

The CARICOM countries

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The Caribbean region is an archipelago of small and relatively young island nations in the Caribbean Sea combined with a few neighbouring countries on the contiguous coast of Latin America. The island nations range from a size of 103 square kilometres (Montserrat) to 10 000 square kilometres (Jamaica).

The countries of the Caribbean are largely English speaking, with the exception of Dutch-speaking Suriname, French-speaking Haiti and Spanish-speaking Cuba and the Dominican Republic (see chapter on Latin America for coverage of the two latter countries). This chapter deals only with the members of the Caribbean Common Market (CARICOM) (see box on page 79 and Table 1).

The English-speaking island nations have developed strong cultural, economic and educational links through institutionalized mechanisms. For example, the University of the West Indies (UWI), founded in 1948, is pivotal to tertiary education for many of these island nations, whereas CARICOM – not to mention the game of cricket – provides the ‘glue’ that binds the Caribbean people together.

Caribbean nations do however have diverse natural resources, economic policies and political strategies which have produced a considerable variety of economic, educational, industrial and cultural achievements.

NEW TRENDS IN HIGHER EDUCATION

Besides the UWI, which has three main campuses (one each in Barbados, Jamaica and Trinidad), there are the University of Guyana with two campuses, the University of Technology (Jamaica) and the University of Suriname, which are publicly funded. The Northern Caribbean University (Jamaica) is private (Table 2). There are other major publicly funded tertiary institutions important to science and technology (S&T), such as the Sir Arthur Lewis Community College (St Lucia), College of the Bahamas, Barbados Community College, College of Science, Technology and Applied Arts (Trinidad and Tobago), College of Agriculture, Science and Education (Jamaica), Belize College of Agriculture, and Central American Health Science University (Belize Medical College). These institutions allow S&T students to complete

the junior portions of first degree programmes in their own countries at a relatively low cost and in familiar cultural surroundings before heading to major campuses in Barbados, Jamaica and Trinidad to complete their degrees.

A recent addition is the University of Trinidad and Tobago, which came on stream in July 2004. Initially, this university is offering programmes only in the sciences and engineering, at both the undergraduate and postgraduate levels.

The UWI has established postgraduate programmes leading to MSc, MPhil and PhD degrees. Enrolment in higher-degree programmes in 2002/03 amounted to 4 638, of which 1 726 (37%) were in S&T disciplines. The University of Technology, University of Guyana and University of Suriname are also expanding and consolidating their postgraduate programmes.

In the mid-1990s, the UWI was the recipient of an Inter-American Development Bank loan of US\$ 56 million guaranteed by governments to consolidate, strengthen and expand S&T infrastructure (equipment and laboratories) and human resource capabilities (laboratory technicians and academic staff). The UWI’s S&T teaching and research are improving as a result of this investment. Figure 1 shows research output over three decades. Steps will need to be taken to improve scholarly output from the agricultural and engineering sciences; however, the engineering faculty is credited with playing a vital role in building the vibrant manufacturing and petrochemical industries in Trinidad.

One of the very noticeable trends within the region’s tertiary education is the under-representation of males. Since 1982, the number of female students registered at the UWI has not only caught up with that of males but even exceeded it. In 1999/2000, male students constituted only 33.7% of total enrolment and 31.3% of the graduating class.

The trend in S&T disciplines is similar, but the ratios still favour males. Some 3 491 males, or 51.2% of the total, enrolled in programmes in the agricultural, engineering, medical and natural sciences in 1999. The overall figure is largely influenced by the domination of male students in engineering sciences (79.3%).

Table 1
KEY INDICATORS FOR THE CARICOM COUNTRIES, 2001–03

	Population (thousands) 2001	HDI ranking ¹ 2002	GDP growth (annual %) 2001	GDP per capita, PPP (current inter- national \$) 2001	Public expenditure on education as % of GDP 2001	Public expenditure on tertiary education as % of total expenditure on education 1999–2001	GERD as % of GDP 2002	Internet penetration 2003 (% total pop- ulation) ²
Antigua and Barbuda	72	55	2.3	10 620	3.5	15.1	–	12.82
Bahamas	307	51	4.5 ³	16 690 ³	4.0 ¹	–	–	26.49
Barbados	268	29	-2.1	15 410	6.7	29.9	–	37.08
Belize	245	99	5.1	5 920	6.8	16.2	–	10.89
Dominica	78	95	-3.9	5 580	5.6	–	–	16.03
Dominican Republic	8 485	98	2.9	6 380	2.5	10.9	–	–
Grenada	81	93	-4.7	7 040	4.5	–	–	16.90
Guyana	762	104	3.4	4 320	4.5	–	–	14.22
Haïti	8 111	153	-1.1	1 640	1.1	–	–	1.80
Jamaica	2 603	79	1.5	3 850	6.8	19.2	0.08	22.84
Montserrat	3	–	–	–	–	–	–	–
St Kitts and Nevis	42	39	3.3	12 030	8.5	21.2	–	21.28
St Lucia	147	71	-6.3	5 290	7.7	12.8 ⁴	–	8.24
St Vincent and Grenadines	118	87	0.9	5 410	10.0	5.2	0.15	5.98
Suriname	429	67	4.5	–	10.2 ²	8.8 ⁴	–	4.37
Trinidad and Tobago	1 294	54	3.3	9 180	4.3	3.7	0.10 ⁴	10.60

1. Human Development Index as defined by UNDP (1–55 corresponds to high human development).

2. Data for Antigua and Barbuda, Belize, Dominica and Guyana are for 2002.

3. 2000.

4. 2001.

Source: for population and education data (except tertiary): UNESCO (2005) *Education for All: the Quality Imperative*. EFA Global Monitoring Report. UNESCO Publishing, Paris; for tertiary education and HDI data: UNDP (2004) *Human Development Report*. Oxford University Press, New York and Oxford, UK; for GDP figures: WDI CD ROM 2004; for GERD: UNESCO Institute for Statistics S&T database (2005); Internet penetration: UN Millennium Development Indicators: <http://unstats.un.org>

The situation is believed to reflect an increasingly under-performing male population, a new phenomenon in gender imbalance and its implications, which is under study. The proportion of women in academic positions at the UWI is increasing. They represented 33.2% of academic staff in 1998 and 36.8% the following year, including professorial appointments.

STRUCTURE AND ORGANIZATION OF RESEARCH

All Caribbean nations, individually and through CARICOM, recognize that they will have to make major progress in absorbing and applying S&T to achieve better living conditions for their people. Little attention has been paid to how this might be done or to the

roles of various levels of scientific research activity (curiosity-driven versus application-targeted basic research and applied research directed towards problem solving).

There seems to be no mechanism for setting research goals and priorities, judging whether any research goals have been met, or evaluating research results from within and outside the Caribbean for their potential beneficial impact on the lives and economies of the region. This is a very serious policy and management deficiency that must be corrected quickly if S&T innovation is to be entrenched in the Caribbean culture and the productivity of its science enterprise is to grow to optimal levels.

The lack of a conceptual framework for understanding and evaluating innovation in the region has meant that

many research programmes have been established and maintained without any performance evaluation or the requisite infrastructure, financial and human resources to achieve their mission. For these reasons, alumina, bananas, sugar, tropical rainforests and other resources of vital economic interest to the region have remained poorly understood, and their diverse potential is largely unexplored.

What is most distressing is that there are significant earnings from economic activity in these areas, but there is no endogenous research and development (R&D) capacity to sustain them. There are of course bright spots of excellent achievement in research in the region, but this is largely a result of determined individual effort and initiative rather than a planned and sustained cultural movement towards regional or national scientific excellence in the economically vital fields.

Research is conducted in universities, national and regional publicly funded special research institutions and, to a limited extent, in the private sector. Examples of national research institutes are the Scientific Research Council in Jamaica, the National Agriculture Research Institute in Guyana and the Institute of Marine Affairs in Trinidad and Tobago. The Caribbean Agriculture Research and Development Institute and the Caribbean Environmental and Health Institute are two of the better-known regional institutes.

Guyana boasts a unique centre for research into international forest conservation, *Iwokrama*¹, which encompasses 3 600 square kilometres of lush pristine tropical rainforest in central Guyana. The centre receives research grants from a number of countries as well as from international donor agencies, but it has no core funding.

R&D OUTPUT

The scholarly publication rates of research institutions outside the academic sector are insignificant. Of the research papers published by academic institutions between

1. Amerindian word meaning 'place of refuge'.

CARICOM

The Caribbean Community and Common Market (CARICOM) succeeded the Caribbean Free Trade Association (CARIFTA). CARICOM was established by the Treaty of Chaguaramas – signed initially by Barbados, Jamaica, Guyana and Trinidad and Tobago – which came into effect on 1 August 1973.

Today, CARICOM is composed of 15 members, the most recent admissions being Suriname (1995) and Haiti (1997). The CARICOM members are Antigua and Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, Suriname, and Trinidad and Tobago.

The Treaty of Chaguaramas creating a single market and economy has been ratified and is due to come into effect in July 2005. In addition to trade, it contains provisions for the setting up of a Caribbean Court of Justice.

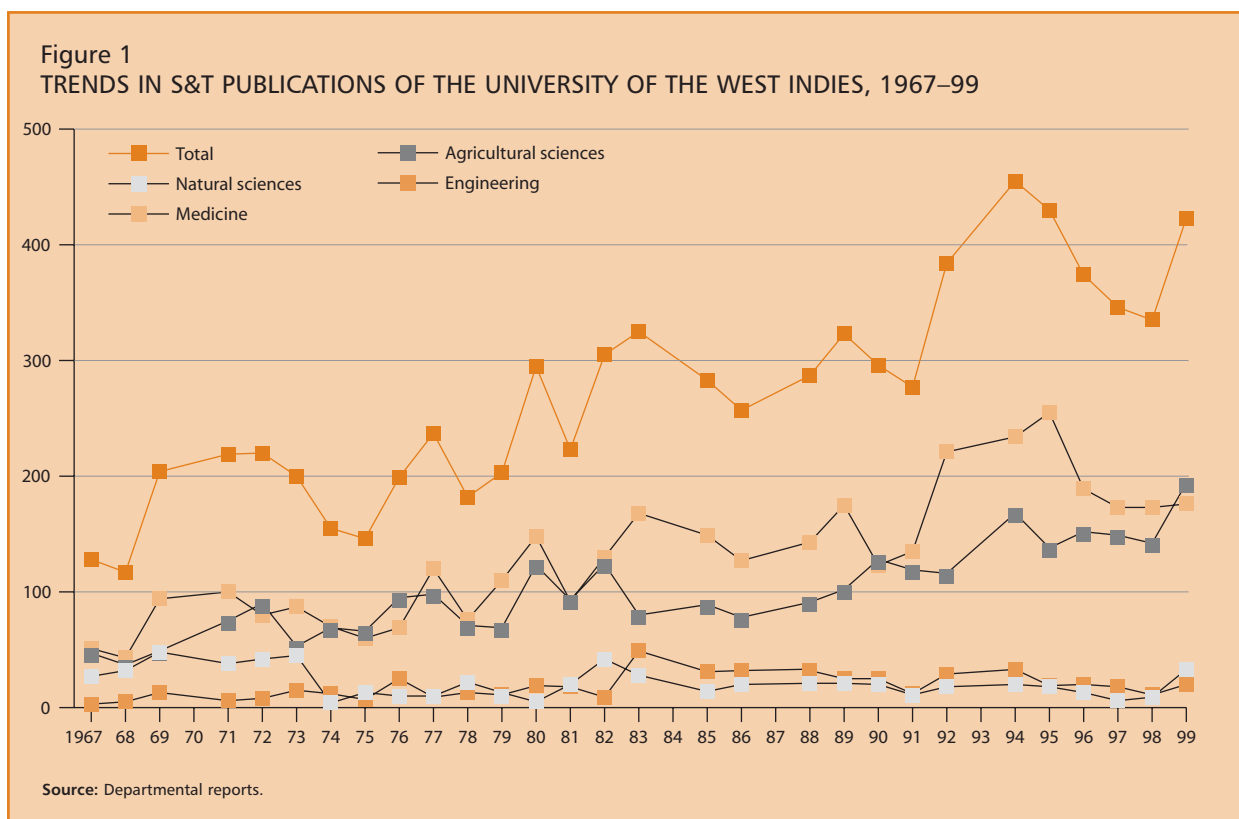
Source: CARICOM website: <http://www.caricom.org>

August 1999 and July 2000, approximately 92% originated from the regional research facility, the UWI, which has recorded significant growth in publication rates as shown in Figure 1.

Table 2
UNIVERSITY ENROLMENT IN THE CARIBBEAN, 2000

University	S&T fields	Total
University of the West Indies	6 822	23 369
University of Technology	2 823	6 636
University of Guyana	1 207	4 962
University of Suriname	178	509
Northern Caribbean University	320	3 000

Source: UWI (2000) *Official Statistics for 1999/2000*; compiled from responses to authors' survey. University of the West Indies.



Publications from other tertiary institutions over the same period amount to 31. Overall, the region's 6.4 million inhabitants published 460 papers in refereed journals: at 71 papers per million inhabitants, the figure is encouraging. It compares favourably with figures for Latin America identified in UNESCO's *World Science Report 1996* (Figure 5, p. 59), which showed fewer than 50 research papers per million inhabitants for all but Argentina and Chile in 1993. Only the latter country, with a figure of 90, boasted a better publication rate than the Caribbean. Cuba in 1990 had a rate of 14 per million. This said, the figures for Singapore and Taiwan of China for the same year were 375 and 200, respectively, which means the Caribbean has a long way to go.

Among the peer-review journals in which the region's papers appeared are periodicals from the region. These are concentrated mainly in five science journals, three of which are based at the UWI. *Tropical Agriculture*, which was first published in 1924, is the region's longest-

surviving journal. The *West India Medical Journal* is the region's premier scientific journal, which today reaches over 75 countries with about 700 individual subscribers and a circulation of over 2 000. Like *Tropical Agriculture*, it is published quarterly. Published biannually by the Faculty of Engineering at the Trinidad Campus, the *West Indian Journal of Engineering*, which first appeared in 1967, has a very impressive list of international advisers/reviewers. Its contents, though, are to a large extent local. The *Jamaican Journal of Science and Technology*, containing peer-reviewed papers in many fields, is published twice a year by the Scientific Research Council. The *Bahamas Journal of Science* is published twice a year by Media Enterprises Limited.

R&D EXPENDITURE

Gross expenditure on R&D (GERD) is modest. For example, even in the biggest island nations, it amounts to only

0.08% (Jamaica, 2002) and 0.10% (Trinidad and Tobago, 2001). The amount of funds actually available to R&D is proportionate to the tiny size of the Caribbean economies (Table 1).

In Jamaica, the Environmental Foundation of Jamaica, with normal funding of up to US\$ 100 000 per project selected from peer-reviewed applications, is the most significant single source of substantial research funding. The Foundation supports environmental conservation, sustainable development and closely related research projects and promotions, for which it has approved over US\$ 8 million in support of 421 projects since 1994 (disbursements for 1999/2000 amounting to some US\$ 1.8 million for 52 projects). The Commonwealth Caribbean Medical Research Council also provides small grants.

Success in competitive funding awards from external sources is modest. Commercialization of research results is a potential source of revenue, and the region is active in intellectual-property developments. The sale of licences in educational software by the UWI to an international company, new food products turned out by the Scientific Research Council, and the Small Business Incubators at the University of Technology in Jamaica are some encouraging examples. The Centre for Resource Management and Environmental Studies in Barbados has been responsible for developing sources of renewable energy, which today meet 15% of the island's needs. The Centre expects to double this proportion to 30% by 2012.

Recently, the region's academic institutions have attracted international companies to operate resident R&D activities. Funds earned from such arrangements are ploughed back into research infrastructure (e.g. as a significant contribution to a new 500 MHz NMR at the UWI in Jamaica). There is a similar arrangement at the UWI's Cave Hill campus in Barbados with the company BioChem Pharma.

POLICIES FOR S&T

Some countries do have S&T and industrial policies that are strategically linked. Others are in the process of formulating

such policies. These call for the establishment of national coordinating and management agencies for S&T, and this has been achieved with some measure of success. In Jamaica, the National Commission on Science and Technology succeeded in establishing a technology fund of US\$ 2 million, of which about US\$ 820 000 was disbursed in 2000. This fund serves as catalytic venture capital for technology innovators and investors. Generally, though, policies have become outdated, and their implementation has been slow owing to lack of personnel and funding.

ETHICAL DIMENSIONS OF R&D

Ethical pressures are being brought to bear in field trials of genetically modified plants and animals, human consumption of genetically modified foods and the complex web of environmental health, occupational safety and economic development. Generally, issues of preservation of the environment and promotion of human health are now better understood because of educational activities undertaken by researchers, environmental-protection advocates and tourism interests, the last being a major source of the region's income. However, more needs to be done in understanding and assessment of risk to public health.

TRENDS IN INDUSTRIAL R&D

Industrial activity is very low, with the exception of Trinidad and Tobago, which has oil, gas, a thriving petrochemical industry and other industries that are taking advantage of relatively low energy costs, and Jamaica, Guyana and Suriname where bauxite mining and alumina production are well established. These industries tend to rely heavily on parent companies overseas for R&D, which stifles endogenous S&T and frustrates bright young people seeking challenging and fulfilling research careers at home.

We note, however, that major alumina, oil, gas and petrochemical, and sugar (and related products) establishments have modestly supported research activities at universities in the region, including through endowments and graduate-student scholarships in selected research areas. But these are usually sporadic rather than consistent or long term, and graduates of

such programmes have frequently not found employment in the sectors that supported their research, undermining the evolution of an endogenous R&D base in the region.

The vibrant tourism industry does not usually employ highly trained scientists but could do better by supporting research in information technology, environmental management and marine science, which are important to the tourism business.

REGIONAL AND INTERNATIONAL COOPERATION

Given the geography, small population and limited human and financial resources of the Caribbean region, it is critical to focus first and foremost on regional cooperation in order to build a science enterprise with the requisite critical mass. There are three regional scientific organizations in existence: the Caribbean Council of Science and Technology (CCST), the Caribbean Academy of Sciences (CAS) and CARISCIENCE.

Caribbean Council of Science and Technology

CCST was adopted by governments and established in 1981 with limited members drawn from policy makers and scientists. One of its first activities was to prepare an S&T policy document for the Caribbean; unfortunately, not very much seems to have been done in the way of subsequent implementation.

Caribbean Academy of Sciences

A non-governmental organization (NGO), CAS was launched amidst much fanfare in 1988, with promises of support from some regional governments. This support did not materialize. Nonetheless, the academy, whose members are leading scientists in the region, has been able to mount some programmes and an Annual Scientific Meeting, which is the only forum in the Caribbean at which scientists from all disciplines may present their research work. CAS has a very successful Distinguished Lecture Series programme, which to date has attracted three Nobel Prize winners. Internationally, it plays an active role on the InterAcademy Panel, a global network of the world's national and regional science academies that was launched in 1993, and whose main focus is on the scientific aspects of critical global issues.

As part of its tenth anniversary celebrations, CAS hosted a major Conference on Furthering Cooperation in Science and Technology for Caribbean Development in 1998.

CARISCIENCE

CARISCIENCE is of more recent vintage, having been launched in Jamaica in 1998. It is a UNESCO network of R&D and post-graduate programmes in the basic sciences in five Caribbean countries. An organization administered by active researchers for researchers, its main objective is to promote academic excellence and to improve the quality of scientific research in the region. Its record in its short period of existence is impressive. With limited funding, it has been able to assist a number of scientists, particularly young and female researchers, and encourage cooperation and exchange within the region. It has also introduced a relinking of expatriate Caribbean scientists and presents annual CARISCIENCE–UNESCO–Academy of Sciences for the Developing World (TWAS) Awards to outstanding postgraduate students.

Boosting regional cooperation

There is a need for CCST and CAS – which both seem to be experiencing funding problems – to start dialoguing and developing a framework for mutual cooperation and strengthening cooperative scientific activities, especially among universities. Centres of excellence, particularly in areas of science that impact on development, can enhance regional development, minimize duplication and optimize use of human resources.

The International Centre for Environmental and Nuclear Sciences, which is focusing on the linkages between geochemistry, food, health and the economy, is one such example. A Centre for Renewable Energy, to be located in Barbados, is expected to come on-stream in 2002. Chances are that regional governments and other institutions will take the Caribbean science enterprise seriously if scientists and their organizations arrange themselves into a more productive critical mass that speaks with a single voice.

There are also a few well-established, active scientific associations, such as the Caribbean Solar Energy Society, the

Caribbean Chemical Engineering and Chemistry Association and the Caribbean Congress of Fluid Mechanics, whose regular scientific meetings attract international gatherings.

The development of S&T in the Caribbean can be boosted by greater cooperation with international bodies and on an individual level with scientists from the developed countries. The latter would enable our scientists to keep abreast of their field and increase their chances of accessing funding.

With respect to international bodies, UNESCO has demonstrated in a tangible manner its commitment to the region. It has played a major role in bringing CARISCIENCE into existence and has also supported a number of conferences, including the historic 1998 conference in Trinidad.

Other organizations from which the region has benefited are TWAS, the Organization of American States, the International Council for Science (ICSU) and the International Foundation for Science.

SPECIAL DIFFICULTIES

The most serious difficulties are lack of funding, inability to attract and keep quality staff, poor working conditions (including salaries), maintenance of equipment and staff development opportunities.

In Guyana and Suriname, these problems are acute, owing mainly to the very weak economies of these countries. In the United Nations Development Programme's *Human Development Report 2004*, Guyana, for example, ranked 104th out of 177 countries under the Human Development Index (HDI). Very limited funds are available for research and the purchase and maintenance of equipment; weak infrastructure – including an unreliable supply of electricity – tests the patience of researchers; and only a few scientific journals are available. In addition, scientists at the universities in these two countries carry very heavy teaching loads, leaving them little time for research.

To compound the problem, staff income is anything but attractive; this is reflected in the countries' inability to attract highly qualified scientists and the scholastically unproductive phenomenon of moonlighting. In the Faculty of

Natural Sciences at the University of Guyana, out of 33 full-time staff, only six have PhDs and some have only a first degree. A paltry five international papers were recorded at this university last year. The situation in these two countries calls for intervention by the international scientific community.

The hub of scientific activities in Barbados, Jamaica, and Trinidad and Tobago is centred around the campuses of the UWI. Scientists here are much more fortunate than their counterparts in Guyana, Suriname and most countries in the Caribbean and Latin America. They enjoy better salaries and working conditions, as well as such fringe benefits as travel grants and access to limited internal research grants. The major need encountered here is mainly that of adequate research funding and better management of the science enterprise to match the productive potential of the academic staff and the science infrastructure. The creation of a Regional Research Council to fund research of interest to and focused on regional problems has been proposed to the Heads of Caribbean governments. At their annual meeting in 1999, these governments endorsed a proposal by the UWI to establish a Caribbean Regional Research Agency.

The challenge of migration affects the Caribbean greatly. For example, in the years 1991-2000, Jamaica saw some 20 000–25 000 (close to 1% of the population) emigrate each year (Planning Institute of Jamaica, 2000). Over 11%–15% of those migrating have skills or professions that might include S&T fields. Emigration rates of professionals and skilled Caribbean people can be expected to increase, owing to aggressive recruitment campaigns by foreign employers. For example, over 800 Caribbean teachers were sought for the New York state education system in May 2001.

The region's leadership finds the contribution made by the diaspora to the balance of payments, in particular, significant enough to warrant its attention. However, research institutions have not developed creative mechanisms for expatriate scientists to participate in the regional science enterprise. This needs to be done. Moreover, working conditions and the state and productivity of the science enterprise itself will need improving in order to minimize the effects of brain drain.

There are also minor problems, such as poor staff retention, lack of a systematic approach to staff development, lack of short-term research attachments, recruitment difficulties in competitive areas like information technology and a seeming lack of motivation among some researchers that has gone unchecked for too long. Substantive evaluation of research programmes and researchers themselves is lacking, as is action from management to combat mediocrity, or a collective will to award differential benefits for highly productive researchers. This has stalled the development of an endogenous research culture.

POPULARIZATION AND PUBLIC SUPPORT

Science popularization and raising public understanding of science to stimulate support have been taken seriously in the region. Activities have taken diverse forms, such as science lectures of public interest or that expose the region to high-quality science elsewhere, as well as public forums bringing together researchers, government policy makers, the media, private sector and NGOs to discuss challenges, opportunities and strategies for S&T development.

Various science interest groups in the region have organized science fairs, workshops, annual conferences, open days for schoolchildren, science days on university campuses, prime-time discussions with popular radio talk-show hosts and participation in national and international mathematics and informatics Olympiads. Trinidad and Tobago's popular Yapollo, an interactive science exhibition for schoolchildren, has toured other Caribbean countries.

It is encouraging to note that the government of Trinidad and Tobago is about to construct a science centre. Jamaica also operates a small but symbolic science centre.

Funds for these programmes have come from direct government and institutional budgets, the national science coordinating bodies, local industries, CARISCIENCE and international science organizations such as the Royal Society of Chemistry.

FUTURE TRENDS

In spite of the obstacles faced by the scientific community in the Caribbean, it has managed to contribute to the development of science as well as to national and regional development. Approximately 46% of the Caribbean population lives below the poverty line. As governments and other interest groups become more aware of the potential of S&T in fighting poverty and as an engine of economic growth, we expect a need for greater focus on the following areas:

- human resources development;
- exploration of alternative forms of energy (solar, wind, geothermal and biomass);
- use of biotechnology in agriculture to boost food production and exports and reduce the high food-import bill;
- development of strategic alliances rather than 'paper' agreements among research institutes and strengthening of regional cooperation in science;
- materials development, especially those utilizing regional resources (alumina, limestone, petroleum and related products or high value-added products);
- health challenges and diseases affecting the region;
- exploitation of natural products;
- entrenchment in regional culture of standards guaranteeing quality products, to protect consumers and enhance global competitiveness of Caribbean products.

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Harold Ramkissoon is Professor of Mathematics at the University of the West Indies campus in Trinidad. He received his training in mathematics in Jamaica and Canada. He has been the recipient of an Alexander von Humboldt Fellowship (Germany), a Fulbright Fellowship (USA) and a Third World Academy of Sciences Fellowship (China). In the course of his academic career, he has published over 75 research papers.

Professor Ramkissoon is a founding member and President of both the Caribbean Academy of Sciences and the Caribbean Congress of Fluid Mechanics. Recently, he was elected Vice-President of the Caribbean Scientific Union, which is based in Bogotá, Colombia. He serves on the Executive of the Inter-Academy Panel headquartered in Trieste, Italy, and is the Executive Secretary of CARISCIENCE.

In recognition of his contribution to science and the development of science in the Caribbean, he has been the recipient of a National Award (the Chaconia Gold Medal), the Key to the City of Havana and the Simon Bolivar Gold Medal from the University of Simon Bolivar, Venezuela.