



CARIBBEAN COUNCIL  
FOR SCIENCE AND  
TECHNOLOGY

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**Science Technology and  
Innovation  
Framework for the  
Caribbean**

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## **1.1 Rationale**

CARICOM countries are already wedded to regionalism in most areas of national development. The widening of that regionalism to include Science Technology and Innovation is inevitable. Caribbean countries, individually and collectively, have for decades given emphasis to and have been cooperating in several aspects of Science and Technology. Considerable work has been done especially in meteorological sciences, in Health and Agricultural and Food sciences, in professional level training and technical information sharing, among others. Significant institutional building has taken place in most member countries. However, the absence of coordinated and integrated policy approaches has been a major deficiency. The emphasis on individual development in Science and Technology, while yielding positive results for individual countries, has left the region as a whole deficient and sub-optimal.

The principal value of a Regional Science and Technology Policy is that it affords an opportunity for coherent development initiatives that maximise economic performance of the whole while optimising the use of resources and enhancing the social welfare function of our peoples.

Indeed the main focus of the Policy will be the role of governments in fostering scientific and technological progress for the economic growth of the region and greater social well being of our peoples.

The preferred mechanisms should be based on harmonising national strategies in S&T and creating complementarity. They must also seek to strengthen links between science and economic activities to the benefit of all sectors in the economy. Prioritization of Research and Development, information dissemination, human resource development, and utilization of results require a regional perspective and focus. Considerable progress can be achieved through policy definition, greater regional cooperation and improved networking.

The creation, distribution and exploitation of knowledge offer a competitive advantage in wealth creation and in improvements in the quality of life.

## **1.2 Science, Technology and Innovation in a Global Context**

As other Regions form larger and larger economic blocks, and as they initiate new trading regulations and agreements, Caribbean countries are

finding it increasingly difficult to compete. This situation makes it absolutely vital for Caribbean countries to themselves tighten their cooperation across the full range of development areas, which will allow them to survive, compete internationally and sustain development.

Innovation is a key driver of long-term economic growth, and competitiveness in world markets.

CARICOM at this time faces the challenge of strengthening scientific, technological and innovating systems to entrench its development and the move towards a knowledge-based economy.

### **1.3 Challenges and Scope of ST&I Policy**

Caribbean nations are already well aware of the critical role of Science, Technology and Innovation. Yet, there is still an arms-length approach to this issue, treating it as a stand-alone activity rather than as an integral component of the national development planning. There is need to integrate ST&I as a legitimate development sector with cross-cutting linkages to the other productive sectors of the economy, and therefore deserving of integrated decision making at the highest level of policy definition, planning and implementation. The region as a whole has yet to achieve such a level of integration.

The diffusion of technological advances throughout society challenges traditional modes of administration. Previously, the pursuit of scientific endeavours was left to scientists. However, the multiplication of the direct links between Science, Technology and Innovation and the other sectors and sub-sectors of the economy requires new approaches.

New and innovative management styles are necessary to maximise the potential benefits of technological innovation and advancement. The creative and unpredictable dimensions of Science, Technology and Innovation require greater management flexibility and improved information networking. It requires particularly the removal of obstacles and the promotion of an environment of change and inventiveness, including a system for recognition and reward of inventors and innovators, protection for patents and intellectual property rights, and for the users of inventions and innovations.

## **1.4 A Culture of Science, Technology and Innovation in the Caribbean.**

As with all aspects of culture, attitudes towards science and inventiveness must be promoted, cultivated and sustained as an integral part of the consciousness of Caribbean peoples at all levels of our communities (school, work or social group). ST&I would flourish when a new habit of science is cultivated and rewarded. In developing a science culture in the region, Science, Technology and innovation must become familiar, down-to-earth issues, and part of our daily tool of operation at home and at work. The internalisation of technology must become commonplace.

Sufficient factual scientific know-how must be at the ready disposal of Caribbean peoples to enable and encourage them to solve day to day problems and to absorb and make rational economic use of ST &I.

In the new knowledge-base international environment, it is knowledge and creativity that will give nations their competitive edge. The cornerstones of innovation are originality and creativity. As a region, there is a need to develop the potential of our people by fostering that creative spirit of innovation. Changing attitudes and fostering creativity in ST&I is partly social conditioning which can be triggered through relevant changes in curricula and in teaching methodologies, so as to encourage new paradigms in thinking.

Immersing young minds into the psychology, culture and pursuit of inventiveness requires a nurturing climate. Integral parts of ST&I include observation, deductive reasoning, research, experimentation, and problem solving. These skills can be incorporated as pedagogical tools in school curricula delivery, thereby conditioning young minds to develop innovative patterns of thought.

The stimulation of entrepreneurship should evolve consequentially, as the compelling need for earning a livelihood triggers the application of creativity and inventiveness into economic activities.

Needed too are policies and activities that encourage and nurture the growth of the successful entrepreneur. Some of these activities include:

1. Changing teaching practices and activities to generate attributes of creativity and entrepreneurship,

2. Establishing of user friendly centres for research and information.
3. Reduced costs and bureaucracy for the protection of intellectual property
4. Effective methods for identifying and rewarding innovative practices in all communities from grassroots to academia and from any age group.
5. Bringing innovation centre-stage into the national consciousness
6. Supporting R&D with incentives and rewards especially for the successful innovations.

## **2.1 Popularisation of Science**

By international standards, the size of the CARICOM's human resource base in Science and Technology (S&T) is very small. Statistics show that approximately 15-20% of the student cohort writing the CXC examination do so in Science subjects. Of this percentage, approximately 50% pass the examinations with approximately 55% obtaining a Grade III.

In order to build a sustainable regional community of scientists and innovators, there is urgent need to increase the numbers of students pursuing Science subjects and to increase the success rate of students writing the CXC examinations. This will constitute a foundation for the CSME'S competitiveness and the development of the knowledge-based economy.

For most students in the region, Science education is an alienating experience. Popular notions include that science is difficult and it is only for the few gifted students. These attitudes, fuelled by poor science teaching, account in no small measure for the large numbers of technology illiterates in our societies and the small stock of scientists, researchers and innovators.

A large societal base that is science literate, technologically alert, creative and innovative is essential for living and working in this new age of technology and knowledge. S&T literacy is therefore an important survival skill.

Popularisation of Science, and progressive science teaching methods are critical to demystifying S&T. Popularisation of science will demonstrate its commonplace applications to day-to-day living. Demystifying Science and

Technology would encourage young people to be venturesome, more creative, and would motivate them to aspire to careers in science and engineering. Global research shows that the establishment of Science Centres are effective in this regard and constitute an important aid to formal science education and the development of an S&T literate citizenry.

CARICOM member countries should embark on a science popularisation programme encompassing some of the following:

- Science Centres, with feel and touch science exhibits; and where the emphasis on hands-on participation shall be developed as a science education resource;
- Seminars and workshops involving all segments of the national community;
- Programmes for the promotion and recognition of inventions and innovations;
- National awards for excellence and contributions to STI at all levels;
- Greater emphasis on quality STI materials available through public libraries;
- Promotion of improved teacher training in science and technology;
- Promotion of activities within the private and public sectors which lead to greater STI awareness and experimentations and problem solving within the workforce;
- Promotion of greater awareness, understanding of, and consideration to, the region's scientific heritage;
- Promoting knowledge of regional pioneers in STI;
- Production of science magazines, websites with scientific content, books, films and videos.

### **3.0 Science and Technology (S&T) Education**

There is a need to optimise the benefits of education and training. The potential of S&T for the promotion of regional development goals can only be realised in the context of sound educational systems. The new technologies require skilled workers but the relevant skills are more readily accessed by literate and numerate populations. The development of the scientifically knowledgeable and innovative citizen begins at the earliest stages of the education cycle when attitudes to inquiry and creativity are moulded. Education must be equated with bringing out and rewarding the

creative forces rather than mere regurgitative skills. Teacher training and orientation at all levels of the system and the organisational and managerial aspects of the system itself need to be redirected to bring them into congruence with the emerging perspectives concerning the development of creative and adaptive persons.

The achievement of competitive advantage depends heavily on the relevance of provisions for education and training, and a shared commitment to lifelong learning. Tertiary education has already become prerequisite for most jobs in the knowledge society. The perspectives on tertiary education however, need to be broadened to encompass other forms of learning and increasingly, non- university types of institutions and programmes. Another important aspect of tertiary provision is the operation of a seamless system of qualifications and agreed accreditation procedures.

Among the major objectives in Education and Training are:

- (a) Development of a community of highly skilled and committed scientists and technologists in the region who are responsive to the needs and potential of the region
- (b) Fostering of a culture of research among students
- (c) Addressing the gender dimension of science and its impact on society.
- (d) Development a cadre of skilled technicians
- (e) Creation of a level of scientific and technological literacy in Caribbean populations that would allow them to function with competence and confidence in a society that is increasingly being influenced by knowledge, by S&T, and to provide informed support for Caribbean scientists and technologists.
- (f) Fostering entrepreneurial activity based on the application of technology and innovation. Stimulation of a competitive spirit and creative aggressiveness as required in knowledge-based activities.

#### **4.0 Human Resource Planning**

Human Resource Development encompasses not only education and training but also the effective use of knowledge and skills. Particularly relevant in the present context is recognition of technical, organisational and cultural

aspects of technology and the imperative of aligning social and cultural organization with technological development.

Important considerations in the implementation of an efficient and effective system for Human Resource Development must include:

- The development of labour market information systems, and predicting human resource needs in strategic fields such as engineering, biotechnology, environmental science.
- the development of mechanisms for linking the worlds of work and education/training so as to address issues of relevance, of demand-driven provision of training, facilitate student career planning, and more strategic recruitment and retention by employers
- Re-engineering of organizational systems [for development and use of human capital] to make them flexible to facilitate innovative and creativity and efficiency in output.

Particularly important in the present context is recognition of technical, organisational and cultural aspects of technology and the imperative of alignment of social and cultural organization with technological development.

Human resource capacity development in key scientific areas is mandatory at professional and post graduate levels in such priority areas as:

Engineering, especially  
    Chemical, petroleum, mechanical, and computer  
    Metallurgy  
Biotechnology and Biosafety  
Integrated Water Resource Management  
Waste management  
Soil specialisation  
Agriculture and agro business  
Marine studies (engineering, fishery, ecology, etc..)

## **4.0 Policy Advice**

Governments' policies play the pivotal role in creating a suitable environment for the application of science and technology for economic transformation. Most Caribbean countries possess institutions including Ministries with responsibilities in S&T; but they tend to operate with little or no coordination or central focus. This fragmented approach to ST&I in policy formulation, in management and operational focus often result in duplication of efforts, sub-optimal use of resources and inefficiencies in achievements.

Effective governance structures nationally and regionally are needed to improve priority determination, resource allocation and application of results.

One of the key areas of ST&I which requires policy adjustment is the way in which governments receive advice related to the priority and resource allocation, and the use of ST&I in development planning and budgeting. Nations have adopted varying methods to address this deficiency, but the one which has proved most effective for small countries is the establishment of National Science Councils. Many regional States already possess such Councils, but the Councils are often weak and defective, or are side lined, and exercise little influence in national policy making. They invariably suffer from lack of funding and human resources. Science Councils must become an essential component of development planning and budgeting.

Science Councils must be structured to secure independent and private sector inputs into the national policy and planning of S&T on a continuous basis from a wide cross section of the society, especially from technology users.

## **5.1 Planning and Finance**

The myriad ST&I activities that form part of the developmental strategies of Caribbean States all require serious planning and funding if they are to be successfully implemented.

Caribbean governments have already recognized that S&T is too critical an area of activity not to be included in the national planning stage.

To ensure that S&T considerations are structured into the national development planning process, Member States are encouraged to:

- (a) Identify and incorporate in each Sector Plan the technological needs to fulfil the goals, objectives, and targets of the sector and of selected projects;
- (b) Establish a component for review and evaluation of results.

## **5.2 Research and Development**

Scientific research and technological development are at the heart of what makes and shapes a society. The governments of the region are the major source of funding in R&D activities. A snapshot of the existing situation in R&D in the region reveals that governments' investments are low, at approximately 0.13% or less of the GDP.

Links between research and production are also very low, with little industry investment and a very small trained work force to draw upon. There are currently few government programs to encourage industry research co-operation. Less than 1% of government funding is used to encourage technology development by private industry in most countries and the private sector itself spends approximately 0.02% of GDP on R&D. The region has approximately 0.15 scientist/engineers per thousand population (or less in some cases) a very low figure compared to 6 or more in advanced countries.

The percentage of GDP spent on R&D in developed countries varies from 1% to 4% of the GDP. In Latin American countries, it is less than 1%, Costa Rica is 0.20%, Venezuela is 0.47%, Mexico is 0.35% while Singapore and Ireland two countries which were at similar stages of development as small island states are 1.88% and 1.21% respectively.

An active R&D programme is an essential investment in the region's future.

Direct forms of government support to encourage private sector Research & Development is an area for priority attention. Tax incentives, grants and loans and government financing will also need to be tailored to the specific financing obstacles that regional firms confront. New strategies have to be formulated for attracting higher levels of public and private investments in scientific and technological development.

Support for R&D in Small and Medium Sized Enterprises (SME's) will remain an important element of the policy mix.

Innovative fiscal measures are critical to ensure successful implementation of the policy objectives.

Therefore a regional policy should propose:

- To guarantee the establishment of an efficient, agile, flexible financing system composed of funds coming from national contributions, and regional and international sources.
- To prepare strategic projections for science, technological and innovation on a regional level as a base for the determination of prioritized programs of science and technology.
- To formulate incentives for R&D activities, particularly in Industry, Agriculture and Services, and for attracting higher levels of public and private investments in scientific and technological development.
- To reinforce regional R&D projects to enhance competitiveness and future industrial development.

The region will need to build:

- RD&I linkages that stimulate partnerships in delivering public and private goods and services.
- A private sector, which values and performs research because it sees the potential commercial advantages.
- A private sector which matches or outperforms its counterparts in other countries in exploiting research and technology.

In order to build R&D capacity for sustainable development and to stimulate innovation for competitive growth, the region will also need to:

1. Create linkages between the University, S&T Institutions and industry.
2. Increase the level of investment in R&D to at least to 0.3% of GDP in the medium term
3. Promote sustained improvement in S&T infrastructure.
4. Facilitate innovation financing.
5. Create a strong incentive regime for technological development, research and innovation.

The challenge to Caribbean institutions is how to allocate adequate funding for the support of research and development from the modest financial resources that is generally available.

The creation of the CSME provides the framework and mechanism for promoting a technologically integrated region.

Among other things a CARICOM innovation-support mechanism must be a part and a tool of the CSME.

## **6.0 SPECIFIC POLICY AREAS**

### **6.1 Agriculture and the Food Sector**

The issue of food security is an area of priority for the CARICOM. Countries that are successful in agriculture invest considerable sums in research and development in areas as:

- improving primary production
- marketing,
- processing,
- developing attractive and competitive value added products,
- competitiveness.
- Developing best agricultural practices with regard to the use of the natural resources

CARICOM countries would need to follow suit and to extend investments in science and technology to other areas which are technological threats:

- Mitigating the effects of global climate change on agriculture
- Protecting the genetic resources of the Caribbean

Further, support measures would include:

- Improved teaching of science in order to make science an attractive career path for young scientists in agriculture
- Greater collaboration among regional institutions involved in research and development within agriculture.
- Improved linkages with international agricultural scientists
- Improved linkages between extension and research and development

### **6.2 Environment and Natural Resource Management**

The Caribbean is blessed with diverse but fragile natural resources. These must be managed effectively to sustain present and future population.

Natural Resource Management issues must be multi-sectoral and interdisciplinary. The lack of information is a major threat that continues to plague efforts to plan more scientifically.

Other critical regional challenges depending quite heavily on S&T for solution include:

- **Biodiversity Conservation**
- **Climate Change**
- **Sustainable Management of Land Resources**

### **6.3 Disaster Management**

Disaster Management in the Caribbean region has evolved from the ad hoc and reactive preparedness mode to one that is disciplined and structured. Focus must now also extend to research on causes of natural phenomena and contributory human behaviour activities that aggravate them; developing practical technological solutions for pre-disaster preparedness, and mitigation and management of post-disaster situations.

Related focal areas would include:

- Building Codes
- Hazard Mapping
- Land Use Mapping
- Disaster Forecasting and Modelling
- Data Collection/ Research Studies

### **6.4 Health**

In the area of Health, R&D in food related issues such as nutrition present the greatest challenge. Research and development in the use of herbs and spices offer valuable potential alternative economic activities.

### **6.5 Alternative Energy**

Alternative technologies in hydro, solar, wind, and geothermal energy as well as fuel technologies have remained largely undeveloped and under-utilized in the region.

A key prerequisite to developing alternative energy is scientific assessment and evaluation of existing alternative energy resources.

Human capacity in energy within the region must be strengthened to provide technical expertise in assessing and evaluating alternative energy sources and technologies. Capacity building programmes should produce regional energy experts..

The Region should also embark on an aggressive energy efficiency and conservation initiative, employing the latest technologies available in its overall strategy to reform the energy sector.

## **6.6 Information Communication Technology (ICT)**

The Region must accelerate the completion of its ICT Strategy and Plan. The Plan should pursue the objectives such as:

- Raise and develop awareness, build vision and generate enthusiasm about the advantageous use of ICT in everyday social and economic life
- Design and implement policies to capture information and knowledge for development
- Promote and build connectivity and the necessary infrastructure for access to information and development
- Build required human and social capacities and institutions, and provide training and education to impart requisite skills
- Create new livelihood and employment opportunities;
- Empower communities and disadvantaged groups; reinforce participatory approaches and good governance and foster networking;
- Build a public service that allows and encourages electronic access to public information, and facilitates low-cost electronic transactions with the civil society.

Integral to the implementation process will be -

1. Government's leadership and the commitment of resources
2. Smart Partnership with key sectors.
3. The involvement of all stakeholders in the execution and the continuing development of the action plan.
4. Rigorous pursuit of results within the planned timeframes.

## **6.7 Standardization**

CARICOM has already taken steps to develop regional capacity and processes in Standards. This must now be given exposure at popular level. Deepening standards into daily economic activities would require, among other things:

- Establishing and upgrading of national and regional facilities for industrial and legal metrology, product quality and testing, sectoral calibration and testing framework.
- Popularizing and simplifying information on standards, and encourage metrological practices among vendors and self-employed;
- Popularizing standards and metrology among the young;
- Capacity-building programs for improved quality and industrial management.
- Setting up and upgrading of national and regional standardization bodies, networking of standardization bodies at regional and international level.

## **6.8 Waste management**

Reducing the amount of waste that a nation produces is a crucial aspect of sustainability. It is therefore critical that appropriate and sustainable waste management systems be promoted both at national and regional level.

Adequate attention must be given to the planning, implementation and maintenance of collection of transfer systems, waste recovery, final disposal and hazardous waste management.

Technological cooperation to reinforce the capacity to improve hazardous waste management and promote adoption of clean and sustainable technologies should be on the national agendas of all countries. Setting priorities on actions to prevent and reduce human exposure to hazardous wastes and ecotoxicologic damage is of great importance, as is research on the health risks of exposed populations and the protection of populations at risk.

Regional governments can focus on developing incentives and introducing various mechanisms to encourage recycling such as home composting and promoting educational, institutional and promotional programs in waste reduction.

## 6.9 Water

Water is a finite and vulnerable resource, essential to all life. CARICOM comprise mainly small island States, characterized by a high degree of stress on the environment, and dominated by concerns of domestic water supply.

The key areas of action to support a sustainable future for water as identified in the Caribbean's Water Vision Exercise (March 2000) include public education and awareness, improved efficiency of institutional and organizational structures, improved research and quality of information, support for poverty reduction, stakeholder participation in water resources management, maintenance of environmental integrity and securing financial resources for the sector.

Science and technology must therefore seek to address issues to eradicate or alleviate the problems identified in the Water sector, and develop best management practices in relevant aspects.

Some of these problems are:

- Lack of integrated water management
- Lack of harmonized legislative and regulatory framework
- Inadequate data collection, analysis, assessment and data/information quality control
- Poor water quality and pollution management
- Inefficiency of water use and lack of conservation programmes
- lack of investment in the development of research
- lack of a sound research information base
- lack of irrigation technology

Science in the Water sector should therefore be utilized to better enable the formulation and implementation of environmental, land use and development policies and support effective decision making. To accomplish this, it will be essential to enhance scientific understanding and strengthen technical capabilities in all countries, improve long-term assessments, and ensure that the scientific activities undertaken are geared to meeting emerging needs.

## **6.10 Marine Resource Management**

Marine resources are important to the people of the Caribbean. The Caribbean marine resource is of major importance to the region as a whole. The diversity of marine fauna makes it necessary to develop and implement a well-coordinated process of harvesting.

The sustainability of the fishing industry is of major importance. There needs to be S&T research activities throughout the region that can be utilized effectively to minimise over-fishing or which do not create non-capacity.

Key science and technology issues that need to be addressed include the following:

- i. Improved scientific information to increase the capability for optima; decision-making.
- ii. To improve management for economic growth and sustainability
- iii. To establish the policy, legislative and regulatory and institutional framework.
- iv. To promote regional and international cooperation

## **6.11 Sustainable Tourism**

The Tourism and Leisure Industry continues to grow at a steady pace. As visitor arrivals increase, there is a concomitant increase in the stresses placed on the region's fragile ecosystems and limited natural resources. The long-term survival of the tourism industry must be framed within a context of sustainability. This can only be achieved if the ecological and cultural ramifications associated with the expansion of the industry are identified and addressed promptly.

The following are some of the major areas which S&T can assist in addressing sustainable tourism:

- Agriculture/Agro-processing
- Waste management
- Water management
- Application of Information and Communication Technologies

## **6.12 Development of Small, Medium and Micro Enterprises**

The majority of new jobs in the economy is created by small, medium and micro size enterprises. The small, medium and micro size enterprises (SMMEs) in general are isolated from their own national and regional capacity in science and technology.

Linkage between national R&D institutions and the small enterprises can help them in the selection of technology, adaptation of technology and training, tailored for local conditions. The relationship can help change the mind-set of small entrepreneurs and encourage sustainable change in the enterprises.

## **6.13 Biotechnology**

Biotechnology is one of the most promissory technologies of our times, that utilises technique to manipulate biological systems, providing goods and services. Nanotechnology interfacing with biotechnology could complement and expand the application possibilities significantly. Hence there is a need for parallel investment and integrative development across these fields. Biotechnology can provide significant benefits to society through the improvement of the quality of life. These benefits accrue to, but are not limited to, economic development, health, agriculture, industry, environment and social welfare. To achieve biotechnology proficiency, the region must:

- Develop a strategy that defines priorities and goals for biotechnology development and trained human resources.
- Increase their commitment to research and development. Biotechnology research must be product-oriented.
- Establish collaborative effort at the hemispheric level,
- Develop human resources and infrastructure in biotechnology, Establish legal framework within which biotechnology development occur. Lack of clear regulation and laws regarding research and use of biotechnology products and the deficiency collaborations between and within the Caribbean and North America and Europe are important factors for insufficient development of biotechnology in the Caribbean

## **7.0 Regulatory Framework and Intellectual Property Rights**

One of the issues brought to the fore by treating innovation as a national priority is that of intellectual property rights. These rights need to be correctly and strategically used in recognition of their importance in a competitive environment. The fullest protection of competitive intellectual property from must be encouraged and promoted.

Protection is a strong stimulant for investment by private sector in Research and Development. Research is not only expensive but is also a risky business. It is reasonable for the investors in Research and Development to expect protection of the law in recovering the benefits of their investment.

Policymakers in the Caribbean need to introduce appropriate regulations and laws to encourage and promote ST&I development through the protection and use of property rights. Adjustments, of the Intellectual Property Rights legal system will also be required to respond to a changing environment. Well-developed regulations can serve to stimulate innovation and enhance the competitiveness of the regions' industry.

The general population as well as researchers and innovators need to become conscious about their rights and responsibilities in the area of intellectual property and patents registration and management.