CHAPTER 5

The organisational context of knowledge acquisition

This chapter discusses the organisational context in which knowledge is acquired in Arab countries through the transfer and adaptation of technology. The discussion considers issues such as: the importance of national innovation systems; policy and institutional prerequisites for establishing a knowledge economy; and the vital role of entrepreneurs. It reviews the experience of Arab countries in transferring and adapting technology in the past, and assesses the role of foreign direct investment (FDI) and business incubators in contemporary Arab market economies.

INNOVATION SYSTEMS AND TECHNOLOGY[1]

Innovation is the ability to manage knowledge, as embodied in technology, in a creative way in response to market requirements and the needs of society. Dynamic national innovation systems are the key to the efficient management of technology transfer, absorption, adaptation and diffusion in knowledge economies. The basic concept behind such systems is that it takes multiple actors to innovate and produce knowledge. Innovation does not depend solely on how individual enterprises, universities and research institutions perform, but also on how they interact with one another, and with the public sector. Effective innovation systems are flexible networks capable of using existing technologies and knowledge capital to create new forms of technology that raise productivity and growth, increase competitiveness in world markets and serve human development.

As indicated in figure 5-1, an effective innovation system is a complex whole. Moreover, its success is heavily influenced by social values and culture and by prevailing economic, legal and political systems and structures. The state plays a particularly important role in developing public policies and directions and in establishing institutions and systems capable of diffusing innovation in society. The state is responsible for establishing a favourable economic environment, an effective educational and training system and an advanced communication structure. It provides critical supports to the economy and industry by replenishing factors of production and it encourages the development of markets that can absorb the products of firms and enterprise

Where do Arab countries stand vis-à-vis innovation systems of this kind?

It takes multiple actors to innovate and produce knowledge.

TECHNOLOGY TRANSFER, MANAGEMENT AND ADOPTION IN THE ARAB WORLD

With few exceptions, the experience of individual Arab countries in technology transfer, management and adaptation has not met initial expectations, although technology transfer has always been a top national priority. Arab countries recognised, at an early stage, that their socio-economic development required moving towards industrial (including agricultural in-

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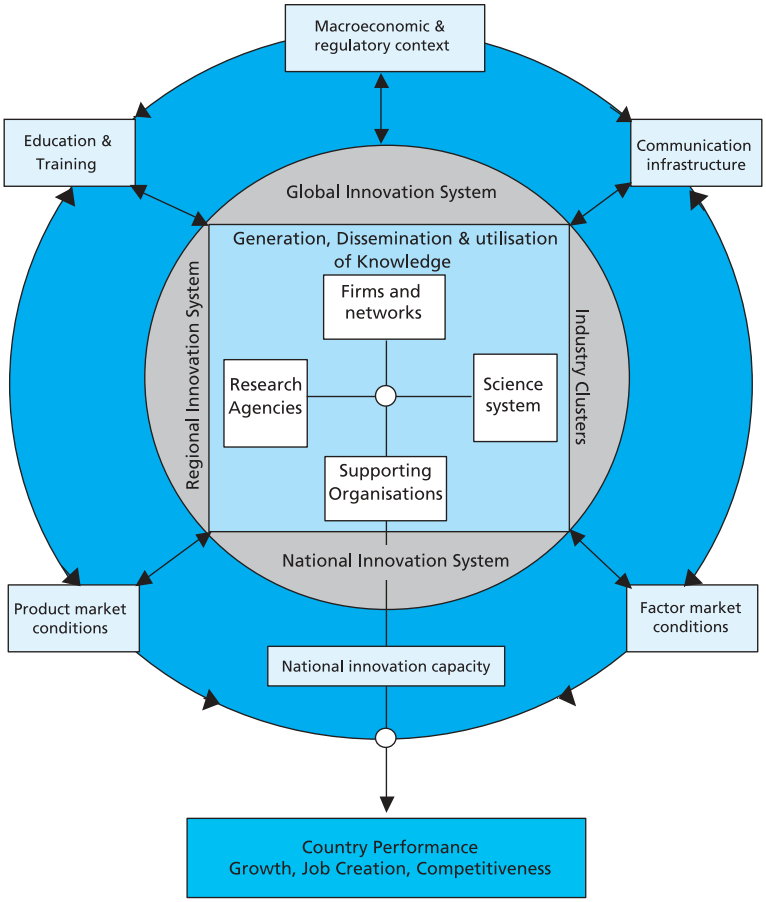
[1]Technology has a life cycle which starts with its birth in research and development laboratories, and continues through its testing and empirical adoption, at which point it is called emerging technology. It eventually reaches the stage of maturity with actual use and, over time with the emergence of more modern technologies, it becomes "old" or obsolete technology.

Technology *management* includes several processes starting with technology testing, followed by acquisition and use. The adaptation of technology is the stage that follows the *import* of technology, when local human resources and institutional structures are able to control and fully understand transferred technology, at which point it becomes possible to employ this technology effectively in realising the purposes of the society. Technology *development* is a more advanced stage that makes it possible to invent new technologies locally, by which new and globally competitive products can be manufactured. This includes the unpacking of bundled technology, reverse engineering, local development and adapting technology to the environment and human development. An even more advanced stage in this chain is the *generation* of technology, which includes the activation of technological research and development, the management of the national innovation system, the adoption of patents and intellectual property rights and the stimulation of human development through the application of new technologies.

Figure 5.1:
Actors and linkages in the innovation system



Source: Organisation for Economic Cooperation and Development, Managing National Innovation System, Paris, 1999, P.23.

dustries) and export-based economies. This perception, in principle, was correct, yet it was not translated into effective policies. Industrialisation policies, in particular, centred merely on the acquisition of factories and production technology (purchase contracts), and on the training of local labour to produce goods in acquired factories using acquired means of production. The erroneous belief was that this step in itself would constitute a technology transfer that would be a prelude to the indigenisation of technology.

For the first time, a dilemma that had long been intractable – the transfer and adoption of technology – seemed to have been resolved.

Initially, such factories used technologies and production processes that kept up with (or lagged only slightly behind) the international state of the art at the time. This allowed factories to meet all or some of the local market's needs for a period of time. But these simple acquisition policies, which did not recognise the importance of managing and adapting these technologies, left the production sector highly vulnerable since the technologies it depended on became obsolete over a short period of time. Once caught in this trap, most Arab countries responded by passing and enforcing protection laws, which inevitably, and unrealistically, prolonged the life of those early production units. Spread out in the economy, these industrial dinosaurs eventually become a drain on national resources and a major impediment to socio-economic development.

As the crisis of development in Arab countries grew worse, reflected in the severe deterioration of national infrastructure and public services, and as the gap between them and the advanced countries widened, many abandoned their failing industrial policies. They turned instead to liberalising the economy and trade and enacting laws to encourage foreign direct investment (FDI).

Some countries, such as Tunisia and Egypt, espoused wide-ranging FDI-friendly policies. They created a host of legal and financial incentives to entice multinational companies to open subsidiary branches on their soil so that Arab production systems could be part of a vertical integration process reaching up to the international economy and opening up two-way flows of knowledge and technology. For the first time, a dilemma that had long been intractable – the transfer and adoption of technology – seemed to have been resolved.

Arab governments that took this approach bet on the idea that open trade, economic and industrial policies would encourage the advanced world to invest in the growth of the region, strengthen national infrastructures and create an environment conducive to free flows of technology. They believed this new course was superior to the previous acquisition-based approach and part of the logic of globalisation. Indeed, the new laws and investment opportunities did stimulate a financial and economic revival in most of the Arab countries that applied this approach. However, this revival was uneven across the region and within countries its benefits were not equally spread; moreover, it proved to be short-lived.

The windfall that Arab countries experienced from these policy changes was temporary because they were not actively and effectively involved in the global production and export movement. Growth quickly

reached a stagnant point and then receded. More significantly, the open door policies that were implemented were not conducive to the real transfer and adaptation of technology.

Reflecting on their experiences with FDI and with vertical integration, Arab countries have come to realise that their expectations may have invited another disappointment. Whether the extended production chain involves the manufacture of spare parts, electronics components or garments, the common experience is that multinational companies reserve the knowledge- and skills-intensive components of the production process for themselves and leave developing country partners to produce at the low end of the technology tree.

In Tunisia, for example, the new policies led to the establishment of companies vertically integrated with the European car industry, on the face of it a sound development. However, a closer look shows that the new companies specialise entirely in the low-technology stages of the car industry, such as the production of seats and electrical systems. Yet this experience can also be judged from a broader perspective: integration on these terms represents only an entry point to technology acquisition and transfer, and to becoming an active part of the global production system, one that avoids protectionist policies that are eventually harmful to the host economy.

TECHNOLOGY POLICIES IN ARAB COUNTRIES

Experts estimate that more than 45% of the increase in per capita income in the West in recent years is attributable to technological advancement. Investment in R&D brought in the highest gross investment returns, compared to investments in other sectors. (Imad Mustapha, background paper)

Some Arab researchers maintain that Arab industrial and technology acquisition policies since the mid-20th century have been largely ineffectual (Antoine Zahlan, *in Arabic*, 1999). Although Arabs invested more than US $2.5 trillion in gross fixed capital formation between 1980 and 1997, chiefly in factories and infrastructure, the average gross domestic product per capita actually declined during that period.[2] This indicates that those substantial investments did not promote real technology transfers; *what was transferred were the means of production and not the technology.* Agricultural production in the region represents a striking example of a sharp decline in productivity and poor use of modern technologies: more than 50% of the Arab labour force work in this sector, yet value added from it accounts for just 10% of Arab GDP.

Evidently, Arab countries have not attained a level of development that would enable them to adapt the technologies they have imported at different times. In the absence of national science and technology policies geared to the creation of national innovation systems, this is hardly surprising. Practically speaking, the absence of such systems in Arab countries means that past investments in industrial infrastructure and fixed capital have been wasted. Those investments have yielded neither gains in technology, nor increases in productivity or social returns.

Investment in the means of production does not mean a real transfer and ownership of technology; it only means an increase in production capacities – a gain enjoyed for a limited period of time and one which quickly starts to vanish as the acquired technology becomes obsolete. Products and services generated by this technology become economically unfeasible and uncompetitive in local markets, while at the same time technology and production in the advanced countries renew themselves and accelerate forward, thanks to the dynamism of their national innovation systems. The Arab world, which is obliged to purchase new production capabilities whenever the technologies it owns become obsolete, is currently – and expensively – stuck at the wrong end of the technology ladder, a situation which drastically reduces Arab investment returns.

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[2]It is only fair to point out that a large portion of gross investments in Arab countries went to infrastructure projects which, in most cases, were urgently needed and which do not necessarily bring in quick economic returns.

ORGANISATIONAL ISSUES OF KNOWLEDGE PRODUCTION IN ARAB COUNTRIES

Industrial R&D institutions are weakly linked to production priorities and the knowledge level of basic industrial technologies remains low.

The current state of knowledge institutions and networks in the Arab world is far removed from what is required to establish an effective Arab innovation system. While this state persists, major problems will recur in the transfer and adaptation of technology and in knowledge production. The following paragraphs highlight some salient differences between the current and the ideal situation in innovation and knowledge production.

LINKS BETWEEN RESEARCH INSTITUTIONS AND PRODUCTIVE SECTORS

Promotion of R&D Results

The vigorous promotion of scientific research and the active utilisation of research results in development are among the most important criteria for measuring how far R&D institutions have achieved their goals and succeeded in diffusing new knowledge in society. Yet the promotion of R&D results faces major difficulties and obstacles in most Arab countries. Among the reasons are weak links between R&D institutions and the production and service sectors and the absence of, or marked gaps in, vital innovation "brokers" such as research institutes and think tanks that occupy an intermediary position between R&D and production and marketing.

Many accomplishments of Arab R&D institutions remain incomplete, because they do not reach the stage of investment.

Industrial R&D institutions are weakly linked to production priorities and the knowledge level of basic industrial technologies remains low. Moreover, many R&D centres lack design and modelling abilities and demonstration and experimentation units. These institutions also suffer from poor planning and organisational capabilities and lack appropriate methods for managing technology, innovation and diffusion. Academicism in research is another significant flaw. There is a trend in many R&D institutes to reward and promote researchers on the basis of academic research and published scientific papers rather than for purposeful applied research and its contribution to solving problems faced by the production sectors. Research projects of interest to industry, firms, enterprises and services that help industry absorb and develop imported technologies and advance their innovation activities are few and far between.

As a result, many accomplishments of Arab R&D institutions remain incomplete, because they do not reach the stage of investment. Some Arab countries have taken initial steps to adopt effective mechanisms for the use or promotion of R&D results. Chief among these is the introduction of "contract research" in universities and research centres, a modality that ties research more closely to market demand. This approach has increased the ratio of completed research projects in universities for the benefit of recipient sectors, helped to identify appropriate local substitutes, penetrated the industrial secrets surrounding some industrial components, enhanced the performance of some production units and overcome obstacles to manufacturing. The size of this experiment, however, is still extremely limited. In Egypt, for instance, the number of research contracts the results of which have been marketed in this way was about 142 during the period 1971-1997. Projects completed on demand from recipient firms did not exceed 43 during the same period (Amr Armanazi, background paper for the Report).

Intermediate Institutions Supporting Technological R&D Production

In addition to the direct links between R&D centres and universities on the one hand (supply side), and production firms on the other (demand side), R&D efforts can gain force and find their way to production firms through various intermediary institutions and structures, both governmental and private, which can offer key technical, professional and support services in one or both directions (supply and demand), according to their specialisation. These structures include industrial R&D centres linked to specific production activities, design bureaux, contract research institutes and business incubators. In Arab countries, industrial R&D centres are almost non-existent, and design bureaux are limited almost entirely to the construction sector.

In the absence of the sophisticated and

value-adding services normally associated with intermediary institutions, such as design engineering, project engineering, production engineering, process engineering and quality engineering, R&D remains largely decoupled from the process of technological change. A promising change in this respect is the growth of business incubators, which are starting to play an increasing role in Arab countries.

No knowledge economy can take off without substantial, targeted and risk-tolerant investment. Such investment requires a supportive financial and banking system. This includes the development of venture capital systems of all kinds to help kick-start new industries based on knowledge and modern technology. Investment banks, development capital banks, venture capital funds for innovation and grants for the employment of scientists and researchers in industry and the private sector are much needed intermediary institutions in Arab countries. These financing entities provide critical links between R& D, production and services.

The Role of the Creative Entrepreneur and Technological and Business Incubators

Many Arab countries are moving quickly to establish free market economies. Reaping the rewards and efficiencies of the market, however, requires two basic conditions: competitiveness and the encouragement of a critical mass of creative entrepreneurs ready to accept risks in seeking new areas of technology generation and goods and services production. Neither condition is a common feature of Arab economies. The realisation of both requires changes throughout the entire fabric of society, from systems of upbringing and societal values to the public policy environment and the supporting institutional infrastructure, including educational and financial institutions. The dominant value and educational systems in Arab countries remain largely risk-averse. There is little recognition that entrepreneurs are natural and necessary innovators in the economy. Moreover, financial institutions in Arab countries are still not limber enough to respond quickly to new opportunities, particularly when it comes to providing funds for small and micro-enterprises. In the West, many new and value-adding projects start small, particularly in the field of information and communication technology. Venture capital plays a substantial role in catalysing technological change by supporting start-up firms and businesses.

Business incubators are relatively new structures for supporting innovation in small and medium-sized enterprises and for encouraging pioneering creative developers who lack the necessary means to develop and market their research and technological innovations. The basic concept behind incubators is that the authors of a new project or innovative idea need sponsorship and a learning environment in which to grow and acquire the means for success. Incubators provide a controlled environment, services, including skills and advice, and materials that fledgling enterprises need to take off. In short, incubators connect talent, technology, capital and know-how to leverage entrepreneurial talent, accelerate the development of new knowledge-based businesses and thus speed up the commercialisation of new technology.

No knowledge economy can take off without substantial, targeted and risk-tolerant investment.

Arab countries have taken more and more interest in business incubators since initial attempts and trials started in Jordan and Egypt in 1989 and 1994 respectively. Recently, Tunisia (1999) and the Emirates (Abu Dhabi in 2000) have started their own projects of this kind. In other Arab countries incubators have appeared in technological capacity-building plans or in various support programmes for small and medium sized enterprises.

The experiments of Jordan and Egypt provide further examples of the development of incubators in Arab countries. The Social Fund for Development in Egypt, originating in a UNDP initiative in 1992, established a major network of incubators as part of its programmes for the development of small enterprises and income generation. The Egyptian Incubators Association, a non-governmental organisation established in 1995 for this purpose, implements the incubator programme. The Association has conducted feasibility studies for 37 business incubators and technology support and services centres in various Egyptian governorates. Nine have already been implemented. In Jordan, the Jordanian Technology Group has established 17 independent companies in various technological

Financial institutions in Arab countries are still not limber enough to respond quickly to new opportunities.

fields.

FOREIGN DIRECT INVESTMENT

Until Arab countries develop and seamlessly connect the elements of their innovation systems, technology transfer through FDI will remain capped by certain technological limits.

It was noted earlier that the traditional industrialisation policies of Arab countries did not lead to the transfer and adaptation of technology, nor did they push the wheel of development forward. New Arab policies for encouraging foreign direct investment (FDI) may not lead to this goal either unless they take into account the basic conditions for the creation of a knowledge-flow environment that would contribute to developing innovation systems in Arab countries. The basic and most important factor in the process of technology transfer and adaptation remains the R&D sector, which drives the process from the initial stage of flawed transfers through adaptation and then on to technology generation and effective participation in the world technological system. Understanding that today R&D is the weakest link in Arab innovation systems is the first step in overcoming present-day impediments to knowledge production.

Until Arab countries develop and seamlessly connect the elements of their innovation systems, technology transfer and development through FDI will remain capped by certain technological limits. Countries will not be able to transform their rentier economies into high value-adding economies, let alone knowledge economies that would allow human development to take root in the Arab world.

TABLE 5.1
Estimated Net FDI flows, by host country 2000-2001 (millions of dollars)*

Country	2000	2001
Algeria	438	1196
Bahrain	358	92
Egypt	1235	510
Jordan	39	169
Kuwait	16	-40
Lebanon	298	249
Libya	-142	-101
Morocco	201	2658
Oman	23	49
Qatar	252	237
Saudi Arabia	-1884	20
Syria	270	205
Sudan	392	574
Tunisia	779	486
United Arab Emirates	260	-156
Yemen	-201	-205

* Net FDI flows in five cases (Kuwait in 2001, Libya in 2000 and 2001, Saudi Arabia in 2000, United Arab Emirates in 2001, and Yemen in 2000 and 2001) were actually negative.
Source: World Investment Report (2002) UNCTAD.

FDI and its role in technology transfer and adaptation in Arab countries

Arab experts continue to debate the merits and demerits of FDI as an international technology transfer channel. Some point to the failures of vertical integration with global industrial chains. Others argue that Arab countries have not done enough to take advantage of such chains, and the FDI they funnel, or to create local capacities and environments conducive to the transfer and indigenisation of technology. They note, for example, that, as partners, Arab countries have been incapable of negotiating effective management contracts or responsive technology licensing agreements.

It remains a fact that Arab countries have so far met with little success in attracting FDI. It would be optimistic to expect to see any Arab countries listed among the top ten recipients of FDI worldwide, given that current global patterns favour the wealthier countries and East Asia; certainly none is. But not one Arab country appears in the top ten among developing countries either. Table 5.1 illustrates the anaemic level of FDI in some Arab countries in the period 2000 - 2001.

The table makes it clear that FDI levels in the region are very low. Morocco comes high only as a result of selling 35% of the shares of the Morocco Telecommunication Company to a foreign investor for US$ 2.7 billion, which helped to raise its inflow in 2001. Yet this is obviously neither a recurrent nor sustainable trend.

The investment environment in Arab countries remains an obstacle to FDI inflows. Figure 5-2 shows that in 1999 this environment was well below the optimum level in all the Arab countries in the sample.

Tunisia and Egypt have tried to link FDI flows to technology transfer by adopting policies that promote that connection. For example in Tunisia, all investments geared towards energy preservation, research development and marketing of new capacities are entitled to a 10% discount on import taxes. In addition, value-added tax (VAT) on imported goods and materials that have no local substitute is

suspended.

Tunisia's philosophy is to invest in human resources. The state's active investment policy is guided at the highest governmental and national levels. Top priority has been given to training Tunisia's human resources and labour force (one quarter of the country's general budget is earmarked for education and training). The focus of training is on technological specialisations, particularly information and communication technologies. As an Arab country which launched a national initiative to upgrade its technological level, and which established a special organisation for FDI promotion, Tunisia is a good example of what an Arab state can accomplish in this field.

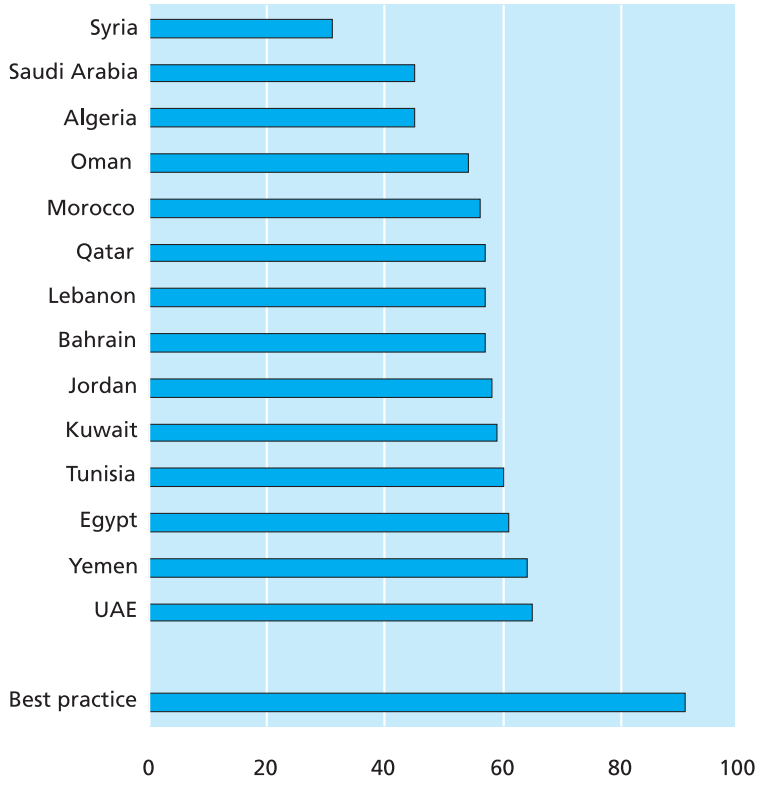
FDI actually receded globally in 2001, with the bulk of its flows confined to channels between the US, Western Europe, the NAFTA region and South East Asia. While Arab policy makers and experts continue with their debate on the benefits and risks of FDI, the fact remains that Arab countries are fractional players on the margins of this global economic activity. Whether FDI leads to the transfer and adaptation of technology, or simply stimulates job opportunities, new dynamics in the economy and the movement of technology in the Arab region, any talk about expanding Arab countries' participation in the general trend remains notional at this time.

Arab policymakers often speak about attracting international investments by granting firms tax incentives and promoting their countries' comparative advantages, yet they frequently ignore the fact that FDI flows are also related to a number of other equally vital factors that are part of the national innovation system, as identified in Figure 5.1. That figure illustrates the various factors that positively or adversely affect FDI in the fields of technology and industrialisation, particularly the availability of flexible, trained and highly skilled workforces.

Very likely, economic growth based on R&D, rather than simply on FDI, holds out the principal hope for accelerating development in the region and narrowing the gap between Arab countries and the technologically advanced world. The reason is that growth never occurs merely as a result of the accumulation of resources (the conventional approach adopted in the past in Arab countries), but as a consequence of the enhancement of productivity and of increasing the value added in production.

Figure 5.2

The Environment for Investment: 14 Arab countries rated, 1999



Source: the Economist Intelligence Unit, 1999.

In this context it is worth noting that most commercial activities in Arab countries are confined to trade between industries abroad and consumers (import agencies) inside the region. Notwithstanding calls in the WTO for more trade between the North and the South based on mutual benefit, this pattern of trade only benefits one party in the trade formula. The commercial relationships that give momentum to development and that play a major role in technology and knowledge transfer are those that involve inter-industry trade. Since this kind of trade is much stronger amongst industrial countries, and is almost non-existent between them and Arab states, the current trade patterns of Arab countries will not have much effect on technology transfer.

A further reality to be borne in mind is that when multinational companies make direct investments in developing countries, they normally keep their core technology and knowledge within the company itself.

Economic growth based on R&D, rather than simply on FDI, holds out the principal hope for accelerating development in the region.

Knowledge and know-how transfers and technology diffusion are seldom if ever part of their primary strategies. This simply underscores once again why Arab countries need to strengthen their national innovation systems in order to take more advantage of technology-carrying FDI and technology imports.

Governments have large responsibilities for promoting knowledge.

THE ROLE OF THE STATE AND SCIENCE AND TECHNOLOGY POLICIES

Arab countries need to realise that technology transfer and adaptation entail re-thinking their understanding of the role of their technology-earmarked investments. This requires a shift away from their customary tendency to invest in tangible assets (machinery, facilities and infrastructure) and towards investing in intangible assets (knowledge and human resources). Without significantly increased investment in the latter, Arab countries will not be able to create successful national innovation systems or approach the achievements of other developing countries that have put the ideas, skills and abilities of their people first.

R&D institutions and research activities are subject to many influences originating with governments that can either facilitate or obstruct their healthy development, efficient performance, impact, and objectives. Government policies and legislation that bear on the financial, tax and legal environment for research are one set of important factors. Another set are national policies relating to conditions of employment, general infrastructure, education, health and social security. Policies related to development sectors, such as industry, agriculture, communications, information and energy comprise a third set; while import-export policies and state-sponsored measures to raise public awareness of the importance of science and technology can also be influential.

Successive waves of change by-passed an inward-looking Arab scientific and technological establishment, leaving it isolated from the dynamic global mainstream.

Add to this the role of the state in building scientific and technological infrastructure, establishing and financing independent and university-affiliated R&D centres and their programmes, and supporting the education, training and skills development of research personnel, and it is clear that governments have large responsibilities for promoting knowledge. Indeed, the role of the state takes on greater significance wherever local scientific, technological and innovation capacities are weak, as is the case in most Arab countries. Cogent and comprehensive national and regional science and technology policies are therefore a top priority in the Arab world.

Concentrated efforts have been made in the past to formulate such science and technology policies, with varying degrees of completeness from one country to another. The prime movers were generally government authorities, research centres and universities, and the resulting plans usually reflected the interests and requirements of the supply side, rather than of those parties on the demand side (the business sector, the state and civil society). Most of these plans have therefore remained vague, unpublicised and under-utilised. Those Arab countries that did succeed in formulating coherent science and technology policies were still held back for lack of strategic and operational plans. Egypt, Jordan, Saudi Arabia and the United Arab Emirates, all of which have taken steps to launch initiatives in science and technology with specific and well-defined goals, have been exceptions to this pattern.

Several Arab countries have established central organs to plan and design scientific research policies. Some of them were charged with the task of coordinating the work of specialised research institutions, while others were associated with their own research centres. In other cases, Ministries of Higher Education and Scientific Research assumed the task of designing scientific policies. However, these institutions rarely settled down to a stable programme of work; some were eventually abolished and others succumbed to structural weaknesses, which compromised their results. Scientific concepts and practices remained rigid, and were not influenced by the new thinking that took place in developed countries during the 1980s and 1990s. Successive waves of change bypassed an inward-looking Arab scientific and technological establishment, leaving it isolated from the dynamic global mainstream.

MISSING PARTNERS: NATIONAL AND PAN-ARAB FUNDS FOR FINANCING R&D

Governments continue to bear the biggest burden of financing scientific and technological institutions in an environment where absolute spending on R&D is insufficient.

While recent increases in government expenditure on the various levels of education in many Arab countries are laudable, the volume of expenditure on scientific and technological activities also needs to be boosted significantly. Yet governments have difficulty meeting these additional financing requirements themselves. The strongest justification for establishing specialized financial institutions to take up the slack in funding is the importance of stimulating qualitative changes in the scientific and technological policies and activities in Arab countries and promoting demand for the outputs of Arab scientific and technological institutions. These are tasks that dedicated funding agencies can best address.

More than 25 years after the unsuccesful attempt to create an Arab Fund for Science and Technology Development and following several country and national efforts in that vein, the region is still in need of specialized financial institutions for scientific and technological development. There are some exceptions, however, such as the Institute for Scientific Research in Kuwait and King Abdul-Aziz City in Saudi Arabia.

Without underestimating what some institutions (such as the Arab Fund for Economic and Social Development and the Islamic Bank for Development, for example) have been able to provide in this area, their priorities and the structure of their technical organs have not enabled them to play an influential and decisive role in bringing about the required qualitative leap. At the same time, international specialized agencies, such as UNESCO, are not set up as funding agencies and moreover face constraints in staffing that handicap their efforts to play such a role effectively.

While regional and international assistance, both technical and financial, to some Arab countries has grown in recent years, most of this assistance has been directed towards reorienting economic policies, restructuring the economy and developing infrastructure, in addition to humanitarian assistance and social services. In education, aid to the region has concentrated on reforming and developing basic education, particularly increasing the rate of enrolment at schools and the teaching of girls in rural areas. Only a very small part of regional and international resources has been allocated to scientific and technological development, and most of that has gone towards projects concerned with the preservation of the environment.

Thus, the many justifications for an Arab Fund for Science and Technology Developmen, put forward more than 25 years ago, remain valid. Rapid changes in technology as a driver of economic development have created additional justifications that make the establishment of national and regional funds even more imperative to help Arab countries take advantage of new opportunities and potentials. The Kuwait Institute for Scientific Research for instance, is a promising example of what can be achieved.

The many justifications for an Arab Fund for Science and Technology Development, put forward more than 25 years ago, remain valid.

Among their purposes and priorities, these proposed funds could help to:

- Formulate policies and create machinery to encourage increased demand for the outputs of Arab science and technology institutions.
- Encourage qualified Arab scientific and technological institutions to become regional centres of excellence and more competitive at the global level.
- Support studies, research and projects, which focus on finding scientific and practical solutions for enhancing the quality of institutions in education, science and technology.
- Enable general and university education institutions to benefit from the enormous pos-

BOX 5.1

Pioneering Successful Non-governmental Initiatives - The Kuwait Institute for Scientific Research

The Kuwait Institute for Scientific Research is a pioneering example of an active and successful non-governmental foundation established with support and encouragement from a government. The Foundation was established in 1978 on the initiative of the current Emir of Kuwait, when he was Prime Minister, and the Kuwait Chamber of Commerce and Industry. Under a Bill of the Emir, joint-stock Kuwaiti companies offer 5% (later reduced to 2% then 1%) of their annual net profits to the cumulative resources of the Foundation, whose assets have now reached around one billion dollars. The Foundation spends money on scientific activities in Kuwait and the Arab world from the proceeds of these funds. Perhaps its most famous activities are the five annual Kuwait Scientific Awards given to Arab scientists every year.

Source: Adnan Shihab-Eldin, Background Paper For AHDR2.

sibilities of information and communication technology and connect learning and scientific research activities and outcomes to economic development.

BOX 5.2

The Arab Fund for Science and Technology Development: The Bold Venture That Almost Succeeded

In 1976, a serious attempt was made to create an Arab Fund for Science and Technology, which almost succeeded. Several positive factors were in place at the time, including the availability of relatively adequate financial resources deriving from lucrative oil export proceeds and the then-prevailing belief in the importance of joint Arab action.

The Conference of Arab State Ministers in charge of the Application of Science and Technology for Development had recommended in its meeting held in Rabat in 1976 the establishment of an Arab Fund to provide assistance in the financing of scientific and technological activities.

The Outstanding Ministerial Follow-up Committee established by the Conference entrusted the Arab Fund for Economic and Social Development, the Kuwait Fund for Economic Development and the Kuwait Institute for Scientific Research with the task of carrying out a technical feasibility study and of preparing a draft agreement to establish an "Arab Fund for Scientific and Technological Development".

The document establishing the proposed fund set the main goal of the Fund as "the creation of an organ to help Arab states in their efforts to overcome the backwardness of their scientific and technological capacities, their dependence and their marginal activity and to promote the dedication of these capacities to the service of economic and social development."

The project set out a plan to translate this goal into a number of objectives, proposing that they include the provision of financial and technical assistance to:

- Develop appropriate policies in the fields of scientific and technological development
- Exploit the scientific and technological capacities, which are already available
- Promote the consolidation and development of these capacities
- Intensify the use of services that science and technology can offer to the various branches of production
- Encourage the appropriate transfer of scientific and technological knowledge from abroad and set the terms and conditions upon which such transfer will be based
- Support private initiatives on inter-Arab cooperation in the field of technology.

The feasibility study indicated then that the range of purposes and functions was very large. It was, therefore, necessary to establish work priorities in light of the priorities of member states. It was also proposed that, with regard to the methods chosen to support scientific and technological projects, the Fund should adopt a flexible policy, including the provision of scholarships and financial subsidies, technical services and loans.

It was also proposed that the Fund should focus its efforts on high-impact projects under specific programmes and not on financing institutional support. It should assume a complementary role in relation to subsidies and loans provided by others. It was also proposed that the minimum capital required as a target for the Fund should be 150 million Kuwaiti dinars. The amount should be regarded as an endowment asset dedicated to the Fund's purposes. The capital would not be touched but instead invested in safe financial assets. The income accruing from this investment would constitute the actual resources placed at the disposal of the Fund to carry out its activities.

Despite the availability of relatively adequate financing in some Arab countries at the end of the 1970s and the declared commitment of these countries to contribute to the Fund's capital, political differences over the management of the Fund's operations and its headquarters prevented its establishment at that time. As the region's development prospects began to change at the beginning of the 1980s, and with diminishing financial resources accruing from oil exports and the fatigue that afflicted joint Arab action, enthusiasm for the Fund diminished and its establishment was abandoned.

Source: Adnan Shihab-Eldin, Background Paper For AHDR2

NETWORKING OF R&D INSTITUTIONS AT THE PAN-ARAB AND INTERNATIONAL LEVELS

Networking is key to the success of scientific and technological work because it enables many actors to contribute to raising the knowledge and value-added content of problem-solving research. Studies reveal that in many cases nearly half the inputs needed to solve a scientific problem come from unexpected sources. Productive scientists usually belong to several networks, which provide them with channels for enhancing their knowledge and experience. Some Arab R&D institutions have made efforts in the past two decades to develop institutional networks to increase performance and support product development, but achievements at the country and pan-Arab levels have been limited, while initiatives at the international level have proved stronger.

At the Arab level

Networking among R&D institutions at the pan-Arab level is generally limited and, where it occurs, is often temporary and not sustainable.

Significant indicators of collaboration include scientific publications. In 1995, for instance, the number of scientific publications by scientists from Morocco, Algeria and Tunisia amounted to 1,205 papers. Of this number, 769 papers included contributions from outside the country, but only seven included contributions from a researcher in another *Maghreb* country. Out of those seven papers, only one publication did not include a contribution from a Western country. It is obvious that scientists from the *Maghreb* countries have been deeply integrated into the international scientific community, but do not seem to be as integrated into their national or regional scientific environment. Scientific cooperation at this level has been infrequent, both through exchanges of experience and information.

The situation in member states of the Gulf Cooperation Council is not materially different. In the same year, the ratio of publications that included contributions from researchers in one or more members of the Gulf

Cooperation Council was 3% of the total number of publications. Those including a joint contribution from an Arabic source were only 15% of the total. This chiefly reflects the fact that universities and research centres in the GCC countries employ large numbers of researchers from other Arab universities, while the larger part of joint contributions comes from outside the Arab countries altogether.

In countries of the Arab East (other than GCC member states) the ratio of joint contributions, including by scientists from developed countries, was 25% of the total. Considering that the volume of R&D activities in any Arab country is limited to begin with, it is only logical to assume that networking with other Arab scientists would partially compensate for a low overall level of activity. Moreover, since Arab countries face a large number of common technological and technical challenges that can be solved through effective cooperation, the importance of collaborative research hardly needs to be underlined. In the vital area of water sciences, for instance, there is a wide spectrum of problems that could be dealt with through joint research. Such activities are still weak, however, and can be substantially strengthened if fragmented efforts in every Arab country are brought together and lubricated by an exchange of experiments and experience.

On the international front, an opportunity currently neglected by Arab R&D institutions is to network with Arab scientists and technicians living abroad and, through them, with the R&D centres and universities in which they work or with which they have ties. There are currently several institutional frameworks supporting this pattern of networking. One of them is "TOKTEN", a programme established by UNDP in the late 1970s and which continues to operate.

At the international level

How far Arab R&D institutions benefit from networking with the scientific and technological community in developed countries ultimately depends on their capacity to plan, organise and manage such networks in ways that meet Arab needs and goals. Failure to energise communication and international cooperation can be attributed in most cases to the absence of institutions with clear objectives. Other factors are the lack of a critical mass of researchers on national levels in areas of priority for the international R&D community, insufficient research funding and poor

BOX 5.3

The Arab Science and Technology Foundation, a non-governmental initiative to support research and development in the Arab world

One recent promising initiative is the creation of the Arab Science and Technology Foundation, established in 2000, in the Emirate of Sharjah, with the aim of building a coalition of Arab scientists living in the Arab world and those residing abroad who occupy leading positions in overseas science and technology institutions and universities. The Foundation aims to become an all-embracing Arab foundation, providing scholarships within the framework of a full scientific review by scientists. The Foundation has secured funding to meet recurrent and programme costs and launched its activities, which included two expanded scientific meetings in 2000 and 2002 that brought together a large number of Arab scientists and researchers from Arab countries and abroad. Foundation priorities include the establishment of sustainable relationships with Western laboratories and the funding of joint research projects by scientists from the Arab world and from abroad, aided by Arab researchers living overseas.

Source: Amr Armanazi, Background Paper For AHDR2.

BOX 5.4

The Arab Academy for Science & Technology and Maritime Transport

The Academy is a unique institute in the region, one originally established to train people in the field of maritime transport that has now developed into a distinguished university for science and technology.

The Academy was established in 1972 in Alexandria, Egypt as a regional project offering maritime education and training to seamen in three disciplines: navigation, maritime engineering and business studies, in addition to the training of sailors. In its first 12 years, its student body grew from 733 students in 1972 to over 2500 in 1984.

In subsequent years, the Academy diversified its syllabus to cover new fields, such as engineering and management, in order to become self-financing. Its name was changed to the *Arab Academy for Science & Technology and Maritime Transport*, and it adopted a collegiate structure which includes the College of Engineering & Technology, the College of Management, Technology and Maritime Transport and the College of Technology. These colleges grant a bachelor's degree in technology.

The College of Maritime Transport and Technology was provided with an integrated complex of simulators used for various maritime sciences and the protection of the marine environment from oil pollution. It combines in one building the following simulators, laboratories and major equipment: a simulator for the management of oil spills, oil pollution control systems, oil analysis laboratories, a simulator for the management and piloting of ships, and simulators for the transportation of liquefied gas. It also houses a Centre for Geographical Information Systems and a Multi-media Centre.

In addition to its three colleges, the Academy includes other institutes, centres and programmes, which contribute to its accomplishments: the Institute of Advanced Administration, the Institute for Productivity and Quality, the Higher Institute for Professional and Applied Studies, the Institute for Educational Resources, the Institute for International Transport and the Centre for Logistics and Community Service.

The Academy's role transcends the boundaries of the Arab world. In the past 30 years, the Academy provided training opportunities to 257,000 students from 58 Arab, African, Asian and other states. It has thus moved beyond its regional identity to become an interregional university of science & technology and marine transport, with recognized technological capabilities and facilities.

In 1999, the Academy was awarded the ISO 9001 Certificate, having developed and implemented a quality system in all its bachelor's degree programmes.

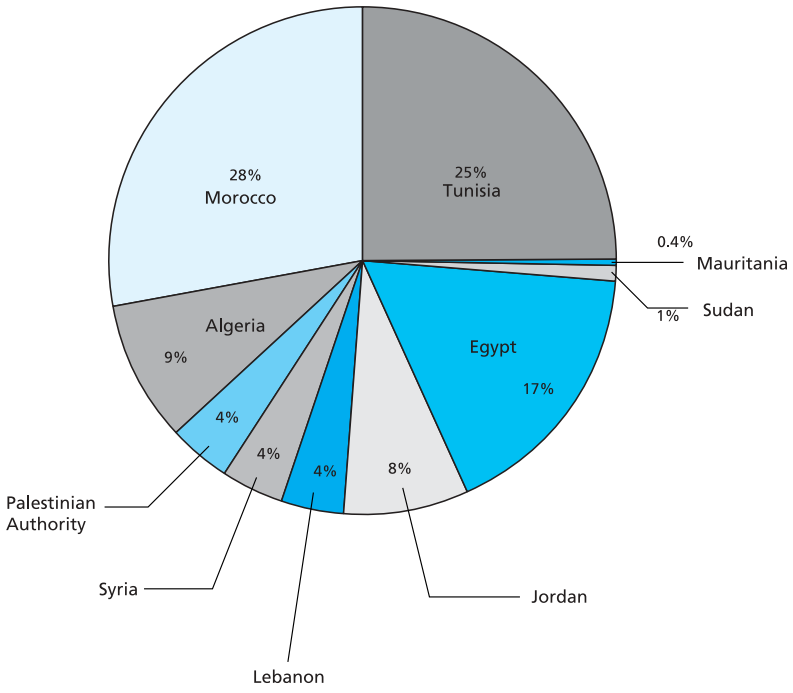
Source: Arabian Gulf University.

prioritisation of research objectives in terms of national goals.

During the period 1992-1995, several co-operation programmes were instituted between scientific and technological institutions in European countries and collaborating institutions in Arab countries, supported by the European Union. Arab-European scientific and technological cooperation received new momentum following the Barcelona Conference on Euro-Mediterranean Cooperation in 1995, which resulted in the launching and financing of new programmes, most importantly the activities carried out within the MEDA Programme, the financial instrument of the Euro-Mediterranean Partnership. These programmes aimed to support technological research and development, redress problems resulting from the widening of the scientific achievement gap, activate exchanges of experience in scientific sectors and policies (to enable Mediterranean partners to narrow the gap between them and their European neighbours), support technology transfer and help build scientific and technological capacities through increased contributions to joint research projects.

Joint Euro-Arab R&D activities in the modern sciences, such as biotechnology and new materials, are few and far between.

Figure 5.3
Distribution of Euro-Arab cooperation projects in research and development among Arab countries



Source: Al-Bizri, 2000.

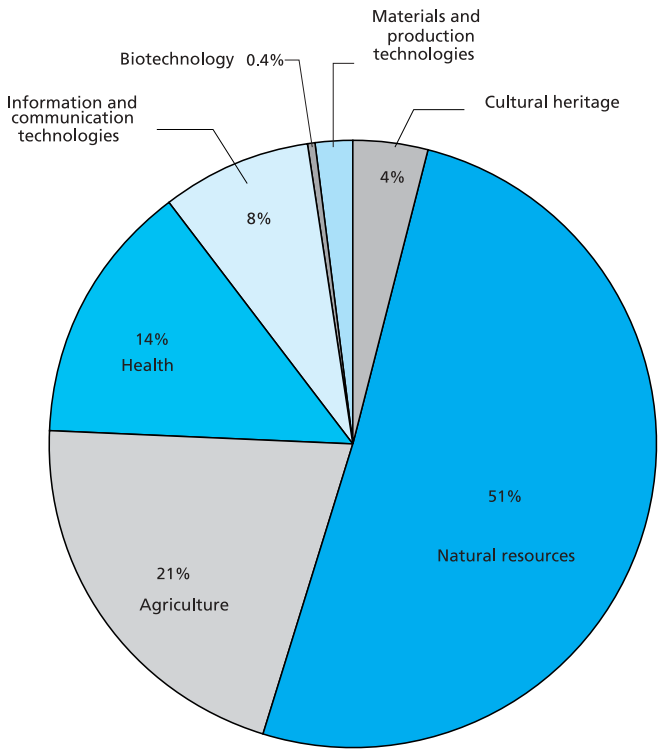
Figure 5.3 indicates the distribution of co-operation projects among participating Arab countries. The data shows that Morocco participates in 28% of these projects, Tunisia in 25% and Egypt in 17%.

Figure 5.4 indicates the distribution of co-operation projects by field. It illustrates that most cooperation projects relate to natural resources (51%), agriculture (21%) and health (14%). Projects related to modern technology are limited in number: information and communication technology (8%), materials and production technology (2%) and biotechnology (0.4%).

Evidently, joint Euro-Arab R&D activities in the modern sciences, such as biotechnology and new materials, are few and far between. Among the most prominent programmes of scientific and technological cooperation between the Arab region and the West are the programmes carried out within the framework of an agreement concluded between Egypt and the United States of America in 1995 for a period of five years. The framework was renewed for another five-year period with effect from 2000. This agreement aims to enhance scientific and technological capacities, promote cooperation between scientific and technological communities in both countries and provide opportunities for scientific contacts.

Research has concentrated on biotechnology, industrial technology, environmental technology, standards and measures, information technology and energy. More than 70 research projects were funded in the latter fields in the period 1995-2000. Research institutions in Egypt and more than 30 US research institutions cooperated in the implementation of these projects, some of which produced results that aroused the interest of the industrial sector, paving the way for negotiations to transform the results of these research projects into products.

Figure 5.4
Distribution of Euro-Arab cooperation projects among R&D fields



Source: Al-Bizri, 2000.

It is not possible for Arab countries to benefit from the fruits of global knowledge without investing in local production, local knowledge workers and local knowledge traditions.

Chapter five observes that Arab countries' experience with the transfer and adaptation of knowledge through technology, and their efforts to organise and make effective use of their own accumulated human and natural capital, have, on the whole, been disappointing. Weak national innovation systems and institutional frameworks largely account for this outcome and for relatively meagre technology returns on FDI. The general absence of coherent, action-oriented scientific and technological policies is a further constraint. The chapter concludes that it is not possible for Arab countries to benefit from the fruits of global knowledge production and technology without investing in local production, local knowledge workers and local knowledge traditions. Current indicators of research production and economic output tell this story plainly enough.
This chapter completes the assessment of the status of knowledge in Arab countries. Starting with Chapter Six, the Report takes up an analysis of the societal context affecting knowledge acquisition in the Arab world.