INTRODUCTION

Throughout history, innovations based on new scientific and technological knowledge have led to productivity enhancement, improvements in living standards and long-term economic growth. In the course of the past few decades, in particular, innovations based on new technologies such as information and communications technologies, biotechnology and new materials have accelerated to an unprecedented degree, infiltrating many aspects of the global economy and holding out the promise of rapid socioeconomic progress in the developing countries.

Experience in a variety of political, economic and social settings indicates that a number of prerequisites are essential for devising cost-effective approaches to sustainable socioeconomic development capable of reaping the full benefits of technological innovation. Primarily, the capacity to access, adapt, disseminate and generate new technologies has to be based on sound science and technology (S and T) policies. Such policies, in turn, will bear fruit only when a dynamic system of national innovation is in place, allowing the integration of new technologies within the fabric of national economic activity. Policies governing national systems of innovation should guarantee:

(a) Rapid dissemination of new technologies;

(b) Incentives for private firms to innovate;

(c) Lifelong learning and upgrading skills;

(d) Continuous and relatively safe investment in innovative inputs to boost the productivity and competitiveness of existing firms and to encourage the start-up of new firms based on new technologies;

(e) Adequate institutional structures and networks.

The literature of science and technology policy, which has constituted a particularly thriving area of both theoretical research and heuristic study in recent years, points to a number of lessons for countries in the process of technological capacity-building. One of the most important of these lessons is that science, technology and innovation policies must be linked to socioeconomic development objectives. In all the ESCWA member countries, these objectives include:

(a) Restructuring and diversification of their economies and optimal use of their natural resources;
(b) The injection of new technologies into traditional sectors;
(c) Adequate responses to the rising expectations of the region's growing and youthful populations;
(d) Adequate solutions for a number of environmental problems in urban and rural settings.

Experience has also shown that attempts to attain objectives such as these through isolated policy, legislative and regulatory measures or exercises in institution-building and human resource development are doomed to failure. Demand-driven approaches in which policy, legislative and regulatory action is supplemented by appropriate institutional and human resource development schemes are much more effective. The role of national initiatives of this kind, developed in direct response to demand, is of incalculable importance for the attainment of the above objectives.

The fact that a number of ESCWA member countries have launched initiatives aimed at formulating national science and technology policies is an essential and auspicious initial step in the capacity -building process. Policy initiatives such as these will help set national priorities and lead to the development of implementation strategies in harmony with national visions, specific socioeconomic development needs and resource constraints. It is now apparent, however, that efforts along these lines must be supplemented with initiatives directly aimed at clearly defined objectives in the areas of institution-building, networking and human resource development. The keys to technological capacity-building are:

(a) Knowledge creation, normally the preserve of research centres and university laboratories;

(b) Knowledge acquisition, adaptation and dissemination, generally a task that falls to enterprises, in both the private and public sectors, but sometimes to universities and research centers as well;

(c) Human resource development, often a task for universities and higher vocational training institutes;

(d) Financing, based almost totally on government funding in the developing countries;

(e) S and T infrastructure building and support services, also almost exclusively the province of governments in the developing world.

The forging of strong bonds between institutions involved in these activities has been a major concern in both the developed and the developing countries. Initiatives have been launched with a view to fostering robust and cost-effective participatory approaches aimed at enabling such institutions to act in a co-ordinated fashion. Examples that have shown considerable promise for technological capacity-building and subsequent positive contributions to socioeconomic development include technology parks, technology incubators, innovation centres, high-technology industry clusters and research networks. Many such institutional forms have been set up in various parts of the world. Some have provided viable responses to long-standing problems in networking and co-operation among stakeholders concerned with technological capacity-building. Even more importantly, some have been shown to promote new forms of co-operation in various areas that had previously been virtually impervious to co-ordination and networking. A key factor in the success of such initiatives is capitalizing on the strengths of each of the parties involved, including government departments, private enterprises and non-governmental organizations.

In particular, some of these new institutional forms, such as technology parks, have been found to have an immensely positive impact on industry-university links. Technology incubators, when successfully set up and managed, have been found to afford an effective means of disseminating new technologies as bases for new business ventures. Others, such as high-technology industry clusters, have effectively fostered the rapid introduction of new technologies into obsolescent traditional industrial sectors. In general, given an adequate S and T policy framework, initiatives of this kind may:

(a) Provide support for industrial R and D by strengthening university-industry collaboration in solving industrial problems;

(b) Enhance technology diffusion mechanisms by establishing direct links between research and innovation institutions on the one hand and production/service firms on the other;

(c) Help create new technology-based firms capable of growing and leading to further job creation, higher productivity, lower prices and a greater variety of competitive products;

(d) Provide practical means for lifelong learning, manpower skill upgrading and the enhancement of employability and re-employability in a rapidly changing technological environment;

(e) Establish sustainable environments which are conducive to innovation and constitute fertile soil for technological entrepreneurship;

(f) Constitute practical testing grounds for the implementation of S and T policies, which require constant evaluation and overhaul if they are to remain effective;

(g) Strengthen public/private partnerships and foster co-operation between different actors;

(h) Facilitate technology transfer through the development of international collaboration mediated by technology-based multilateral firms involved in initiatives of the kind referred to above.

The proliferation of science, technology and research parks in Europe and the United States during the past 20 years has been the result of the above-mentioned advantages. In 1997, over 210 parks were to be found in the European Union, accommodating more than 11,200 firms with over 214,000 employees.[1] In the

[1] OECD, *Technology incubators: nurturing small firms* (Paris: OCDE, 1997), p. 18.

United States, science and technology parks tend to be larger than their European counterparts, as do the firms located there. There are six important research/science parks in the United States[2] that accommodate anywhere between 18 and 2,000 firms and employ a total of 12,000 to 34,000 people, average firm size being between 160 and 750 employees, except in the case of firms in the Irvine Spectrum park, which employ an average of 16 people each. Eight well-known European parks and technopoles[3] are home to between 35 and 2500 firms and employ 500 to 22,250 people, with average work force size ranging between 9 and 60 employees per firm.

Questions such as:

(a) Who should design and implement these initiatives?
(b) How should such initiatives be managed?
(c) On the basis of what criteria should they be evaluated?

merit attention. Answers to such questions will have to be based on specific conditions and overriding priorities in the ESCWA member countries in accordance with their future plans. Concerned government departments, universities and research and development institutions involved in science and technology capacity-building will often tend towards long-term solutions. On the other hand, the private sector, with its proverbial haste to recoup investment and move on to other conquests, is likely to be incapable of exerting a sustained impact. Non-governmental organizations, with their generally limited resources and their concern with solutions to the most urgent development problems, would not fare much better on their own. The situation thus calls for approaches in which governments' propensity to target strategic and long-term objectives, the dynamism inherent in the practices of private enterprise and the resoluteness of non-governmental organizations are combined to achieve optimal results.

Furthermore, effective implementation of these initiatives must be based on close consideration of national and local factors. Differences in economic and technology policy, legislative systems and technological maturity within the end-use sector, as well as differences in degree of industrial specialization, make it essential to customize capacity-building initiatives for specific situations, with a view to producing frameworks capable of providing maximum benefits while avoiding possible pitfalls.

The present study discusses the most common models for technology-based initiatives, charting practical approaches to their design and implementation. It includes case studies for S and T policy initiatives as well as various technology capacity-building initiatives such as technopoles, incubators and high-technology industry clusters. These case studies are taken from various developed and developing countries, and are analysed in the context of their original setting and prevailing conditions. In so far as possible, lessons are drawn from these experiences in the hope of providing food for thought to designers of ESCWA country initiatives. Pioneering initiatives in some ESCWA/Arab countries are also discussed as pointers to the current status of the region. A framework for future action in the ESCWA/Arab countries is offered as a proposed set of guidelines for the promotion and development of further such initiatives. Recommendations adopted at an ESCWA expert group meeting on S and T capacity-building initiatives in November 2000 are also included.

[2] Stanford Research Park, Research Triangle Park of North Carolina, Charleston University Research Park, Metro Tech., Irvine Spectrum, and Louisiana Biomedical and Development Park.

[3] Sophia Antipolis, the Tetrapole in Grenoble, Nancy Brabois Innovation and the Villeneuve D'Ascq Technopole in France; Cambridge Science Park in the UK; Milano Centrale Servizi, the Area Science Park of Trieste and the Bari Technopolis in Italy.