DRAFT

NATIONAL COUNCIL FOR SCIENTIFIC RESEARCH

A PLAN FOR A NEW SCIENCE, TECHNOLOGY AND INNOVATION POLICY FOR LEBANON

STIP

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OUTLINE

EXECUTIVE SUMMARY

Objective

Lebanon runs the risk of losing out on two of its most valuable assets: many of its young highly educated people wander abroad or are unemployed; capital, too, wanders abroad in search for profitable investment opportunities. This STIP Plan for a new Science, Technology and Innovation Policy for Lebanon aims at creating high quality jobs and investment opportunities, in line with the desire of the Lebanese government, the private sector, and organizations such as NCSR and the universities to make Lebanon part of the worldwide move towards a knowledge-based society.

The first objective of the STIP Plan is to increase and focus the national efforts in science, technology and innovation.

Secondly, to strengthen the STI institutions and gear them to create high-quality jobs and economic growth, improve the quality of life, and strengthen the position of Lebanon as a regional centre for high-quality learning, economic development, trade, tourism and health care.

Thirdly, the STIP Plan aims at strengthening partnerships between universities, NCSR and institutes; and between these organizations on one hand and private enterprise, other private organizations, and public agencies on the other.

Fourthly, it purports to strengthen Lebanon's embedding in regional and wider international networks in science, technology and innovation, and to use those networks for the most effective and efficient implementation of the Plan.

Some 30 experts from Lebanon have worked in three task forces, together with Dr. Peter Tindemans and the NCSR, to prepare this plan. Substantial input has come from ESCWA, and financial support from UNESCO and ALECSO.

While prepared under the auspices of the Lebanese NCSR, it is a plan for Lebanon as a whole that addresses a number of key challenges and needs specific to Lebanon, and the weaknesses of Lebanon's present science, technology and innovation system. NCSR, the major universities and institutes, and of course the government and the private sector must play a key role to guarantee its successful execution.

Challenges for and needs of Lebanon

In view of the relatively young demographic composition, the growth rate, and the relatively high level of education of the Lebanese population, attractive jobs need to be created in the high added value branches of industry and services.

The use of technology more efficiently and in more creative ways is the only way to establish higher added value production and services. Through them, export capacity could be increased in order to reduce the huge trade imbalance.

Making the most of domestic and foreign technology and information is crucial to revitalize the industrial manufacturing sectors and building up stronger professional service sectors. Major

inputs in R&D and entrepreneurial incentives are the way to bring about a jump in productivity, export performance, environmental sustainability of agriculture and attract private investment.

The medical and health care sector, as well as related industrial and service activities (e.g. in the field of ICT) can become a strong pillar in the Lebanese economy, if one steps up, in line with international practice, investments in R&D and the knowledge level of medical and para-medical staff.

Dedicated efforts in R&D and innovation will help greatly reduce energy and water consumption, use available resources efficiently and even create export potential.

Tourism will benefit from rehabilitation and preservation technologies, and from applying humanities and cultural sciences, ICT and marketing research. ICT and marketing research are key factors to advanced, innovative and efficient financial services.

All such efforts will contribute to reduce the national debt burden by boosting economic growth, and will offer investment options for capital that is now invested abroad by Lebanese banks.

In three vital domains for Lebanon, specific opportunities have been identified that should be grasped by addressing the following societal needs:

In basic science, industry (including services) and engineering:

1) Improve the management of energy, water, and other natural resources by adopting an integrated, sustainable approach
2) Reduce industrial operating cost (energy, equipment, and maintenance)
3) Harness information and communication technologies for development
4) Harness and strengthen scientific research for development
5) Improve productivity in industry, increase technology and information content
6) Establish new suitable industries for development and job creation
7) Increase share in international trade and export performance.

In environment and agriculture:

1) Stabilize (and eventually prevent) coastal deterioration through sustainable management
2) Integrated water management for an effective supply/demand balance
3) Grasping new agricultural economic opportunities
4) Improved nutritional food quality.

In medicine and health care:

1) Resume the position as a regional leader in the field of medicine and health care through improving higher medical and health science education, and through improving the quality and cost-effectiveness of medical and health care
2) Create an environment conducive to a flourishing biomedical industry and services sector.

Strengths and weaknesses of higher education and research in Lebanon

Lebanon has a long tradition in higher learning, research and science policy. There is an abundance of indigenous talent, the value of higher education is appreciated, and there is a high percentage of educated individuals with a relative gender un-bias. The environment to apply science and technology through developing individual initiatives exists, and the needed creative design skills and entrepreneurial and commercial drives are available. PC and Internet usage are wide-spread. There is a large network of Lebanese scientists abroad with many links to Lebanon.

But there is another, negative side to the higher educational system in Lebanon. There are many un- or underemployed qualified graduates with much emphasis on degrees in arts and humanities and theoretical sciences, all contributing to a significant "brain drain".

Most scientific research is being carried out by only a few institutions, and there is limited funding usually coming from a small number of sources, whether public or private. There are few institutional incentives to reward initiative, merit and performance. There is little collaboration. Outside of a few institutions, critical mass is lacking. The research institutes, the IRI maybe apart, have an urgent need for competent staff and equipment, and need to be re-positioned for new challenges, including stronger links to universities and stakeholders. Skilled technicians are often lacking, and infrastructure of technical systems underdeveloped. The gap between university research activities and industrial needs is large. Managerial and entrepreneurial skills are rather underdeveloped among scientists.

To improve this, a distinction should now be made between universities that have the ambition to do serious research and to link their teaching to research, and those who do not or cannot. For the first category, the research output should be part of their auditing. Teaching as well as research tracks should be provided. Collaboration should be encouraged; decision making and customs procedures accelerated; and international contacts made more easy. To achieve critical mass centres of excellence need to be set up, which will also assist in establishing partnerships with industry.

The initiatives of the STIP Plan

Experience and insights from those countries that have best and longest profited from science, technology and innovation show that a Science, Technology and Innovation system (STI system) that is up to the task displays several characteristics. Examples include setting of strategic priorities, a highly skilled workforce, strong universities and institutes, performance-oriented attitudes and procedures, a strong outward orientation and active pursuance of partnerships, mobility and technology transfer.

The STIP Plan cannot address all possible ways to improve the functioning of the STI system. A selection has been made, which together form the STIP Plan. By demonstrating that the activities of the Plan will lead to concrete progress in tackling the societal needs mentioned above, the STIP Plan will contribute to the conviction that STI Policies are vital. In this way of 'developing STI Policy by demonstration' the first 5-year STIP plan is meant to be supplemented by additional actions in 3 years time, and to evolve after 5 years into a structural approach, that might include institutional reforms as well.

A. Research Programmes targeting strategic priorities

Research Programmes are proposed in the following areas:

1. IT deployment in the enterprise sector
2. Web and Arabized Software Technologies
3. Mathematical modelling including financial/economic applications
4. Renewable energy resources (e.g. chemical, wind, hydroelectric, solar)
5. Materials / basic sciences for innovative applications
6. Sustainable management of coastal areas
7. Integrated water management
8. Technologies for new agricultural opportunities
9. Nutritional food quality

10. High quality research in subfields of molecular and cellular biology (one or two).
11. High quality research in clinical sciences (one or two programmes)
12. Forging links between the practitioners of medical and health sciences and technology, social sciences and paramedical professions.

B. Improving the Research Environment

To address several of the main weaknesses of higher education and research in Lebanon a variety of measures have to be taken.

Universities

- The functioning of universities needs to be improved by requesting a commitment to research and enforcing this by introducing new standards based on performance and auditing; by introducing more graduate, and in particular PhD programmes; and by making the funding of postdocs and centres eligible for support under the various STIP programmes.

Research Centres/Institutes

- A Virtual Centre for Instruments for Environmental Analysis coordinated by a properly staffed NCSR Centre for Marine Sciences should be established.
- A Nutrition Research Centre that could be hosted at one of the better equipped universities, should be established as a national centre.
- A Medical Research Institute should be set up with a core in molecular and cell biology, that would eventually serve the research needs of other sectors as well.
- The Ministry of Agriculture should develop long term funding, staff and governance policies for the ARI to enable it to participate in the STIP Plan and play a central role in a wider and innovative agricultural system .
- NCSR should develop long term plans for its Centres in conjunction with the implementation of the STIP Plan.

Incentives for collaboration

- Incentive programmes should be developed to stimulate collaboration with respect to research equipment and between people across disciplines, institutions, borders, and the public and private sector.

Streamlining of procedures

- NCSR should take the initiative to draft a White Book listing the major adverse regulations, procedures, administrative practices, and so on, for research, and seek to resolve them with the Interdepartmental Committee to be mentioned later.

A culture of responsibility and performance

- The arrangements on auditing, performance, careers for universities should be applied throughout the research system.
- NCSR should make sure that STIP management and funding decisions are highly transparent and responsible. It should also continue to improve its internal operations and grant procedures in the same direction.

C. Information and Communication Infrastructure

Here two activities are proposed:

- The scope and an implementation plan for an advanced Information and Communication Network for Higher Education and Research should be defined.

- An incentive programme for Innovative Information Products should be established.

D. Linking academia and institutes to the private sector and public agencies, NGO's and society at large

Exploiting and disseminating science and technology is envisaged in the STIP Plan by a number of initiatives:

- A Knowledge Gateway Industry Lebanon should be established. This consists of a database and Technology Promotion Units at each of the major universities and IRI to help especially SME's to articulate needs and benefit from university and IRI expertise and resources.
- Sectoral centres of excellence (real or virtual) should be set up for sectors such as clothes, shoes and furniture, with the aim to provide technical know-how and laboratory services. They could be based on the model for the wine industry.
- In a joint effort NCSR, IRI, LIBNOR and the Ministry of Industry should agree to set up teams to support the adaptation and adoption of technical standards.
- NCSR should take the initiative to set up a team to define the format of workshops and experiments with e.g. degree course requirements in the area of entrepreneurship and business development.
- Consideration should be given to the establishment of a small funding initiative, maybe linked to BERYTECH or other incubator initiatives to provide seed money very early on for ideas based on scientific work.
- A structured approach towards establishing new incubators should be established.
- A stronger representation of the outside world in steering committees and advisory boards of universities and institutes should be systematically pursued.
- Public and Professional Information Units should be created in four areas, based on existing centres or centres to be established:
    - Coastal Zone
    - Water
    - New agricultural opportunities
    - Food quality.

  Their task will be to provide all strata of Lebanese society with the highly relevant information that will be accumulated by the STIP research programmes.

E. STI Policy system aspects

Two areas for strengthening the STI Policy System have been selected:

1. Getting better statistical data and indicators on STI:
    - With the help of ESCWA and the UNESCO Institute of Statistics a unit should be established at NCSR that should develop into an STI Observatory.
    - Its scope should be pragmatically defined and one needs therefore to identify an initially limited but structured set of indicators to monitor Lebanon's performance in STI and the knowledge society.

2. Strengthening the co-ordination role of CNRS:
    - NCSR has, as reconfirmed by the recent circular 17/2003 of the Prime Minister on the coordinating role of NCSR vis-à-vis the various government departments, a national responsibility and thus should lead the implementation of the STIP Plan to the benefit of Lebanese society as a whole.

- Stakeholder meetings and an appropriate organization of the implementation should ensure that the enterprise sector, government departments, universities, institutes, and relevant societal bodies identify with and 'own' the STIP Plan.
- NCSR should conclude co-ordination agreements with international donors and ministries to ensure synergy between their financial efforts and the STIP Plan.
- An interdepartmental committee should be set up to involve in a more formal way relevant ministries in the implementation of the STIP Plan and in developing STI policies more generally.

F. National and international partnerships

- The STIP Plan will not only benefit from, but should explicitly aim to strengthen partnerships between the universities, CRNS, the institutes, and the private and public sector enterprises and organizations. Several mechanisms to achieve that goal have been identified.
- Cooperation in the region and in the Arab world are important too, but should be pursued on a case-by-case basis.
- More generally, the various activities under the STIP Plan should assist to incorporate Lebanese scientists and institutions in international networks. Using the contacts with the large Lebanese scientific community abroad, the EU Association Agreement, bilateral funding agreements, institutional partnership links with foreign universities, involving foreign experts in an advisory capacity, are all actions that can serve a useful purpose. Funding under the STIP Plan should make it obligatory for Lebanese partners to demonstrate international 'embedding', of course in ways suitable to the activities concerned.

Implementation, monitoring and evaluation

Expected outcomes and monitoring and evaluation

In order to chart the performance of the STIP plan in creating tangible results, a quantifiable metric is preferably needed. One, however, must be realistic in this respect. Proper overall economic and social stimuli and conditions, which are not the subject of the STIP Plan, need to be in place. Moreover, a single "5-year" STIP Plan must evolve into a continuous effort to lead to sustainable improvements.

The NCSR Programme Management Unit (see next paragraph) should work closely with those who will be responsible for managing the various activities to establish either genuine performance targets or 'proxy' or process targets. Approval of funding is conditional on verifying that such yardsticks are available. This Unit should also work with the other actors to establish a monitoring and evaluation mechanism to verify that yardsticks have been met.

For sectors such as Coastal Management, Water Management, Agriculture, Food Quality, or Energy Production and Use, genuine performance targets can be identified. For water management, for example, one might aim at an increase of 30% after 5 years of the expected available water supply in 2015 compared to the current estimates; and a reduction after 5 years of water consumption per household of 25%, and of 50% for the enterprise and the government sectors.

Measuring the contribution of the STIP Plan to an improved performance of the enterprise sector, however, can only be done by 'proxy', intermediate or process targets. For example, for an applied research programme (such as *IT Deployment in the Enterprise Sector*) that focuses on how small companies can get effective, yet easy-to-use ICT tools to enhance their 'internal' business processes and better manage the 'external' supply chain they are part of, two possible proxy performance targets could be, for example: that after 3 years at least 25 students per year will graduate at Masters level (by participating in applied research projects) in relevant degree courses; or that after 3 years average yearly increases of 10% can be found of the number of enterprises in relevant sectors that apply either the 'internal' business process improvement tools or the 'external' ones, or both.

Organization and responsibilities

A *Programme Management Unit (PMU)* will have overall responsibility to initiate activities, approve plans, allocate money, and establish a reporting, auditing and evaluation mechanism of the STIP Plan. For each activity or group of activities an organization (which may also be a consortium of organizations) will be identified as *Primary Actor*, to forward a detailed implementation plan and set up the actual implementation agents. Primary Actors report to and receive money from the PMU. A *University Consortium* comprising the main universities should be set up for some of the measures, implicating joint responsibilities.

A high level *Steering Committee,* including expatriate Lebanese scientists and industrialists, is to supervise and facilitate the work of the PMU. NCSR should establish financial, administrative and other guidelines for the PMU to be approved by the Steering Committee.

Budget

The STIP Plan aims to increase substantially the overall spending on STI, largely by creating a pyramid-like community of researchers 'bottom up', including a PhD, post-doc, junior and senior researcher positions. In contrast to present practice salary costs and costs of equipment will therefore have to be reimbursed.

On the basis of estimates of the costs of the various activities and their gradual ramping up to full scale, and taking into account preparatory costs and management costs of some 5%, the overall STIP budget is expected to be as follows (in thousands of US$):

Y0	*Y1*	*Y2*	*Y3*	*Y4*	*Y5*
155	**698**	**2620**	**4500**	**5098**	**5098**

The small Preparatory Budget for Year 0, i.e. 2004, is to prepare for those activities that should start at the beginning of Year 1 (that is January 1, 2005, the expected date for the initial implementation of the STIP Plan) and for those activities that preferably should even precede the completion of the full formal decision process. The Plan of Action assumes that when the Cabinet decides to approve the STIP Plan, prior to Parliamentary approval, it decides to make that Preparatory Budget available.

The proposed budget does not include a separate budget for new PhD programmes. Even though part of the costs will be covered by STIP Research Programmes, the overall costs have to be considered in the context of total university funding. The costs of new Incubator initiatives and of the Higher Education and Research Computer Network have not been included, either.

Plan of Action

A Plan of Action has been drawn up that describes in great detail what needs to be done before and during the first year (2005) of STIP Plan Implementation. It proposes suggestions for actions needed to start carrying out the highest priority activities, which however need to be agreed upon by a National Seminar of the stakeholders. On that basis, formal approval by the government and the parliament has to be obtained for the STIP Plan: its budget, the mandates and the coordination structures at the government level. Also in 2004, the implementation organization has to be established, together with the cooperation agreements between the major parties. For later years similarly detailed plans can easily be derived.

A knowledge-based society

Finally, some international background is given about the reality and the pertinence of the concept of a knowledge-based society; the reasons why companies and countries invest in STI in order to increase prosperity and quality of life; and also about the concept of national or regional systems of innovation and associated concepts like economic clusters which underlie the current thinking about STI policies worldwide.

Overview of contents

The *first chapter* of this Plan for Science, Technology and Innovation Policy in Lebanon states its objective: its stakeholders wish to develop and use science, technology and innovation to help solve major Lebanese economic and societal problems, strengthen Lebanon's regional position and turn it gradually into a knowledge-based society. Formulated first in macro socio-economic terms, the challenges that Lebanon faces will clearly benefit from bringing science, technology and innovation to bear upon them. A limited number of specific societal needs in three important domains – *Basic Sciences, Industry and Engineering*; *Environment, Agriculture and Biological Sciences*; and *Health and Medical Sciences* – has been selected that offer great opportunities for Lebanon when determined efforts are made in research, training and dissemination and innovation.

A brief sketch of the situation in higher education and research in Lebanon is also given to provide the background for the initiatives that form the STIP Plan. However, without partnerships, dialogue and mutual understanding between governments and companies on the one, and scientists, engineers, universities and institutes on the other hand, the gap that inevitably exists between science efforts and their useful and tangible economic and social applications will, however, not be bridged.

Not every approach to develop a policy for science, technology and innovation is equally appropriate. *Chapter two* describes the approach that was judged best suited for the circumstances prevailing in Lebanon. Against the background of what has to be built up in the long term in areas ranging from priority setting to reinforcing universities or institutes and strengthening policy making capabilities, the STIP Plan selects in chapter 2.1 a particular set of activities and measures for Lebanon. Chapter 2.2 describes then how these are part of a strategy that will gradually achieve a much more central role for STI in Lebanon in such a way that the investments in STI will lead to recognizable economic and societal improvements, as well as a stronger environment for research. In this way a 'self-propelling' mechanism is created for further expansion of both investments in STI and the framework of and the institutions for STI policies. "Policy by demonstration" is the phrase coined. The Plan has been prepared by three Task Forces of Lebanese experts with contributions from a number of international partners. A specific methodology has been followed which is described in chapter 2.3. The Task Force members and the other persons involved are mentioned in chapter 2.4.

The elaboration of the STIP Initiatives for the next 5 years is to be found in *chapter three*. A number of research programmes is proposed, which should be accompanied by some major actions, including efforts in education and training, to improve the research system in Lebanon. The information and communication infrastructure needs upgrading. A variety of concrete proposals is made to strengthen the links between the research community (academia and institutes) and the private sector and public agencies, NGO's and the public sector at large. The STIP Plan, however, also encompasses a few crucial enabling mechanisms, notably in the areas of indicators and statistics on STI efforts and in strengthening coordination between the key players in STI policy and in funding STI efforts. These mechanisms will further develop STI policies and increase the impact of STI on the Lebanese society and its economy. Chapter 3.6 then provides a succinct overview of all the initiatives the STIP Plan comprises. Finally, the vital role of national and international partnerships both as an objective and a means to implement the STIP Plan is discussed in this chapter.

Chapter four concentrates on the implementation of the STIP Plan. First, an effort is made to describe the expected outcomes of the STIP Initiatives. Next, the organization that needs to be set up for the Plan's implementation is put forward, and the roles and responsibilities of the various constituent parts are established. An important responsibility among those concerns is the monitoring of the implementation progress and evaluating its impact and results.

A detailed budget is proposed in chapter 4.3. As it is impossible to carry out all activities right away, the detailed Plan of Action that follows, identifies what steps should be set and in which order, priorities proposed among the Initiatives, and what budgets will be needed in the various years the STIP Plan covers.

The implementation of the STIP Plan requires some specific legal and administrative provisions, which are the subject of *chapter five*. In the first place a Framework Law (Loi Programme) is needed to allow for a multi-annual financial perspective. However, some other legislation is necessary. To support the partnerships between the key Lebanese players which are so crucial for the implementation of the Plan, model agreements between NCSR and its main partners have been drawn up and are presented in chapter 5.3.

The final *chapter six* provides some international background about the reality and the pertinence of the concept of a knowledge-based society, about the by now well-established reasons why companies and countries invest in STI in order to increase the prosperity and quality of life, and about the concept of national or regional systems of innovation and associated concepts like economic clusters which underlie the current thinking about STI policies worldwide.

Dr. Peter Tindemans

1. OBJECTIVE, STAKEHOLDERS, PROBLEMS TO ADDRESS

1.1 Objective and stakeholders

Lebanon runs the risk of losing out on two of its most valuable assets: many of its young highly educated people wander abroad or are unemployed; capital, too, wanders abroad in search for profitable investment opportunities. This STIP Plan for a new Science, Technology and Innovation Policy for Lebanon addresses this problem through an attempt to create high quality jobs and investment opportunities. It should therefore be seen in the context of the desire of the Lebanese government, private sector, and organizations such as NCSR and the universities to strengthen the economy, improve the quality of life, and support Lebanon join the worldwide trend towards becoming a knowledge-based society.

> *The objective of the STIP Plan is to increase and focus the national efforts in science, technology and innovation in Lebanon, with the aim of strengthening and gearing the STI institutions towards the creation of high-quality jobs, hence economic growth and improvement of the quality of life, as well as towards strengthening the position of Lebanon as a regional centre for high-quality education and research, economic development, trade, tourism and health care. In particular, it identifies a number of specific opportunities in three areas: 1) basic science, industry (including services) and engineering; 2) environment and agriculture; and 3) medicine and health care.*
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> *The STIP Plan also aims at strengthening partnerships between universities, NSCR and research institutes on one hand; and between those organizations and the private enterprise, other private organizations, and public agencies on the other hand. In addition, it purports to strengthen Lebanon's embedding in regional and wider international networks in science, technology and innovation, and to use those networks for the most effective and efficient implementation of the Plan.*

The STIP Plan envisages that in the first place all actors in the field of science and technology, including NCSR, universities, research institutes and individual scientists commit themselves to its goals and its implementation. Respectful of every actor's autonomy, the Plan is a challenge and an invitation to jointly address both the opportunities for Lebanon to become a knowledge-based society, as well as the hindrances that should be overcome to achieve this objective.

However, the private sector including the enterprises and the wider private organizations, as well as the government and other actors within the public sector are key players to fine-tune its targets and to be actively involved in the implementation of the STIP plan. The government has an especially critical role in creating the necessary conditions, particularly financial and regulatory conditions, to accomplish the economic and social potential implied in the activities of the Plan. However, while financial means are important, they are not the whole story. The STIP Plan is also aiming to represent a change in culture and in attitudes. Individual researchers, universities and institutes are invited to adopt new or reinforce existing approaches based on awareness of societal needs, public accountability, rigorous research standards, and entrepreneurship in one's own environment.

Though the Plan has been prepared under the auspices of the Lebanese NCSR, many specialists from universities and other national organizations have been involved in its development. It is in

the first place a plan for Lebanon as a whole, addressing a number of key problems and needs specific to the country, and apart from NCSR, all major national universities and institutes must play a key role for its successful execution.

1.2 Science, technology and innovation and socio-economic challenges in Lebanon

Modern societies are becoming knowledge-based societies (refer to chapter 6). This in essence means that most or all of the production factors of economies and societies (to account for 'social production') including capital goods, human capital, information and knowledge capital, and institutions, become heavily transfused with knowledge. This is not just knowledge as accumulated experience, but science-based knowledge. Being part of the globalized world imposes developing and using such production factors 'transfused with knowledge'. Education, research and innovation are key words for this process of 'transfusion', and companies and governments worldwide invest heavily in them. The success of companies (i.e. at the micro-economic level) and economies (the macro-economic level), as well as the increase in individual freedom, the improvement in the quality of life and societal well-being (the social level) world-wide depends on this concept. To just give two illustrations: more than 30% of annual revenues in the manufacturing sector derive from new or improved products whereas, for more than a century, a steady GDP growth occurred in those countries that have accounted and still account for most of the world's R&D investments.

Innovation is the result of technological change (a category used by economists to analyze economic growth) in combination with many other changes, such as in organizational design, management methods, marketing concepts, financial techniques, and policy approaches.

Technological change and several of the other above-mentioned developments increasingly depend on scientific research in the natural, engineering and medical sciences. Today also research in social sciences and humanities has become even more important than in the past.

Private firms in particular realize very well that innovation pays off: in almost all OECD countries the trend of a business funding of its own R&D, as well as of public-sector R&D has increased considerably from 1981 to 2001. Presently, Lebanese private firms are in general small family businesses that are not very active in R&D. The STIP Plan however, aims at changing this perspective.

Governments should have the same impulse to improve through R&D and innovation the quality, productivity, cost-effectiveness and accessibility of a variety of services. But as firms will not invest much in basic and strategic research, governments are the main sponsors for it. Neither firms nor governments, finally, can afford to rely exclusively on accessing or buying knowledge produced elsewhere since much knowledge is embodied in persons, procedures, and organizations. Learning is necessary to appreciate and assimilate ('absorb') results from elsewhere. Neither companies nor countries can 'free-ride' on science developed elsewhere.

What does this mean for the various socio-economic sectors in Lebanon?

The relatively young demographic composition, the growth rate, and the relatively high level of education of the Lebanese population make it appropriate and convenient to create attractive jobs in the high added value branches of industry and services. This is an urgent condition to improve the economic productivity, reduce unemployment and combat the severe brain drain that the

country is facing since decades. Besides, a better match of degree courses chosen and the potential for job creation must be part of the policies adopted at the national level.

Reducing and eventually eliminating the huge trade imbalance, requires substantial increases in export capacity. Given resource limitation or scarcity and relatively high wage levels and production costs, the only way to expand the Lebanese exports is to move into higher added value production and services. That means among other things using technology more efficiently and in more creative ways as well as improving quality levels in the productive (industrial and agricultural) and services sectors.

Revitalizing industrial manufacturing sectors and building up stronger professional service sectors are essential aspects of such a strategy. This can only be brought about by creating an environment that stimulates people, firms and institutions to make the most of domestic and foreign technology and information in creative and entrepreneurial ways.

Similarly the agricultural sector that is suffering from low productivity, low added value, absence of private and public investment and characterized by an output largely for domestic consumption, is in need of a leap in productivity, quality improvement and export performance. This will only occur by major inputs in R&D and entrepreneurial incentives, ensuring a proper balance with environmental sustainability.

With a clear strategy, the medical and health care sector, as well as related industrial and service activities such as the field of ICT, can become a strong pillar in the Lebanese economy. As these sectors are now permeated world wide with ever more science and technology inputs, there is no way of achieving this aim without investing strongly in STI. Enhancing the knowledge level of medical and para-medical staff will help restrict a substantial economic drain through abuse in medications, medical procedures and sick-leaves.

Reducing energy and water inputs, and making better use of available or potentially available energy, water and other natural resources reduce costs to Lebanese industry and services, the government and consumers. It would accordingly improve the export potential of national products. Achieving this is also impossible without dedicated and focused STI efforts.

Developing further the tourism potential, a traditionally important pillar of the Lebanese economy, not only requires entrepreneurial initiatives but also the full use of rehabilitation and preservation technologies, inputs from humanities and cultural sciences, ICT, marketing research and so on.

All these efforts contribute to reducing the debt burden of Lebanon because they will help Lebanon to achieve high and sustained economic growth rates. They will improve the trade balance and offer investment options for huge amounts of capital that is now invested abroad by Lebanese banks. On top of that developing and applying ICT and related scientific and technological fields as well as marketing research are nowadays key factors for offering advanced, innovative and efficient financial services.

1.3 Societal needs as the basis for Lebanon's STI Policy for 2004-2009

The STI Plan intends to develop activities and policies in three domains whose importance for the Lebanese economy stands no doubt, and which have strong links to major fields of science.
The first domain concerns industry, including the service sector, basic sciences and engineering that are relevant to it and to development in general. As industry is the key engine for economic

development, it is only appropriate that the Lebanese science and technology organizations and workers exert a determined effort to focus on its needs and define the respective underlying research, HRD and dissemination activities.

The environmental concerns and challenges for Lebanon being huge, the environment is the umbrella for the second domain. But since agriculture is of such pre-eminence in Lebanon, at the economic, social and environmental levels, and its operations increasingly linked to and often restricted by environmental conditions, concerns and measures, it is a combination of environment and agriculture that spans the second domain. One challenge here will be to identify common activities based on the large commonality in the underlying science base and in opportunities open to them.

For any country and in a regional context even more so for Lebanon, the domain of health care and medicine will become more important for the future. This domain has characteristically been pervaded over the past decades by science and technology.

In each of these domains many opportunities exist for the fulfilment of vital societal needs through the implementation of science, technology and innovation. Since not all of these societal needs can be addressed at the same time, a selection has been made of those needs that are judged to be particularly suitable and urgent.

1.3.1 Societal needs in the domain of : Basic sciences, industry and engineering.

The ambition is to address seven societal needs, which are based on regional and national studies.

1) Improve the management of energy, water, and other natural resources by adopting an integrated and sustainable approach;
2) Reduce industrial operating cost (energy, equipment, and maintenance);
3) Harness information and communication technologies for development;
4) Harness and strengthen scientific research for development;
5) Improve productivity in industry, increase technology and information content;
6) Establish new suitable industries for development and job creation;
7) Increase share in international trade and export performance.

Justification

The industrial manufacturing sector has been evolving in Lebanon since the fifties. Recently, it represented about 17% of GDP, for which in 1998 around 22,000 units were responsible.

Unlike several countries in the region, the Lebanese government never sought the creation of large nationalized industrial firms. Instead, Lebanon has historically depended on import for most of its industrial and consumer goods. The industrial sector is composed almost entirely of small family-owned firms employing on the average less than ten people, converting semi-finished imported goods for the local market, or producing bulk items, such as furniture, paper products and beverages. Value added industries are confined to a small jewellery-finishing sector and an equally limited fashion industry. Other local industries include certain perishable and delicate goods and processed foods. There is also a small market for time-sensitive and delicate goods, such as unprocessed food. For various reasons, including the reduced transport cost, most Lebanese manufacturing plants are located around population centres.

The industrial manufacturing sector in Lebanon faces several internal problems and challenges including:

- Small-sized industrial firms;
- Labour-intensive production and investment;
- Limited diversity in production;
- Predominance of family businesses, characterized by monopolized decision making;
- Limited industrial investments;
- High costs of production (including cost of raw material, energy, etc.);
- Generally poor quality of products limiting their ability to penetrate foreign markets;
- High transaction cost, leading to increase in opportunity cost (time, money);
- High energy intensity;
- Limited resources at the Ministry of Industry (MoI) for proper management and support of the sector;
- Limited control on the application of standards and norms in the sector.

The above mentioned internal sector problems are accentuated by external ones such as:

- Poor competitive ability at the international market, especially with the high production cost and the irregular conformity to quality standards;
- High competition in the FDI markets (foreign direct investment) markets, especially in the absence of the appropriate environment in Lebanon to attract FDI;
- Increase in regulations, resolutions and standards codes that the industry has to abide by since the signing of bilateral and multilateral trade agreements with the various Arab countries and the WTO.

Serious efforts by the private sector itself and also the MoI have been exerted during the last few years to further develop the industrial sector in Lebanon. Several analytical studies have been conducted and reports written that were mostly in agreement on recommending the implementation of the following measures for the overall development of the sector:

- Improvement of industrial information and technical consulting services;
- Creation of legal and organizational frameworks triggering incentives for industrial development;
- Improvement of the industrial infrastructure;
- Reduction of production costs;
- Provision of sources of finance with attractive conditions;
- Modernization of the sector;
- Expansion of local markets for local commodities and fight dumping;
- Development of exports;
- Organization and administration of WTO negotiations from a strategic perspective.

It is becoming urgent at this phase to mount sustained efforts to harness the potential of science, technology and innovation to the medium and high-tech industries in Lebanon.

Energy is a critical factor in this domain. High energy consumption is not limited to manufacturing industry only but covers all other economic and social sectors. Presently, Lebanon imports all of its fuel, by far the major source of energy, and the primary energy consumption has been steadily increasing over the past years.

The use of solar energy to heat water unfortunately continues to be very limited in Lebanon, compared with other neighbouring countries such as Cyprus, Greece, and Jordan. According to one study (ALMEE, 2000: "le Solaire au Liban"), the installation of 400,000 solar heaters in Lebanon, over a 10-years period, would entail electricity energy saving of about 8 %, and consequently avoid the need to expand the power production capacity by 100MW, saving more than 100 million US dollar yearly as capital cost. On the other hand, this would lower the energy bill by about 30 million US dollar over the 10-years, and would also reduce the atmospheric pollution from thermal power plants.

R&D on renewable energy, and on energy conservation, are hence essential needs for the Lebanese economy. The establishment of the Lebanese Centre for Energy Conservation and Planning is a step ahead in this direction.

Financial services constitute an important economic sector in Lebanon, whereby banking services used to rank first in the region. This sector, however, is presently witnessing high competition from other countries in the region such as Bahrain and Dubai. The sector is also witnessing worldwide great technological changes, particularly in the areas of e-banking new communication technologies such as General Packet Radio Service (GPRS) and new modelling techniques and operations research. Assimilating and adopting these new technologies by the Lebanese financial sector is critical. By taking up these technologies and developing them further, the Lebanese industrial companies would not only be serving the needs of the banking sector, but also will be creating a higher value-added industrial activities and products. Currently, billions of dollars are being invested by Lebanese banks outside Lebanon because return on investment is not high in the Lebanese market. At the level of the whole Arab World, it is estimated that more than one trillion dollar of Arabic capital is invested outside the Arab world.

1.3.2 Societal needs in the domain of: Environment, Agriculture and Biological Sciences

The ambition is to address four societal needs, which reflect national policy documents and international obligations in which Lebanon is engaged.

1) Stabilization (or prevention) of coastal deterioration through sustainable management
2) Integrated water management for an effective supply/demand balance
3) Grasping new agricultural economic opportunities
4) Improved nutritional food quality

Justification.
The coastal zone in Lebanon is already highly artificial and suffers increasing pressure from competing demands and interests threatening both its economic activities (production and tourism) and the conservation of natural habitats and biodiversity. This makes it increasingly difficult to cope with the requirements of the many international MoUs and protocols the government has signed and ratified. It is becoming increasingly urgent to mitigate the pressure on the coastal zone by finding sustainable and nationally acceptable solutions that are based on well informed, data-supported land-planning studies. Unfortunately, presently this seems difficult to achieve due to the limitation in reliable data, technically knowledgeable personnel and the appropriate regulatory framework.

It is estimated that the supply of available renewable water resources in Lebanon will sharply decline from 945 m^3 per person per year to an estimated 705 m^3 in 2025. In parallel the levels of water tables will drop and seawater intrusion will be on the increase. Presently, reservoir construction for better use of surface water is ongoing. However, other less expensive and

disruptive small-scale solutions need to be further analysed. The level and efficiency of irrigation need to be seriously improved especially after suffering badly during the Lebanese civil war. It is also important that new and hitherto practically un-tested demand management measures should also be considered.

A major problem that is regularly encountered is the absence of a comprehensive database. This is the result of the disrupted collection of water resources data that is hardly accessible and poorly computerized. It is also affected by the absence of continuous monitoring and auditing and the limited availability of qualified personnel. More efforts could also be invested in the field of water recycling, where potable natural water could be an important industrial sector in Lebanon, particularly when considering the market of the Arab Gulf countries. This is especially true if competitive technologies are used for its production and packaging. The Ministry of Energy and Water Resources (MoEW) has a 10-year plan for water projects, with a budget of 850 million dollar over the coming 10 years with which the STI Plan should establish connections.

Agriculture remains an important economic sector in Lebanon contributing to 12% of the national GDP and 40% of total workforce. The civil war has had a severe impact on this sector, mostly through isolating farmers and producers from new concepts in agriculture, new improvements and innovations in production, packaging and marketing technologies, and through limiting research to adaptive research. Accordingly, Lebanon's traditional markets were lost to new developing markets in the region, and productivity declined to often 30-40% less than in developed Mediterranean countries. So far little priority has been given to the sector by the government, which neither invested to make the sector comply with international agreements it ratified, nor anticipated on the impact or on opportunities of European import/export or market regulations.

Yet, Lebanese farmers demonstrate entrepreneurship, and a remarkable willingness to take risks. Besides, if properly used and exploited, the precious and unique natural resources are major assets for Lebanon to develop innovative high valued added products.

Food has evolved from a basic necessity for survival to an essential part of an individual's and a population's health and well being. Improving food quality is a broad area ranging from human nutrition and food science to consumer protection and clinical studies. In Lebanon, the increasingly varied markets and consumer choices coupled with upcoming safety concerns make the need for a reliable reference body ever more felt. Local and regional nutritional trend studies are lacking so far. While demand for education and reliable knowledge and products is on the rise and education programmes have been initiated, neither research on the link between diet and disease, nor food and nutrition monitoring have resulted in a reliable reference body. Besides, no development of new products according to specific requirements are yet following suit.

1.3.3 Societal needs in the domain: Health and Medical Sciences

The ambition in this domain is to address the following societal needs:

1) Resume the position of Lebanon as a regional leader in the field of medicine and health care through improving higher medical and health science education, and through improving the quality and cost-effectiveness of medical and health care services.
2) Create an environment conducive to a flourishing biomedical industry and services sector.

Justification

Though a developing country, Lebanon ranks among the developed countries as far as the number of physicians and sophisticated medical equipment available per capita. Though expensive, the health-care system in Lebanon is well developed, with the availability of high-quality care. For those born in 1995-2000, the average life expectancy is one of the highest in the region, at 72.6 years, compared with 61 years in Egypt. Infant mortality is relatively low at around 28 per 1000 life births, which is much lower than the Middle East average of 51. In year 2000, there was one doctor for every 476 people in Lebanon, compared with 1320 people in Egypt. Indeed, Lebanon has for many years established itself as a regional leader in the field of higher education, medicine and health care.

However, the civil war has not left this position unaffected. The economic importance of this sector at the regional level, which was high, has suffered greatly. There are presently justified concerns as to whether the level of higher education and research in the field of health and medical care are sufficient not only to maintain the present situation, but to reclaim the former position as a regional leader. Clinical research, as an example, seems to be presently revolving around relatively un-important epidemiological or retrospective clinical studies. This is in part due to the nature of funding usually supported by drug companies for promotional purposes rather than through drug development. This kind of research has a limited impact on the practice of medicine locally and abroad. A wider consequence of this has been that so far Lebanon has not yet been able to profit from the closer links that are emerging all over the world between the medical and health care system and biomedical industry and services.

Lebanon remains poised to resume this function. Capitalizing on the country's proven history coupled with future investment should regenerate and expand its ability to lead in the fields of health and medicine. An additional opportunity that should be seriously considered is that of 'medical tourism', which appears to be expanding in Lebanon and several other countries. Lebanon, has the potential to combine high quality medical and health care with excellent tourism facilities.

It is well recognized that good quality teaching, medical and health care depend on the upgrading of knowledge. This is done mainly through good quality research, the production of new knowledge and participation in international specialised meetings where the latest results of new research and their translation into teaching and health care are discussed. Besides, improvement of technology basically depends on improvement of scientific research. For these reasons, investment in research is expected to improve higher education, medical and health care.

Such improvements in this sector will also create the potential for generating new companies and hence offer new jobs in the sector of biomedical industries. These industries have developed on the basis of biomedical technologies such as pharmaceuticals, biotechnology, medical devices, hybrid devices, biomedical engineering, diagnostics, and health care-related information technologies. Lebanon too should tap on and develop the valuable source that is represented by a partnership with local and international biomedical industries. But in the area of biotechnology, for example, there is a long lag phase between initial investment and profitability and hence it is difficult for capital markets to assess accurately the risk associated with early-stage technologies. For these reasons, and due to lack of incentives that encourage such investments, the private sector under-invests in commercializing the results of basic and early-stage applied research. Currently, support for basic and clinical research from industry is negligible. Special effort should be made to provide clear and attractive information about the promises and the investment opportunities in medical research and technologies. Several mechanisms should be implemented to convince local industrialists using imported technology to invest in research and biotechnology.

The identification of the most important societal needs and their translation into priority areas for research in the domain of health and medical sciences is not as straightforward as in other domains. The Lebanese population conforms to the rest of the world with respect to medical and health needs. Although there are a few regional genetic and infectious diseases, the Lebanese suffer from diseases common to other parts of the world. While some of the specific problems arise from the developing nature of Lebanon where ignorance and poverty may impact health issues, these too, do not easily lead to research priorities. The latter will have to depend more on where the highest quality is to be found, and where industrial opportunities arise. The initial approach to this domain within the STI Plan must therefore be different.

1.4 Lebanese higher education and research: strengths and weaknesses

Lebanese universities, research institutes and science policy institutions together with private enterprises and other societal organizations face huge challenges in their attempt to grasp the opportunities in changing Lebanon into a knowledge-based society. When put against the background of their recent history, the importance and difficulty of this role stand out much more clearly.

Historically, Lebanon has been home not only to numerous higher education institutes but also to some prestigious ones. The number of educational institutes in Lebanon has recently mushroomed. There is on average no shortage of well qualified academic staff, many of them being graduates of internationally renowned universities. Excellence in the rise of education in Lebanon can be attributed to a relatively young population with an abundance of indigenous talent, understanding of the value of higher education and a thirst for achievement through it.

The unique language capabilities among Lebanese scientists but also among the population more generally, and the multicultural traditions further strengthen this fertile soil. This results in a high percentage of educated individuals with a relative gender un-bias compared to neighbouring countries. Graduates from Lebanese universities have played a pioneering role in regional development.

Besides, when it comes to investing in research and science policy, Lebanon enjoys a relatively long tradition among countries in the Middle East. NCSR is now more than 40 years old, it has set up a number of research institutes in several highly relevant areas. On the other hand, there are two active larger public research institutes that work close to or under ministries, namely, the Lebanese Agricultural Research Institute (LARI) and the Industrial Research Institute (IRI).

There seems to be a good potential in Lebanon for the application of science and technology: there is an adequate environment for development of individual initiatives; creative design skills are available; there is no lack of entrepreneurial and commercial drive; and the use of the PC and Internet are wide-spread.

Lebanese scientists who have moved abroad as a result of brain drain and absence of work opportunities, have kept their links to the mother country; something which represents a potential resource and an important network of professionals. Lebanon's exposure and interaction with various cultures is unique in the Middle East. The recent partnership agreement with the EU, which among others will allow for a grace period before full competitive conditions apply, and the renewed international financial support create a favourable environment for international support as long as the national situation continues be improved. One must also add in this context

that amongst other opportunities is the fact that the cost of quality research in the country continues to be relatively low.

The overall current situation, however, leaves much to be desired for a variety of reasons.

The explosion in the higher educational system in Lebanon, for one, is not without perils. Recently, and in the absence of significant Ph.D. programs and uniform academic standards, interest has been focused on degrees at the level of B.Sc., M.Sc. and MD. With levels exceeding local needs, a pool of unemployed or underemployed qualified graduates is being created. Moreover, most graduates are in the fields of the arts, humanities and theoretical sciences with little emphasis on applied sciences. This overproduction results in a mass exodus of graduate students, leading to a significant "brain-drain". In some areas and circles it is reported that this problem is compounded by a regretful tendency among some male Lebanese graduate students to go abroad to escape military service, never to return.

Characteristically, very few institutions are monopolizing the bulk of scientific research in Lebanon and local funding for research is limited to very few sources whether public or private. Moreover, the most productive research is usually championed by dynamic individuals, based on their earlier achievements abroad, commonly with little or no institutional incentives. The lack of reward and punishment "up or out" in many of the Lebanese universities, cultivates a culture of apathy. Internal regulations and bylaws concerning promotion, merit or workload are often outdated in many of the Lebanese universities. The absence of any meaningful collaboration between researchers or between groups working on related or similar topics, whether from the same or different institution, adds to the severity of the problem.

Except for a few research-intensive institutions, critical mass is generally lacking. Fragmentation of human and financial resources is even increasing as more universities are being established, most of which cannot provide the proper conditions for research implementation. The increase in the number of universities may add no advantage to research and development in the country, as many of these universities cannot or do not have the interest in undertaking serious research and linking it to their teaching goals. Unfortunately, isolated researchers, even with the best qualifications, will soon lose their edge and fail to keep up with the advances of modern science.

Public research institutes, on the other hand, probably with the exception of the IRI, were at a disadvantage compared to universities in recovering from the difficult period of the Lebanese civil war and in profiting from the first period of national reconstruction. Accordingly, there is an urgent need in these institutions not only for competent staff and equipment, but also for re-positioning in the light of new challenges whereby strengthening of networking and coordination with stakeholders becomes critical. Presently, these institutes are unable to play a significant role in extension service activities and technology transfer, nor are there good substitutes in order to fill this gap.

The lack of skilled technicians is another important factor hampering strong research units in both universities and research institutes, and it often hinders the exploitation of research in enterprises and public agencies. In some areas, however, there are adequately trained skilled technicians and analysts, but no jobs available, let alone career perspectives. This problem is often linked to a not yet sufficiently developed 'technical' infrastructure ranging from the computer communications infrastructure to the power infrastructure, monitoring and analytical systems, etc., a situation accentuated by poor supply of peripherals and poor maintenance.

The gap between university research activities and industrial needs is large. This is in part due to the poor and underdeveloped managerial and entrepreneurial skills among scientists.

The present weaknesses of the higher education and research systems in Lebanon are partly caused and in any case further complicated by a prevailing dismal economic situation, with a huge national debt and subsequently a meagre budget for national research despite a relatively high GDP compared to most countries of the region.

The outcome of the situation is a weak research output with few quality publications, thus jeopardizing the chances of external funding from international competitive sources, or the capitalization on potential patents from important discoveries.

The creation of a research culture and a proper environment, in short, has not been forthcoming in Lebanon. The reasons for these shortcomings have to be defined and remedial action recommended. Here one touches not only on matters related to a lack of funding, but also on the absence of a number of vital institutional conditions that together define and create a performing and vibrant research environment.

In this context, one important aspect concerns the linkage between teaching and research. Good quality teaching depends on good quality research and the production of new knowledge. Most of the universities in Lebanon are institutions for automatic transmission of "second hand" knowledge. Research should be mandatory at the university level and research output should be used in the auditing process of universities and their teaching activity. For modern research, gathering qualified technicians, students, staff, including qualified mentors and modern tools of information together with modestly expensive equipment in well-defined structures is much more important than the massive investments in equipment.

The most productive years in a student's life are during the Ph.D. and post-doctoral training. Structural solutions for the successful launching of Ph.D. programs and the funding of post-doctoral research fellowship should be implemented. The creation of teaching versus research tracks within universities or the reduction of teaching and administrative duties of promising research scientists are options to consider.

Also important for the creation of appropriate research conditions and culture is the support to collaborative research programs in order to pool specialist expertise and the most advanced instruments and techniques. As research is now evolving at a high rate, various support mechanisms including government regulations should allow for rapid decisions ('reduce red tape'), quick customs procedures and easy international contacts.

All these measures will help to attract back to Lebanon quite a few prominent scientists now working abroad. Others can be enlisted in collaborative research programs through funding of bilateral travel and support.

Successful modern research is further conditioned by critical mass, nationally or regionally. This requires the strengthening or the creation of institutes, independent or as part of universities, to become centres of excellence for a better use of available resources and to attract newcomers. They can also generate science-based innovations if partnerships with industry are established. Such centres, however, in addition to individual support schemes, require solid evaluation, auditing and quality assurance mechanisms.

1.5 Partnerships to bridge the gap between science, government and industry

A major gap inevitably exists between scientific efforts and their useful and tangible economic and social applications. Bridging this gap certainly requires an effort from both governments and companies on the one hand, and scientists, engineers, universities and institutes on the other. Resulting benefits may not always be seen as directly linked to research efforts, as this certainly is a long time process. Scientists for example, have to think responsibly about priority setting and gear up to real socio-economic needs. Politicians are often right in assuming that science cannot solve all problems, but they should not underrate how much their range of interventions could increase as a result of scientific research. Preventing earthquakes, for example, will most likely not be within the scope of science. But knowing more about their causes, prevalence and impacts enables preventive measures to be taken by governments so that damage would be substantially limited, for example by appropriate construction methods. Building up such a mutual rapport is essential for policies on science, technology and innovation to be effective.

2. STRATEGY AND METHODOLOGY FOR DEVELOPING STI POLICIES IN LEBANON

2.1 Selective focus for the STIP Plan

A long-term viable and productive STI system has foundations in many areas. Within these, the STIP Plan proposes to focus on the following:

2.1.1. Strategic priorities

To achieve the greatest effect while making the most of the limited resources, actions of the various private and public enterprises and organizations should be aligned. For the realization of this goal, it is important to try and agree on a set of strategic priorities primarily for the economic and social sectors or activities and secondarily for science and technology.

There is certainly a growing awareness in Lebanon that, in the next several years, certain sectors in the economy should underpin the economic development. Yet strategic focusing and priority setting, in the sense of formally agreeing on priorities and on concentrating resources, are still insufficiently developed in several areas including that of science and technology. This is due, at least partly, to the lack of appropriate means.

It is proposed to concentrate efforts on establishing a number of priority research programmes. By linking such programmes to specific socio-economic needs of Lebanon, derived as much as possible from official government and industry statements, research efforts are visibly linked to Lebanese priorities and benefit at the same time from a structured implementation mechanism. Moreover, their longer-term nature and coherence imply that they have a strategic potential for Lebanese industry and society.

Stakeholder ownership of such programmes, and more generally of science and technology efforts in Lebanon, must then be developed.

2.1.2.People, universities and institutes, attitudes and career perspectives

At the basis of exploitation of science and technology are factors such as availability of well-trained and skilled people and the capacity to auto-develop knowledge and absorb knowledge from elsewhere. This will usually be possible if one benefits from strong universities, research institutes and companies with a research culture.

Lebanon's position is widely recognized to be advantageous when it comes to education. However, it does not seem to be always properly focused, in the sense of an insufficient matching between the students' choices and the labour market, nor is it properly supported by strong and effective institutions, and most importantly not sufficiently supplemented by adequate career perspectives and incentives. The result is often migration, which for some categories of youngsters is reinforced by other motives, such as a desire to escape military service, or insufficient morale and dedication. This is quite in contrast to countries of comparable size where factors such as those add up to a vibrant system underpinning innovative efforts.

It is proposed that the STIP Plan concentrates on the following tools to create a proper research environment:

- *Work on a clear commitment to research by more universities, and on official standards and legislation to support this commitment. This translates in strengthening graduate education in a close match with labour market needs, in order to provide career perspectives. Professional or vocational training that is imperative to implement results of priority programmes will be considered as well.*
- *Start addressing the establishment of a number of new national Centres of Excellence and/or institutes or strengthening existing ones, that suffer from inadequate staffing and support, in order to achieve longer term sustainability of research and educational efforts.*
- *Work on creating incentive mechanisms to support collaboration across disciplines, universities and institutes, public and private sectors.*
- *Work on streamlining procedures to reduce red tape.*
- *Propose initiatives laying more emphasis, for both institutions and individuals, on flexibility, autonomy, initiative, performance and accountability to improve the conditions under which scientists, engineers, universities and institutes have to work. A culture in which research performance counts should be institutionalised. This is a culture commonly linked to 'hire', 'career', 'fire' and 'up or out' policies in places where ambition is and should be to do science.*

2.1.3. Information and communication infrastructure

Achieving a productive STI system is nowadays not feasible without having a high-quality, cost-effective information and communication infrastructure. The value of this infrastructure extends beyond supporting education and research and the proper functioning of institutions. It also enhances greatly the ability of people and institutions to reach out and function in networks, which are crucial processes for transforming ideas and science and technology to economic and social value.

The situation with respect to equipment, computers, information and communication within the research institutions in Lebanon is rather varied, but on the whole should be strongly improved.

The STIP Plan concentrates on defining the scope of information and communication infrastructure for research and higher education that is well connected internationally, and on identifying the parties and resources needed for its implementation.

2.1.4. Outward orientation, partnerships, mobility and technology transfer

One must make sure that education and research institutions and the persons working in them adopt an outward-oriented approach: strong interactions with private companies and public organizations are necessary, although they may have alternative roles to play.

Creating science, developing technologies, and elaborating innovations successfully do not often go well together: nor should they, as long as priorities are being discussed, technology transfer is organized and personnel mobility is stimulated. Partnerships between universities and the enterprise sector or government agencies, as an example, need to be built up for properly evaluating technologies, discussing priorities, and engaging in mutual learning processes.

This should all be considered in Lebanon in a context whereby awareness about S&T is still unsatisfactory. Yet, Lebanese industry is expressing readiness to act and participate in efforts to step up Lebanon's S&T base and its utilisation by firms and for tackling societal problems.

The STIP Plan will concentrate on a limited number of practical actions concerning technology transfer, product development, innovation, entrepreneurship, translational research, collaborative research projects as well as on ways to engage more intensely the private enterprise sector as well as other private and public customers of research. The latter being particularly important.

2.1.5. *Systems of innovation: economic clusters*

It is important that the interactions and the cooperation between universities, research institutes, enterprises, local and regional governments, chambers of commerce, schools or banks, venture capital funds or private investors are developed systematically. This will result in networks or systems of innovation, and clusters of economic activity, that are now widely regarded as the fabric of innovative economies and societies. For even in a globalizing world where ICT results in global technology flows, local, regional and national knowledge networks play a crucial role in shaping innovative success and social quality.

Institutional provisions are part of such systems of innovation, and relate to such factors as transparent market conditions, Intellectual Property Rights, etc. Entrepreneurship and taking initiatives are vital for these systems which will be supported through such networks. Governments play a prominent role in creating the conditions for their successful functioning. Chapter 6.3 will elaborate more on the importance of systems of innovation in current theoretical and empirical knowledge about successful innovation.

This STIP plan favours a practical approach implying that no specific actions other than those focusing on more and stronger partnerships are foreseen at this stage. It is assumed that there will be a natural stimulus to at least begin creating those networks.

2.1.6. A properly differentiated STI policy

Several elements are essential to such an explicit STI policy. In the first place it is the formulation of policies (targets, measures, etc.) on the various aspects mentioned so far: on human resource development; on building strong universities, institutes, national research facilities and other services; on creating an ICT infrastructure; on providing incentives for mobility, technology transfer, university-industry links and dissemination; and on supporting the growth of clusters and systems of innovation. The formulation of such broad policies requires the development of proper co-ordination mechanisms at a high level; and their implementation is in need of adequate financing not just for research and training, but also for innovation-related activities, using a variety of schemes including tax incentives and support for venture capital.

The STIP Plan will concentrate on three issues:

- *The institutional aspects of science policy will build for the next five years on the formal framework and the key actor that is in place, namely NCSR. Institutional changes both in the formulation and the implementation of policies may eventually be necessary, but they*

have less priority now than concrete activities. However, the issue of co-ordination at the national level, involving also the collaboration with the international donors and sponsors who come in at this level, will be addressed.

- *Actions are formulated to ensure the availability of (statistical) data and indicators.*
- *A plan is proposed to arrive at a more varied system of funding mechanisms, involving not only direct industry contributions, but also from the government side fiscal and other incentives for industry, private foundations and other relevant institutions.*

2.1.7. Proper overall economic incentives and other government policies

Finally, it goes without saying that a crucial condition that would allow all these efforts to successfully lead to economically valuable innovations and results, is the existence of a favourable overall economic and incentive regime. Mechanisms to alleviate information problems, such as product standards, training certificates and credit reports, must be in place to ensure the effective functioning of markets. Here, the WTO membership and the EU Association Treaty should provide strong incentives to create these conditions in Lebanon. It should be noted that regulatory policies in many areas can either contribute to or impede innovation. In the course of preparing the STIP Plan several examples have been identified.

No specific actions in this broader area are foreseen as part of the STIP Plan, but it is hoped that its adoption and implementation will encourage responsible parties to consider such measures.

2.2 Strategy for developing the STI policy in Lebanon

The resulting strategy for developing a science, technology and innovation policy for Lebanon may be called "developing STI Policy by demonstration".
As was stated in chapter 1.3 the focus is on opportunities in three important areas:

- Basic Sciences, Industry and Engineering;
- Environment, Agriculture and Biological Sciences;
- Health and Medical Sciences.

Such a focus will allow for a much more tangible appreciation of the benefits of investing in STI. The emphasis is on concrete activities in the field of 1) research, 2) human resource development, 3) dissemination, 4) technology transfer and 5) innovation, which together lead naturally to more generic measures that strengthen the research environment, and accordingly the STI policy. Inviting co-operation and partnerships between different parties practically illustrates the 'network' concepts that are crucial to modern STI policies. Networks are effective means of making sure that R&D efforts are linked to societal needs, that R&D is linked to innovation, or that clusters of stakeholders, including universities, companies, government agencies, do develop. Ensuring that these concrete activities are carried out in a fully transparent way, using independent peer review, will, moreover, enhance the institutional capabilities and credibility of the bodies responsible for implementing STI policies.

It is envisaged that the presently proposed activities form a 5-year stage: Funding is largely supposed to occur through a 'Loi Programme', so that the actors have not only a framework but also a financial perspective of a 5-years scope.

After the approval of the 1st stage of the STIP Plan, the longer term strategic aim would be:

1. to extend after 3 years, the presently used approach to a few more areas by defining and funding in those areas comparable activities as those presently suggested;
2. to evaluate and modify, when needed, and subsequently formalize this approach after 5 years;
3. to incorporate this formalization in institutional reforms within the overall system of policy making since the needs would have become clear and accepted, and introduction feasible.

2.3 Methodology

Over the past several years the Lebanese National Council for Scientific Research (NCSR) has increased its efforts to initiate a new policy for science, technology and innovation for Lebanon. The basis for doing so is the legal mandate given to NCSR. In April 2001 a report was written and presented by Dr. Peter Tindemans to the NCSR and UNESCO as a plan of action for the preparation of a Lebanese science and technology policy that is fully integrated with overall economic and social policies. The report was based on the available documentation and numerous discussions with relevant stakeholders in Lebanon during February 2001. For a variety of reasons, however, it was only in late 2002 that the proposed plan of action for the STIP proposal was approved.

It was then decided to elaborate the STIP Plan essentially by some 30 Lebanese experts. Accordingly, and during the first half of 2003, the experts working in 3 task forces (domains mentioned in Chapter 2.2), namely Basic Sciences, Industry and Engineering; Environment, Agriculture and Biological Sciences; and Health and Medical Sciences, presented their final reports. The Lebanese experts within each of the three task forces mentioned above were from the universities, the NCSR and occasionally from the private sector or industry.

The three task forces worked independently but closely with Dr. Peter Tindemans and the NCSR, which assured the overall coordination and logistical support. The present consolidated plan draws heavily on the task force reports. It is important to note that substantial technical input has also been provided by UN-ESCWA. The STIP plan hereby presented was supported financially by UNESCO and ALECSO.

Several working sessions were held with all three task forces with the aim of coordinating their work methodology. Each task force then identified, prioritized and selected a number of *societal needs or ambitions*. The justification for their selection came from the challenges and opportunities that Lebanon faces economically, socially or environmentally, and whose legitimisation is to be found in government policy documents, stated economic priorities, international protocols etc. Each societal need was then translated into highly relevant activities in research, education and training as well as other activities strengthening the research system, including activities in the area of dissemination, technology transfer and innovation. To achieve these results while ensuring that the Lebanese situation has been properly taken into account and that the highest level of consensus among the experts has been reached, several commonly used techniques such as SWOT[1] analysis and QFD[2] have been applied. The detailed analysis of each societal need in each domain can be found in the full Task Force reports which are Annexes to this Plan. Many of the observations and findings in chapter 1.4 about the present situation of

[1] Strengths, Weaknesses, Opportunities, Threats.
[2] Quality Function Deployment

Lebanese higher education and research is derived for example from the SWOT-analyses of the Task Forces.

The resulting activities suggested within the Task Force reports, will not only significantly contribute to grasping the opportunities presented by the societal needs chosen in chapter 1.3, but they will also result in a more vigorous research system. Together they address the policy activities which have been selected in the italicised paragraphs in chapter 2.1.

Relevant to the nature of the domains studied, the emphasis on the type of activities are expected to differ accordingly. This explains why, for instance, research priorities in the 'health care and medicine' domain have often been less explicit than in other domains, as this was justified by the fact that diseases are much less specific for Lebanon than issues related to the industrial sectors or environmental conditions. In the combination of quality and societal relevance an even higher weight must therefore be accorded to quality.

2.4 The teams involved

The 3 Task Force team members were identified and selected by the NCSR from amongst prominent Lebanese scientists . They served in their personal capacities voluntarily. Their names and affiliations are mentioned in page viii and in the task force reports.

3. THE STIP INITIATIVES

3.1 Overview of the STIP Plan

As a preview and in order to provide the complete framework, all the initiatives that together will comprise the STIP Plan are listed here prior to their are further elaboration in the remaining section of this chapter.

Research Programmes targeting Strategic Priorities (section 3.2)

In total 13 Research Programmes are proposed to be gradually implemented gradually,

- 5 in the area of Basic Sciences, Industry and Engineering;
- 4 in the area of Environment, Agriculture and Biological Sciences, one being at the interface with the area of Health and Medical Sciences;
- 4 (tentatively) in the area of Health and Medical Sciences.

Improving the Research Environment (section 3.3)

To strengthen or create a proper research environment the STIP Plan entails:

- Improving the functioning of universities: a commitment to research, new standards based on performance and auditing, PhD programmes, post-doctorate programmes and centres;
- Strengthening existing and establishing several new centres (environmental analysis; nutrition research; medical research);

- Incentive programmes to stimulate collaboration between people across disciplines, institutions, borders, and the public and private sector, etc. and with respect to shared use of research equipment;
- Streamlining of procedures;
- Measures to promote a culture of responsibility and performance.

Information and Communication Infrastructure (section 3.4)

Here two activities are proposed:

- Defining the scope of an implementation plan for an advanced Information and Communication Network for Higher Education and Research;
- An incentive programme for Innovative Information Products.

Linking academia and institutes to the private sector, public agencies, NGO's and society at large (section 3.5)

Exploiting and disseminating science and technology in the STIP Plan is envisaged by a number of initiatives:

- Establishing a Knowledge Gateway Industry Lebanon;
- Establishing (virtual) sectoral centres of excellence;
- Setting up teams to support technical standards adaptation and adoption;
- Entrepreneurship development;
- Seed money provision;
- Establishing new incubators;
- Stronger representation of the outside world in steering committees and advisory boards;
- Creating Public and Professional Information Units in four areas:
    - Coastal zone
    - Water
    - New agricultural opportunities
    - Food quality

STI Policy system aspects (section 3.6)

Three areas for strengthening the STI Policy System have been selected:

- Getting better statistical data and indicators;
    - STI Observatory;
    - Starting with a limited structured set of indicators;
- Strengthen the role of NCSR, and co-ordination more generally:
    - Role of NCSR;
    - Stakeholder ownership for STIP Plan;
    - Co-ordination agreements with international donors and ministries;
    - Interdepartmental committee for STI Policies.

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National and international partnerships (section 3.7)

- The STIP Plan will not only benefit from, but should explicitly aim at strengthening partnerships between the universities, NCSR, the research institutes, and the private and public sector enterprises and organizations;
- Cooperation in the region and in the Arab world are addressed;

- The STIP Plan also must serve the incorporation of Lebanese scientists and institutions in international networks.

3.2 Priority Research Programmes

The Research Programmes that follow have been selected because they, more than others, have the potential to tackle the societal needs identified by the task forces. Within each of these programmes are several themes and sub-themes that would also need to be prioritized and probably amended. Since it is not possible to start them all concurrently, the setting of this 'double prioritization' would require discussions with the relevant stakeholders. The resulting list of priority themes should then be binding. Accordingly, project proposals submitted in response to a call for proposals would only be eligible for funding if they fit these priorities, and meet all other conditions of quality and cooperation.

The programmes identified in the domain 'Basic sciences, Industry and Engineering' as well as 'Environment, Agriculture and Biological Sciences' have already been put in a priority ranking by the relevant Task Forces. For the reasons mentioned above in section 2.3, Research Programmes in the domain of 'Health and Medical Sciences' will be identified later on the basis of recommendations of a committee of international experts.

Moreover, in chapter 4.2 it is proposed that the implementation of a particular research programme be preceded by an analysis of research activities and output, human resources and infrastructural facilities in the relevant areas and institutions of research.

3.2.1. IT deployment in the enterprise sector

Increasing the competitiveness of the local industry becomes an indispensable strategy facing the globalization and open markets. Making decisions based on information is currently a survival tool rather than a luxury. IT deployment in the enterprise sector, whether manufacturing, other industrial enterprises or the service sector, supports local industry in turning the challenges of the markets into growth opportunities. This is accomplished through various tools that should be customized to meet the selected priorities with local conditions. The IT tools can address procurement, marketing, management, maintenance, design, production and control needs of the industrial processes and products.

3.2.2. Web and Arabized Software Technologies

The ease of communication between various government bodies and the private sector is a key ingredient for the effective public services that ultimately leads to competitive economy. The rapid pace of development in web technologies will bring fundamental transformations in business processes and relationships. These technological changes will also redefine the nature of government and its relationship with its citizens. The impact of web technologies on governance in the Digital Economy and in the internal processes for the delivery of citizen-centric public services will be recognized by e-Government. This transformation of government cuts across all aspects of the public sector from leadership, delivery of electronic public services, internal government operations and e-business, while retaining the flexibility to adapt to changing needs.

To maximize the benefits of such technologies it is important that they are based, to a substantial degree, on Arabized software and software tools. Developing Arabized software and software tools will not only impact the communication to and from the government, but will also offer many new management and job opportunities to companies in the private sector.

3.2.3. Mathematical modelling including financial/economic applications

The lack of information that is based on system behaviour in the economic and finance sectors hampers the effective analysis and planning for the socio/economic development of Lebanon. Along this, the absence of true mathematical modelling of integrated systems (products/ Processes) remains an obstacle to attain the required high quality standards and consistent products.

Mathematical modelling should aim at solving real-world problems in various applications such as financial, economic, geometrical and industrial. The use of computational and mathematical modelling supports the sectors of finance and economics to model interest rates, anticipate recession, predict the growth rate, allocate assets in a portfolio, assess price options and edge currencies. Geometrical and industrial modelling strongly supports a numerically controlled machining that helps diminish the obstacles facing the current state of the local industry.

3.2.4. Renewable energy resources (e.g. chemical, wind, hydroelectric, solar)

There is a need for every society to make the best possible use of its natural resources, stimulate economic development and improve livelihood conditions. So far, there are several under-utilized opportunities not only to reduce energy consumption, but also to produce electricity from renewable sources. The main focus is to cut energy costs, which while contributing to the preservation of the environment, would help enterprises in all sectors become more competitive in local and foreign markets. A subsequent aim is to develop the human resources in this field as technical expertise and trained people capable of establishing enterprises that are competent in delivering competitive products in the field of renewable energy solutions. The programme will be based on technologies developed abroad and their adaptation to the opportunities available locally, thus identifying the most suitable technologies for application in the Lebanese enterprises and energy production plants, and in niche markets for new products. The main opportunities in this case are related to 1) hydro-electric power, building on the fact that rivers mostly originate at very high altitudes; 2) solar energy panels, as commercial commodities as well as energy producing devices, and solar cell technologies; and 3) advanced windmills for use in the inner country.

3.2.5. Material / basic sciences for innovative applications

The use and functionality of all objects in our material world, whether it concerns products from manufacturing industry, handicrafts, or even art objects, depend increasingly on a fast growing knowledge base of the material from which they are made. Their properties and characteristics, their function, transformations, their substitutions are the subject of materials science and technology, in order to determine the performance and function of the products and objects we use. The production of the full range of materials, from construction through magnetic materials, to polymers, or surface coatings, down to biomaterials, is becoming ‘science-based’. Taylor-made functional materials are becoming more in sight as nano-technology and science develop.

The research programme envisaged here has three objectives. It aims at developing a solid materials science and technology base for the use by enterprises. This base would be well connected to international materials science centres and thus to advanced developments in analytical and characterization methods and in rapidly developing fields such as nano-science and technology. The programme will comprise applied research projects which take their starting point in specific materials and transformation processes in use in Lebanese enterprises and trades, in order to develop improved functions, new functions and products and more cost-effective manufacturing processes. Synergies with other STIP initiatives should be exploited, whereby developing biomaterials might be a case to be considered. Finally, the materials science and technology base, strengthened in this way, will be actively promoted for carrying out research and development projects for domestic and regional companies.

3.2.6. Sustainable management of coastal areas

The objective is to create the requisite data, knowledge and trained human resources that together will provide policymakers with the basic requirements for the implementation of a sustainable management system for the coastal areas. Working within the framework of the Lebanon Environment and Development Observatory (LEDO), the programme will thus be a significant contribution to its continuation.

The Programme will have three distinct research lines:

- Focus on *the interaction between physical and biological systems* through monitoring, modelling and impact studies.
- Focus on *land use planning* with a series of topics: Impact of land-based activities; Anthropogenic effects and mitigation; Hot spots and areas of conservation; Coastal processes and study of geodial elevations for protection; Socio-economic impact of coastal activities (including tourism).
- Focus on the promotion of *environmental studies using new technologies and techniques*, such as environmental impact assessment studies, integrated coastal management techniques, and GIS and remote sensing technologies.

3.2.7. Integrated water management

The objective is to increase the availability of water resources and improve the water use efficiency, in addition to providing decision makers with the tools to do so.

The Programme will have four research lines.

- Focus on *Sustaining Water Sources* which addresses the following topics: Watershed management; Assessment of ground water aquifers (local and shared); Seawater intrusion and salinization of soils and aquifers; optimizing water use (quantity and quality) in the agriculture sector and forestry.
- Focus on *Increasing Water Availability* including the following topics: Snow water management; Submarine fresh water sources (intervention management); Rain water harvesting (studies and technologies); Industrial wastewater effluents (innovative technologies for treatment and reuse); and Forest management and reforestation.
- Focus on *Water Conservation Technologies* dealing with: Rainfall precipitation analysis; Reclamation and recycling of sewage (studies and technologies); Conservation technologies (agricultural, industrial, recreational, and domestic); and Adaptation and use of new plumbing materials.

- Focus on *Water Valuation* incorporating socio-economic studies. It includes such research topics as: Socio-economic impacts of water pricing; Cost recovery systems; Tariff protocols; Privatization strategies; and Cost-sharing programmes.

3.2.8. Technologies for new agricultural opportunities

The objective is to create the information, the knowledge and the technologies for new agricultural production opportunities with high comparative advantage to Lebanon and accordingly high business potential. These include using high quality plant propagation materials, local plant biodiversity, organic production technologies, sustainable agricultural production systems and improved rangeland management as sources for new high added value economic opportunities.

The Programme will have five research lines.

- *High Quality Plant Propagation Materials*: Focus on their production under local conditions, use of modern technologies for disease diagnosis, infection prevention and eradication, as well as the relevant market studies for specific high potential crops.
- *Medicinal, Agricultural and Industrial Use of Local Plant Biodiversity*: This area addresses programmes to improve the productivity of local domesticated varieties and wild biotypes in the areas of breeding, cultural practices and post-harvest technologies; development of new improved varieties using traditional or new biotechnological approaches; extraction of oils and pharmaceutical products; documentation, assessment and use of local traditional knowledge; biotypes and population dynamics; adaptation of modern technologies based on indigenous methods; nutritional value assessment; and market and consumer trend research.
- *Organic Production of Plant and Animal Food Products*: This area deals with adaptive technologies for production, processing and commodity conversion of organic plant and animal husbandry products; their nutritional qualities; post-harvest technologies; and regional and international market studies.
- *Sustainable Production Systems*: This area focuses on the assessment of the efficiency of farming systems under various Lebanese conditions; assessment of new and local crop varieties; evaluation of pest control systems and components; and development of sustainable crop and animal production systems.
- *Improved Rangeland Management*: This area addresses the identification of local pasture plants and animals and assessment of their nutritive value; introduction of new high nutritive value pasture plants; rangeland protection systems; and forage production.

3.2.9 Nutritional food quality

The objective is to create the information, knowledge and the corresponding technologies to enable producers, food industry, consumers and government agencies to improve the nutritional quality of food products and diets, and to open up new economic opportunities.

The Programme contains three research lines.

- *Nutritional Characterization of Locally Produced Foods*: This involves the determination and labelling of nutrient characteristics; development of standards on composition and common labelling criteria; and development of monitoring systems for Quality Assurance.

- *Functional Foods*: This involves food fortification; dietary-linked, locally produced new food products; and relations between food and diet-related diseases.
- *Safe and Nutrient Value Preserving Food Processing Techniques*: This area focuses on modern technology in analysis and manufacturing; and quality enhancing and nutrient value preserving technologies.

3.2.10 High quality research in subfields of molecular and cellular biology for health and medical sciences

In the field of *Health and Medical Science,* it has been agreed that a committee of international experts will be asked to identify the priority themes for research programmes. It has been suggested; however, by the Task Force of this domain, that there should be two programmes with appropriate subfields in each of molecular and cellular biology, as this area is now rapidly underpinning medical practice. This research will most likely be based in or coordinated by the Medical Research Institute that is proposed in chapter 3.3.1.

3.2.11 High quality research in clinical sciences

Similarly, the working hypothesis of the international committee as suggested by the Task Force, should encompass one research programme in clinical sciences, as for a modern system of health and medical care, it is indispensable to develop expertise and experts not only in the basic medical disciplines but also in clinical sciences.

3.2.12 Forging links between the practitioners of medical and health sciences and technology, social sciences and paramedical professions

The quality of health and medical care will get a strong boost if one succeeds in involving the various professional groups both in the development of knowledge and its incorporation in their professional practice. A smaller programme has been identified by the Task Force to address this issue. Its objective is to

a) Encourage and provide incentives for the creation and development of multidisciplinary research teams that integrate basic health and medical sciences with social sciences and clinical medicine;
b) Encourage, and provide incentives for the involvement of social scientists in health related research;
c) Encourage and provide incentives for research in the fields of health promotion, prevention, rehabilitation, and towards identification of alternatives to hospitalization;
d) Encourage and provide opportunities and incentives for the involvement of paramedical personnel in modern medical and paramedical technologies

3.3 Improving the research environment

3.3.1 The functioning of universities

Carrying out research programmes effectively as identified above cannot be accomplished without strengthening substantially Lebanon's research infrastructure. There is a general need for more universities to focus on research by developing appropriate legal standards or other regulations as well as by providing incentives.

It is worth repeating here a remark from the first chapter about the objective of the STIP Plan. Improving the functioning of universities and creating or strengthening institutes or centres of excellence is not something that can be imposed. It can be stimulated, and it is hoped that the STIP Plan leads to a financial impetus to do so. However, it rests on the conviction of the major parties involved as a joint responsibility to address these issues and to come forward with national solutions.

1. A substantial investment in research is necessary unless a university has the stated ambition of providing only bachelor degrees.

   NCSR should make it a policy to provide research grants only to universities when there is a clear commitment and a realistic plan by the university concerned for providing complementary investments or building up on them.

2. This policy should be reinforced by the Ministry of Education, and where appropriate other ministries, legislating new standards for universities that ensure good quality education, teaching, training, and research. These standards should involve certain measurable outputs. One important way of implementing such standards is through strict personnel policies. Decision on hiring, promoting and tenure should be based on meeting the relevant set criteria, that distinguishes career tracks focusing more on research or on teaching. A system of auditing has to accompany the introduction of such standards with consequences in case of non-adherence to the standards, for example in the overall financial support to a university or department. Adherence to such standards should also be used for evaluation of eligibility for re-licensure when appropriate, as in the case of schools of medical and public health and eligibility for research funding.

   New university policies should be instituted and enforced for personnel management, performance evaluation and auditing practices.

3. The momentum of the new STI policy Plan should be used to work on establishing more PhD programmes in Lebanon. The three domains and the research programmes identified in the Plan should determine the areas where an effort should be made. Shorter advanced master or doctoral or even postdoctoral programmes might also be useful, especially that they have a shorter term impact. These shorter training programmes could certainly be considered for those areas that would facilitate value-added "product" oriented research. The relevant departments of a few capable universities should consider launching joint PhD or shorter doctoral programmes using additional support under the STI Policy Plan. This will create a larger resource base which will also be more attractive for cooperation with foreign universities and external researchers. It would indeed be advisable to start by using a hybrid PhD programme whereby foreign universities are granting degrees for research activity completed in Lebanon under the mentorship of faculty members in various local universities. This is an area where co-operation with senior Lebanese researchers and faculty members abroad could offer great advantages.

A number of new PhD and other postgraduate programmes should be established.

4. *The various research programmes identified above should also incorporate the funding of post-doctoral research fellowships in Lebanon.*

5. Similarly, these programmes should provide incentives to form centres of excellence in research or identify them where they exist both in and outside universities.

3.3.2. Institutes and Centres of Excellence

Centres of Excellence group qualified teams of professionals, personnel and trainees together with appropriate equipment, access to professional networks and modern tools of information. They can be part of one university, but could also operate as (partly) virtual centres involving two or more universities and Centres affiliated to the NCSR. Senior professionals (as mentors) and researchers committed, partly or totally, to such Centres could be given incentives and rewards in the context of the implementation of the STI Policy Plan. By being part of international networks of research, these centres of excellence could attract to Lebanon prominent and established scientists who would be able to develop research dynamics that would develop opportunities for other researchers thus helping address the challenges of brain drain. The STIP programmes should have in-built provisions to stimulate the formation or the strengthening of such Centres of Excellence

In addition, specific initiatives to establish national centres in order to provide critical mass, an environment for excellence and conditions for efficient dissemination need to be considered. the important role of already existing institutes in reaching the STIP Plan objectives must also be stressed with a concomitant effort in order to strengthen them.

A Virtual Centre for Instruments for Environmental Analysis

There is a need in Lebanon for continuous environmental monitoring and analysis. With the relevant equipment that are presently available in Lebanon or should become available with the support of the current Plan, a Virtual Environmental Centre could be created to ensure the most efficient use of equipment and best quality assessment. The university departments and institutes owning environmental monitoring and analysis would then be part of this centre. The coordination of the virtual centre could be handled by a properly staffed NCSR Centre for Marine Sciences.

A Nutrition Research Centre

It is also recommended that a nutrition research centre be established in Lebanon that can act as an ultimate referential body for the local community and market. It is foreseen as a national centre on which Lebanese and also people from the region rely on. The Centre would use the latest technology and international standards to assess local products, and provide information to the public.

At present, there is detrimental misinformation among the public in the region on diet–related disease, diabetes, hyperlipidemias and obesity and cancer. There is a dire need to conduct research related to life style practices including diets and diet-related diseases. Public awareness

should be enhanced and consciousness should be created to protect the population, and produce solid and reliable research results.

While most Western countries have agencies, institutions, societies, or centres overseeing food and nutrition issues, this demand is not adequately fulfilled in Lebanon and many countries in the region.

The centre will address and conduct studies in a wide range of subjects such as food analysis for nutrients, relationship of local dietary practices and disease, production of special foods, metabolic and clinical studies on diet – disease interaction and consumer science studies.

Indigenous and specialized expertise does exist in a few local universities in this regard. It is suggested that an arrangement be made between the government/CNRS and the best equipped of these universities so that it hosts such a centre that should become a nation resource open to external researchers.

A Medical Research Institute with a core in molecular and cell biology.

There is a need to establish an autonomous research institute in medical sciences. It is suggested that this Institute be managed by the NCSR and be associated to different research centres and universities in Lebanon. Its ultimate goal is to provide the proper mechanism and the help for the transfer of research and research culture to the universities.

The proposed Institute should contain all necessary equipment for molecular and cellular biology research as well as other facilities that respond to research needs in other areas in the medical and health fields.

The Institute should group a basic skeleton of both qualified scientists, whose working conditions enables them to devote large portions of their time to research, as well as qualified research assistants or technicians. Several group leaders are required to maintain sustainable, productive and high quality research activity. Research programmes will benefit from the visiting local and international expertise, especially Lebanese scientists working abroad.

The Institute should be led and managed by one or two senior scientists with established expertise and achievements in the fields of health and medical sciences.

It will host and provide services to PhD students, post-doctoral research fellows, junior and senior researchers and university professors.

It will create academic/industrial/community bridges and should over time be the focal point of a "technopole" for biomedical and health related technologies. Its scientific activities should be reviewed by an international advisory board, and audited more formally on a regular basis by an international panel of specialists.

The Agricultural Research Institute

The Agricultural Research Institute (ARI) has played an important role in enhancing standards in Lebanese agriculture, introducing new technologies, training personnel, developing strategies and supporting international cooperation. The STIP Plan can only benefit from a well-functioning

ARI. It is clear, however, that ARI at present and for a variety of reasons cannot fulfil those expectations. The Ministry of Agriculture would be expected, as a necessary complement to this STIP Plan, to establish long term funding plan and appropriate staff policies, which will enable the ARI to play its proper role in the implementation of the STIP Plan. It is important to define a framework for its governance as an effective and integral part of an agricultural system of innovation, comprising not just the ARI, but also universities and the extension service, thus imparting to it an ambition and appropriate means to play a regional role. The NCSR should work with the Ministry to make sure that the ARI can then benefit maximally from the STIP support.

The NCSR Centres

The NCSR Centres, and especially those that have an important role to play in the implementation of the STIP Plan, similar to ARI, are not yet in the appropriate position to do so. This is mainly due to the difficulties in recovering from the impact of the civil war, and to their inability to catch up with modern technologies that are increasingly imposing the need to build up a critical mass in order to benefit from economies of scale. Here, too, it is crucial to develop these centres as integral and constitutive parts of local and regional research, monitoring and dissemination efforts and in close association with universities. Starting primarily with those Centres that have to play a key role in the STIP Plan, NCSR will develop long term plans in conjunction with the implementation of the STIP Plan.

The Industrial Research Institute

No special consideration needs to be given to the Industrial Research Institute. It is well-placed to cooperate with the other actors on the implementation of the STIP Plan.

3.3.3 Incentives for collaboration between people and in using research equipment

When implementing the various programmes and activities proposed here, NCSR should aim for added value by creating incentives for working modes that would give an additional boost to the Lebanese research system.

- One aspect concerns intra or inter-university collaboration between established Lebanese scientists working in complementary fields.
- A second aspect relates to coordination in procurement and use of capital equipment for research that should be accessible to researchers from all over the country.
- Synergy between national and international funding sources is yet another aspect here. This would require that national funding per project should be increased (and in the end across the board) to reach a level that is appropriate to attract further funding. Moreover, information about opportunities for extramural funding from competitive international sources should be more widely diffused and made better accessible to all. Other helpful measures could be providing technical support in the application process and provisions of better matching funds in order to increase the chances for external funding.
- Fourthly, collaboration with Lebanese scientists overseas could be explored and stimulated further as there are many high calibre Lebanese active in all fields of science, social science and humanities, especially in Europe, North and South America, and Australia. The NCSR should take the initiative of making a survey of Lebanese scientists overseas, organizing workshops and setting up a database of Lebanese scientists in the diaspora.

3.3.4 Streamlining procedures

Several areas have been identified where research in Lebanon suffers from adverse regulations, procedures, and other administrative practices. Examples here concern customs regulations with respect to importation of equipment, biological and chemical species, substances and samples. Health-related regulations, with no consideration to the specific needs of research with a view to deliver its health improvement potential, only compound the problems further. Another area that should be considered here concerns the restrictions with respect to international collaboration and exchanges that have a vital role for the future of Lebanese research and education..

NCSR should draw up, together with the main universities and institutes, a White Book listing the major impediments. The Interdepartmental Committee whose establishment is part of this STIP Plan (see chapter 3.6.2) would then be the appropriate vehicle to seek resolution of these problems.

3.3.5 A culture of responsibility and performance

Realizing high ambitions in a globalizing knowledge-driven world makes it imperative to adopt certain rules of the trade. It is a world where performance counts at the individual and the institutional level. Responsibility and autonomy are granted, but accountability and evaluation are demanded. Professionalism, initiative and transparency are necessary, and however straining they may sometimes appear, individuals, organizations and society at large will be rewarded.
The STIP Policy Plan will be utilized to instigate such rules of conduct at several levels.

Universities:
For universities the first two issues of chapter 3.3.1 address the crucial switch to a new culture. No separate action is necessary.

Institutes:
With respect to institutes it will be important that the responsible parent organizations (Ministries, NCSR) establish similar arrangements as to auditing, performance and careers as mentioned for universities.

NCSR:
NCSR can in two more ways contribute strongly to establishing such a new culture:

- The implementation of the STIP Plan should follow the principles of project management with clear goals, timelines, resources and management responsibilities. The procedures used, for example in 'calls' for research projects, should fully guarantee transparency and objective review. Regular reporting and evaluation should be built into the implementation plan.
  Also funding decisions under the STIP Plan, to begin with, should make adherence to the new principles mandatory, as mentioned in 3.3.1,.
  NCSR STIP management and funding decisions should follow the new policies of transparency and responsibility.
- *NCSR should continue vigorously to adopt similar rules in its internal operations and the procedures for its ('non STIP') granting schemes.*

3.4 The information and communication infrastructure

A national Lebanese research network with high speed outward connections

Over the past two decades, research and higher education communities all over the world have striven towards establishing computer networks that link them together. Broadband local area networks (LANs) were constructed in buildings and campuses to satisfy the growing need for communication between researchers, professors, students and administrative staff in a given institution, while wide area networks (WANs) linked the various research and teaching institutions in a country. National research networks have been established assisting research, teaching, administration as well as innovation, since these networks always have been the pioneers of novel services. High throughput connections to regional backbones and other continents have led to an infrastructure that is being upgraded every four years or so to higher speeds and a wider range of multimedia services. The EU is heavily supporting these initiatives in Europe.

If aspirations to becoming an integral part of international networks and communities of scientists have to be realized, then access to these services and the worldwide research community becomes essential for the researchers and their establishments. ICT networks are no longer the privileged tools of advanced industrial countries; without them there is no way of realizing the ambitions of the STIP Plan.

The UNESCO Cairo Office has planned to emulate the model of a national research network in the Arab region. The Lebanese project, with funding coming largely from UNDP and OMSAR with some cost sharing from UNESCO and the LU, focused on establishing a Lebanese University Network to connect about 20 campuses and sites, mostly in the Beirut area as a first stage to a national network. Private universities and research institutes and centres should all be part of such a network that should also provide high speed and affordable connections to the outside world.

Establishing this network and improving the campus or site networks of the various universities and institutes/centres is urgent. This task must be a joint effort of telecommunications actors in the major universities, the NCSR and public and private sectors. The momentum of the EU supported EUMEDIS project aiming at connecting Mediterranean partner countries to the European backbone (the present stage being called GEANT) offers distinct advantages in this regard.

It is therefore important to carry out a Quick Scan of the situation in Lebanon, and on that basis propose solutions that must involve the creation of a permanent budget to upgrade the network regularly.

What can be done depends very much on available funds. Experience in Europe and the USA shows, however, that the special circumstances of this community allow for different and cheaper solutions than are normally possible commercially. Presently, the European organization of national research networks, TERENA, which is also the main party for the EU Commission when it comes to defining and implementing next stages of the European network, is ready to send a team to carry out such a Quick Scan.

Supporting the development of innovative information products

The Task Force on Environment, Agriculture and Biological Sciences has specifically identified several electronic information products that would be of great support to research, applications, and product development. Examples are electronic support systems providing information on markets, pest and disease outbreaks, international regulations, etc.; expert systems for farmers, producers and extension agencies; growth simulation models and pest forecasting systems to

assist integrated crop production; electronic support systems with information on global nutrition trends, innovations, markets, population diseases and processing technologies; and so on. It is easy to see that similar ideas apply to the other areas, such as energy, materials, or medicine and public health.

To complement efforts in improving the infrastructure for information and communication, the NCSR should establish a programme to support, on a competitive basis, these types of novel information products primarily in but not necessarily restricted to the three domains of the Plan.

3.5 Linking academia and institutes to the private sector and public agencies, NGO's and society at large

A variety of measures should be taken to stimulate links between universities and research institutes on the one hand, and industry, public agencies, hospitals, environmental organizations, farmer organizations etc. on the other in order to tune education and research better to the needs of these potential users. 'Industry' is just used in the following sections as shorthand for the whole gamut of these organizations.

Knowledge Gateway Industry Lebanon

As Lebanon's industry consists to a very large degree of SME's with as yet practically no in-house R&D capabilities, there is a need for an effective mechanism to provide information about expertise, facilities and equipment and ongoing projects in universities. This will allow in the first place identifying better and articulating with the industry its needs, and also to linking these needs to what is available in the country. This allows industry to benefit from university resources; universities profit from potential applied research activities financed by contracts or sponsored by industry, as well as from input into the educational process to make it less theoretical and to provide real-life problems for university R&D.

A twofold mechanism could be established as a joint effort of the Industrial Research Institute and the major universities: a database, and Technology Promotion Units (TPU) at each of the universities and at the IRI. The database would contain all relevant information on resources available and would be linked to a web-tool that allows industry to ask questions, state problems etc. Such a tool and database can then be developed as a matching tool between industry needs and university resources. The TPU's would be small units to effectively link specific requests from industry to the university or institute concerned and actively provide information on such aspects as the potential to carry out 'product' oriented research and the possibilities of getting 'seed money' support (cf. earlier in this chapter). Together they can support the Gateway by scheduled interactions, meetings, workshops etc. The TPU's might also provide more specialized services. As an example, they might identify areas where, within Lebanese universities, projects can be carried out for international companies with limited funds from industry (e.g. in proteomics, structural genomics and drug discovery, pharmacogenomics, etc.) where a relatively small investment with Lebanese money is likely to be profitable in the short and long term.

Virtual Sectoral Centres of Excellence

A particular category of Centres of Excellence should address the Research and Development needs of various industrial sectors in Lebanon. In addition, the centres would provide technical know-how and laboratory services to improve the competitiveness and growth of the industry. While the centres' priorities are actually derived directly from industrial sector needs, they must be implemented with the expectation that both industry and public interests are served. The

national benefits include economic development, increasing productivity and value added, creating new job opportunities, improving health safety and environmental concerns, and promotion of export.

The NCSR can start with existing sectors such as wine, clothes, shoes and furniture. The basis for future centres should be agreements between NCSR, relevant local universities and relevant industrial associations or major companies for the dissemination of knowledge in various identified domains and for developing new knowledge and technology using industrial financing or co-financing.

These centres are called virtual because they bring together in a focused and coordinated way dispersed resources. There is, however, no reason why occasionally there should not be a physical centre as the core of such collaboration. It might be a practical way of obtaining business or private sponsorship, provided the government would be able and willing to provide fiscal stimuli for it.

Teams to support the adaptation and adoption of technical standards for Lebanon

Export growth requires local industry to adopt international standards for products and processes in various sectors, occasionally after national or regional modifications. Adhering to standards is one part of Quality Assurance systems. A campaign to promote standards and quality assurance is not of course the responsibility of NCSR or universities. But the expertise in universities can be of great help to identify and clarify important standards which are not yet widely adhered to in Lebanon and identify where local adaptation is necessary. This activity should be executed in coordination with the Ministry of Industry, its Institute for Industrial Research and the Lebanese Standards Institution (LIBNOR). Activities carried out thus far by LBNOR appear to be promising.

Workshops for Business Plan and Entrepreneurship Development for the Scientific Community

Transforming creative ideas into innovative products, and useful solutions requires critical skills, but above all attitudes that are often complementary to still what used to be the core of curricula of universities and expertise of scientists and engineers. A series of workshops should be organized as an interuniversity effort under the aegis of several interested departments. To define the format and the contents of these meetings, the NCSR should take the initiative to establish a team consisting of a few professors with working experience at the interface with industry, a few from business departments, and some outside experts with organizational experience in similar workshops (e.g. from the École des Mines, Paris). One of the more interesting offshoots of such an exercise could be the establishment of a degree course by one of the participating universities, whereby writing and implementing a business plan becomes a degree requirement. These workshops should target scientists and engineers (faculty and students) in the various higher education institutions and technical schools.

Seed money to enhance commercialization

A special, initially small funding initiative should be established to provide seed money to projects that aim at testing out potentially marketable ideas based upon earlier scientific work. Being the first stage on a road that eventually would involve venture capital or company investments, it is worth exploring experimentally. The aim of the experiment is to find out if such an initiative indeed entices researchers to try and bring results of their research in a commercial trajectory. The NCSR could link this to BERYTECH and other similar science parks or

incubators that might evolve, as these would provide the right environment for making available management, marketing, legal and other professional forms of support needed to guide a project from the research stage to commercialization.

New incubators

Potential entrepreneurs and seed money to get things going are usually not enough. The BERYTECH initiative is the first example of a science park annex incubator in Lebanon. As more students or faculty members outside universities and institutes would try to set up businesses, there is a need for more incubators which may be specialized. The Medical Research Institute mentioned in 3.3.2 should, over time, become the focal point for a "technopole" for biomedical and health related technologies.

It is suggested that NCSR calls for a seminar of all parties concerned to try and agree on the best way forward: should there be more initiatives? Should the major universities try and first concentrate on working with BERYTECH? and so on. Such a seminar might result in a decision to commission a feasibility study or even the writing of a business plan along the lines of preferences.

Steering committees and advisory boards

Universities, NCSR and institutes should invite more widely persons from industry, communities, and other relevant parties on research boards, steering committees or advisory boards in order to have a broader gamut of outside views represented in research-related decision-making.

Public and Professional Information Units on Coastal Zone, Water, New Agricultural Opportunities and Food Quality

The research programmes described in chapter 3.2 will bring together a lot of already existing information as well as generate much new knowledge and information. Several individuals and organizations will show a great, but different interest accessing such knowledge and information. In fact it is important that they are provided such access since the objectives of the research programmes that are targeted ('e.g. stopping coastal deterioration', 'improve water management', etc.) can only be achieved if all different parties play their appropriate roles. This holds for a variety of professionals in government agencies and the private sector, for fishermen and farmers and their associations, producers, consumers, tourists, companies, students, municipalities, communities and so on.

It is therefore essential to create the appropriate mechanisms to 'package', store and make accessible information to these various users. The most natural solution would be to give the 'central or coordinating unit' in each of the four areas chosen, in cooperation with the most relevant Ministry or Ministries, the task and the means of defining a programme of activities in order to disseminate information actively. The Task Group Report on Environment, Agriculture and Biological Sciences contains a wealth of specific examples of such activities.

For the "Coastal Zone' and for 'Water Management' this would imply a role for the NCSR Centres for Marine Sciences and Remote Sensing, in cooperation with the Ministries of Environment, Energy and Water Resources.

For 'New Agriculture' it would be a responsibility of the Agricultural Research Institute in cooperation with the Ministry of Agriculture and its Extension Service. For 'Food Quality' the proposed Nutrition Research Centre should assume responsibility in cooperation with the Ministries of Health and Agriculture.

It is evident that the approaches of these Centres to the various tasks will differ widely. Yet there appear to be sufficient points of common interest not only to define dissemination as an important leg of the STI Policy strategy, but also to define at least the initial stages of its implementation scheme as a joint action.

3.6 STI Policy system aspects

3.6.1 Statistical data and indicators

The inadequacy of data and indicators has been previously mentioned in a more general context. This is a concern that has also been expressed for S&T or STI (science, technology and innovation) policy. These data and indicators do not only serve the purpose of international comparisons, but their more important function is to guide and inspire policy makers in developing and targeting new policies, to provide a certain standard of performance and to enhance notions of accountability. An essential part of the STIP Plan, must therefore be to develop a structured but practical approach to substantially improve the situation with respect to indicators and statistical information.

In various international bodies there is now an increasingly detailed experience with indicators in the area of STI. Organizations such as OECD, UNESCO, EU, several regional UN bodies, and the WB have all invested much in establishing precise definitions for the activities about which to collect statistical data, in developing systems of indicators, and in encouraging their member states to collect underlying data in a reliable and comparable way. Three important trends have emerged over the past period. From the earlier focus on input data (basically public and private investments in R&D and higher education, and the number of researchers) output data (such as bibliometric and patent data) are being used increasingly. The realization that innovation is the mechanism through which science and technology 'deliver', and that strongly internally connected 'national innovation systems' support innovation efforts, has now led to considering systems of indicators that try to map innovation efforts and results. The third trend is to turn such indicator systems into composite indicators which enable helpful visualizations and comparisons in a glance of countries' performance. As a result, indicators that enable monitoring of some of the more complicated aspects of the relationship between STI capacity, national growth, and competitiveness are now in use in all developed and most industrialized countries around the world.

The aim of the activities in the STIP Plan is to make sure that in a few years time Lebanon will have at its disposal reliable data on a minimum set of indicators which is large enough to provide meaningful regional and wider international comparisons, and contribute to increasing accountability in the country. Many countries have for that purpose specialized 'STI observatories': units, sometimes in but usually outside the national statistical offices, that build on these data, add bibliometric and other data as necessary, and provide the dedicated STI indicators on which policies rely.

ESCWA has provided in a background document (See Volume II of the STIP documents) a very useful survey of the current state of play in Lebanon for a variety of STI indicators. It also intends to act as a hub for a regional network of national 'observatories', and to assist in several ways, such as in training for a Lebanese 'STI Observatory'.

A Lebanese 'STI Observatory'

It is accordingly proposed to establish a small team as a separate unit at the NCSR who would develop in a few years' time into a Lebanese 'STI Observatory'. With the support of ESCWA and the UNESCO Institute of Statistics in Canada, this could then become a viable and sustainable effort.

A limited structured set of indicators to start with.

The ESCWA Report mentioned above (Annex 4) identifies a large number of potential indicators. In order to limit the efforts and to gain as much as possible from international comparisons, it is suggested to adopt as an initial framework the two composite indicators that are now being used in the EU. The first highlights "Investment in the knowledge-based economy", the second "Performance in the knowledge-based economy". The first is composed of 8 sub-indicators providing different measures of knowledge creation and knowledge diffusion. The second comprises 5 sub-indicators measuring the economy's productivity, S&T performance, output of the information infrastructure, and the effectiveness of the education system.

Composite indicator 1: Investment in the knowledge-based economy

Sub-indicators	Type of knowledge indicator
Total R&D expenditure per capita	Knowledge creation
Number of researchers per capita	Knowledge creation
New S&T PhDs per capita	Knowledge creation and diffusion
Total Education Spending per capita	Knowledge diffusion: human capital
Life-long learning	Knowledge diffusion: information infrastructure
E-government	Knowledge diffusion: new embedded technology
Gross fixed capital formation (excluding construction)	

Composite indicator 2: Performance in the knowledge-based economy

Sub-indicators	Type of knowledge indicator
GDP per hours worked	Productivity
European and US patents per capita	S&T performance
Scientific publications per capita	S&T performance
E-commerce	Output of the information infrastructure
Schooling success rate	Effectiveness of the education system

Source: http://trendchart.cordis.lu/scoreboard2003/index.html

3.6.2 NCSR and coordination

Role of NCSR

This STIP Plan addresses responsibilities of, and identifies activities to be carried out by a large number of organizations both in the public and private sectors. The National Council for Scientific Research (NCSR) is one of these organizations insofar as it manages research centres and operates as a grants-providing agency. But the primary capacity in which NCSR has initiated this STIP Plan is in its lead role in developing the national science and technology policy. This role has been defined in the Law of 1962 and consists of the preparation of the main directions of a national science policy, their translation into five year programmes, and the yearly allocation of the research budgets in the respective chapters of the state budget of those ministries whose activities have research components. On all these matters the NCSR, reporting to the Prime Minister, advises the government, that is the decision-maker. The mandate of the NCSR has been enlarged in 2002 to encompass the social sciences and the humanities. The recent circular 17/2003 of the Prime Minister reconfirms the coordinating role of NCSR vis-à-vis the various government departments that fund research, hence underlining that NCSR not only has a responsibility for its own budgets, personnel and institutes, but rather has a national responsibility and an obligation to work together with government funding parties and universities and other institutes as well as industry.

The NCSR has the potential of being the pivotal player in the Lebanese STI 'serving' the interests of society at large (industry, government departments, universities, institutes etc.). This should also be a guiding principle in complementing its role in the implementation of the STIP Plan.

Stakeholder ownership of the STIP Plan

The STIP Plan must therefore be 'owned' by all these stakeholders and be perceived as their common challenge in order to reap more benefits from science and technology. A number of factors and steps contribute to reach this goal.

The identification of the societal needs in the current Plan is based on official documents, policy statements, international agreements, or information obtained otherwise from external parties.

The Steering Committee formed by NCSR to oversee the preparation of the STIP Plan and under whose aegis it will be presented to the government, gathers many of these stakeholders, thus adding to 'ownership'. Through his responsibility for the NCSR the Prime Minister already is in a position to express the backing of the whole government, which might be reinforced by affiliating this Steering committee even more directly to the Prime Minister's office.

A number of stakeholder meetings, separately for the private sector (including NGO's), international donors, and government departments and agencies, will be organised to get more input and commitments for the STIP Plan implementation.

Coordination agreements with international donors and ministries

As stipulated once more by the recent circular 17/2003, the NCSR has a coordinating responsibility. To ensure the input of other ministries and an effective and efficient implementation of the STIP Plan, a few formal measures have been identified.

One area in which it is of particular importance to strengthen this coordinating role of the NCSR concerns the relations with international donors, who usually invest large sums of money in Lebanon in programmes that often have a research component. These donors commonly operate through various government agencies. Synergy between their efforts and the efforts now being elaborated in the STIP Plan will be mutually beneficial, as one commonly notes increasing dissatisfaction among donors and beneficiaries alike about lack of sustainability, assessment and follow-up, as well as about duplication. Several examples displaying one or more of these concerns can be easily found, especially in the environmental area, the health area but also in the communication infrastructure.

NCSR should conclude formal agreements with relevant international donors and the responsible government agencies to define their respective roles in the implementation of STIP programmes and activities, to ensure synergy and to identify steps that contribute to sustainability of international financial contributions through appropriate institutional mechanisms.

An Interdepartmental Committee for STI policies

The formation of an Interdepartmental Committee for STI policies becomes imperative for implementation, further adjustments and follow-up of the STIP Plan, as well as for discussing more general policy issues related to research, higher education, technology and innovation, including the yearly coordination of the science budget allocations. This committee would meet on a regular basis and would comprise secretaries-or directors-general of those ministries and agencies most heavily involved in STI matters: the Ministries of Education, Industry, Finance, Health, Agriculture, Environment, Water, Energy, the Council for Reconstruction and Development, and of course NCSR. Its chair could either be the NCSR SG or the SG of the Prime Ministers Office.

3.7 National and international partnerships

The STIP Plan has to strengthen partnerships between the universities, the national research centres, the institutes, the private and public sector enterprises and organizations. This takes place at multiple levels. The Plan must be supported by the key players, and its execution should demonstrate this aspect of partnerships as well. It is indicated below how this can be done for the main activities.

For the Research Programmes the general approach may be as follows:

Each Programme should have as a starting point a workshop between the key enterprises, organizations and researchers in the area concerned. Its aim is to discuss in more detail the themes and sub themes proposed, and it should result in identifying the priority (sub) themes that should be the subject of the first call for proposals. Depending on the subject such a workshop might need some dedicated preparation; in the case of 'ICT deployment in the enterprise sector' for example in the form of a brief diagnosis and benchmarking of ICT performance of sectors. Next, it should be stimulated that joint teams from different universities and/or institutes and where appropriate industry carry out research projects. Moreover, as the programmes and their priority themes will reflect in many cases the real interests of identifiable outside parties it should be considered, as a general rule, to ask for a financial contribution of, say, 20%.

Each of the institutes and centres of excellence should be set up within a partnership. That may be between the two, three or four main universities and/or institutes involved; it may be between NCSR and one or more universities; it can be between one (or more) university(ies) and private sector organizations; etc. How this will translate in the governance and the operations of the centres or institutes concerned will have to be considered on a case-by-case basis.

It is, of course, the very essence of activities, concerning university-industry linking activities and dissemination more generally, that they be based on partnerships, and to be carried out in close relationship between organizations and individuals in the field of science and technology and those to whom the activities are addressed to. Appropriate modalities should be found for each case. Funding of specific proposals for linkage and dissemination activities must be made conditional upon finding solutions which are satisfactory to the 'clients' concerned. The final review of proposals must therefore give due weight to this aspect as well.

Similarly, the proposal to strengthen the co-ordination at the level of the government seeks by definition to support the idea of a partnership between the various ministries involved. This could be followed up through specific Research Programmes or other activities being co-funded by NCSR and one or more of these ministries (including, of course, international donor funds, as has been mentioned).

There is also an international component to the idea of partnerships. Pursuing such partnerships is important for several, but different reasons.

One pertains to regional cooperation. Attaining the required scale and scope for scientific and technological endeavours may point in the direction of collaboration in the region. Similarly, common regional problems (e.g. in the field of water management, the environment more generally, transport, energy) suggest such cooperation. In implementing the STIP Plan, the option of enhancing the impact of what one wants to achieve by seeking regional approaches, deserves serious consideration. It has to be done, however, on a case-by-case basis. The present situation in the region is not conducive to a wider geographical base for developing and implementing such STI policies.

The situation does not appear to be any different when it relates to collaboration within the Arab world. It is clear that a Programme to develop 'Web and Arabized Software Technologies" will benefit greatly from collaboration with other partners in the Arab world. For other activities this is less obvious. So again, the potential for such collaboration should be evaluated when deciding to start the implementation of activities.

There are, however, more reasons to pursue international collaboration. Strong STI capabilities nowadays rest on two pillars: good facilities and resources in one's home base, but at the same time a solid integration in international networks. For Lebanon at present an additional argument is to try and use existing international contacts to accelerate and reinforce the intended effects of the STIP Plan. On the one hand this relates to contacts with the very large community of highly qualified Lebanese scientists and entrepreneurs outside the country. On the other hand, the increasing number of international agreements and associations to which Lebanon has acceded or will accede to also offer numerous possibilities for benefiting from internationally embedding research and training activities. The EU Association Agreement is a case in point that should be utilized to the fullest. Existing Mediterranean partnership programmes, such as the EUMEDIS Programme, already facilitate such collaboration. Invoking the assistance of the European Research Networking organization TERENA to work out plans for a Lebanese Research Network will, for example, make such a network effectively part of the European, and in this way of the

global network infrastructure. Agreements in the wider region on water and other environmental areas are another example. There are at least four ways in which the implementation of the STIP Plan can incorporate these opportunities.

Firstly, some Research Programmes, most likely in the field of environment and agriculture should be as much as possible embedded in broader international programmes under such agreements.

Secondly, it should be a funding precondition under the STIP Plan that the Lebanese partners demonstrate international 'embedding'. What form this exactly takes will depend on the particular activities. Sometimes it will suffice if researchers on an individual basis show that they are well connected internationally. In other cases, one may require that an international team actually takes part in the implementation. Bilateral financial support schemes may be instrumental in funding such collaborative efforts.

Thirdly, it should be possible to establish institutional links with universities or institutes abroad to implement some of the proposed activities. One example concerns the strengthening of graduate training. Using especially but not exclusively the contacts with Lebanese scientists abroad it should be attempted to reach arrangements with a few foreign universities that may include offering courses in Lebanon, 'hybrid' or 'dual' PhD programmes that envisage yearly stints of say 3 or 4 months abroad, and so on.

Fourthly, one should aspire to involve foreign scientists in an advisory capacity in various research programmes and in the creation of institutes or centres of excellence. It would seem a good idea to involve in such advisory roles also scientists coming from countries which have recently developed a technological base, and are now taking the necessary steps to underpin that with a science base. Greece, India, Taiwan are examples.

4. Implementation; monitoring and evaluation

4.1 Expected outcomes

The STIP Plan will have to lead to concrete results. Therefore an effort has to be made to identify some sort of a mechanism that enables one to measure in as quantifiable a way as possible how much progress is being made in meeting the societal needs and the underlying macro socio-economic targets mentioned in chapter 1. Obviously, a one-off effort, even if it were a 5-year one, will not necessarily lead to sustainable improvements. These can only occur if the STIP Plan gathers momentum and initiates a continuous effort in strengthening Lebanon's STI capacity. But even then one should not overstate the case. Science, technology and innovation do not function in a vacuum: proper overall economic and social stimuli and conditions need to be in place, for example. Within the STIP Plan expected outcomes will only come about as a result of several activities which are mutually reinforcing (such as a Research Programme and a Public and Professional Information Unit to disseminate results to companies, practitioners, agencies etc.). Moreover, one cannot always quantify easily such improvements. Nevertheless, a determined effort is appropriate in identifying, prior to the start of execution of any particular activity, what the intended achievements might be. Part of the approval procedure of the Programme Management Unit (see the next chapter 4.2) must be to verify that satisfactory yardsticks have been identified. The PMU and the respective Primary Actors (see again chapter 4.2) should

together establish what the most appropriate monitoring and evaluation mechanism should be in order to allow verifying at the end, that such yardsticks as have been identified, have also been met.

Two distinct types of targets or yardsticks usually will have to be distinguished.

In the first place one should try, whenever possible, to formulate *overall performance targets* for sectors addressed by the STIP Plan. This can be done for the following sectors :

- Coastal management
- Water management
- Agriculture
- Food quality
- Energy production and use

It is, however, much more difficult to set such targets in matters dealing with improved performance of the enterprise sector that the STIP Plan hopes to contribute to. Therefore for each STIP-Plan activity one should at least formulate *intermediate or process targets*.

These targets pertain to the intermediate output the activity aims to produce (e.g. the number of enterprise contacts realised by the Knowledge Gateway Industry Lebanon). They are called intermediate because they are instrumental in realising or contribute to the realisation of the final aims. If for example the aim is to reduce energy use in enterprises by 25%, the intermediate goal of a Research Programme should be to develop new, or integrate existing knowledge in focused solutions for companies to use. A dissemination activity would have as intermediate or process target the number of enterprises reached with such information.

The distinction is particularly relevant in considering the macro-economic goals the STIP Plan addresses. They pertain largely to the performance of the enterprise sector, i.e. its export performance, its productivity, its employment opportunities and so on. Here one can usually not do much better than to approximate final effects by some set of intermediary outputs.

Illustrations of targets that could be identified will be given for two activities. Some of these will be performance targets, and the others of the intermediary type. A more comprehensive identification of such targets should be part of the preparatory phase for each of the activities (here reference is made to the Plan of Action in chapter 4.4). As to the overall sector targets, the Programme Management Unit should make sure that they are well established and agreed upon by all the Primary Actors before the start of the implementation of specific activities.

Research Programme: "ICT Deployment in the enterprise sector":

It is notoriously difficult to establish the final effects of this programme (i.e. productivity improvements, export increases, etc.) as a consequence of investments in ICT, let alone as a consequence of a Research Programme in ICT. However, one can define useful intermediary indicators for increased competitiveness of enterprises, or at least the potential for it.

An applied research programme that focuses on how small companies (with a differentiation maybe among sectors) can get effective, yet easy-to-use ICT tools to enhance both their 'internal'

business processes and better manage the 'external' supply chain they are part of, will be considered effective if, for example:

- After 3 years, at least 25 students per year will graduate at Masters level (by participating in applied research projects) in relevant degree courses;
- After 3 years, an average yearly increases of 10% can be found in the number of enterprises in relevant sectors that apply either the 'internal' business process improvement tools or the 'external' ones, or both;
- After 3 years, a similar 10% yearly increases occur in the number of enterprises that are actively using the web as part of its business activities (sales, purchasing, etc.);
- After 4 years, 3 companies have been established, as a joint result of this programme and the Research Programme on Arabized software, that produce Arabized software tools for 'internal' or 'external' business process improvements.

Research Programme: "Integrated water management":

Performance targets for this programme could be

- After 5 years, an increase of 30% in the expected available water supply in 2015 compared to the current estimates;
- After 5 years, a reduction of water consumption per household of 25%, and of 50% for the enterprise and the government sectors.

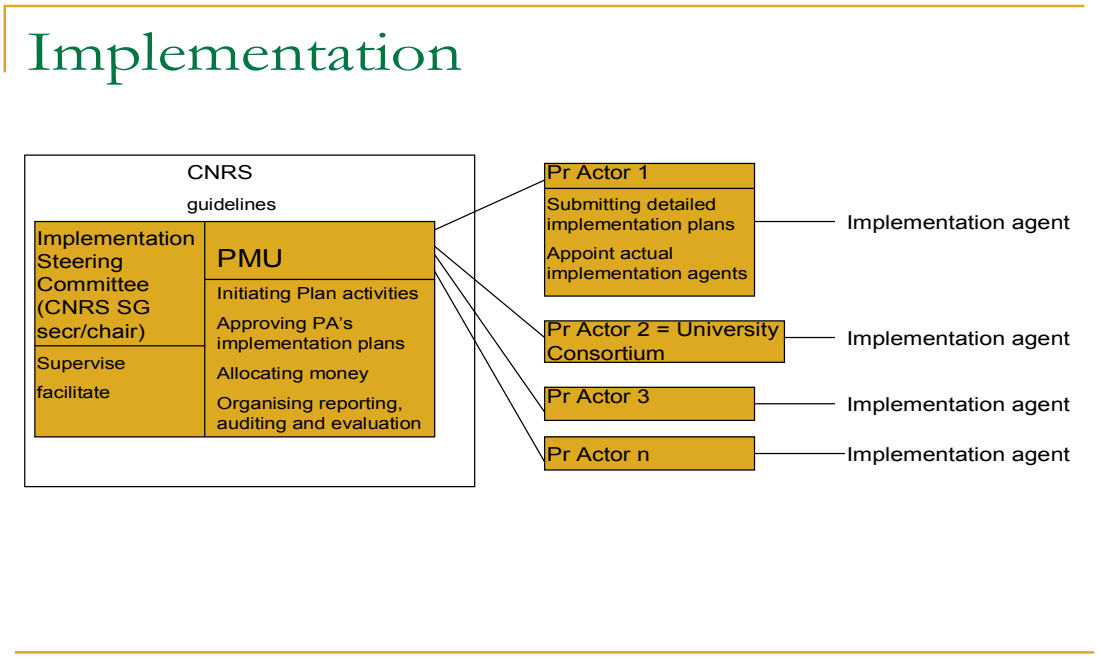
4.2 Implementation organization: roles and responsibilities

The STIP Plan should be implemented in a coordinated and comprehensive way to ensure that the largest synergy is accomplished, and reporting on progress is uniform. However, one has to distinguish between the overall responsibility for implementing the STIP Plan and the responsibility for the direct implementation of the various activities. Thus the following structure is proposed:

Under the Secretary-General of the NCSR, a *Programme Management Unit (PMU)* will have overall responsibility for initiating activities as identified above, approving plans for them, allocating money to them, and for organizing and implementing a reporting, auditing and evaluation mechanism for each of them and for the STIP Plan as a whole.

For each activity or group of activities an organization (which may also be a consortium of organizations) will be identified as *Primary Actor (PA)*. It will be the PA's responsibility to put forward a detailed implementation plan, and to set up the actual implementation agents. They will report to the PMU, and receive the money granted from the PMU. The overview of activities (section 4.3.2.) identifies the various Primary Actors. A University Consortium comprising the main universities should be set up to have these universities bear a joint responsibility for some of the measures proposed.

NCSR should appoint a special high level *Steering Committee* to supervise and facilitate the work of the PMU. It is advisable to have also several members from abroad, for example highly respected expatriate Lebanese scientists or industrialists. NCSR should establish financial, administrative and other guidelines to be approved by the Steering Committee within which the PMU has to operate.



4.3 Budget

4.3.1 Preliminary considerations

To estimate the budgetary implications of the STIP Plan, a few preliminary issues have to be discussed. The most important one concerns salary costs and costs of equipment. So far the policy of NCSR has been not to reimburse salary costs when giving research grants, nor for that matter the costs of equipment. As the present Plan aims to substantially increase the overall spending on STI in Lebanon, which amounts to saying that many new jobs have to be created in this area, there is no other way than to adopt the practice prevalent in all countries with serious STI investments of paying the full costs involved in carrying out research projects or activities that have been approved, including, in the end at least, some overhead. Of course, the auditing and career policies proposed for universities and institutes will result in scientific personnel not only having more time available for research, but actually spending it on research. However, these effects are difficult to quantify, and one should not make the funding of specific research programmes dependent on such relatively uncertain factors. More importantly, one of the underlying aims of the STIP Plan is to create a larger community of researchers 'bottom up'. That is, by creating a pyramid with a sizeable amount of PhD positions, a smaller number of post-doc positions, a still smaller number of junior and senior researchers, and so on.

A second point has to do with the availability of researchers. It will be impossible to spend right away from the onset the full annual estimated budget. So, while the estimates per activity will be made for their maximal scope, there will in practice be a ramping up. The total annual budget will therefore be rather arbitrarily adjusted in the first three years.

4.3.2 Categories of activities

The various activities which the STIP Plan comprises can be distinguished in a number of categories as follows:

a. *Multiple activities*: These activities basically are or resemble research programmes. They will have the same implementation mechanism. Moreover, within each programme there are usually several be several projects of a similar nature.

b. *Policy measures*: These activities could refer to regulations that the government has to institute, or they could also concern internal regulatory or policy mechanisms within universities, the NCSR or other institutes.

c. *Quartermaster-type*: These are one-off activities that result in creating a new institute or unit, and rely heavily on the person who will be in charge.

d. *Implementation Design*: These are activities that concern the way other activities have to be implemented

e. *Plan Preparation*: Activities for which it is first necessary to prepare a plan

A full list of these activities follows in the table below.

The table also indicates the year of actually starting the various activities. For a Research Programme (RP), this would mean the actual start of projects, or at least the issuing of a call for proposals; for a new Centre, its actual 'groundbreaking'; for a new regulation, the moment of its entering into force. It is clear that before this can happen, preparatory activities are needed.

Y1 is here assumed to start on January 1, 2005.

Multiple activities	*Primary Actor*	*Execution/Entering into Force*
RP IT deployment in the enterprise sector	NCSR	Y1
RP Web and Arabized Software Technologies	NCSR	Y1
RP Mathematical modelling including financial/economical applications	NCSR	Y2
RP Renewable energy resources (e.g. chemical, wind, hydroelectric, solar)	NCSR	Y2
RP Material / basic sciences for innovative applications	NCSR	Y3
RP Sustainable management of coastal areas	NCSR	1 research line in Y1, 1 in Y2, I in Y3
RP Integrated water management	NCSR	1 research line in Y1, 2 in Y2, 1 in Y3
RP Technologies for new agricultural opportunities	NCSR	2 research lines in Y1, 2 in Y2, 1 in Y3
RP Nutritional Food Quality	NCSR	1 research line in Y1, 1 in Y2, 1 in

		Y3
RP 1 on a theme in Molecular and Cellular Biology in medical and health sciences	NCSR	Y1
RP 2 on a theme in Molecular and Cellular Biology in medical and health sciences	NCSR	Y2
RP on a theme in Clinical/Epidemiological Sciences	NCSR	Y2
RP Forging links between the practitioners of medical and health sciences and technology, social sciences and paramedical professions	NCSR	Y3
Supporting the development of innovative information products	NCSR	Y3
Seed money to enhance commercialization	NCSR	Y2
Policy measures		
Only universities adhering to importance of research are eligible for NCSR grants	NCSR	Y2
Institute new university policies for personnel, performance evaluation, auditing policies	Universities Ministries	Y2 or Y3
Streamlining procedures	MoE, NCSR	Y1
Institutes and parent organizations to establish new personnel, performance evaluation and auditing policies	NCSR, Ministries, Institutes	Y2 or Y3
NCSR STIP management and funding decisions to follow new policies of responsibility	NCSR, Council of Ministers	Y1
Normal NCSR mechanisms to continue to adopt such principles	NCSR	Y1
Outside representation in steering committees and advisory boards.	Universities, NCSR	Y1
A limited structured set of STI indicators to start with	NCSR, government departments	Already before Y1
Quartermaster-type of activities		
Institute PhD courses	University consortium	Y2
A Virtual Centre for Instruments for Environmental Analysis	NCSR	Y2
A Nutrition Research Centre	AUB	Y2
A Medical Research Institute with a core in molecular and cell biology	NCSR	Y2
Knowledge Gateway Industry Lebanon	University consortium	Y1
Virtual Sectoral Centres of Excellence	University consortium	1 in Y1, 1 in Y2, 1 in Y3
Teams to support the adaptation and adoption of technical standards for Lebanon	Universities, LIBNOR, IRI	Y2
Workshops for Business Plan and Entrepreneurship Development for the Scientific Community	University consortium	Y2
New incubators	NCSR +university	To be decided in Y1 on basis of

	consortium	detailed feasibility study
Public and Professional Information Units on Coastal Zone, Water, New Agriculture, Food Quality.	NCSR Institutes for Marine Sciences and Remote Sensing; ARI; Nutrition Research Centre	1 in Y2, the other 3 in Y3
A Lebanese 'STI Observatory'.	NCSR	Already to be initiated before Y1
Implementation design		
Include post-doc grants in STIP support mechanisms	NCSR	Before Y1
Include institutional support to emerging or existing Centres in STIP support mechanisms	NCSR	Before Y1
Built-in incentives for collaboration and synergy	NCSR	Before Y1
Plan preparation		
A national Lebanese research network with high speed outward connections	NCSR + University Consortium	Before Y1

4.3.3 The STIP Budget

In the Annex the detailed assumptions on which the STIP budget is based are given.

The first assumption relates to the total salary costs of the various categories of personnel involved in the execution of the STIP initiatives.

A second assumption relates to the (average) size of the Research Programmes (250 k$ per year, respectively 100 k$ for the two incentive programmes concerning information products and seed money) and the Centres and Institutes that the STIP Plan proposes to establish. Here the Medical Research Institute will eventually acquire an annual budget of 600k$ which includes the cost of carrying out one of the Research Programmes in Medical and Health Sciences. Three other Centres are budgeted at 200 k$ per year; the Sectoral Centres of Excellence at 50 k$ as they will depend largely on existing expertise, will focus less on expanding capacity and will have to generate substantial contract or sponsor income.

For all the other, smaller scale, activities only a total figure for each is estimated.

To arrive at the budgets for the successive STIP implementation years, two aspects need to be taken into account.

- Not all activities start in the first year, as indicated in chapter 4.3.2.
- Most activities will not start at their full scope and size, as it will take time to hire people, buy equipment, etc.

In Annex 1, one finds also detailed assumptions on the build-up rate particularly for the Research Programmes and the Institutes which result in both cases in first year budgets of about half the full scope budgets.

As will be explained in more detail in the Action Plan in chapter 4.4, most activities need a preparatory phase prior to start of implementation. The cost of these preparatory activities is assumed to be small and have been included in the budgets of the various years. However, for those activities that should start at the beginning of Year 1 (that is January 1, 2005) and for those activities that should preferably even precede the completion of the full formal decision process, a small Preparatory Budget for Year 0, i.e. 2004, of 155k$ is necessary. The Plan of Action assumes that when the Cabinet decides to approve the STIP Plan, prior to Parliamentary approval, it can decide to make that Preparatory Budget available.

Finally, three major initiatives have not been budgeted separately. With regard to the PhD programmes, part of the costs can actually be considered to be included in the costs of relevant STIP Research Programmes. Other parts, however, are intricately interwoven with the general costs of universities, the way these are financed and the impact the proposed new university policies might have on all this. It is accordingly, impossible, at this stage to come forward with concrete estimates of additional costs. Secondly, as the precise nature, scope and costs of new Incubator initiatives is not yet clear, these cannot be budgeted either. Thirdly, the Higher Education and Research Computer Network can only be budgeted after a concrete plan is available on the basis of the outcome of the Quick Scan that the STIP Plan proposes to undertake urgently.

Management costs have to be included, too. A figure of 5% has been assumed which reflects international practice. The resulting overall STIP budget will then be as follows (in thousands of US$):

Y0	***Y1***	***Y2***	***Y3***	***Y4***	***Y5***
155	**698**	**2620**	**4500**	**5098**	**5098**

4.4 Plan of Action

This Plan of Action describes all the steps that need to be set successively or in parallel to implement the STIP Plan. Three major areas need to be distinguished.

1. First, there are those steps necessary to get formal approval by the government and the Parliament of the STIP Plan, the budget, the mandates and the coordination structures at the government level.

2. Second, the implementation organization has to be established, together with the cooperation agreements between the major parties.

3. Third, a detailed plan needs to be prepared, and successively implement the individual activities that comprise the substantive part of the STIP Plan. For the first Implementation Year a list of priority activities is presented. For any subsequent year Y such a list should be established early in the preceding year Y-1, so that any preparatory activities will be

completed before the year Y commences. As a matter of fact the Work Plan for year Y should comprise all the preparatory work to be carried out in that year.

4.4.1 Formal steps

In the table that follows, it should be understood that "approval" usually implies approval after modification.

When	***Number***	***Action***	***Responsible***
02/04	I.1	National seminar • Approval STIP Plan • Approval priorities for 1st Implementation Year	NCSR
04/04	I.2	Submission to Cabinet. Request to: • Approve STIP Plan • Provide small additional budget for preparatory activities in 2004 • Provide NCSR with mandate • Agree Loi Programme and Budget • Establish Interdepartmental STI Committee	NCSR
06/04	I.3	Cabinet approval; submission to Parliament	Prime Minister
06/04	I.4	Make Preparatory Budget available	MoF
11/04	I.5	Parliamentary approval	Parliament
01/05	I.6	Make first implementation budget available	MoF

4.4.2 Building up the implementation organization

When	***Number***	***Action***	***Responsible***
04/04	II.1	Identifying head of Programme Management Unit (PMU)	SG NCSR
06/04	II.2	Establish PMU (head + 2 more persons)	SG NCSR + head PMU
06/04	II.3	Establish Steering Committee from stakeholders to supervise STIP Plan implementation	NCSR
06/04	II.4	Conclude cooperation agreement between NCSR and universities (LU, AUB, LAU, USJ, …) Includes: • Principles of Partnership and Cooperation (e.g. in PhD programmes, in establishing new centres, Knowledge Gateway, etc) • Identifying Primary Actors (PA) • Outside representation in advisory boards etc	NCSR
06/04	II.5	Conclude cooperation agreement between NCSR and ARI, IRI Includes identifying Primary Actors (PA)	NCSR
07/04	II.6	Establish Responsibility and Reporting Document about the responsibilities and mutual relations of PMU, PA's and IA's (Implementing Agents)	PMU
07/04	II.7	Establish administrative guidelines for spending the	PMU, NCSR

		preparatory budget for 2004	
07/04	II.8	Identifying Implementation Agents (IA) for each of the activities in the first year priority list	PA's
07/04	II.9	In particular, NCSR should set up IA structure for implementing the various research programmes (RP's)	NCSR (as PA)
10/04	II.10	Conclude cooperation and coordination agreements with ministries and with international donors/organizations	PMU, NCSR
10/04	II.11	Establish Implementation Protocol (including Eligible Costs, Administrative Guidelines and Monitoring and Evaluation Protocol) for STIP Plan implementation	PMU, NCSR
10/04	II.12	Establish Work Plan Y1, with preliminary plans for Y2 and Y3.	PMU
11/04	II.13	Workshop with all PA's and IA's to Discuss Implementation Protocol Agree on Work Plan Y1	PMU

4.4.3 Preparation and implementation of STIP activities

Preliminary activities

Several activities can be carried out prior to the setting up of a PMU, or even approval of the STIP Plan, as they will have a value of their own even when funds for the eventual implementation of the prepared activities would only come later.
These concern:

1. Overview studies of research activities in Lebanon in the three domains considered as a basis for the implementation of the STIP Plan;
2. The quick scan of needs, dimensions, international embedding and an implementation plan for a Lebanese Higher Education and Research Computer Network;
3. Establishing the core of the Lebanese STI Observatory.

With respect to the overview studies, two pieces of analysis are needed.

1. An analysis of research activities and research outputs in Lebanon in the last 5 years:
   - Quantitative analysis and tabulation of the distribution of funded research proposals submitted to the NCSR, based on the assumption that research applications to the NCSR constitute a representative sample of research in Lebanon.
   - Quantitative and qualitative analysis of the research outputs (list of publications in peer reviewed international journals)
   - Identification of the sources of research funding as well as the institutions that have received research funding in the past. (Amount of extramural and total funding, when available).
2. It is also important to identify what human resources and infrastructure facilities exist in Lebanon in the various fields included in the STIP. This mapping will include an estimate of:

- The number of established researchers
- The number of recent recruits in the various relevant research fields
- Major equipment and their distribution
- The number of qualified engineers, technicians and other personnel
- The number of trainees (MS, PhD, post-doc).

Preparatory activities

As soon as there is approval by the Council of Ministers, one should start preparing for the implementation of the Y1 priority activities (section 4.3.2) with the Preparatory Budget that would be available by the middle of 2004, if the planning mentioned above will be met.

Most of these activities are obvious, but there is one that needs further explanation. In the field of Health and Medical Sciences, and as previously indicated, a committee of international experts, is expected to define the major three or four research areas that should be the focus of Lebanese researchers in the health fields in the next 5-10 years. It is proposed that the data generated through the analysis of research activities and outputs and the mapping of the human resources and infrastructure facilities, shall serve as a basis to be used by this committee to define these major research areas.

The recommendations of the committee of international experts should lead to the:

- Definition of the basic structure of the Lebanese National Medical Research Institute that may house the basic core of full time researchers and technical staff and conduct some research on some of the proposed projects;
- Formation of the major research groups based on the existing research activities and priorities in the various institutions.

Resulting Y1 Action Plan for Substantive STIP Activities

When	***Number***	***Action***	***Responsible***
03/04	III.1	Quick Scan and Implementation Plan for Lebanese Higher Education and Research Computer Network	NCSR/ P.T.
04/04	III.2	Analysis of research activities and their outputs, human resources and infrastructural facilities in basic sciences and engineering	NCSR
04/04	III.3	Analysis of research activities and their outputs, human resources and infrastructural facilities in environmental and agricultural sciences	NCSR
04/04	III.4	Analysis of research activities and their outputs, human resources and infrastructural facilities in health and medical sciences	NCSR
06/04	III.5	Setting up the core of Lebanese STI Observatory	NCSR
07/04	III.6	Establish the Task Force to prepare Knowledge Gateway Industry Lebanon	Joint Universities, PMU, IRI, ALI
07/04	III.7	Identify 3 areas for (Virtual) Sectoral Centres of Excellence, after which the respective IA's will start preparations	Universities, ALI, PMU
09/04	III.8	Establish Committee of International Experts in	NCSR, PMU

		Health and Medical Sciences to advise on priorities	
09/04	III.9	Priority setting Workshop RP: IT Deployment in Enterprise Sector	NCSR + ALI
09/04	III.10	Priority setting Workshop RP: Web and Arabized Software Technologies	NCSR + ALI
09/04	III.11	Priority setting Workshop for one research line RP Sustainable Management Coastal Areas	NCSR + Ministries
09/04	III.12	Priority setting Workshop for one research line RP Integrated Water Management	NCSR + Ministries
09/04	III.13	Priority setting Workshop for two research lines RP Technologies for New Agricultural Opportunities	NCSR + ARI + MoA
09/04	III.14	Priority setting Workshop for one research line RP Nutritional Food Quality	NCSR + MoA + MoH
11/04	III.15	Policy prepared and ready on inclusion of postdocs, institutional support and incentives for collaboration and synergy in STIP Programmes and activities	PMU and NCSR
12/04	III.16	All necessary preparations completed for the initiation of for all 8 RPs (7 mentioned above, plus the one in Health and Medical Science) in early 2005. Arrangements done by the IA structure for Research Programmes at NCSR. Preparations include call for tenders: • Programme document • Eligible costs • Review and grant award mechanism	RP-IA at NCSR; PMU
01-03/05	III.17	Start of implementation of first 8 RP's	RP-IA at NCSR
01/05	III.18	Submission of White Book on Streamlining (Government) Procedures for Research to the Interdepartmental Committee on STI	NCSR
02/05	III.19	Establish Joint High Level Group on 'New University and Institute Policies'	Universities, NCSR, MoE
02/05	III.20	Establish 2 Joint Working Groups to prepare 2 new PhD/postgraduate programmes	Universities
02/05	III.21	Establish Joint Working Group to initiate series of workshops and/or training courses for entrepreneurship and business plan development	Universities
02/05	III.22	Call special meeting (Universities, ministries, ALI, banks, BERYTECH, etc.) to discuss way forward with respect to incubators and to result in a feasibility study along the lines preferred	NCSR
02/05	III.23	Establish Task Force to prepare Medical Research Institute	NCSR/PMU, after agreement with universities
02/05	III.24	Appoint Quartermaker to prepare Nutrition Research Centre	NCSR/PMU, AUB
03/05	III.25	Knowledge Gateway Industry Lebanon to start, after approval of plan by the Universities, IRI, ALI and PMU, and after appointment of Quartermaker and host organization	Host organization, PMU

03/05	III.26	Decision on the first (Virtual) Sectoral Centre of Excellence that will be started, chosen on a competitive basis by a jury, established by PMU. Its actual founding depend again on appointing a Quartermaker and a host organization	PMU, Host organisation
06/05	III.27	Priority setting Workshop RP: Mathematical Modelling	NCSR + ALI
06/05	III.28	Priority setting Workshop RP: Renewable Energy Sources	NCSR + ALI
06/05	III.29	Priority setting Workshop for one research line RP: Sustainable Management Coastal Areas	NCSR + Ministries
06/05	III.30	Priority setting Workshop for two research lines RP: Integrated Water Management	NCSR + Ministries
06/05	III.31	Priority setting Workshop for two research lines RP: Technologies for New Agricultural Opportunities	NCSR + ARI + MoA
06/05	III.32	Priority setting Workshop for one research line RP: Nutritional Food Quality	NCSR + MoA + MoH
06/05	III.33	Priority setting Workshop RP: Molecular and Cellular Biology to discuss the 2nd Programme in this area	NCSR + MoH
06/05	III.34	Priority setting Workshop RP: Clinical and Epidemiological Sciences	NCSR + MoH
07/05	III.35	Decision to establish Nutrition Research Centre	NCSR/PMU with the university(ies) and ministries concerned
07/05	III.36	Establish Task Force to set up teams on technical standards	NCSR/PMU with LIBNOR and IRI and Universities
09/05	III.37	Appoint Quartermaker to prepare Virtual Centre for Instruments for Environmental Analysis	NCSR/PMU
10/05	III.38	Establish Task Force to prepare general outline of the Public and Professional Information Units	NCSR/PMU, Institutes/Centres concerned
10/05	III.39	Decision to establish Medical Research Institute	
10/05	III.40	Calls for next 10 Research Programmes	IA-RP at NCSR, and PMU

5. LEGAL AND ADMINISTRATIVE PROVISIONS

6. A KNOWLEDGE-BASED SOCIETY

This chapter provides some background about widely accepted notions and arguments relating to building knowledge-based societies, investing in science, technology and innovation, and about the perspective of building on a regional- or national-scale interactions between companies, knowledge institutes, government departments, banks and so on, that can gradually evolve into what one calls nowadays national or regional systems of innovation.

6.1 Knowledge-based economies and societies

The knowledge based economy is sometimes presented as a new stage in the succession of stages through which economies successively pass. From the agricultural stage to the industrial phase, on to the service, the information economy and now finally the knowledge economy. But of course, knowledge, in the form of accumulated experience, through inventions (think only of the Florentine invention of double book-keeping) and since the 19th century increasingly through science-based technologies, has always played a role. And if one wants to single out a turning point, one should perhaps rather with A.S. Whitehead point to the greatest invention of the 19th century, as the *invention of organized invention*. Yet there is no doubt that a cumulative and mutually reinforcing processes of introducing new inventions and technologies in the capital stock of enterprises, and educating the workforce alone have a ready totally transformed industrial production. But that is not all: companies and societies as a whole rely ever more on complex infrastructures which, too, reflect societies' dependence on putting knowledge to work. The provision of energy, the communication infrastructure, the infrastructures of roads, railroads, waterways and air transport in combination with the transport vehicles used on them, the complex pipeline systems are ever so many examples. The advent of information and communication technologies over the last 30 years has only added to this dynamic and has now affected the service sectors to such an extent that they too have begun to be characterized by the mix of knowledge embodied in persons and vast realms of modern technologies that one could discern in industrial companies before. The same is true for the more or less public goods in the provision of which governments and public agencies usually play a prominent role. Defence is age-old example often credited with the first government-led development of technologies. Health care is a fine example, too and one might equally point to managing a sustainable environment, which requires for example intricate ecological simulation models. As a consequence one sees the rise of the professionals trained in natural or social and economic sciences or humanities in developing government policies. Indeed, the very debates between for example governments and NGOs or public discussions and public culture in general are hardly to be imagined without the concepts and results of science and technology. That is one reason why training and education are so vital for feeling 'at home' in modern societies.

Such a description shows that one may speak of totally interdependent 'upgrading' and transformation of the traditional production factors and production methods of goods and services by the introduction of knowledge. It is hardly surprising, then, that the institutions and mechanisms societies had developed to manage the economy, to improve social well-being and for dealing with international relations are changing too. It should also be clear that this is not a reversible process or one that one may limit to, for example, industrial production alone. The spheres of governance and open, transparent communication in societies are an integral part. One cannot aspire to share in prosperity and social quality made possible by the knowledge that has been and continues being developed without finding ways to make all spheres of society cope with it. It is important to stress that there is no single blueprint for this. Circumstances in different parts of the world vary; different people may assign different emphases to values. So one should

learn from successful companies and governments, and at the same time stress that specific Lebanese societal needs should be one's guide in developing the Lebanese path towards a knowledge-based society.

6.2 Why companies and governments invest in STI

What Lebanon should exactly spend on research and particularly in what areas, depends, of course, very much on specific local circumstances. Solid experience leaves no doubt, however, that innovation (i.e. developing and commercially and/or societally exploiting new products, processes, services, infrastructures, etc) is vital for the success of companies (i.e. at the *micro-economic* level) and economies (the *macro-economic* level), as well as to increase individual freedoms, the improvement in the quality of life and societal well-being (the *social* level) in all countries. Generally speaking more than 30% of annual revenues in the manufacturing sector in the OECD countries derive from new or improved products. Total factor productivity is higher when expenditure on R&D and technology diffusion per employee are higher. Historically, steady GDP growth occurred for more than a century in those countries that have accounted and still account for most of the world's R&D investments. While fast-growing 'newcomers' catch up in R&D expenditure, the 'elderly' keep going up.

Innovation is the result of technological change (a category used by economists to analyze economic growth) in combination with many other changes, e.g. in organizational design, management methods, marketing concepts, financial techniques, and policy approaches.

Technological change and many several of the other above-mentioned developments rest increasingly on scientific research in the natural, engineering and medical sciences, and today to a greater degree in social sciences and humanities than in the past.

Private firms realize very well that innovation pays off: in almost all OECD countries business funding of its own R&D, as well as of the public-sector R&D has increased considerably from 1981 to 2001 (OECD STI Scoreboard 2003). However, the trend is to move away from longer term research since they do not know whether they will be able to use its results, or whether they can prevent others from using results which have to be in the open literature to be validated, or they conversely believe they can benefit from investments of other companies. These companies accordingly, expect those inputs largely to come from universities and institutes.

Governments should have the same impulse to improve through R&D and innovation, the quality, productivity, cost-effectiveness and accessibility of a variety of services, infrastructures and policies for which the government itself is totally or largely, directly or indirectly is in charge of. These include defence, education, health, water, energy and food security, physical infrastructures, governance, social security and protection from crime. International obligations also increasingly require research efforts to meet targets for regional and global sustainability. The most significant example remains agriculture in which, despite its being within the private sector, dissemination and innovation have been seen as a public responsibility since 150 years research. Research and new technology enabled a dramatic productivity rise: to feed one person in 1900 needed ½ ha. and more than 1 year of labour; that same ½ ha. now feeds 10 persons with only 1½ day of labour.

As implied by the arguments mentioned above on why firms will not invest in basic and strategic research, including that of relevance to industrial technology development, this is an area where governments have to interfere, and they usually do. A good example for consideration here is the fact that 60% of research funding in all USA universities comes from the federal government.

The reason why firms do not completely step aside from strategic and basic research is exactly why governments cannot simply rely on accessing or buying knowledge produced elsewhere. Much knowledge is 'tacit' knowledge (embodied in persons, procedures, organizations); and using published knowledge does not come for free. Extensive (and expensive) learning processes are involved, capabilities (people, equipment) are necessary to appreciate and assimilate ('absorb') results from elsewhere. Neither companies nor countries can 'free-ride' on science from elsewhere.

6.3 Systems of innovation: economic clusters

One can already infer from some of the arguments given above, that interactions between the players in a knowledge-based economy or society are crucial. Such interactions must be systematically developed, thus resulting in networks or systems of innovation, and clusters of economic activity. In a globalizing world where ICT results in global technology flows, local, regional and national knowledge networks play a crucial role in shaping innovative success and social quality. They depend on the cooperation – formally as well as informally – of universities, research institutes, enterprises, local and regional governments, chambers of commerce, schools, or banks, venture capital funds or private investors. The latter, of course, is to ensure the availability of capital for the various stages of the innovative process, from seed capital and risk capital to normal investment capital.

Proper institutional provisions, including legal and regulatory ones on beneficial fiscal arrangements, intellectual property rights or market or export/import or safety regulations are necessary for these local, regional or national systems of innovations to function effectively. These networks build on several key components: market conditions must be transparent; competition law must be in place; organizational diversity must be promoted; and the different roles in interaction must be recognized: some companies compete, while there may be business-like transactions among companies and between companies and universities. Networking is needed to achieve a larger common mind-set and information base, as well as mutual trust. Entrepreneurship is vital and people should be stimulated to take initiatives. They will receive support and challenges through such networks. Governments play a prominent role in supporting the establishment of such networks, and creating the conditions for their successful functioning.

Annex 1: Cost estimates

This annex contains the assumptions on which the cost estimates for the STIP Plan are based.

1. Annual costs Research Programme and Research Institute

In Table 1 first annual (total) salary costs for the various personnel categories are estimated. Next an assumption is made as to the average composition of a Research Programme. Also for the Medical Research Institute such an assumption is being made.

TABLE 1

Annual costs personnel categories	
Costs PhD student	12 k$
Costs postdoc	18 k$
Costs (junior) scientist	30 k$
Supervision professor/senior scientist	5 k$
Group Leader	50 k$
Technician	20 k$

Composition and costs RP		*Composition, costs Medical Res. Institute*	
6 PhD	72 k$	3 group leaders	150 k$
3 postdocs	54 k$	2 (junior) scientists	60 k$
2 (junior) scientists	60 k$	4 PhD	48 k$
3 supervisors	15 k$	2 postdocs	36 k$
equipment and other research expenses	45 k$	6 technicians	120 k$
	~250		
Total	***k$***		***~600 k$***

For the other institutes and centres the costs are estimated to be lower (less personnel, less equipment)
For the same reasons the two remaining incentive programmes will be cheaper

2. Budget profiles

Table 2 presents an assumption about the speed of building up the full Research Programme.

TABLE 2

Assumptions for RPs	***cost Y1***	***cost Y2--5***
PhDs: 2 after 4 months, 2 after 7, 2 after 12	26	
postdocs: 1 after 4 months, 1 after 7, 1 after 12	19.5	
(junior) scientists: 1 after 4, 1 after 7	32.5	
supervisors: 3 after 3 months	33.75	
equipment: 25 in first year	25	
	136.75	***250***

In the calculations this is rounded off to ½ of the full annual costs for the first year

Assumptions for Institutes
Building up an institute will on average require relatively more funding for equipment and building and less on personnel. As a rough estimate the same proportion of 1:2 is used for the first year vs. full annual costs.

In Table 3 the total annual STIP Plan costs, with all activities running at full development and costs, are calculated.

3. Annual STIP costs

TABLE 3

Activity	*#*	*Costs/Y*	*Total*	*#*	*k$ Y1*	*k$ Y2*	*k$ Y3*	*k$Y4*	*k$Y5*
Research Progrs	12	250	3000	4	540	1079	1079	1079	1079
				5		571	1142	1142	1142
				3			390	779	779
				12	***540***	***1650***	***2610***	***3000***	***3000***
Med Res Institute	1	600	600	***1***		***300***	***600***	***600***	***600***
V Centre Instr Env An	1	200	200	***1***		***100***	***200***	***200***	***200***
Nutr Res Centre	1	200	200	***1***		***100***	***200***	***200***	***200***
			0						
V Sectoral CoEs	3	50	150	1	25	50	50	50	50
			0	1		25	50	50	50
			0	1			25	50	50
			0	***3***	***25***	***75***	***125***	***150***	***150***
			0						
Knowledge Gateway	1	100	100	1	***50***	***100***	***100***	***100***	***100***
Public and Professional Information Units	4	70	280	1		35	70	70	70
				1			35	70	70
				1			35	70	70
				1			35	70	70
				4	***0***	***35***	***175***	***280***	***280***
Wshops Bus Pl & Entrepreneurship			50			***25***	***50***	***50***	***50***
Standards Teams			25			***10***	***25***	***25***	***25***
STI Observatory			50		***50***	***50***	***50***	***50***	***50***
Incentive Progr Innov Info Prods			100				***50***	***100***	***100***
Seed money programme			100			***50***	***100***	***100***	***100***
			4855		***665***	***2495***	***4285***	***4855***	***4855***
Overhead @ 5%			242.75		***33***	***125***	***214***	***243***	***243***
Total			5098		**698**	**2620**	**4500**	**5098**	**5098**

Remark: The costs of 1 of the 4 RPs in Medicine and Health is assumed to be included in the costs of the Medical Research Institute; hence one finds only 12 instead of 13 RPs for calculating the costs.

4. Preparatory Budget Year 0 (2004)

Finally in Table 4 an estimate is given of the preparatory costs likely to be incurred in the year preceding the actual execution of the first STIP activities. They form the Preparatory Budget referred to in chapter
It is assumed that all preparatory costs in Y2 and further are included in the budgets of the various activities, as they are small anyhow.
So there has to be a special preparatory budget only for Y0, i.e. 2004.

TABLE 4

3 Overview studies in the 3 domains	3	15	45
International Expert Group Medical and Health Sciences	1	30	30
Workshops to prepare first series of RPs	6	5	30
STI Observatory	1	25	25
Management			25
Total			**155**