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Research and Development in the Arab States: the Impact of Globalization, Facts and Perspectives

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I. Research and development in the Arab States: an overview

In 2007, the Arab World accounted for twenty-two countries with a total population of approximately 300 million people. Striking contrasts exist among these countries in terms of revenue, socio-economic development and *per capita* income. Arab countries with significant oil and natural gas resources benefit from high income, thus contrasting with the financial revenue of countries with limited or no such resources. Human resources, despite the endeavours made to date, are insufficient or even lacking in several areas, especially in the scientific and technological ones. The Arab States have a low ranking in research development and technological innovation. The overall spending in R&D is about 0.15 per cent of the gross domestic product (GDP), compared with an average of 1.4 per cent in the world, and 2.5 per cent in Europe. This spending is provided by the public sector to a very large extent (97 per cent).

Covering the period 1990-2000, there were about 500 scientists and engineers involved in R&D per million people in the Arab States, compared with more than 4,000 per million people in North America, 2,500 in Europe and about 700 in South and East Asia. The world average was around 1,000 per million.

By the end of the twentieth century, the number of publications – original writings and translations – per million people was around 0.05 in the Arab World, compared with an average of 0.15 worldwide and 0.6 in the industrialized countries. In Africa in 2006 and in terms of scientific publications, Egypt ranked first, followed by Morocco and Tunisia.

In addition to universities, there were about 280 scientific research institutes or centres in the Arab States, while the number of patents registered in the United States by Arab countries over the twenty-year period 1980-1999/2000 amounted to 171 for Saudi Arabia, 77 for Egypt, 52 for Kuwait, 32 for the United Arab Emirates, 15 for Jordan, 10 for Syria and 6 for Bahrain, compared with 16,328 for South Korea, 7,652 for Israel and 147 for Chile.

II. Case Studies

1. Biotechnology

Among the key factors that determine the successful development of biotechnologies in emerging countries, the following are worth mentioning:

- Strong political should be expressed over the long term (for at least 20 years).
- Selection of biotechnology as a major priority sector among a few priority areas.
- Design of a consistent strategy for short-, medium- and long-term policies, involving all the actors and entities such as financial, educational and R&D institutions, as well as providing for the formulation and enforcement of laws, regulations and procedures.
- Setting up a strategy that enables focused R&D to lead to specific products that meet a demand in the local market or in the regional and international ones.
- Coordination of the whole R&D and production system at the highest level of the government (e.g. in the Prime Minister's Office) so as to ensure an effective coordination among all the institutions involved, to avoid duplication of efforts and to develop synergies.
- Mobilization of the private sector, which should find good reasons for association and be convinced that it is crucial in its own interests.
- Collection of sufficient resources for investing in R&D and production.

Among the Arab States, Egypt, Tunisia and, to some extent, Jordan and the United Arab Emirates (UAE), have tried to fulfil some of the above-mentioned criteria and be present in the field of medical biotechnology. However, far less than other developing countries such as Cuba (which invested more than US$1 billion over 20 years in the development and production of bio-technology derived diagnostics, vaccines and

drugs, and continues to work hard on new processes of drug development), or India, Brazil or the Republic of Korea.

Agricultural biotechnology, in its simplest techniques such as *in vitro* micropropagation of crop species and their commercial clonal multiplication, is carried out in several Arab States, e.g. Morocco, Saudi Arabia, Tunisia, and the Gulf Arab States (particularly for the date palm). But, except for Egypt, no genomics work is being carried out, nor is there any development of transgenic crops which are more resistant to pests and tolerant to abiotic stress. However, the impact of globalization can be perceived through some multilateral or bilateral assistance programmes and cooperation, which include the advanced training of scientists so as to initiate more sophisticated R&D projects.

An illustrative example is that of the Pasteur Institute of Tunis, founded in 1893 by Dr Charles Nicolle, who discovered the vector (lice) of exanthematic typhus (*Rickettsia prowazekii).* Nowadays, this institute employs 370 persons, including 60 scientists. In addition to its contribution to the implementation of public health policy, it is an R&D institution as well as a training ground for about 100 graduate students (Master and Ph.D. degrees) per year. Up until the end of 2005, the Pasteur Institute was also in charge of producing vaccines, controlling their quality and distribution. The number of publications in international journals by the Institute's researchers had reached 322 in 2003 but, thereafter, decreased to 27 in 2004 and 12 in 2005. The main R&D areas are tuberculosis, leishmaniasis, rabies, venoms and toxins. Patents have been awarded for the identification of a tripeptide in viper's venom having an anti-aggregation platelet effect; for the identification of molecules in scorpion's venom with a pharmacological effect; and for the identification in *Leishmania* of virulence factors that could be a target for medicines. Other patents have been filed for *Leishmania* proteins that could be used in the development of a vaccine against this disease; such as a DNA anti-rabies vaccine with a high immunogenicity in a single shot. Research is being carried out on the production in the yeast *Pichia pastoris* of recombinant alpha-interferon and of a molecule of *Mycobacterium tuberculosis* that could help to better diagnose the disease. Production capacity of the Institute is about 75,000 10ml-vials of anti-scorpion serum, 70,000 10ml-

vials of anti-rabies serum, 40,000 10ml-vials of anti-venom (viper), as well as 10 million doses of BCG per annum.

The research and development of the Pasteur Institute of Tunis are closely associated with cooperation involving overseas research groups or teams, particularly in France, where there is an important diaspora of Tunisian scientists, physicians and engineers. This is another important impact of globalization on the current and future evolution of R&D in Tunisia, and also in Algeria and Morocco, but much less for the Gulf Arab States and Egypt. These scientists who have made the decision to live and work in Europe have often kept close ties with their Maghreb countries of origin; and not only they can assist assist in various teaching and training tasks locally on a part-time basis, but also help in designing and implementing cooperation agreements.

Another example is that of the Faculty of Medicine and Health Sciences (FMHS) of the United Arab Emirates (UAE) University. Although "biomedical research publications in the Arab World mostly focus on the relatively cheap curative/comparative clinical services rather than the more expensive research and development aspects" (Tadmouri *et al*., 2003), a small number of people at FMHS/UAE University produced significant contributions over the period 2000-06 in the areas of clinical research, basic research and translational or applied research. For instance, in clinical and molecular immunology, this was carried out in cooperation with Italian teams in Milan, Italy. Cooperation has been established with the Terry Fox Cancer Research Fund on cancer immunotherapies, for the early diagnosis of Parkinson's disease; with the Wellcome Trust and the University of Cambridge, UK, and with the Michael J. Fox Foundation for Parkinson's Research in the US. There is also a significant increase in funding for biomedical research. Despite the lack of a national strategy for funding scientific research, there is a nascent post-graduate education programme and opportunities for mutually beneficial scientific exchanges, both amongst the Arab States and internationally. There are fellowships available to support exchange visits by European students and postdoctoral fellows to laboratories in the UAE and *vice versa*. The UAE is considered an attractive geographic location with modern facilities. Well-trained young scientists are increasingly

being recruited. Hiring on soft-money has become possible and the UAE University Office of Research is very active in engaging industrial and private support for research funding. Globalization has an obvious impact, due to the pro-business approach of the government and its forward-looking mindset and to the favourable labour market conditions. This is quite striking in the area of information and communication technologies (ICTs), and the setting up of Dubai Biotechnology Park (Dubiotech) and of the Arab Science and Technology Foundation (ASTF) could be considered good steps in the right direction.

2. Pharmaceutical industry

This is an area which is closely associated with R&D in the biomedical sciences and biotechnology and on which globalization has a profound impact.

By 2005, the market value of pharmaceutical products in the Arab States was estimated at US$6.2 billion, i.e. 1.5 per cent of the world market, for 6 per cent of the world population. Jordan was the first exporter of pharmaceutical products for about US$280 million in 2003.

There were about 230 producers, private or public companies, working in association with foreign partners. While some 90 per cent of raw materials are imported, R&D is at an embryonic stage and corresponds to less than 2 per cent of revenues. Products are mainly generics manufactured under license and the formulation and reformulation of these products is an important activity. A major challenge relates to the respect of intellectual property rights (IPRs) and to the duration (up to two years) of registering a new drug with the Ministry of Health (MOH).

In Jordan, the pharmaceutical industry occupies second rank in the country's economy. About sixteen factories, including eight private and six public, have a turnover ranging between US$4 million and US$40 million, which is far below the minimum efficient scale in Europe or the US (around US$500 million). Invested capital is about US$400 million and the number of workers totals 5,000.

In 2005, total production reached a value of US$275 million, 77 per cent of which was exported. A total of five companies dominated the local market (90 per cent), and the sector grew by an average 15 per cent annually over the decade 1995-2005. Ventures of Jordanian companies outside the country exist in Algeria, Bosnia, Egypt, Italy, Libya, Morocco, Portugal, Saudi Arabia, Sudan, Syria, Tunisia and Yemen. The pharmaceutical products are: 60 per cent antibacterials, antirheumatics and pain killers; 30 per cent hormones, ophthalmic preparations, anticancer and cardio-vascular drugs; and 10 per cent over-the-counter (OTC) products.

The pharmaceutical sector has become the second largest export earner (US$193 million) behind textiles (US$673.5 million). Among the Arab States, Jordan is the first exporter of pharmaceuticals. The main importers are Arab countries (90 per cent), especially Algeria, Saudi Arabia, Sudan, Iraq and the United Arab Emirates. Jordan's pharmaceuticals are registered in more than 60 markets worldwide, including Europe and the US. It is expected that Europe will be Jordan's main export destination and North America the second, thus shifting the balance away from the traditional Arab markets. Henceforth, the establishment of alliances to better meet the challenge of globalization which include licenses with Takeda Pharmaceutical Co. Ltd. (Japan), Fujisawa (Japan), Pfizer (UK), Roche and Bayer (US), packaging with Novartis, co-marketing with Eli Lilly (US) and established Watson in Jordan. Also, all companies have the local and regional good manufacturing practices (GMP) accreditation, and six of them have the European Union (EU), US Food and Drug Administration and GMP accreditation. In addition, Jordan has four clinical research organizations (CROs) meeting international requirements. Eight pharmaceutical colleges graduate about 800 pharmacists a year (55 per cent of them are Jordanians) and there is a Centre of Excellence in Healthcare (CEH). Jordan has gained good experience in drugs registration in the region, in Europe and in the US.

However, despite the registration of forty patents by the Jordanian pharmaceutical industry in Europe, the US and Japan, R&D corresponds to only 2 per cent of total sales, compared with over 17 per cent in industrialized countries. The limiting factors are the

financial resources and the infrastructure for clinical testing. The owners of Jordan's pharmaceutical industry try above all to satisfy the shareholders by giving dividends of more than 50 per cent of the annual net profit, although they do not spend more than 2 per cent on R&D itself. This is generally the case for all Arab countries.

Dar Al Dawa (DAD, Home of Medicine), Jordan, established in 1975 as a public shareholding company, has been considered number one for six consecutive years in the Jordanian market and number sixteen in Saudi Arabia and number fourteen in the UAE. With a total registered capital of around US$28 million, DAD employs 800 workers, produces 200 pharmaceuticals (with annual sales of US$66 million in 2005), and exports to twenty-five markets.

DAD has partnerships in several companies: DADVet (Veterinary and Agricultural Industrial Co., Ltd., 33 per cent ownership), SAIPH (*Société Arabe des industries pharmaceutiques*), Tunisia; SAIDAL Pharmaceutial Production, Algeria; JORAS Pharmaceutical Spa, Algeria (with 70 per cent ownership). Strategic alliances include licensing with Pfizer Inc.-US, Novartis-Switzerland, Taisho-Japan, Octavis Island-Turkey; contract manufacturing and supply with Australian, Dutch, French, Irish, Swedish and Turkish companies. DAD has developed a new anti-bacterial molecule, the patent for which has been filed in Europe, Japan and the US, with the preclinical studies looking promising. One product, registered in Sweden, is expected to be marketed in 2007, while 12 other products were submitted in 2006 in Europe and Australia.

Jordan's pharmaceutical industry owners are currently convinced that they should invest more funds in R&D areas, because of the harsh competition and penetration of the regulated markets. On the other hand, the cost of developing a generic product in Jordan is far less compared to that of Europe and the US and consequently more European companies have started cooperating with the Jordanian ones to develop products for the European market. Co-developing technology in Jordan, then outsourcing to Europe or the US, will lower the cost of the operation. Managers need more training in order to penetrate the industrialized countries' markets. Companies, mostly owned by families,

must open up to face competition and be present in the new regulated markets. Mergers will help to achieve a capital size that can attract multinationals and thus increase the competitiveness of these companies.

Morocco's pharmaceutical industry is another good example of a sector that is striving to develop locally and, at the same time, to adapt itself to globalization. In addition, it is an example of an incipient collaboration between the private sector and the academic one in R&D.

The Moroccan pharmaceutical sector is considered as one of the most mature in Africa, the Arab World and the Maghreb. In 2006, it included twenty-seven industrial sites where national laboratories and multinationals are manufacturing their products under certification by French regulatory bodies and by Canadian and British bodies in several cases. The sector plays an important socio-economic role: 35,000 persons employed directly or indirectly, including 20 per cent managers and executives; 10 per cent of the whole production is exported, mainly to French-speaking African countries; drugs represent 37 per cent of health care expenses by households.

About 80 per cent of national needs are met by the pharmaceutical sector. The antibiotics share of the market value is 16.5 per cent, followed by anti-inflammatory and anti-hypertension drugs. About €40 million are invested annually by the sector, mainly for improving production and quality. R&D is incipient and illustrates the pioneering activity of some national laboratories. Current challenges are the following:

- How does one cope with the small size of the national market? Drug expenses amount to MAD200 (about US$20) *per capita* per annum; the number of drug units sold has been stagnating since 1998; the whole annual turnover is around €500 million, with annual growth not above 2-3 per cent over the last five years (2001-05). One solution is to expand the business internationally and in so doing be in tune with globalization.
- How to anticipate the impact of the compulsory illness insurance set up in Morocco in October 2005?

- How to support the growth of generics locally? Generics made up 23 per cent of Morocco's pharmaceutical market in 2004, compared with 18 per cent in 2000.
- How to benefit from globalization through playing a more active role in the international market? For example, drawing on the free-trade agreement (FTA) concluded in 2004 with the US, the European Union (EU, to be in place in 2010), or with Turkey which is an important and promising market.

Even if it is true that the size of the Moroccan pharmaceutical market and the profits generated, both locally and internationally, cannot support the costs of developing new drugs, some R&D work can still be carried out nevertheless. For instance, clinical research can be done in collaboration with multinationals, or efforts can be made to produce 'botanical drugs' from medicinal plants or plant extracts. Since 2006, an agreement has been concluded between the Faculty of Pharmacy of the University Mohammed V, Sousissi, Rabat, and the private laboratory of the pharmaceutical firm Cooper Maroc, to carry out research on the argane tree (*Argania spinosa*), which is an endemic tree species growing in the southwest of the country (Souss Region, Morocco) exploited for its edible oil. This R&D work is supported by the Foundation Mohammed V for national solidarity. As the argane oil has been used in cosmetics and skin ointments, the objectives of the collaboration between Cooper Maroc and the Faculty of Pharmacy are to: (i) develop physicochemical studies; (ii) examine galenic preparations; (iii) identify market needs and translate them into upstream research on the most appropriate galenic preparation (cream or gel, for instance, and concentration of saponines); and (iv) file the relevant patents.

3. Renewable energy

Abu Dhabi, the capital of the United Arab Emirates (UAE), the fourth largest OPEC oil producer with about 10 per cent of known reserves, is seeking to become a centre for the development and implementation of clean energy technology. In 2006, the Emirate of Dubai launched the Masdar Initiative (*masdar* is the Arabic word for source), which has signed up major oil and technology companies and universities around the

world, as well as UAE ministries, so as to help develop and commercialize renewable energy technologies backed by heavy funding from Abu Dhabi.

The UAE has been singled out as one of the world's highest *per capita* emitters of carbon dioxide and other greenhouse effect gases. The UAE has an especially high energy demand to maintain a luxurious life of air conditioning, cool swimming pools and even an indoor ski slope in Dubai. But the UAE is the most serious among Persian Gulf oil-producing countries whose consumption for electrical power has spawned efforts to find other sources of energy to save high value fossil fuels for export. Masdar has drawn up a US$ 250 million Clean Technology Fund and begun construction of a special economic zone for the advanced energy industry. In February 2007, Abu Dhabi announced plans to build a 500-megawatt solar power plant in the area – one of the most ambitious of its kind in the world. It should be operational in 2009, either as a stand-alone plant or as part of a desalination project.

Furthermore, Masdar announced an even more ambitious project to develop a graduate-level research centre in association with the Massachusetts Institute of Technology (MIT) and to focus on renewable energy technologies. Scientists who join the programme will be able to attend MIT courses in Boston and will be assisted in developing research and courses at Abu Dhabi. The MIT administrators likened the endeavour to one that the university spearheaded in Bangalore during the 1960s that helped create the high-technology corridor in India. "This is the first oil-producing state that has accepted and agreed with the concept that oil may not be the only source of energy in the future", stated Professor F. Moavenzadeh, Director, Technology Development Programme at MIT. In a decade, Masdar's executives and MIT's administrators predict that Abu Dhabi is likely to have expertise in solar energy, photovoltaic, energy storage, carbon sequestration and hydrogen fuel. Consequently, Abu Dhabi's expertize will be in energy, not just in oil. Sultan A. Al-Jaber, Chief Executive of the Abu Dhabi Future Energy Company (ADFC), the government arm that manages the Masdar Initiative, stated: "We realize that the world energy markets are diversifying, so we need to diversify too. We see the growth of renewable energy as an opportunity, not as a problem".

Abu Dhabi is undoubtedly a forerunner, but other Arab countries (oil rich and exporters of oil and natural gas) have also dabbled with renewable energy. The Bahrain World Trade Centre (BWTC) Project includes wind turbines that, developers say, will meet up to 35 per cent of the Project's power needs. Solar heating in houses is encouraged, while desalination of sea or brackish waters is benefiting from technology advances aimed at saving energy. Last but not least, Saudi Arabia and other Gulf Arab States have begun research programmes to look into nuclear energy.

III. Conclusions

National and regional studies, carried out by Arab experts, expatriates, or foreign specialists (including from the United Nations specialized agencies and the United Nations Development Programme (UNDP) have concluded that scientific research, development and technological innovation in the Arab States needed a major whiplash to become closer to the world average indices, such as the: (i) expenditure as a percentage of GDP; (ii) number of scientists, engineers and technicians per million inhabitants; (iii) number of scientific publications in peer reviews; and (iv) number of patents filed and of technological innovations that improve the quality of manufactured products.

However, despite the wide range of social and economic situations, there is an increasing awareness of the need to invest in R&D, in higher reduction, and in the training and retraining of highly-qualified personnel and skilled labour, in addition to building the effective infrastructures necessary. Certainly, foresight and political business acumen will play a key role in this endeavour. This is witnessed, for instance in the case of launching the Masdar Initiative in Abu Dhabi; in the case of the Education City in Doha, Qatar, which owes a lot to Her Highness Sheikha Mouza Bint Nasser Al Misnad, Chair of the Qatar Foundation, and her successful efforts to attract some of the best universities in the world; witnessed also in Jordan, in the area of information and communication technologies (ICTs), as well as in the pharmaceutical sector; and in Morocco and Tunisia, which are striving to undertake good and relevant research aimed at supporting social and

economic development – with practically no support from oil revenues – in health care, medicine and pharmacy, as well as in agriculture, forestry and fisheries.

Globalization plays a key role in this awareness and policy-making because it can offer opportunities and benefits to those:

- Who would like to penetrate markets, using their competitive advantages (skills, labour, geographical position, free-trade agreements, etc.).
- Who seek to build alliances and make joint ventures; and those
- Who are willing to adapt their technology and production to international standards and regulations.

To these ends, *research, development* and *innovation* are key factors. This trend is obvious in the case of pharmaceuticals: the prospects for the development of the pharmaceutical sector in both Jordan and Morocco are not only to meet local needs, but also to move towards the international arena. Likewise, nowadays certain multinational pharmaceutical groups (mainly European and North American) are trying to conclude cooperative agreements and joint ventures with Indian firms – world champions in generics development, manufacture and sales – often considered as foes (because they sell their generics at cheap prices, and may infringe on the patents of drugs produced by the big pharmaceutical companies and thereafter sell generic equivalents). However, enemies may become allies in the globalized pharmaceutical market. Thus, Indian firms can develop new drugs (and even blockbuster drugs) from the multitude of molecules screened by the multinationals at a lower cost and even more rapidly, in addition to keeping their supremacy in the development and manufacture of generics.

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