INTEGRATED DEVELOPMENT THROUGH ADVANCES IN SCIENCE & TECHNOLOGY: ESSENTIAL INSIGHTS FOR BANKERS

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Abstract

Banking Foresight for Integrated Development requires that professional bankers are aware of national policies and envisaged strategic directions along which a country is expected to progress towards its national development goals. Advances in Science & Technology (S & T) leading to globally-competitive products and services are the keys to achieving rapid economic development and wealth creation in a country. The objective of this paper is to create awareness among the banking community on the broad policy goals and strategic directions for transformation of S & T in Sri Lanka to make it a key player in Sri Lanka's march towards integrated economic development. Such awareness would enable the banking sector to seize opportunities to provide the financial services that are essential for advancement of S & T and thereby share its benefits. The paper describes: (a) the current status of the S & T sector in Sri Lanka; (b) The National Science & Technology Policy of Sri Lanka, which identifies the broad areas for S & T intervention and development; (c) The Science, Technology and Innovation Strategy for Sri Lanka 2011-2015, which identifies the specific strategic directions; (d) Some of the potential opportunities for the banking sector to get involved. While identifying the enormous potential of S & T to bring about rapid and long-lasting economic development and prosperity to Sri Lanka, actual realization of this potential requires paradigm shifts in the thinking and mode of operation of all stakeholders such as the policy makers, scientists and technologists, the public-sector research and development institutions, the private sector entrepreneurs and the business community, including the banking community.

Introduction

With the conclusion of the 30-year armed conflict in 2009, Sri Lanka entered a period which presented a multitude of diverse opportunities to achieve rapid economic development. The strategic geographic location of the island, its varied natural resources and successive governments which have actively pursued an 'open' economic policy allowing reasonable interplay of free-market forces have the potential to attract considerable external investment. A dynamic and skilled workforce, both in the blue collar and white collar jobs, partly the result of its high literacy

rate, has always been a particular strength of Sri Lanka. Hence, it is incumbent upon the policy makers and key strategic decision makers, both in the public and private sectors, to have a clear vision on the direction and form of Sri Lanka's future economic development, in the short-, medium- and long-term.

Banking is one of the key drivers of a country's economy and its economic development by providing liquidity to the economy for businesses and enterprises to grow and create wealth. Hence, it is essential that the banking sector also is aware of the specific financial needs of the envisaged economic development as determined and engineered by the key decision-makers in the public and private sectors. Such strategic awareness is an essential aspect of 'Banking Foresight', which is part of the broader theme of this volume.

Integrated Development, the other part of the broader theme of the current volume, when applied to the economic development of Sri Lanka, means the sustained upliftment of the goods and services produced by all key sectors of its economy in a way that would increase wealth creation and the standard of living of all strata of the Sri Lankan society. Sri Lanka's has traditionally been an 'Agricultural Economy', based predominantly on the income generated through export of largely 'raw' agricultural products, with limited processing and value-addition. It is a well-known fact that the contribution of Agriculture to an economy decreases with economic development. Furthermore, it is hardly possible to base significant economic development on export earnings from agricultural products with a low level of processing and value addition, because of fluctuations in their global markets. Therefore, an essential requirement to achieve significant economic development in Sri Lanka is to transform its economy from one that is based on exports of 'raw' agricultural products to one that is based on export of high-value goods and services, which are competitive in the global marketplace. It is here that advances in Science & Technology (S & T) become an essential pre-requisite for Sri Lanka's economic development. Hence, integrated development towards economic prosperity for Sri Lanka requires innovations and advances in S & T in all key sectors of its economy including Agriculture and Industries.

The broad objective of this paper is to create awareness among the banking community on the broad policy goals and strategic directions for transformation of the S & T Sector in Sri Lanka to make it a key player in Sri Lanka's march towards integrated economic development and prosperity. The specific objectives are: (a) to provide some insights in to the potential of Science & Technology to bring about integrated economic development and prosperity to Sri Lanka; (b) to describe the current status of S & T sector, and specifically the National Research, Development and Innovation System (NRIS) in Sri Lanka; (c) to apprise the banking community of the National Science and Technology Policy and the National Science, Technology & Innovation Strategy for Sri Lanka, that outlines a roadmap for achieving Sri Lanka's economic development through advancement of Research & Development (R & D) so that the banking community could use its Banking Foresight strategically to become significant contributors and partners in this endeavour.

Economic Development through Advances in Science & Technology

Economic development of a given country requires its manufactured goods and services to be competitive in the global marketplace as against those from other countries. To be competitive in the global market, the goods and services should either be of superior quality or cheaper or both. Superior quality and lower cost of production are only possible through scientific innovation and technological advancement. This is especially relevant for a country such as Sri Lanka, where the labour wages are higher in comparison to its regional neighbours, thus limiting the scope for reduced cost of production. Notably, Robert Solow, the Nobel laureate for Economics in 1987, showed through his Solow-Swan neo-classical economic growth model that advances in technology contributed 80% to the increased output per worker in the US[1], which enabled it to become the leading economy in the world. Therefore, it can be argued that the gap in economic prosperity and standard of living between the developed and developing countries is predominantly a gap in technological advancement. Accordingly, innovations generating new technologies through R & D in S & T are the key to bring about integrated economic development in Sri Lanka.

The potential of advancement in S & T for bringing about rapid and substantial economic development is amply illustrated by South Korea, which had a per capita GDP (nominal) of US $ 80 in the 1960's in comparison to Sri Lanka's 320 US $ during the same period. By 2010, South Korea had increased its per capita GDP to 20,757 US $ in comparison to Sri Lanka's 2,423 US $[2]. Several indicators point to the fact that innovations in S & T leading to generation of advanced technologies made a significant contribution to the remarkable economic development achieved by South Korea. For example, high-tech value-added products form 33.4% of the manufactured exports of South Korea in comparison to a mere 1.8% by Sri Lanka[3]. While South Korea invests 3.47% of its GDP on R & D (amounting to 41.7 billion US $), Sri Lanka invests only 0.11% (0.5 billion US $)[3]. While only 159 patents, an indicator of innovations in S & T, were registered in Sri Lanka in 2008, over 5000 US patents were obtained by South Korea for innovations. Therefore, it is clear that in today's highly competitive global market, rapid and sustainable economic development is possible only through continuous innovation and advance in S & T which then need to be harnessed in product development and successful commercialization. The wide disparity in some of the key relevant indicators between Sri Lanka and South Korea as illustrated above show that Sri Lanka has a considerable way to go in these aspects.

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[1]Solow, R.M. (1956). A Contribution to the Theory of Economic Development. Quarterly Journal of Economics 70 (1): 65-94.

[2]World Development Indicators Database, World Bank. (http://databank.worldbank.org)

[3]Sri Lanka Science, Technology & Innovation Statistical Handbook 2008. National Science Foundation.

Innovating, exploiting and commercializing new technologies is essential for ensuring global competitiveness of Sri Lanka's manufactured goods and services, which could act as a key driver of integrated economic development in Sri Lanka. It has been noted that the proportion of high-tech products[4] in the global market has been increasing during the last decade. In 2008, high-tech exports formed 14% of all global exports[5]. Two major groups of products, i.e. 'Electronics – telecommunication' and 'Computers – office machines' formed 64% of the above exports while 25% consisted of products and services in the categories of 'Scientific equipment', 'Aerospace' and 'Pharmacy'. During the period from 2005 to 2007, the total market value of high-tech intensive sectors were substantial with 1662 US $ in Telecom, 1200 US $ in Electronics, 1073 US $ in Information Technology, 147 US $ in Nanotechnology and 73 US $ in Biotechnology[6]. While South Korea had a 6.3% share of the global high-tech exports, it is not surprising that China, which has the fastest-growing economy in the world, is the global leader in high-tech exports. It is also notable that two relatively small Asian countries, Hong-Kong and Singapore have market shares of 8.1% and 7.0% respectively of total global high-tech exports, primarily due to the high volume of high-tech goods that are transiting through these countries due to their hub effect and re-export of high-tech products. This is an important pointer to a possible developmental pathway that Sri Lanka could explore as well.

While high-tech products are highly-R & D intensive, goods and services so generated have a higher return-on-investment than traditional products with low value-addition. Hence, generation of new technologies in product development through increased investment in R & D in S & T can be a cornerstone of rapid economic development of Sri Lanka, especially in view of its limited financial capability (and willingness) for investment in R & D in S & T. Furthermore, high-tech industries are knowledge-intensive and therefore are highly-suited to the relatively more literate work force in Sri Lanka. Moreover, high-tech industries generally provide well-paid employment, thereby ensuring social protection and a higher standard of living to its employees.

As generation of high-end technologies are knowledge- and R & D-intensive, it is pertinent to examine the current status and capability for R & D and knowledge creation in the S & T sector of Sri Lanka.

Current Status of the Science & Technology Sector of Sri Lanka and Its Capability for Generation of High-end Technologies

Capacity of a country's S & T Sector, and specifically its research, development and innovation system, to generate new knowledge and technology, be it high-end technologies or appropriate technologies, would largely depend on several pre-requisite factors operating synergistically. These include:

[4]Products and services that have a high R & D intensity (i.e. R & D Expenditure as a proportion of total sales) are categorized as 'High-Tech'.

[5]http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/High-tech_statistics (Last accessed on 28.08.2011)

[6]Science, Technology & Innovation Strategy for Sri Lanka: 2011-2015, Ministry of Technology & Research, 2010.

(a) A clear national policy on the direction along which a country's research and innovation drive should proceed with clearly defined priority areas;

(b) A firm and sustained commitment to invest adequate resources (i.e. financial, physical and human) on R & D in the identified priority areas while enlisting support of the private sector to make substantial contributions to the national research, development and innovation effort;

(c) A well-established and well-resourced network of research, development and innovation institutes in the identified priority areas with a network of linkages to the international centres of excellence and their scientists and an enabling environment for maximum inter-institutional collaboration, both within the country and across national borders;

(d) A comprehensive and well-resourced system of tertiary education to build-up a highly-skilled and innovative pool of research scientists and an 'army' of technical personnel in the diverse supporting areas such as advanced instrumentation and laboratory maintenance;

(e) Adequate remuneration packages for highly-skilled research scientists and technologists to prevent 'brain-drain';

(f) Adequate legislation for protecting Intellectual Property Rights of the innovations generated through R & D;

(g) A well-resourced supporting system for commercialization of innovations *via* product development, their incubation, mass production and commercialization;

(h) Close collaboration between stakeholders in the public and private sectors (i.e. public-private partnerships, PPP) at all stages of research, innovation, product development and commercialization.

Several comprehensive reviews undertaken during the last decade have shown that the S & T sector and the NRIS of Sri Lanka are weak in all the above-mentioned pre-requisites for achieving a high enough capability for knowledge creation and technology generation in order to fuel rapid integrated national development. Some of the key weaknesses of the current status of the S & T sector and the NRIS of Sri Lanka, in terms of these crucial pre-requisites, are briefly discussed below:

(a) Exceptionally-low investment in Research and Development in S & T

At present, Sri Lanka invests only 0.11% of its GDP in R & D, which is extremely low in comparison to global and regional standards (Table 1). Per capita GERD (i.e. Gross Expenditure for R & D) of Sri Lanka compares favourably with those of India, Pakistan and Thailand. However, this is little consolation because those countries have a much greater total investment in terms of GERD as it is the total investment that can make a significant impact on capacity building in

R & D on advanced technologies. This is especially essential for a country like Sri Lanka, with an extremely low share of high tech products (i.e. 1.8%)[7] in its manufactured exports.

Table 1: Indicators of investment in Research and Development in Science and Technology: International Comparison of Gross Expenditure on Research & Development (GERD) - Sri Lanka in comparison with selected countries

Country	†GERD ('000 PPP $)	(GERD as a percentage of GDP) %	GERD per capita (PPP $)	% contribution to GERD from private sector
Sri Lanka*	504,773.36	0.11	24.90	19.90
India	24,784,716.13	0.80	21.28	n.a. ‡
China	104,901,360.26	1.49	78.93	72.29
Malaysia	2,085,039.49	0.64	79.90	84.92
Thailand	1,205,910.66	0.25	18.13	40.92
Pakistan	2,751,785.37	0.67	15.89	73.25
South Korea	41,654,789.59	3.47	868.49	76.25
Japan	147,585,472.02	3.44	1158.48	77.89
United Kingdom	37,749,477.31	1.84	619.87	64.10
United States	368,799,000.00	2.67	1194.78	71.91

†Gross Expenditure on Research & Development

*Data for Sri Lanka and Thailand are for 2008 and 2006 respectively. For the rest of the countries, data are for 2007.

‡Not available

Source: Sri Lanka Science, Technology & Innovation Statistical Handbook 2008. National Science Foundation (NSF), Sri Lanka.

Another notable feature in Sri Lanka's statistics on investment in R & D in S & T is the low contribution from the private sector. In the developed countries, the private enterprises have their own research laboratories to generate innovations and new technologies. In addition, substantial research funding is provided to Universities and public-sector research institutions by private companies to carry out demand-driven research. In contrast, the private sector of Sri Lanka has extremely limited infrastructure of its own for research owing to a long tradition of importing technology or finished products with little willingness to invest in R & D for product development.

[7]This compares very poorly against other Asian countries such as South Korea (33.4%), Malaysia (39.6%), Singapore (50.8%), China (28.7%), Thailand (25.4%), Vietnam (8.9%) and India (5.7%).

Instead, the private sector of Sri Lanka prefers to fulfil its limited research needs by providing limited funding to Universities and public-sector research institutions such as the Industrial Technology Institute (ITI). **This is an important potential area of intervention through Banking Foresight where the banking sector can facilitate greater investment from the private sector in the building of national capacity for R & D in advanced technologies as public-private partnerships.** A recent example of such a win-win partnership is the setting up of the Sri Lankan Institute of Nanotechnology (SLINTEC)[8] under the National Nanotechnology Initiative (NNI). It is worth noting that studies have demonstrated high returns on investment (ROI) in R & D in S & T[9], especially in advanced technologies.

The limited involvement of the private sector in R & D in partnership with public-sector research institutions has been a significant contributory factor to the poor record of technology transfer and commercialization of research outputs of the public-sector R & D institutions.

(b) Inadequate Research & Development Institutes in Advanced Technologies

Globally-competitive products and services which require advanced technologies such as Nanotechnology, Biotechnology and Mechatronics are highly-dependent on research to generate the innovations that are essential to remain competitive in the global market. Similarly, significant value addition to the abundantly-available raw materials of Sri Lanka, which are currently exported in their raw form, requires research, very often in advanced technologies. Except for the Sri Lanka Institute of Nanotechnology (SLINTEC) and a few scattered Institutes for Biotechnology research, there are no research and development institutes for advanced technologies in Sri Lanka[10]. This not only limits the country's capacity to generate innovations to support development of value added products through advanced technology, but also causes brain drain of experts who are trained in advanced technologies.

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[8]Karunaratne, Veranja (2009). The Government of Sri Lanka launches nanotechnology as a priority research area. *Journal of the National Science Foundation of Sri Lanka* 37 (2): 81-82.

[9]De Costa, W.A.J.M. (2010). Investing in research. *Journal of the National Science Foundation of Sri Lanka* 38 (2): 77-78.

[10]Out of the 59 research facilities (consisting of national research institutes and university faculties), 23 (39%) are in Agriculture & Veterinary Sciences, 14 (24%) are in Applied Sciences (i.e. the 14 Science Faculties in Universities), 10 (17%) are in Health Sciences, 9 (15%) are in Industrial and Engineering Sciences, 2 (3%) are in Marine and Aquatic Sciences and 1 (2%) is in Fundamental Sciences.

(c) Lack of modern infrastructure for S & T and R & D in high potential areas

The existing network of national research institutes and tertiary education institutes, especially universities, do not have the infrastructure (i.e. laboratories, equipment, inputs for operation, testing, servicing and maintenance facilities etc.) to engage in cutting edge research leading to innovations which would enable production of globally-competitive goods and services.[11,12] This has been a consequence of continuous under-investment in S & T over several years. Out of the limited national investment on R & D (i.e. GERD) investment also, only a small percentage is spent on capital expenditure for infrastructure development[13,14]. Even the limited amount of modernized infrastructure development that has occurred is scattered in different institutes thus limiting its impact on stimulating innovations.

(d) Absence of a critical mass of trained S & T personnel in almost all high potential areas

The existing network of national research institutes do not have adequate numbers of trained manpower to undertake effective R & D to meet the needs of the industry and a competitive marketplace[15]. This has been the result of inadequate investment in S & T human resource development and poor remuneration of scientists and technologists leading to severe brain drain[16]The absence of a critical mass of trained S & T personnel also has a feedback effect in limiting the capacity of national research institutes, universities and other tertiary education institutes to undertake

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[11]De Costa, W.A.J.M. (2003). *Review of Activities of the Science and Technology Institutions of Sri Lanka.* Specialist Consultant Report prepared for the National Science and Technology Commission, Ministry of Scientific Affairs, Sri Lanka. 366 pp. This report highlights the decreasing capabilities of the public-sector S & T institutes in terms of infra-structure and trained manpower and recommends urgent measures to modernize infrastructure and develop human resource capabilities.

[12]Waidyanatha, U.P. de S., De Costa, W.A.J.M., Sanderatne, N.H., Marambe, B. and Fernando, B.R.L. (2010). *Review of Research and Development of the Department of Agriculture, Sri Lanka.* Consultant Report prepared for the National Research Council, Presidential Secretariat, Government of Sri Lanka. 218 pp. This report highlights the modest research output of the Department of Agriculture, which is the largest single R & D organization in Sri Lanka. It provides detailed recommendations for organizational restructuring, infra-structure development and human resource development.

[13]Out of the Rs. 5.05 billion of national expenditure on R & D in 2008, only 16% had been spent on capital expenditure (*Sri Lanka Science, Technology & Innovation Statistical Handbook – 2008. NSF*).

[14]Out of the average annual budgetary allocation of Rs. 1.82 billion for the Department of Agriculture during 2007-09 only Rs. 700 million (38.5%) had been spent on R & D. Out of this Rs. 700 million also, only Rs. 103.8 million (14.8% of the R & D allocation) had been spent on capital expenditure.

Review of R & D of the Department of Agriculture, National Research Council (2010).

[15]Sri Lanka has only 4037 researchers (a full-time equivalent of 1972), which amounts to only 200 researchers per million people (FTE of 98). This compares very poorly with the world average of 894, the developing country average of 374 and the levels of other Asian countries such as 729 (in Malaysia), 6028 (Korea) and 7059 (Singapore). Only 23% of the current R & D personnel are in the Engineering disciplines, thus limiting the capacity for generation of new technologies. Only a small number of the current researchers has expertise in Advanced Technologies such as Nanotechnology (15), Biotechnology (70), Electronics (28) and Mechatronics (02). The number of trained researchers and technologists in Sri Lanka needs to be increased to nearly 18,000 to reach the world average.

STMIS Database, NSF

postgraduate level training of local S & T personnel[17].

(e) Weak inter-institutional and industry linkages

Weak inter-institutional and industry linkages prevent sharing of limited infrastructure and human resources to engage in focused R & D to achieve targeted outcomes. This can also result in significant overlap of research between institutions and substantial gaps between industry demands and research undertaken.

(f) Absence of public-private partnerships and techno-entrepreneurship

Insufficient public-private partnerships act as a serious drawback in conducting demand-driven R & D in the public sector research institutes and universities. Absence of an enabling environment for techno-entrepreneurship acts as a major bottleneck in the transfer of technology generated by the national research and innovation system and its commercialization.

(g) Ineffective organizational culture

The organizational culture, management practices, work ethics and behavioural patterns of the majority of institutions in the national research and innovation system are not conducive to generate advanced technologies and market-competitive goods and services. This situation is exacerbated by the existing rules and regulations for administrative and financial management of public-sector R & D institutions.

(h) Low level of developmental research[18]

Advanced technologies which are essential to make the manufactured goods competitive at the global marketplace are often generated through developmental research. It forms, by far, the largest component of the total research portfolio of developed countries, exceeding 60% in Japan, Korea and the USA. However, developmental research forms only a small proportion of the research conducted in the public-sector research institutes and universities of Sri Lanka. Although

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[16]Research Scientists and Academics combined formed the highest percentage (71%) among a survey of 220 Sri Lankan expatriate S & T personnel, with more than 55% of them having PhDs (Anas, M.U.M. and Wickramasinghe, S.I. (2010). Brain drain of the scientific community of developing countries: the case of Sri Lanka. *Science & Public Policy* 37(5): 381-388).

[17]Sri Lanka produces less than 100 postgraduate research degrees per year (59-89 during 2007-2009) with less than 20% of the potential research trainers being engaged in postgraduate research supervision.

[18]Developmental Research (DR) is broadly defined as research that involves design and development of products, programmes, materials, processes etc. Its primary aim is to reduce the uncertainty of decision making in a complex process of design and development of products and services. Therefore, DR is essentially oriented towards achieving practical goals while advancing knowledge in the relevant sciences. DR is often initiated for complex, innovative tasks for which only very few validated principles are available to structure and support the design and development activities. [*van den Akker, J. (1999). Principles and Methods of Development Research. Kluwer Academic Publishers, Dordrecht, The Netherland*]

it constitutes the largest component in the research portfolio of the private sector, it is still very low in absolute terms because the extremely low total volume of research undertaken by the Sri Lankan private sector[19].

(i) Absence of a coordinating mechanism and an organized governance system for the National Research and Innovation System (NRIS)

The limited amount of S & T activities that take place in Sri Lanka are scattered in a wide range of institutions largely in the public sector[20], under several ministries, and to a limited extent in the private sector, with very little coordination and focus towards achieving national goals in technology generation and economic development. Similarly, there is inadequate coordination between different research funding organizations[21] and policy-making bodies[22].

The foregoing discussion on the current status of the NRIS highlights its extremely scattered and disjointed nature, inadequate infrastructure and human resource base, poor organizational culture and system of governance and the absence of inter-institutional and industry collaboration. All these features combine to make even the very limited investment on R & D in S & T in Sri Lanka ineffective. This necessitates a concerted effort, on the part of the government as well as the private sector, to modernize and re-vitalize the S & T sector of Sri Lanka, if Sri Lanka is serious about its officially-stated goal of doubling its per capita GDP by 2015 and becoming the 'Wonder of Asia'. The wide range of diverse strategies and actions to achieve the above national goal necessitates a clear and comprehensive national policy on Science and Technology. The next section describes the essential features of Sri Lanka's current National Policy on Science and Technology.

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[19]Science, Technology & Innovation Strategy for Sri Lanka: 2011-2015, Ministry of Technology & Research, 2010. (Available at http://www.nsf.ac.lk)

[20]31 National S & T Research Institutes are scattered across 14 Ministries. The 4037 researchers in Sri Lanka are scattered in these 31 research institutes and 16 universities.

[21]National Science Foundation (NSF) and National Research Council (NRC) provide research funding and equipment grants to individual researchers in all disciplines of S & T upon evaluation of research proposals submitted to them. National relevance is one of the primary criterions in evaluating research proposals. Council for Agricultural Research Policy (CARP), since its inception in 1987, provided substantial funding for research in Agricultural Sciences including Agroforestry, Livestock, Aquaculture and Fisheries. However, the contract research grant programme of CARP has been downscaled substantially during the last five years so that currently CARP funds only a very small amount of agricultural research.

[22]National Science & Technology Commission (NASTEC)

Sri Lanka's National Policy on Science and Technology

Although many of the National Research and Development Institutes of Sri Lanka are more than 50 years old, with the Ceylon Institute of Scientific and Industrial Research (CISIR), forerunner to the current Industrial Technology Institute (ITI) being established in 1955 along with the Development Finance Corporation of Ceylon (DFCC) to provide the required financial support, the formulation of a clear national policy on S & T to underpin R & D in S & T had received only limited attention, especially during the first four decades since Sri Lanka's independence from colonial rule. The first National Science and Technology Policy statement for Sri Lanka was drafted in 1978 by the then National Science Council, which later became the present-day National Science Foundation. This initial policy document was expanded further in 1991 by a Presidential Task Force on Science and Technology Development. The rapid pace of advancement in all areas of S & T necessitated a new national policy document in which new thinking and strategic directions are incorporated in to the essential features of the existing policy documents. Accordingly, the current national policy on S & T was formulated and approved by the cabinet of ministers in 2009[23]. The present National S & T Policy was formulated by the National Science & Technology Commission (NASTEC), the policy formulation arm of the then Ministry of Science & Technology (subsequently renamed as the Ministry of Technology & Research) through a consultative process involving a broad range of S & T professionals, both in the public and private sectors, and stakeholders from research institutions, universities, private sector industrialists, entrepreneurs and policy makers from various government institutions.

The National S & T Policy (NSTP) has focused on 10 broad policy goals (Box 1) and proposes strategies for achieving those policy goals. It has gone on to identify the main challenges that are faced by each of the proposed strategies and specifies initiatives to overcome those challenges. **The NSTP has specifically identified Research and Development in water, food, energy and environment and in the fields of Nanotechnology and Biotechnology, as well as Information and Communication Technology, Electronics, Advanced Materials and Mechatronics as priority areas.** Furthermore, the NSTP **encourages collaborative research partnerships between public-sector S & T institutions and industries,** with initiatives for developing clear institutional policies, approaches and systems for management of such partnerships with instruments such as operational agreements and MoUs, in particular relating to Intellectual Property Rights of innovations arising from such partnerships.

[23]National Science and Technology Policy, The Democratic Socialist Republic of Sri Lanka (2008). National Science and Technology Commission, Ministry of Science and Technology, Sri Lanka. (Available at www.nastec.lk)

Box 1: Broad Policy Goals of the National Science and Technology Policy of 2009[23]

1. Science, Technology and Innovation Culture

Foster a science, technology and innovation culture that effectively reaches all citizens of the country

2. Capability in Science and Technology for National Development

Enhance Science and Technology capability for national development, make use of Science and Technology expertise in the national planning process, and strengthen governance and policy implementation mechanisms

3. Human Resource Base

Build up, and progressively expand and improve the resource base of scientists and technologists necessary to respond to the developmental needs of the country

4. Research and Development

Promote basic, applied and developmental research, particularly in areas of national importance and priority

5. Technology Transfer

Develop, or acquire and adapt, scientific knowledge and technologies for transfer to achieve progressive modernization of all sectors and to enhance the country's competitiveness in the world economy

Another key area of focus in the NSTP is **the facilitation of Transfer of Technology**, both locally-generated and imported, by creating an active enabling environment with suitable policies and systems through a state-initiated facilitation process. It identifies the need to transfer technology as a package which includes not only the technology itself, but also the key elements such as marketing, finance, training and administration support. **The banking sector has the potential to play a crucially-important role in some of the above areas to bring about effective technology transfer.**

While emphasizing the need to develop advanced technologies leading to manufacture of high-tech products, the NSTP also recognizes the **need to develop appropriate technologies**

suitable for transferring to small and medium enterprises, particularly in rural areas, through collaboration among R & D institutions, the SME sector and other stakeholders. **This is another area in which strategic interventions from the banking sector could provide the impetus for a vibrant and competitive SME sector, which would be a vital component of Integrated Development.**

In addition to identifying the priority areas for R & D in S & T and encouraging public-private partnerships, some of the key strategies and initiatives identified in the National S & T policy are:

- Progressively increasing the investment for Research and Development in S & T up to 1.5% of the GDP from the present level of 0.11%, while facilitating increased investment from the private sector

- Increasing the number of researchers in S & T from the present level of 200 per million people up to the world average of 894 to develop a critical mass of scientists and technologists, trained particularly in advanced technologies as identified in the priority areas

- Increasing the number of engineering graduates and attract engineers to Research and Development while ensuring opportunities for advanced training with international collaboration

- Establishing a National Research Cadre of high calibre scientists and technologists including Sri Lankan expatriate scientists, based on international criteria, while ensuring suitable incentives to enable cutting-edge research

- Establishing a few world class research centres with state of the art facilities to carry out cutting-edge research in the identified priority areas

- Facilitation of scaling-up research based, innovative processes and technologies to pilot and commercial scales

- Facilitation of entrepreneurship and foresight activities among scientists, technologists, researchers, inventors and other stakeholders

- Promotion of cleaner production technologies which would have minimum adverse impacts on the environment and natural resources while ensuring sustainable use of biodiversity and minerals, marine and other natural resources of Sri Lanka

- Ensuring further development of traditional technologies to promote their application for demand-driven value addition while ensuring Intellectual Property Rights (IPR)

- Developing a culture of innovation and Intellectual Property (IP) by inculcating IP awareness among scientists and technologists, developing institutional policies and guidelines regarding innovations and IPR, establishing mechanisms to facilitate patenting of innovations and establishing suitable mechanisms to effectively exploit innovations

- Ensuring effectiveness of activities of S & T institutions to maintain quality standards of institutional products and services by establishing, implementing and maintaining internationally recognized quality management systems with periodic national and international review

- Using S & T inputs to ensure national security in water, food, shelter, energy and health

- Promoting research on causal factors and effects of natural and man-made hazards to support mitigation and management of disasters

- Developing research programmes to address mitigation, vulnerability and adaptation aspects in respect of climate change effects

- Ensuring and enhancing national defence capability and security from crime through research and application of modern S & T interventions

The National S & T Policy constitutes a comprehensive document which identifies all the key areas and issues that need to be addressed in bringing about integrated national development through advances in S & T. Some S & T institutions and ministries have incorporated some of the initiatives identified in the NSTP in to their corporate plans and R & D programmes. However, the highly scattered and disjointed nature of the S & T sector in Sri Lanka and the absence of a mechanism to coordinate activities of various S & T institutions under different line ministries have meant that no concerted effort has been made to implement the initiatives identified in the NSTP since its formulation and adoption by the cabinet in 2009. This highlighted the need to formulate a comprehensive and co-ordinated strategy to implement the NSTP. Thus, the five-year Science, Technology & Innovation Strategy for Sri Lanka: 2011-2015 was formulated in 2010 by a special task force under the guidance of the then Minister of Science & Technology. The essential features of the Science, Technology & Innovation Strategy are described in the next section.

Science, Technology & Innovation Strategy for Sri Lanka: 2011-2015[19]

The Science, Technology & Innovation Strategy (STIS) provides a strategic direction for implementation of some of the key initiatives of the National Science and Technology Policy and bring about accelerated economic development through advances in S & T. While the NSTP identified the whole spectrum of areas and issues that need to be addressed in the S & T sector, the STIS focuses on specific areas of strategic importance, which are identified as priority areas. Some of the key strategic areas where Sri Lanka has the potential to have a competitive edge in

the global marketplace have been prioritized for greater investment. Accordingly, the STIS is focused towards achieving four major goals (Box 2).

Box 2: Overview of the Strategic Direction of the Science, Technology & Innovation Strategy for Sri Lanka: 2011-2015[19]

Goal 1: An efficient system to actively harness innovations and technologies to generate and improve products and services to contribute towards doubling the per capita GDP in an equitable manner by increasing the high tech value added exports and the production for the domestic market.

Objectives:

1.1 Increase the high tech value added exports from 1.5% to 10% by year 2015 through the Advanced Technology Initiative
1.2 Achieve a marked increase of import replacement by strategic production and social activities in a competitive milieu through enhanced and focused research and development
1.3 Develop a dynamic technology transfer platform for wealth creation through the Techno-entrepreneurship Initiative

Goal 2: Well-established, dynamic and resourced world class National Research and Innovation Eco-system

Objectives:

2.1 Establish a system for efficient and coordinated S & T governance
2.2 Attract, build and retain strategic human capital needed to make Sri Lanka a leading knowledge and innovation hub in Asia
2.3 Create a comprehensive, world-class research and innovation system through a well planned S & T infrastructure and services modernization initiative
2.4 Ensure rationalized, increased investment in R & D supported by facilitated utilization
2.5 Facilitate international partnerships in promoting high end technology and research

Out of its four major goals, the generation of advanced technology **(Advanced Technology Initiative)** through a dynamic, well-resourced and world-class research and innovation eco-system **(National Research and Innovation Capacity Building Initiative)** and a dynamic technology transfer platform for wealth creation through the Techno-entrepreneurship Initiative are the principal strategies that underpin the STIS. Essential features of these strategic initiatives are described below:

Advanced Technology Initiative

The primary objective of this initiative is to increase the share of the high-tech value-added exports from the present level of 1.8% of the total manufactured exports to 10% by 2015. Some of the key initiatives proposed in the STIS to achieve this objective are:

An accelerated programme to establish Centres of Excellence (CoEs) in several thrust areas such as Biotechnology, Nanotechnology, Advanced Materials, Mechatronics, Electronics and ICT

These Centres of Excellence:

- Will be established as public-private partnerships involving the existing Public-sector Research Institutes, Universities and the private sector
- Will be equipped with state-of-the art equipment and facilities
- Will be located in one central location (e.g. a Science Park) to ensure maximum sharing of resources
- Will promote multi-disciplinary industrial and development-oriented research
- Will aim to be self-reliant through private sector funding for contract research and royalty and licensing income
- Will be provided with maximum autonomy and flexibility in governance and operational procedures

Traditional industrial sectors will be targeted initially for infusion of advanced technologies generated through the CoEs. Some of the industries targeted will be textile, apparel, leather, food and beverages, chemical, rubber, plastics and non-metallic minerals.

The Advanced Technology Initiative will also address generation and infusion of technologies that could lead to increased replacement of key imports to Sri Lanka **(the Import Replacement Initiative)**. The sectors and areas targeted will be:

- **Power and energy sector** with a view to reducing Sri Lanka's reliance on fossil fuel energy by technology generation to utilize alternative energy sources such as wind, solar, wave and different forms of renewable energy such as biomass, bio-fuel and bio-waste. The STIS also proposes to consider the nuclear energy option after careful assessment of safety, disposal of waste and cost-effectiveness.

- **Agriculture sector** with a view of reducing the costs of importing fertilizer and agrochemicals through generation of organic farming technologies and other forms of natural and traditional agriculture. Technologies that will enable reduction of some of the major food imports such as milk and other dairy products, technologies that will increase value-addition to raw agricultural products through increased processing and technologies that will reduce the wastage and postharvest losses, especially in fruits, vegetables and grains, will also be accorded a high priority.
- **Fisheries sector** with a view of generating better drying and canning technology and technologies to utilize fish waste.

- Technologies that will enable **value addition to mineral resources** such as ilmenite and graphite will be a major focus. For example, technology developed at SLINTEC has enabled production of Titanium Dioxide from Ilmenite, which is resulting in 250 times

value-addition. Production of Nano-Carbon from graphite has the potential for value-addition of similar magnitude. These advanced products can be the inputs for establishing high tech manufacturing industries in Sri Lanka.

- **Pharmaceutical industry** to enable reduction of the cost of importing pharmaceuticals by utilizing the rich biodiversity and natural products of Sri Lanka through technology generation. Utilizing the vast repository of indigenous knowledge on medicinal plants and their uses could be vital in this regard.

- **Engineering manufacture industry** with a view of generating technology to improve quality and competitive edge of locally manufactured engineering products such as water pumps, electric motors, engines, generators etc..

Techno-entrepreneurship Initiative

The Techno-entrepreneurship Initiative is one of the key areas through which the banking sector can contribute to Integrated Development. This will be an accelerated programme to facilitate transfer of the technology generated through research to commercial industrial enterprises capable of creating wealth. Commercialization of research outputs needs to go through several stages, which need to be supported and nurtured. These include technology/product incubation, scaling-up, quality control and management and marketing. Successful progression of a product through these stages requires a range of techno-entrepreneurial development services and business services.

The techno-entrepreneurial services include Start-up Grants, Seed Funding, Venture Capital, Fund-raising Services, Strategic Matchmaking and Innovation Services which connect the innovations and innovators to commercial partners. The business services include Business Incubation Services, IT Services, and Information Security Services etc. **The banking sector can get actively involved in the process of wealth creation through the Techno-Entrepreneurship Initiative by providing the required financial services.**

The STIS envisages to converge the Advanced Technology Initiative and the Techno-entrepreneurship Initiative within a network of Science Parks[24]. The proposed network of Science Parks will provide a platform to facilitate technology generation for value addition and product development through effective public-private partnerships and techno-entrepreneurship.

[24]A Science Park is defined as "an organization managed by specialized professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions".

The following three-tier network of Science Parks is proposed:

(i) Megapolis

This will be a 'world-class' facility with state-of-the-art technology, equipment and support services to generate high-end technologies through R & D for development of globally-competitive products and services. This will be located in Colombo or its suburbs.

In addition to the state-of-the-art infrastructure for technology generation, the Megapolis will bring together all the support services and stakeholders involved in the entire process of technology generation, product development, commercialization and wealth creation.

These will include facilities for technology incubation, financial services providing start-up grants, angel funds and venture capital, IPR services for filing, protecting and exploiting patents, advanced IT services and all other support services (i.e. secretarial and procurement services, electricity, water and waste disposal etc.).

The governance and activities of the Megapolis will be underpinned by fiscal and non-fiscal regulatory mechanisms and policies that will facilitate R & D to proceed with maximum efficiency.

(ii) Technopolis

These will be provincial level platforms to promote technology generation at the regional level through convergence of resources and capabilities of scientists, technologists, local communities, entrepreneurs and the business community. **The regional development banks could be actively involved in this process by providing the required financial services.**

It is proposed that two Technopolis will be developed initially with a view of expanding them to nine (i.e. one in each province).

(iii) Minipolis

These will be district level platforms linking the local communities, SMEs and micro-enterprises at the grassroots level with governmental and private sector support organizations and mechanisms to drive techno-entrepreneurship to create wealth at the district level. Some of the proposed mechanisms include Small Business Innovation Research (SBIR) and Small Business Technology Transfer (SBTT) schemes which are aimed at supporting the SMEs to innovate and transfer technology, giving priority to high-end technologies giving significant competitive advantage to their products.

Establishment of mechanisms to promote linkages between R & D institutions, universities and industry

Some of the mechanisms to promote linkages include:

- Introducing flexible institutional procedures to facilitate these linkages

- Establishing explicit mechanisms such as matching grants, contract research, consultancy, training, exchange of manpower along with the necessary legal framework
- Developing through appropriate training, the skills in scientists and researchers for business development and management, management of the IP portfolio, forging strategic alliances and collaborations to gain business advantage and ward off competition

- Encouraging R & D institutions to forge public-private partnerships in promoting their technological developments

- Establishing Technology Business Incubators (TBIs) and Technology Commercialization Units in Universities and R & D institutions to assist start-up industries and to upgrade existing industries

- Encouraging lateral mobility of scientists and technologists through Scientist-Entrepreneur Schemes and Industry Placement Schemes

Some of the other important initiatives proposed under the Techno-Entrepreneurship Initiative are listed below:

- **Establishing a National IP Centre** to file, manage and exploit the IP, both locally and internationally, of innovations and technologies generated through the Advanced Technology Initiative. The proposed National IP Centre should be supported by **a strong National IP Policy** and a legal framework and a team of professionals with expertise in all aspects of IPR. Hence, a human resource development drive in IP should accompany the establishment of the National IP Centre.

- Empowering micro and SMEs with ICT capabilities to network and to improve efficiency and productivity of their businesses

- Promoting linkages between R & D institutions, universities and industry

- Providing incentives to set up and sustain R & D units in local industry

- Encouraging private sector companies to invest in R & D through incentives such as attractive tax concessions and protection of IPR

- Encouraging and enforcing companies to have at least one third of the non-executive directors selected from people who are/have been active in S & T activities

- Establishing a conducive environment for foreign R & D companies to establish their R & D facilities in Sri Lanka and providing opportunities for capacity building and employment for local scientists and engineers

National S & T Capacity Building Initiative

The National S & T Capacity Building Initiative is the other essential link that is required to achieve the Advanced Technology Initiative and the Techno-entrepreneurship Initiative. Some of the key initiatives for S & T capacity building that have been identified in the STIS are briefly described below:

- Establishment of a **governance platform to co-ordinate all S & T activities** taking place in different governmental R & D institutions operating under different line ministries and in Universities

- Establishment of a **National Science, Technology and Innovation Council as the instrument of the governance platform** to carryout policy making, plan implementation and progress monitoring and evaluation functions in relation all S & T activities

- Establishment of a **National Technology and Research Fund** to receive *en bloc* the annual allocation for S & T from the national budget and external funding sources and to be operated as a revolving fund

- Establishment of a **National Research Cadre** of Scientists and Technologists to be tiered structure with promotion and continuation to be based purely on R & D performance with attractive remuneration packages

- An aggressive **human resource development** drive to increase the number of trained S & T personnel in all areas of S & T including S & T administration, research, research support, technological support, IP management, infrastructure construction and maintenance, scientific testing, maintenance of quality standards and certification, technology transfer and science education and public awareness

- Re-organizing and modernizing the National Research and Development Institutions and Testing Services to international quality standards

- Establishing a patents pool, with measures to protect patents owned by Sri Lankans and facilitating their exploitation for wealth creation

- Development of **strategic international partnerships** for R & D and human resource development through short- and long-term training

Concluding Remarks

The national policy on S & T and the ambitious strategy for spearheading Sri Lanka's drive towards integrated economic development through advances in R & D in S & T provide opportunities for the banking sector to share the benefits of economic development while contributing to the country's economic revival and social wellbeing. Some of the areas to which the banking sector has the greatest potential to contribute are:

(a) Facilitating technology transfer from researchers to entrepreneurs by providing the required financial services at all stages of the technology transfer and commercialization process;

(b) Providing the capital for increased investment in R & D in high-priority, high-impact, high-return areas such as advanced technologies (e.g. Biotechnology, Nanotechnology etc.) via public-private partnerships;

(c) Providing financial support to SMEs and micro-enterprises to improve quality of their products and services through innovation and adoption of improved technology;

(d) Providing the techno-entrepreneurial development services and business services to facilitate techno-entrepreneurship within the setting of Science Parks.

While there is undoubted potential for wealth creation and accelerated economic development through advances in S & T, a broad range of players from diverse areas of the economy and society have to come together to realize this potential.

Firstly, there should be a strong political will on the part of the policy makers to acknowledge the above-described potential of S & T and substantially increase the investment in S & T to bring about its rapid advancement. A similar commitment for investing in R & D in S & T is required from the private sector as well. A significant portion of the increased investment will have to be channelled for upgrading the National Research and Innovation System, while ensuring adequate investment in human resource development in S & T. Along with increased investment in the National Research and Innovation System, there needs to be a paradigm shift in the organizational culture and the operational behaviour on the part of the scientists and technologists. This paradigm shift should be towards achieving greater professionalism and sharing of resources through formation of productive inter-institutional linkages. The culture of R & D should move towards a research portfolio with a greater portion of demand-driven research with direct commercialization potential. The increased participation of the private sector and banking community should be underpinned and incentivized through mechanisms such as tax concessions. Above all, there needs to be a sense of collective commitment and trust on the part of all stakeholders so that each can play its part with the assurance that its investment will not be wasted.