Towards Establishment of a Framework for Use of Science & Technology in Regional Development

a contribution from the

Caribbean Council for Science & Technology

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1. Introduction [to be completed by Chairman CCST]

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1. Rationale

A regional policy in Science & Technology provides a framework to guide the choice and judicious application of science and technology for national development. While it cannot substitute for national policies and actions, it provides a regional basis and perspective for specific national policies. However small a country might be, there are several issues relating to national decisions and choices over which it potentially has only partial control. This potential is improved through some regional cohesion in the decision-making process, and a regional policy framework provides the chance for such integration to be articulated and developed.

The value of a Regional Science and Technology Policy lies in the opportunity to harmonise key initiatives which can redound to the greatest benefit to Caribbean nations. It also provides the chance to optimise regional resource use and allocation in Science & Technology. Much of these efforts may be achieved through networking, whose fundamental principle lies in establishing a common set of goals and objectives and developing a common mechanism to achieve such goals and objectives.

1.2 On The Nature And Scope of Science And Technology

Science can be defined as knowledge ascertained by observation and experiment, critically tested, systematised and codified under general principles. Technology can be considered to be the use of knowledge for the production of good and services to meet the development needs of a population.

Advancement in modern technology is increasingly science-led. At the same time, by providing new modes and instruments of observation and experiment, technology contributes to the advancement of science. Thus, Science and Technology have a synergistic relationship, and for this reason they tend to be paired as though representing a single entity, that is, “Science and Technology” (hereinafter referred to as S&T).

It is important to recognise that Science & Technology is a cross-cutting tool, the use of which improves efficiency, quality and productivity. It is essential to most sectors of society, including the wealth-creating areas of agriculture, manufacturing and industry, and natural resource exploitation, as well as the service-oriented sectors of health, transportation, education, communication, and energy.

Indigenous research and experimental development work are important in using the methods of S&T to gain a better understanding of the immediate environment and to derive tangible physical benefits therefrom. Equally important are the results of those scientific and technological activities which, though taking place elsewhere in the world, may nevertheless have an impact on countries in the Region. The Internet is one simple example in the latter category.

A S&T policy must be sufficiently broad as to comprehend the crucial issues in all the areas outlined as falling within the ambit of S&T.

Policy is a framework for action. There is , however, a range of potential actions and alternative arrangements. The S&T policy must thus establish criteria for generating, identifying and choosing between the various alternatives and direct action relating to the application of S&T to the development process.

In the specific circumstances of the Region, one objective of a S&T policy is to provide a framework for the appropriate action urgently required at the national and regional levels to address inter alia, the reality that there is:

1. falling productivity, a worsening of the terms of trade and a systematic erosion of metropolitan markets for traditional regional products;
2. gradual loss of comparative advantage with respect to labour inputs in industrial enterprises because of increased levels of automation in industrial plants in the industrialised and industrialising countries;
3. an apparent inability at the national level to swiftly adjust national policies and strategies in response to technological and market changes at the international level; and
4. a rapid widening of the knowledge gap between industrially advanced countries and Third World Countries, including the Caribbean.

Special attention also needs to be drawn to unemployment and poverty. These two issues, along with poor education form a vicious cycle in which whole communities are trapped. It is the ultimate objective of any policy or programme to reduce or eradicate poverty because of its debilitating effect on the human spirit. By focussing on any of these three areas, one reduces the effects of poverty, and provides the opportunity for its final eradication. The S&T policy for the Region, recognises that in a country's development process the harnessing of its human potential is comparable to the harnessing of its physical resources. It takes the view that in the technological age the two most critical factors to development will be information and education.

In these circumstances, the S&T policy envisages that at the national and regional levels, decisions will have to be made on an on-going basis about specific areas in which sound knowledge and attendant skills must be developed. Within the areas identified, countries working individually or collectively need to formulate innovative strategies and plans of action in order to achieve the required base of knowledge and skills.

1.3 Science And Technology in Society

The continual development and application of S&T in the Caribbean will depend significantly on the creation of a climate and infrastructure for S&T to become an integral part of Caribbean culture, and the recognition that S&T matters are the concern of not just a few, but of the whole society. Programmes designed to create such acceptance and general understanding should be encouraged.

It is important to identify technology which is appropriate to the Caribbean and to train a workforce which can apply those technologies to produce a Caribbean in which we would all like to live, and which we will pass down unspoilt to our children or in better condition than that in which we received it. This does not necessarily imply the use of simple technology as Caribbean peoples are capable of the most advanced technologies, but rather technologies which are appropriate to our climate, size, material resource endowment etc. Thus, Science & Technology is considered to be pivotal in the promotion and embracement of the principle of sustainable development.

2. A Vision of the Caribbean in the Future

We see the Caribbean in the future as a part of the world where the people have a high quality of life with the entire population having its basic needs satisfied - food, clothing, shelter, education, health care and employment.

Such a people live in an environment of equally high quality - clean air and water, clear running streams, healthy coastal and marine systems, an environment where the diverse ecosystems are conserved and maintained as part of the developmental process, and the people are adapted to life in a multicultural society, are attentive to the needs of others and are dedicated to preservation of the best of our traditions.

The development of the human resources and the application of S & T in the Regional context must be focussed on the realisation of such a vision. Faced with the effects of globalization, this vision of the Caribbean Region includes that of a single-market economy, where the rights of each country and its peoples will be enshrined in international law and social justice.

2.1 The Position of Science And Technology in Achieving This Vision

To achieve this vision, a planned developmental path must be pursued both nationally and regionally. Such a path will be expected to optimise the utilisation of the regions's resources, achieving greater efficiency, quality of output and productivity. This can be best achieved through an integrated approach to planning, that foresees the importance of certain important initiatives which have major spin-off benefits in all areas of the society. In most developing countries, Government will have to take the lead role in identifying and promoting systematic interventions which lead to innovation at all levels of the society.

The use of Science & Technology provides a basis for the articulation and realisation of this plan. For this reason, serious attention must be paid to the application of S&T to the development process. This demands development of a system to coordinate S & T at all levels given the scarce resource base of the Caribbean. This may be achieved through the organisation and coordination of S&T activities at the national and regional levels by way of councils, or via other suitable mechanisms established within the national planning process.

There is need for clear guidance for preparation of plans based on these policies, identification of resources for implementation and for monitoring and evaluation, in order to ensure that the plans are effectively carried out and the results of focussed Science & Technology activities get into the market place.

There is also need for on-going consultation to inform policy, and the Caribbean Council of S&T must be recognised as a mechanism for regional consultation.

The education system has an important role to play in the application of S & T to development. For this to be occur, we must ensure that the entire population has adequate skills in reading, communication in speech and writing and calculation, and on this base must be produced a computer literate society. There is need to popularise S & T, to indicate to the population that S & T is involved in all their every day activities. S & T awareness must become part of our culture.

We must recognise that much innovation comes from the floor workers and thus our general workforce must become better educated. We need to introduce the concept of best practise,

providing workers with the basic tools to make scientifically sound decisions in their daily activities.

2. The Objectives and Scope of Science and Technology Policy

A S&T policy for the Caribbean Region therefore, must serve to promote the optimal advancement and application of S&T towards satisfying the basic needs of the mass of the Caribbean people for food, shelter, clothing, health and education. In this context, sustainable development and conservation and preservation of the environment remain the guiding principles on which such activities are based.

A S&T Policy for the Caribbean and indeed for each nation must also be seen as a blueprint for partnership between the private and public sector, ensuring that S&T activities are synchronised with the needs of the society, and providing the necessary support to ensure greater innovation and transfer of knowledge to the productive sector.

In order to realise this goal, the S&T policy seeks specifically to:

1. optimise the benefits to be derived from the exploitation of available resources while protecting the environment;
2. develop and make use of skilled human resources as the critical engine for transformation and growth;
3. create dynamism in existing and future Caribbean agriculture and industry to enable rapid adjustment to technological, market and other changes which affect competitiveness;
4. promote and foster a climate conducive to the development, exchange and effective use of technology within the Region;

5. ensure the most cost-effective methods of acquiring, adapting and using technology developed and available within and outside the Region; and
6. preserve and enrich the cultural heritage of the peoples of the Region;
7. Foster a climate of innovation and knowledge sharing between all stakeholders in development.

4. General Policy Areas

4.1 Planning and Infrastructure

To ensure that S&T considerations are structured into the national development planning process. Member states will be encouraged to:

1. incorporate in each sectoral plan the technological requirements to fulfil the goals, objectives, and targets as stated;
2. establish the most appropriate mechanisms for keeping policies under review, for monitoring the efforts to incorporate S&T into the Planning Process, for formulating and monitoring a programme and plan of activities to support the policies, and for advising on S&T activities generally. This may be in the form of S&T Units working within the framework Central Planning Units or key development agencies;
3. determine through a process of consultation, involving Government, the productive and service sectors, scientists and technologists, the priorities for selective action related to S&T. This is extremely important given the constraints of limited human, institutional and financial resources.

4.2 Innovation

It is widely recognized that technological and knowledge-based inputs have become the principal determinants of economic growth. Access to these inputs and the subsequent generation of innovative strategies for development are thus critical to the realization of the development goals of the region. Governments, private sector agencies and institutions of higher education must take the lead in fostering a culture of research in the region. It should be noted however that research and development can only flourish when it is securely founded on a long-term and sustainable basis. Research that is overly dependent for its support on demand-pull is unlikely to yield the innovative breakthroughs that are necessary to trigger economic growth in new sectors. The challenge to Caribbean institutions is how to allocate adequate funding for the support of research and development from their own modest resources. Such allocation should be regarded as investments in developing regional competitiveness and development.

While individual Caribbean territories need to identify and prioritize their own R & D agendas the following areas are considered to be important areas across the Region.

1. Tourism
2. Natural Resources Management
3. The Environment
4. Alternative Energy
5. Information technology
6. Agriculture

7. Manufacturing and Industry

Priority should be accorded to research and development in those areas which are most likely to produce benefits in the near to medium term, and should include:

1. the development of applied research and technology adaptation capabilities in biotechnology with emphasis on agriculture application of tissue culture;
2. expansion of current efforts in mariculture and aquiculture;
3. the development of new systems of agriculture production including livestock;
4. the linking of research and development with the productive sector, and the stimulation of new industries based on local raw materials, including agriculture residues;
5. the management of natural resources and the environment, especially the coastal zone and watershed areas
6. promotion of alternative energy sources and information technology
7. the development and strengthening of a network between national scientific and research institutions and industry in member states
8. the fostering of research capability among the Caribbean youth through such programmes as school-industry links and competitiveness for young inventors and innovators.

The work of regional institutions such as the Universities and other research and training institutions must address regional problems (in agriculture, in industry, in disease, in coastal zone management etc.) and must produce the human resources to carry out the tasks that need to be done in the Caribbean region. There is need for cooperation to avoid duplication of effort and regional support must therefore be given to institutions like CARIRI, Institute of Marine Affairs of Trinidad, NSRC of Jamaica, UWI, the Institute of Applied Science and Technology of Guyana and the University of Guyana, etc.

4.3 Education and Training

Given the escalating cost of human resources development, the need to optimise the benefits of education and training is recognised. The potential of S & T for the promotion of regional development goals will only be realised in the context of sound educational systems in which education in S & T are central. The goal of education with regard to S & T should be:

1. to develop a cadre of highly skilled scientists and technologists in the Region who are responsive to the needs and potential of the Region and who are committed to S & T activities including on-going research and development;
2. to develop a cadre of skilled technicians;
3. to create 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 S&T and to provide informed support for Caribbean scientists and technologists;

These objectives may be realised through the following policies:

1. Ensuring that education in S&T is part of the entitlement of all Caribbean children and youth from primary through secondary level;
2. Recognition of the distinction between S&T and ensuring that the design and mode of delivery at school curricula are such that all children benefit from the potential contribution of these two distinct areas to their general education. All Caribbean children and youth should be educated in S & T regardless of occupational choice;

3. Development of a well-articulated system of Technical and Vocational Education and Training (TVET) within the Region. The programmes at institutions offering TVET should be broad-based, flexible and responsible to the needs of Caribbean economies for a skilled work force;
4. Restructuring universities to ensure their offerings in S & T are responsive to national and regional imperatives. This will include reorienting programmes and equipping institutions to produce policy-specialists, planners, managers etc. who are well versed in the importance of S & T in development
5. Recognition and fostering the informal sector as an avenue for the popularization of S&T so as to reduce the isolation of scientists from the general public;
6. Encouragement to highly qualified teachers in S & T through incentive schemes.

1. Specific Policy Areas

Scientific and technological information is universally recognised as a critical resource in the application of S & T to national development.

5.1 Information Technology, Systems and Services

Information is a key resource and prerequisite for national and regional development. In this context information in S & T is therefore a very important resource in the application of S & T to development. Developing this resource and making it accessible are essential elements of a policy on information technology. Each country needs to have ready access to information generated within its borders, regionally and internationally, that might impact on, or influence its activities or decisions at all levels. Various categories of personnel such as state officials, entrepreneurs, scientists, engineers and researchers need timely access to the best information available whether initially generated in their own country or abroad. Scientific and technological information systems and services also constitute an important element of technological capacity to evaluate and select imported technology, as well as to generate local technology.

Experience has shown that even where information is clearly needed, the demand for it is well below the expected level. Encouraging and educating people to use information is therefore a critical element of any strategy to employ S & T information as a tool for development. Unfortunately, most Caribbean countries have a very weak information infrastructure, i.e Inadequate systems for locating, acquiring, analysing, repackaging and disseminating scientific and technological information to prime users.

It must be recognised as well, that with the plethora of information systems and networks being developed internationally, the regional integration through information sharing stands to suffer unless we identify and prioritise our needs in information exchange.

1. S & T Information already existing in various forms should be made available in an easily accessible format that conforms to simple guidelines which meet national legislation. For this purpose, the internet may be a useful mechanism to facilitate information sharing;
2. National and regional information databases and networks should be developed, fostered and rationalised to better reach the wider community, and best respond to the demands of the productive sector;
3. Recognising the limited electronic access to information that exists, regional knowledge networks should be fostered as an alternative to simple electronic networking;
4. Member countries and contributing agencies must be committed to supplying and maintaining up-to-date information to information databases;

5. Emphasis needs to be placed on information systems related to trade and market intelligence to alert countries in good time of important international developments which affect national economies. Under such a regime, advances in technology may be speedily appropriated to reverse the tendency towards uncompetitiveness and production inefficiencies;

5.2 Telecommunications Technology

Telecommunications in developing countries is an essential pre-requisite for economic, social and cultural development. Reliable and efficient telecommunications can be considered a pre-condition for the integral development of the country in this era.

Over the past few years, major changes have taken place internationally in the telecommunications sector. These changes have been principally in the areas of technology development, international regulations and standards and the participation of private interest in the provision of telecommunication services.

The challenges arising from these changes are so enormous that developing countries are finding it necessary to monitor these changes not only at the national level but also through regional institutions. In the face of these challenges and developments, it is important that CARICOM Member States:

1. Re-examine their respective national policies with respect to telecommunications development in order to formulate national approaches to the new circumstances. Designed national approaches to accommodate effective regional approaches for addressing these developments at the international level;
2. Accelerate the proposed establishment of a regional umbrella organisation for advising on regional telecommunications development and regional arrangements such as University of the West Indies Distance Teaching Experiment (UWIDITE) for accessing and using telecommunications facilities.

5.3 The Environment

The states of the Caribbean are striking examples of vulnerable and fragile ecosystems. It is therefore absolutely imperative that particular attention is paid to the concept of sustainable development. The value of living and non-living natural resources, the possibility of their irreversible loss, and the importance of incorporating ecological principals into development objectives need to be appreciated by policy makers and the public at large. The management of areas of valuable bio-resources, wetlands, watersheds, hillside slopes, and coastal zones warrant very high priority in the Caribbean context.

Deforestation is also a major problem leading to a number of other problems including, siltation of streams, reduction in water supply, damage to reefs and seagrass beds resulting in loss of tourism biodiversity, and fishing potential, loss of productive soil, increased tendency to flooding etc.

1. Countries should undertake a careful inventory and evaluation of their natural resources prior to the consideration of any development projects;
2. Techniques need to be designed, tested and implemented to reclaim destroyed or eroded eco-systems;
3. The establishment of Environmental Management Agencies is critical, as well as making

Environmental Impact Assessments a legal requirement for all major projects;
4. Steps must be taken to halt the removal of sand from beaches, which may necessitate finding an alternative to coastal beach sand;
5. Land utilisation should be planned and managed, taking into consideration renewable and non-renewable resource use;
6. A regional policy regarding transhipment of solid waste, especially nuclear waste, as well as a regional ban on the use of the seas as a dumping ground need to be articulated and implemented;
7. Member countries should examine and support initiatives to assist in the incorporation of environmental issues into the general school curriculum as an important aspect of resource utilisation and management;

5.4 Agriculture and Agro-Industry

Nearly all of the countries of the region have significant potential for improved agricultural and fisheries production and the creation of a viable indigenous agro-industry. This potential can be realised through concerted action, combining the use of research and development, industrial and agricultural extension services, fiscal incentives, information services and marketing expertise. These all need to be provided and coordinated in a thrust to promote agro-industry at the cottage and factory levels.

The Agriculture, Agro-Industry and the Food Sector is one key to the solution of Caribbean problems of unemployment and the generation or saving of Foreign Exchange needed to “buy” goods and services that the region cannot produce. The demand for food at home and for a discriminating tourism sector, as well as for production of agricultural products which are marketable abroad must be met by a vibrant agricultural programme.

However, for the agriculture and agro-forestry, and food industry to make a full impact on national economies, specific problems have to be addressed, namely: declining land resources, pests and diseases that destroy whole crops and lead to isolation of countries’ exports, declining crop productivity, lack of international competitiveness e.g in bananas, low wages in the sector, declining farm incomes, poor institutional support, predal larceny, poor practices in fertiliser use and pesticide management leading to environmental pollution and food product contamination, etc.

It is therefore suggested that:

1. Cost reductions through reduced inputs of fertilizers and pesticides and production of crops suited to the soil and climatic regimen of agricultural areas. In this regard we need to look at the exploitation of native species;
2. Attention must be paid to the growing demand for organically produced food; to the application of integrated pest management methods, to agro-forestry utilising fast-growing species like Leucaena and Gliridiidia, to the production of crops for niche markets eg the West Indian Community abroad;
3. Maximum use must be made of crops produced - by primary and secondary processing, by use of crop residues etc. as specialties targeted to particular niche markets internationally;
4. Research should be done on products that are organically grown and processed basically additive-free, as there is a growing world market for such food products;
5. The region needs to put in place a range of research and development activities and development of appropriate S & T services - crop processing, crop preservation, marketing techniques, labelling, standardisation and quality control;

5.5 Marine Science

The extension of the Exclusive Economic Zone to 200 miles under the Law of the Sea Convention, has increased drastically the significance of the sea as a natural resource for the islands of the Caribbean. Countries should encourage the exploitation of this vast resource and devise suitable policies to this end.

Greater attention needs to be given to such matters as marine policy, infrastructural arrangements for the coordination of marine S&T development, manpower training, information and data services, and regional cooperation in marine sciences and technology.

5.6 Energy

Energy features among the costliest items in the economies of the Caribbean countries. Despite the Region's endorsement of natural sustainable and alternative energy sources such as solar, wind, hydro power, biomass and the opportunities for energy generation through waste conversion, these energy resources remain largely underutilised. Instead, the region continues to rely heavily on the use of fossil fuels, despite its high costs, and the harmful effects on the environment.

There is an increasing body of knowledge from research that indicates that the use of some fossil fuels may be a more expensive option, when the costs associated with human health and the environment are considered. Against this background, member states are encouraged to look again at the possibilities of harnessing other forms of energy (sun, wind, geothermal) in order to reduce dependency and import expenditure in this sector. As well, such a policy of renewable energy promotion would assist in the reduction of environmental degradation.

The following needs to be done on a priority basis:

1. Source appropriate technology e.g wind turbines, etc. and encourage regional manufacture ;
2. Source or generate venture capital for investment in alternative energy;
3. Encourage public utility companies to go for alternative energy sources;
4. Develop energy efficient systems;
5. Encourage "clean" technologies - wind, solar, water power, geothermal, wave energy where applicable;
6. Pursue in accordance with national legislation, least cost, natural energy strategies that consider all options, including energy deficiency, non-conventional renewable energy sources, i.e solar, wind, geothermal, small hydro and biomass and conventional energy resources;
7. Encourage member states to authorize premium rates or other suitable incentives for the use renewable energy sources;
8. Encourage member states to implement market-oriented pricing and other energy sources, and establish a regulatory framework which will allow electric utilities to undertake the actions specified in such policy.

5.6 Construction

The region is faced with a number of imperatives that makes it vital to develop improved construction techniques and methods. It faces natural disasters such as hurricanes, flooding,

and is under threat from sea level rise. There is also increasing pressure from reduced availability of land for construction, and the need to build suitable accommodation to cater for the tourism and eco-tourism business. On the other hand there is a diminishing availability of construction material, and escalating cost of construction that have fuelled the housing shortage. Solving problems in this area is a major task of the universities, the architectural schools and the technical colleges. Technical information packages must be prepared for the construction industry and widely disseminated among builders.

Faced with these conditions the region needs to:

1. Increase automation
2. Find alternatives to using beach sand
3. Find faster building methods to deal with the housing shortage
4. Tailor construction to cater for high winds and earth tremors

6.7 The Mineral and Forest Resources Industry

The exploitation of mineral and forest resources contributes very significantly to the economies many Caribbean countries. In the case of mineral resources, cognisance must be taken of the fact that these resources are non-renewable and, in many instances their extraction contributes much to environmental and human health problems. The incorporation of environmental issues within resource extraction and the promotion of the concept of natural resource management, is very important for the sustained extraction of these resources in a manner that is internationally acceptable. Member states will therefore be encouraged to:

1. Promote recycling or reuse of materials such as road metal, metal cans, glass etc.
2. Restore present mined out areas which have not been effectively closed;
3. Use appropriate technology to enhance extraction and recovery rates;
4. Use appropriate technology for mineral exploration so as to reduce cost for exploration and environmental damage;
5. Promote and develop technologies to process these resources prior to exportation;

5.8 Technology Acquisition and Development

Caribbean countries spend large sums of money acquiring technology in the form of equipment, plant and machinery, and the value derived is often not commensurate with the investment. This technology acquisition takes place in both the state and private sectors. It is therefore important to:

1. Establish and strengthen national and regional mechanisms to facilitate the evaluation of these technology imports in order to minimize costly errors and enhance the benefits to be derived from these considerable expenditures. Of equal importance to the use of acquired technology to increase productive capacity at the enterprise or sector level, will be its use as a vehicle for the development of endogenous technological capacity;
2. Promote endogenous technological capacity mechanisms for the identification and utilisation of technical innovations that occur on the shop floor and in the informal sector should be promoted;
3. Explore opportunities for the enhancement of traditional technologies through blending with modern technology should be developed and pursued wherever possible.

5.9 New Technologies

Among the new and emerging technologies, microelectronics, biotechnology and genetic engineering in particular, have far reaching implications for countries of the Region, and pose both opportunities and threats to Caribbean industry and agriculture. The region must equip itself to make use of the opportunities presented by developments in these and other fields, while simultaneously taking effective measures to offset their most serious negative impacts.

1. In microelectronics, even at the software level, the countries of the Region should seek to pool resources in order to achieve economies of scale;
2. In biotechnology, there is already a nucleus of activity in the Caribbean that could be developed to our advantage;
3. Research institutions generally should allocate adequate resources to develop selective expertise in new technology fields;
1. Appropriate mechanisms must be established to ensure that the region derives maximum benefit form initiatives in the region, as well as from international initiatives, such as the establishment of the International Centre for Genetic Engineering and Biotechnology.

5.10 Standardisation

Standardization is an accepted *sine qua non* for the development of national economies. With the advancement of a free trade zone in the region, the role of conformity to universally accepted requirements becomes critical to ensure a level playing field and to protect consumers. The importance of standards in industry and trade is enormous. They define criteria for products, processes and services, as well as for materials and procedures. More specifically, the development of standards would facilitate design and manufacture, rationalize process and operations and promote quality. Standards also touch every aspects of daily life by ensuring safe and reliable products and services to the customers, to safe guard the environment and to maintain health and safety requirements.

For standardization to play a pivotal role in accelerating economic and industrial process, the entire activity of standardization should be coordinated and made coherent to evolve into a system of standardization at the regional level.

1. Summary of Decisions Needed

In summary the following specific decisions are needed to be taken to:

6.1 Human Resource Development

1. Reduce the curriculum load at the primary level and ensure the maximum attention is paid to basic skills of reading, communication in speech and writing and computation;
2. Introduce universal secondary education as recommended in CARICOM Education Policy and the OECS Education Reform Strategy;
3. Ensure computer literacy in the school system as early as possible;
4. Make use of the Media (radio, TV, closed circuit TV etc.) To ensure that educational packages reach all segments of the population.;

5. Mandate the community colleges to provide continuing education and training in all relevant areas with particular emphasis on technology;
6. Reintroduce an apprenticeship system to occupy all youth to prepare them for the world of work;
7. Initiate an industrial technology extension service for small and medium enterprises as suggested by CCST;
8. Ensure that systems are set up to access, monitor, evaluate, adapt technology for the productive sector and that mechanisms are in place to pass the information on;
9. Sensitise politicians, planners, senior public servants e.g Permanent Secretaries to the importance of the environment and domestic agriculture to national economies etc.
10. Establish through the education system (school and public) awareness of S & T, and the importance of the environment;
11. Encourage the universities to engage in out-reach education. The UWI Continuing Education system for engineers is noted here as well as the CEPAT effort in agriculture;

6.2 S & T and Economic Planning

1. Ensure that S & T considerations are part of the entire planning process by suitable inclusion in the national planning process;
2. Ensure that serious attention is paid to environment management to prevent loss of (or damage to) the region's important natural resources;
3. Develop a land use policy;
4. Develop the agriculture industry, paying particular attention to the production of food for local and regional use;
5. Investigate the production of small scale equipment for industry;
6. Arrange mechanisms for the financing of Cottage Industries;
7. Support the technology extension service proposed by the CCST;
8. Pay special attention to the development of aquiculture;
9. Request the universities and utility companies to pay attention to the development of alternative sources of energy;
10. Request the universities to pay attention to materials science e.g to find alternatives to beach sand for use in construction;
11. Encourage Regional Research institutions and universities to pay attention to ocean sciences;
12. Introduce appropriate standards for the building sector;
13. Ensure regional capability is developed in repair, maintenance and calibration of important scientific and industrial equipment;
14. Focus on primary health care in all states;
15. Insist that regional institutions like CARIRI, IMA and the Caribbean Environmental Health Institute (CEHI) respond to the needs of all members countries;
16. Invest in state-of-the-art information technology;
17. Support and promote regional standardisation across Caribbean countries.

1. Implementation

7.1 Organisation and S & T Management

To produce the vision mentioned earlier there is need for organised management systems for S & T at both the Regional and National levels and the operationalisation of this policy will require the establishment of S & T institutions and agencies to develop and implement plans that would realise the objective mentioned above.

The study of management of S & T in the Caribbean has been going on for sometime, yet the

region has also been slow to recognise the importance of S & T in most activities and there has been a tendency to relegate them to the esoteric and not involve S & T personnel in national planning. The most recent study commissioned by the CCST highlighted the following observations:

1. **Science Councils exist in some States, but either have no legal status or are generally marginalised with unclear mandates. They are generally not involved in policy formulation, direction or planning at the level of the national economy;**
2. **Many S & T institutions exist, but they are poorly co-ordinated;**
3. **Resources given to councils do not match their mandate and often councils have not been involved in decision making at the national level and are not taken seriously by the bureaucracy or at the political level;**
4. **Many councils do not have nay evaluation or monitoring systems.**

All councils appear to have had major constraints namely:

1. **Insufficient resources (physical, financial, human)**
2. **Negligible support by the political directorate**

Given the importance of S & T to the national and regional economies, the role of S&T must be placed high in the order of things if the Caribbean is to survive and develop economically in a sustainable manner. S & T must be brought into the forefront in the region.

7.2 Establishment of National Science & Technology Councils

To this end, it is recommended that all governments establish S & T Councils within their sustainable development commissions.

Science and Technology Councils should have the following functions:-

1. Providing advice
2. Providing policy direction
3. Co-ordination
4. Information gathering and dissemination
5. Science popularisation
6. Identification of areas requiring R & D
7. Sourcing of funds and promotion of R & D activities and results
8. Linking R & D institutions with the private sector
9. Science Agenda development
10. Commissioning research of national importance
11. Articulation of National Systems of Innovation

To be able to carry out these functions,

1. **Science & Technology Councils should be established by law and priorities should be set for them. Which functions they perform would be determined by the resources available, the size of the country, the institutions which already exist etc.**
2. **The council should be the portfolio responsibility of a senior Cabinet Minister of preferably the Prime Minister.**
3. **At the very minimum level of operation (the smallest state) there should be a S&T unit or node within the planning division of the country and all affairs of State should be examined for it's S & T content.**
4. **Councils should be provided with adequate financial support and authority to be**

able to contribute meaningfully to developmental planning.

7.3 Support for the Caribbean Council for Science & Technology

The problem of co-ordination in the region has been further brought out by attempts to get regional input into this paper. Co-ordination at the regional level is essential to provide directions, to save on scarce resources, to avoid duplication of effort etc.

At the regional level the Caribbean Council for Science & Technology (CCST) should be mandated by Governments to be the the Regional Coordinating Body for S & T activities. It must upgraded and strengthened so that it can develop into a regional voice for S & T, to source and access funds for regional S & T activities. Such an arrangement may be a mechanism by which several countries may seek to promote and source funding for regional activities, strengthening their bargaining power and developing integrated approaches to dealing with issues that affect the region rather than individual countries.

The value of CCST, however, must be anchored by the development of proper S & T management systems at the national level. The management system must include consultations between all players - public and private sector, scientist, social scientists, environmentalist etc.

There is need for the periodic measurement of the S & T potential - local as well as regional and ensuring that the S&T policies is put to use. Only strong institutions both national and regional can ensure this.

Finally the CCST should be mandated to be the body that coordinates and lobbies for regional S & T activities and initiatives. It should therefore be given the task of development of a suitable framework through which international agencies and organisations may support regional S & T activities.