Tunisia	46
Tunisia	128	Hong Kong, China	41
Libya	23	Saudi Arabia	27
Iraq	18	Libya	12

Source: World Bank 2001a.

Table 10. Expenditure on higher education and its distribution among government and nongovernment bodies, 1996.

	Ministry of Higher Ed.[a] %	Universities [a] %	Tech. Institutes[a] %	Grand total [a] **(US$ millions)**
Algeria	3.5	90.5	6	535
Bahrain	3	73.5	23.5	59
Djibouti	4	72	24	3
Egypt	2.1	95.1	2.8	1136
Iraq	2	83.1	14.9	431
Jordan	2.8	90.8	6.4	238
Kuwait	2.2	92.4	5.4	303
Lebanon	2.1	93.4	4.5	269
Libya	4.8	84	11.2	161
Mauritania	5.3	78.7	16	11
Morocco	4.2	90.8	5	410
Oman	4.2	87.5	8.3	87
Palestine	4	89	7	71
Qatar	3	93.6	3.4	61
Saudi Arabia	3.2	93.7	3.1	2435
Somalia	0	85.7	14.3	3
Sudan	5.4	93	1.6	72
Syria	4.5	78	17.5	239
Tunisia	3.6	74.6	21.8	242
UAE	4.1	83.9	12	150
Yemen	4.6	90.1	5.3	63
Total	3.1	90.7	6.2	6977

Note: [a] ERF calculations.
Source: Qasem 1998.

Table 11. R&D expenditure by institution & distribution of R&D institution, 1992.

	R&D expenditure (% of GNI) 1997	% share of R&D expenditure by type of institution in 1992		
		Autonomous and ministry-governed	University-based	Private Sector
Algeria	_	56	44	_
Bahrain	_	50	50	_
Djibouti	_	_	_	_
Egypt	0.22	79	21	_
Iraq	_	57	43	_
Jordan	0.26	59	30	11
Kuwait	0.16	82	18	_
Lebanon	_	44	56	_
Libya	_	62	38	_
Mauritania	_	81	19	_
Morocco	_	68	28	4
Oman	_	76	24	_
Palestine	_	_	_	_
Qatar	_	37	63	_
Saudi Arabia	_	64	36	_
Somalia	_	_	_	_
Sudan	_	76	24	_
Syria	0.20	80	20	_
Tunisia	0.30	64	36	_
UAE	_	46	54	_
Yemen	_	82	18	_

Source: World Bank 2001; Qasem 1995.

Table 12. The Index of Technological Progress (ITP) for selected MENA countries.

Country	ITP	ITP Growth 1994-96
Israel	40.09	na
Kuwait	31.70	0.14
Bahrain	25.58	na
UAE	24.12	na
Qatar	22.91	na
Oman	19.74	na
Lebanon	15.89	na
Saudi Arabia	11.25	na
Turkey	10.14	0.20
Yemen	6.93	na
Jordan	6.74	na
Iran	5.07	na
Tunisia	4.55	0.33
Egypt	3.71	0.05
Sudan	2.69	na
Djibouti	1.93	na
Algeria	1.89	0.03
Region		na
Developed	_	0.194561
Eastern Europe	_	0.139865
Latin America	_	0.120391
Asia	_	0.208839
Middle East	_	0.139405

Source: Rodriguez and Wilson 2000.
Note: The ITP is calculated by using principal component analysis. Through this statistical technique information on five indicators of technological output (personal computers, mobile phones, Internet hosts, fax machines, and televisions) are combined and the extent to which variations in the five variables are due to a single phenomenon that differs across countries is measured. The ITP ranges from 0 to 100, the higher the more technologically advanced a country is.

Table 13. Public expenditure at various educational levels.

	Primary % of GDP per capita		Secondary % of GDP per capita		Tertiary % of GDP per capita		Trained teachers in primary education % of total	Primary pupil/ teacher ratio Pupil per teacher
	1980	2000	1980	2000	1980	2000	2000	2000
Algeria	8.7	..	23.2	..	..	..	93.7	28
Egypt	..	..	..	..	54.1	39.4	..	22
Iran	22.6	10.3	36.4	11.8	..	81.6	96.5	25
Iraq	..	..	6.5	..	87.5	..	..	21
Jordan	..	13.7	..	16.1	61.7	31.1	..	..
Kuwait	..	..	..	..	43.8	..	100.0	14
Lebanon	..	10.5	..	..	..	9.3	..	17
Libya	..	..	..	..	..	..	..	8
Mauritania	28.8	11.7	167.6	36.4	..	..	..	42
Morocco	..	20.5	53.6	49.9	150.3	102.7	..	28
Oman	..	11.4	..	20.4	..	..	99.6	24
Saudi Arabia	..	..	..	..	109.5	86.9	..	12
Syria.	..	12.9	15.1	23.3	74.7	..	92.2	24
Tunisia	..	16.2	36.4	28.4	188.1	89.8	..	23
Turkey	..	17.6	8.7	11.8	96.3	72.1	..	..
UAE	..	8.5	..	11.2	..	..	71.0	16
West Bank & Gaza	..	..	..	..	..	..	..	..
Yemen	..	..	..	..	..	..	..	30
East Asia & Pacific	..	7.6	..	..	..	40.1	94.6	21
Europe & Central Asia	..	..	..	..	..	..	94.4	..
LAC	..	..	12.6	..	71.4	..	86.1	26
MENA	..	..	..	..	87.5	..	83.7	24
South Asia	..	7.3	16.1	..	83.7	..	92.1	42
SSA	..	..	..	..	..	..	90.4	47
World	..m	..m	..m	..m	..m	..m	94.3m	27m

Source: World Bank 2003.

Table 14. Gross enrolment ratio at various educational levels.

	Primary % of relevant age group		Secondary % of relevant age group		Tertiary % of relevant age group	
	1980	2000	1980	2000	1980	2000
Algeria	94	112	33	71	6	15
Egypt	73	100	50	86	16	39
Iran	87	86	42	78	..	10
Iraq	113	102	57	38	9	14
Jordan	82	101	59	88	13	29
Kuwait	102	85	80	56	11	21
Lebanon	111	99	59	76	30	42
Libya	125	116	76	90	8	49
Mauritania	37	83	11	21	..	4
Morocco	83	94	26	39	6	10
Oman	51	72	12	68	0	8
Saudi Arabia	61	68	29	68	7	22
Syrian Arab Rep.	100	109	46	43	17	6
Tunisia	102	117	27	78	5	22
Turkey	96	101	35	58	5	15
UAE	89	99	52	75	3	12
West Bank and Gaza	..	..	..	..	..	..
Yemen	..	79	..	48	..	11
World	97	102	49	67	13	22
Middle East & North Africa	87	95	42	76	11	22
East Asia & Pacific	111	106	43	61	3	9
Europe &Central Asia	99	94	86	88	31	44
Latin America & Carib.	105	130	42	86	14	21
South Asia	77	98	27	48	5	10
Sub-Saharan Africa	80	86	15	27	1	4

Source: World Development Indicators, 2003.

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