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Research Report NUMBER 19

# Agricultural R&D in the Caribbean

## *An Institutional and Statistical Profile*

J. Roseboom
M. Cremers
B. Lauckner

## About ISNAR

### *Mission*

The International Service for National Agricultural Research (ISNAR) assists developing countries in improving the performance of their national agricultural research systems and organizations. It does this by promoting appropriate agricultural research policies, sustainable research institutions, and improved research management. ISNAR's services to national research are ultimately intended to benefit producers and consumers in developing countries and to safeguard the natural environment for future generations.

### *Impact*

To maximize the impact of its work in developing countries, ISNAR focuses on three objectives:

- enhancing the capacity of agricultural research organizations to respond to their clients' needs and to emerging challenges
- expanding global knowledge on agricultural research policy, organization, and management
- improving developing countries' access to knowledge on agricultural research policy, organization, and management

### *Background*

ISNAR was established in 1979 by the Consultative Group on International Agricultural Research (CGIAR), on the basis of recommendations from an international task force. It began operating its headquarters in The Hague, the Netherlands, on September 1, 1980.

ISNAR is a nonprofit autonomous institution, international in character and apolitical in its management, staffing, and operations. It is financially supported by a number of the members of the CGIAR, an informal group of donors that includes countries, development banks, international organizations, and foundations. Of the 16 centers in the CGIAR system of international centers, ISNAR is the only one that focuses specifically on institutional development within national agricultural research systems.

*ISNAR's Research Report series presents the findings of research conducted by the institute and its partners in the area of agricultural research policy, organization, and management.*

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*June 2001*

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## AGROVOC Descriptors

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# Foreword

This research report gives an institutional and quantitative overview of the agricultural research capacity in the Caribbean. The goal of the report is to provide a sound basis of information for agricultural research policymakers in the Caribbean.

What comes through compellingly in this study is how the geopolitical fragmentation of the region places a major constraint on the effective and efficient organization of agricultural research. This is a problem not only for agricultural research, but also for most other agricultural support services (e.g., extension, disease control, credit, marketing, and export promotion) and for government services more generally. Despite relatively high agricultural research investment levels in the smaller Caribbean countries, Caribbean farmers find it increasingly difficult to be competitive in export as well as local markets. While many blame globalization and trade liberalization for this, a more fundamental problem is that technological progress is very much based on standardization and scale—factors that are at odds with the diversity and small scale of the Caribbean region.

Enhancing scale in the organization of agricultural research through regional cooperation and networking is not a new idea, but one that, we believe, should be pursued more intensively and with more conviction.

ISNAR would like to thank CARDI for its collaboration—without its support it would have been quite impossible to conduct this study.

Stein W. Bie
*ISNAR Director General*

June 2001

# Acknowledgments

Data collection for this report began in mid-1998 and took more than a year and a half to complete. We received excellent assistance in the actual conduct of the survey from CARDI staff and collaborators in various countries. They often leaned on many others unknown to us to obtain the requested data. We thank them all very much. Caribbean countries not associated with CARDI were approached directly. In the case of the Dominican Republic, the State Secretariat for Agriculture (SEA) and the Center for the Development of Agriculture and Forestry (CEDAF) joined forces to conduct the survey. We especially thank Rafael Perez Duvergé of CEDAF for his coordinating role.

The library staff at both CARDI and ISNAR helped enthusiastically with document searches. On the secretarial front, we were assisted, always cheerfully, by Alma Torres, who worked particularly hard on completing the address database, reformatting spreadsheets, and entering reference material into our reference database. Richard Claase made the map of the Caribbean, while Oona Paredes edited and proofed the text, and Bob van Duuren desktop-published the report.

We received constructive feedback on an earlier version of this report from Dr. Compton Paul (PROCICARIBE), Dr. Arlington Chesney (Caribbean Office of IICA), Dr. M.M. Rahman (ISNAR), and Nienke Beintema (IFPRI), as well as from four anonymous reviewers. We thank them all for helping us improve the quality of this report.

Last but not least, we thank the Japanese Government for its restricted core contribution to ISNAR, which has supported this component of the ASTI project. The ASTI project is a joint initiative by IFPRI and ISNAR.

# Abstract

This study surveyed agricultural R&D capacity in the Caribbean in order to gain better insight into its structure and development, as well as its potential contribution to the development of agriculture in the region.

This study has several principal findings:

a. Agricultural research capacity in the Caribbean is highly fragmented. Of the 116 agricultural research agencies for which data were obtained, 84 employed less than 10 FTE researchers, and 62 employed less than 5.
b. Between 1986 and 1996, the growth in agricultural research capacity in the Caribbean almost halted in terms of the number of researchers, and contracted in terms of expenditures. However, strong positive growth was still noted for the French bilateral research agencies.
c. Agricultural research investment levels relative to AgGDP are rather high for many of the smaller Caribbean countries. This is not necessarily an indication of intensive innovation, but rather a lack of economies of scale. Such high intensities are possible because of generous donor support or a rich non-agricultural sector.
d. For every 100 million dollars of crop, livestock, forestry, and fisheries production, the region employed, respectively, 33.5, 10.9, 13.0, and 48.9 FTE researchers. Assuming that innovation opportunities are the same for all four types of production, livestock and forestry appear neglected when compared to crops and fisheries.
e. Lack of economies of scale in the agricultural input and processing industries, as well as in the provision of public services (including agricultural research), is a serious handicap for modern agricultural production in many of the small Caribbean countries. Commodity specialization and clustering of research activities across countries are some ways of creating enough volume of research benefits to pay for research costs.

# Abrégé

Le but de l'étude présentée dans ce rapport était d'examiner l'effort de R&D agricole dans la région des Caraïbes, en vue de mieux en comprendre les structures et l'évolution, ainsi que d'examiner les contributions potentielles qu'il pourrait apporter au développement agricole de la région.

L'étude a permis de tirer plusieurs conclusions :

a. L'effort de recherche agricole dans les Caraïbes est caractérisé par une fragmentation poussée. Pour 84 des 116 agences de recherche agricole pour lesquelles des données avaient été collectées, l'effectif de recherche en équivalent temps plein était inférieur à 10, et pour 62 des agences, il était même inférieur à 5.
b. Entre 1986 et 1996, la croissance de l'effort de recherche dans les Caraïbes a quasiment stagné pour ce qui est des effectifs de chercheurs, et les dépenses ont décru. Cependant, une forte croissance fut relevée pour les agences de recherche bilatérales françaises.
c. Dans bon nombre de petits pays caraïbes, les niveaux d'investissements dans la recherche agricole sont assez élevés par rapport au PIB agricole. Ce n'est pas

nécessairement le signe d'une innovation intensive, mais plutôt d'un manque d'économies d'échelle. De tels niveaux d'intensité sont possibles grâce à la générosité des bailleurs de fonds ou bien grâce à l'existence d'un secteur non-agricole riche.

d. Pour chaque 100 millions de dollars américains de production végétale, animale, sylvicole et halieutique, l'effectif de recherche en équivalent temps plein de la région s'élevait à respectivement 33,5 ; à 10,9 ; 13 et à 48,9. En assumant que les opportunités d'innovation sont les mêmes pour chacun des quatre types de production, il semble bien que les productions animales et sylvicoles aient été négligées, en comparaison avec les cultures et les pêcheries.
e. Le manque d'économies d'échelle dans les industries agricoles de base et de transformation, de même qu'au niveau de la provision de services publics (y compris la recherche agricole) constitue un handicap grave pour la production agricole moderne dans bon nombre de petits pays dans les Caraïbes. La spécialisation des filières ainsi que le regroupement des activités de recherche au-delà des frontières nationales sont deux des méthodes adoptées pour atteindre un rendement de recherche suffisamment important pour pouvoir couvrir les coûts de la recherche.

# Resumen


Este estudio examinó la capacidad de investigación y desarrollo en el Caribe para comprender mejor su estructura y evolución así como su contribución potencial al fomento de la agricultura en la región.

Contiene varios resultados importantes:

a. La capacidad de investigación agrícola en el Caribe está muy fragmentada. De los 116 organismos de investigación agrícola para los cuales se obtuvieron datos, 84 empleaban menos de 10 investigadores (en equivalente en tiempo completo) y 62 tenían menos de 5.
b. Entre 1986 y 1996, el crecimiento de la capacidad de investigación agrícola en el Caribe prácticamente se detuvo en lo que hace al número de investigadores, y se redujo con respecto a los gastos.
c. Los niveles de inversión en la investigación agrícola, relativos al PIB de la agricultura, son bastante elevados para muchos de los países más pequeños del Caribe. Esto no indica necesariamente que haya una innovación intensiva sino más bien la falta de economías de escala. Una intensidad tan alta es posible gracias al generoso apoyo de los donantes o a la riqueza del sector no agrícola.
d. Por cada 100 millones de dólares de producción agrícola, ganadera, silvícola y pesquera, la región empleó, respectivamente, 33,5, 10,9, 13,0 y 48,9 investigadores (en equivalente en tiempo completo). Suponiendo que las oportunidades de innovación sean las mismas para los cuatros tipos de producción, la ganadería y la silvicultura parecen recibir menos atención comparadas con los cultivos y la pesca.
e. La falta de economías de escala en las industrias de insumos agrícolas y de elaboración así como en el suministro de servicios públicos (incluida la investigación agrícola) es una gran desventaja para la producción agrícola moderna en muchos de los pequeños países del Caribe. La especialización en productos básicos y la reagrupación de las actividades de investigación entre países son algunas de las formas de crear un volumen suficiente de beneficios, resultantes de la investigación, para sufragar los costos de la misma.

# Acronyms

| | |
|---|---|
| ACP | Africa, Caribbean, and Pacific |
| AgGDP | agricultural gross domestic product |
| ASTI | Agricultural Science and Technology Indicators |
| BABCO | Belize Agri-Business Company |
| BAMCO | Barbados Agricultural Management Company, Ltd. |
| BELSIL | Belize Sugar Industry, Ltd. |
| CABI | Commonwealth Agricultural Bureaux International |
| CAIS | Caribbean Agricultural Information System |
| CARDATS | Caribbean Agricultural Rural Development and Advisory Training Service |
| CARDI | Caribbean Agricultural Research and Development Institute |
| CARICOM | Caribbean Community and Common Market |
| CARIFTA | Caribbean Free Trade Association |
| CARIRI | Caribbean Industrial Research Institute |
| CEA | Consejo Estatal del Azúcar |
| CENDA | Centro Norte de Desarrollo Agropecuario |
| CIA | Central Intelligence Agency |
| CIRAD | Centre de Coopération Internationale en Recherche Agronomique pour le Développement |
| CFNI | Caribbean Food and Nutrition Institute |
| CFRAMP | Caribbean Fisheries Resources Assessment and Management Program |
| CTA | Technical Centre for Agricultural and Rural Cooperation |
| CTAS | Caribbean Agricultural Technical Assistance Service |
| CTCS | Centre Technique de la Canne en du Sucre |
| CTFT | Centre Technique Forestier Tropical |
| ECLAC | Economic Commission for Latin America and the Caribbean |
| FAO | Food and Agriculture Organization of the United Nations |
| FANS | Faculty of Agriculture and Natural Sciences |
| FDA | Fundación de Desarrollo Agropecuario, Inc. |
| FTE | full-time equivalents |
| GDP | gross domestic product |
| IDB | Inter-American Development Bank |
| ICTA | Imperial College of Tropical Agriculture |
| IDA | Imperial Department of Agriculture |
| IFAT | Institut Français d'Amérique Tropicale |
| IFPRI | International Food Policy Research Institute |
| IICA | Instituto Interamericano de Cooperación para la Agricultura |
| IMA | Institute of Marina Affairs |
| INDOTEC | Instituto Dominicano de Tecnología Industrial |
| INDRHI | Instituto Nacional de Recursos Hidráulicos |
| INRA | Institut National de la Recherche Agronomique |
| IRAT | Institut de Recherche Agronomique Tropical |
| IRFA | Institut de Recherches sur les Fruits et Agrumes |
| IRD | Institut de Recherche pour le Développement |
| ISA | Instituto Superior de Agricultura |
| ISNAR | International Service for National Agricultural Research |
| NARS | national agricultural research system(s) |
| NIHERST | National Institute of Higher Education—Research, Science and Technology |
| NRM | natural resource management |

| | |
|---|---|
| OECD | Organization for Economic Cooperation and Development |
| ORSTOM | Office de la Recherche Scientifique et Technique Outre-Mer |
| PPP | purchasing power parity |
| PROCICARIBE | Program for Cooperation of Institutes of Agricultural Sciences and Technology in the Caribbean |
| RRC | Regional Research Center |
| SAES | State Agricultural Experiment Station |
| SIRI | Sugar Industry Research Institute |
| T&T | Trinidad and Tobago |
| UASD | Universidad Autónoma de Santo Domingo |
| UN | Universidad Nordestrana |
| UNESCO | United Nations Education and Science Organization |
| UNPHU | Universidad Nacional ‘Pedro Henrique Ureña’ |
| UPR | University of Puerto Rico |
| USAID | United States Agency for International Development |
| USDA | United States Department of Agriculture |
| USSR | Union of Soviet Socialist Republics |
| UVI | University of the Virgin Islands |
| UWI | University of the West Indies |
| WIBDECO | Windward Islands Banana Development and Export Company, Ltd. |
| WICSCBS | West Indies Central Sugar Cane Breeding Station |
| WINBAN | Windward Islands Banana Association |
| WTO | World Trade Organization |

# Executive Summary

The development of Caribbean agriculture depends heavily on its ability to modernize and adapt its production towards new circumstances. In recent years in particular, the sector has felt the harsh effects of losing access to protected markets, and has failed to be competitive enough in its traditional markets, both abroad and at home, as well as in potential new markets. Within this context, the authors of this study surveyed the agricultural R&D capacity in the region in order to gain better insight into its structure and development, as well as its potential contribution to the development of agriculture in the region.

Excluding Cuba and Haiti, the region employed close to 1000 FTE researchers and spent some 106 million dollars (1993 PPPs) in 1996. Reflecting the geopolitical fragmentation of the region, agricultural research capacity is also extremely fragmented. Of the 116 agricultural research agencies for which data were obtained, 84 employed less than 10 FTE researchers, and 62 employed less than 5. The largest agricultural research entity in the region employed approximately 60 FTE researchers. Broken down by institutional category, the shares of local government agencies, bilateral and regional government agencies, universities, and business enterprises (including commodity boards) were 37%, 31%, 19%, and 12%, respectively, of the human resources, and 27%, 39%, 22%, and 12%, respectively, of the financial resources.

The number of agricultural researchers in the Caribbean increased by 6% between 1986 and 1996, while agricultural research expenditures declined by 9% (in real terms). This resulted in an average decline of 15% in expenditures per researcher. The experiences of individual countries or research organizations deviated significantly from this average trend. For example, the French Caribbean countries saw a strong expansion of their agricultural research capacity during this period, which somewhat counterbalanced contractions noted elsewhere.

Funding for agricultural research in the region is also quite diverse and depends heavily on the type of organization. On average, 41% of funding comes from local governments, 39% from donors, 9% from specific taxes and levies, 7% from research contracts, 1% from sales, and 3% from other sources. Across institutional categories, however, the relative weights of the funding sources differ greatly. For example, donor funding ranges from as high as 100% for bilateral agencies to as low as 0% for business enterprises, while specific taxes and levies seem to be the almost exclusive prerogative of commodity boards.

Excluding Cuba, the Dominican Republic, and Haiti, agricultural research expenditures in the region accumulated to a level of 2.6% of AgGDP in 1996. This level is significantly higher than the developing country average (0.5% in 1991) and quite close to the investment level of the developed countries (3.1% in 1993). However, high agricultural research intensity ratios in the Caribbean are not necessarily a sign of a highly innovative agricultural sector, as it is for most developed countries. The lack of economies of scale in most Caribbean countries makes the development of agricultural technology extremely expensive. Therefore, high intensity ratios in these countries are better explained by international and local equity concerns, rather than by intensive innovation.

Cuba, the Dominican Republic, and Haiti have quite distinctive levels of agricultural research investment compared to their smaller Caribbean neighbors. The Dominican Republic invested in agricultural research at a level of only 0.2% of AgGDP in 1996. Investment intensities for Cuba and Haiti are more speculative because of incomplete data. Haiti's

investment level is probably even lower than that of the Dominican Republic. In contrast, Cuba's investment level is probably at 1–2%.

Solving a problem for 1,000 farmers or 100,000 farmers makes a lot of difference in terms of the rate of return that can be expected from a research project. Small countries have three options for overcoming this problem: (1) import technology from elsewhere; (2) specialize in just a few commodities (i.e., reduce scope and thereby increase scale); and (3) cluster research activities with other countries so that the research benefits have enough volume to pay for the research investment. (This is the idea behind CARDI, PROCICARIBE, and other collaborative research efforts in the region.)

These strategies already have a long tradition in the Caribbean. The issue is whether they have been exploited to the fullest or whether there is still significant mileage to be gained by exploiting these strategies further. Assuming the latter, it remains doubtful whether the proposed strategies are a sufficient antidote to unfavorable economies-of-scale conditions for all countries in the region.

# 1. Introduction

The development of Caribbean agriculture depends heavily on its ability to modernize and adapt its production towards new circumstances. Increasingly, the sector is feeling the harsh effects of losing access to protected markets, and fails to be competitive enough in its traditional markets as well as in potential new ones. Within this context, the authors surveyed agricultural R&D capacity in the region in order to gain insight into its structure and development, as well as its potential contribution to the development of agriculture in the region.

In addition to descriptive institutional information, this report summarizes and analyzes new research staffing and financial data that have been collected specifically for this study. In comparison to earlier studies,[1] the current study has progressed substantially in both geographic and institutional coverage. This report should be of interest to those involved or interested in agricultural research in the Caribbean, especially to the agricultural research managers and leaders who set the policies and allocate resources for agricultural research in the region.

The information and statistical data have been collected and presented in such a way that they are comparable across the 28 Caribbean countries, and comparable with data from other country studies under the Agricultural Science and Technology Indicators (ASTI) project. Annex 1 summarizes the methodology and definitions used by the ASTI project, while annex 5 lists all the data sources that were utilized. Country-specific data sets with time-series data per institute are available electronically and as a statistical appendix upon request from ISNAR.

Chapter 2 of this report gives an overview of the structural and economic characteristics of the Caribbean, with particular attention given to the role of agriculture. The chapters that follow provide an account of the historical development and current institutional structure of agricultural research in the region (chapter 3), and the human and financial resources invested in agricultural research (chapter 4). Chapter 5 concludes the report by exploring the future of agriculture and agricultural research in the Caribbean.

The annexes to this report provide the following information: the definitions and concepts used for the data collection (annex 1), country status (annex 2), names and addresses of institutes (annex 3), detailed institutional data (annex 4), and data sources (annex 5).

1. FAO and CARDI (1993); Lindarte (1995); Lindarte (1998); Nestel (1991); World Bank (1993).

# 2. Structural and Economic Characteristics of the Caribbean

## General characteristics

The Caribbean[2] is one of the most diverse regions in the world. Its population has its roots in many corners of the globe and (former) colonial ties are quite diverse, all of which result in a great diversity of languages, culture, and political and juridical systems. The region is comprised of countries that count among the poorest (Cuba and Haiti) as well as the richest (Aruba, Bahamas, Cayman Islands) in the world (see table 1). Most Caribbean countries have very small populations (21 out of 28 countries have a population of less than half a million), but the region also includes several medium-sized countries with populations of 5 million or more (Cuba, Haiti, Dominican Republic). The three largest countries constitute 69% of the region's total population of 38.2 million in 1997.

Although the Spanish were first to invade the "New World," Spain lost its initial monopoly in the region to Denmark, France, Great Britain, the Netherlands, and the United States in the centuries that followed (see annex 1). In the 19th century, Spain lost control over its three remaining colonies in the region (Cuba, the Dominican Republic, Puerto Rico) to local liberation movements that were inspired by the developments in both North and South America. Spanish domination of the Dominican Republic came to an end in 1844, while the Spanish-American War in 1898 ended all Spanish claims on Cuba and Puerto Rico.

At that time, Puerto Rico became a U.S. territory, while Cuba became independent though strongly dominated by U.S. economic and political interests. The Dominican Republic and

**Table 1: Per Capita Income and Population Size in the Caribbean, 1997**

| | Total population (in millions) | | | | |
|---|---|---|---|---|---|
| GDP per capita (PPP dollars) | 0.1< | 0.1–0.5 | 0.5–1.0 | 1.0–5.0 | >5.0 |
| $2,000< | | | | | Haiti<br>Cuba |
| $2,000-4,999 | Dominica<br>Grenada<br>Montserrat | St. Vincent and the Grenadines<br>Belize<br>Suriname<br>St. Lucia | Guyana | Jamaica | Dominican Republic |
| $5,000-9,999 | St. Kitts-Nevis<br>Anguilla<br>Antigua and Barbuda<br>Turks and Caicos Islands | French Guiana<br>Guadeloupe | | Trinidad and Tobago<br>Puerto Rico | |
| $10,000–19,999 | British Virgin Islands | Martinique<br>Barbados<br>Netherlands Antilles<br>Virgin Islands (US)<br>Bahamas | | | |
| >$20,000 | Aruba<br>Cayman Islands | | | | |

2. The Caribbean region, as defined here, is comprised of 24 island states or territories and 4 coastal countries (Belize, French Guiana, Guyana, and Suriname). See annex 2 for the complete list of countries and territories, their formal government status, and membership in the Caribbean Community and Common Market (CARICOM).

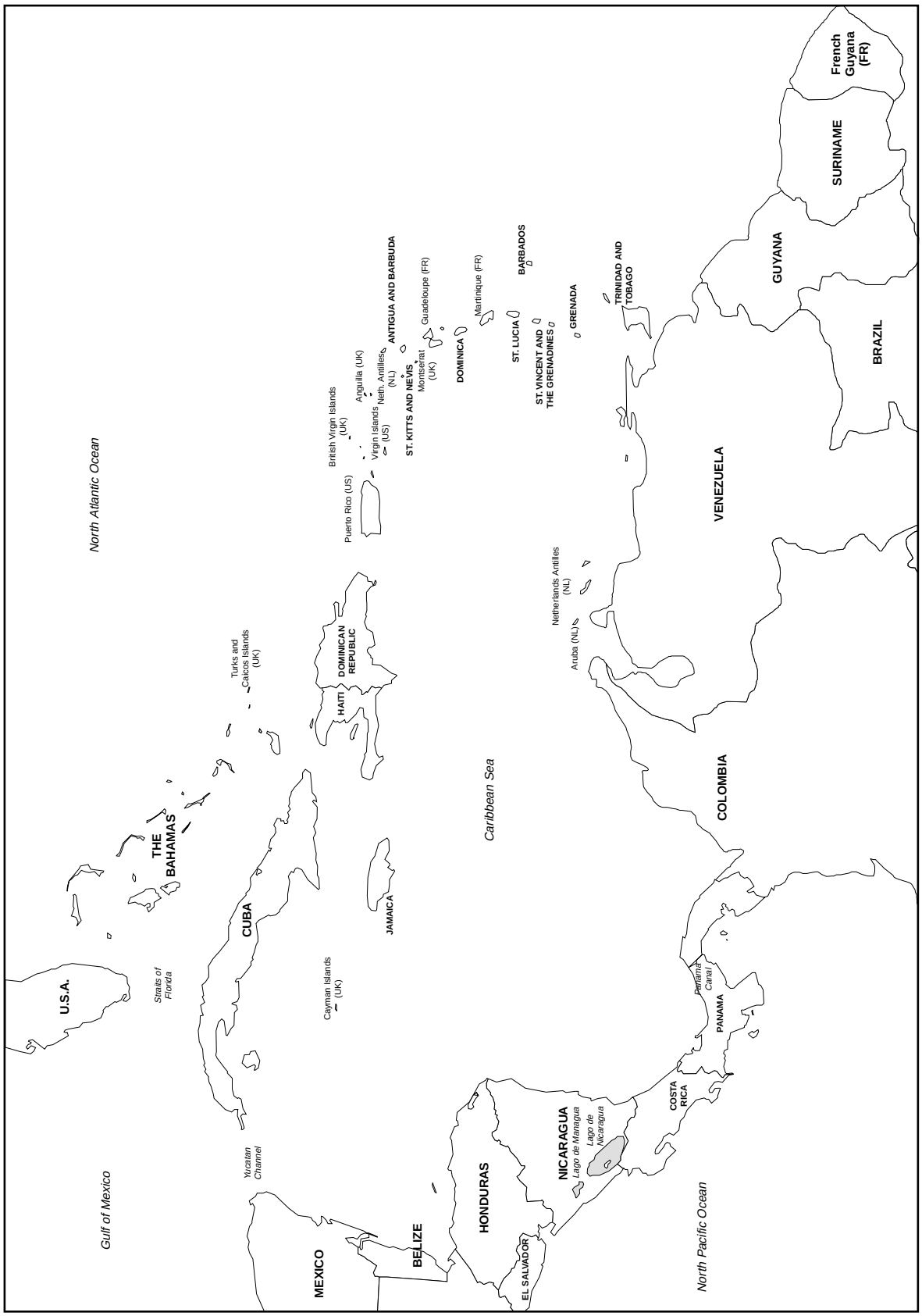


**Figure 1: The Caribbean region**

Haiti,[3] countries with a long history of political instability, came under relatively strong U.S. domination and were invaded several times during the 20th century by American troops for the purpose of restoring law and order. For strategic reasons, the U.S. also purchased from Denmark several islands belonging to the Virgin Islands during the First World War.

A total of 17 out of 28 countries in the region have historical ties with Great Britain, making it the most common (former) colonizer in the region in terms of number of countries. In terms of population, however, Spanish speakers outnumber English speakers by about four to one. Since 1960, 13 of the 17 British colonies in the Caribbean have gained independence, although they all remain part of the (former British) Commonwealth, and most of them retain the British monarch as their titular head of state. Of the Dutch and French colonies in the region, only Suriname gained independence (in 1975).

The region's fragmentation into very small island states is often considered a major structural weakness. Despite an attempt by the British government to consolidate its Caribbean colonies into the British West Indies Federation in 1958, the two largest countries in the federation (Jamaica and Trinidad & Tobago) broke away and gained independence in August 1962. As a consequence, the federation was dissolved, but the need for regional collaboration remained. During the 1960s, several initiatives towards collaboration were launched by the heads of government of the (former) British colonies in the Caribbean. It culminated, among other things, in the establishment of the Caribbean Free Trade Association (CARIFTA) in 1968, which was succeeded by the Caribbean Community and Common Market (CARICOM) in 1973. Membership was no longer limited to (former) British colonies. Other Caribbean countries were invited to join, but only Suriname and Haiti have done so to date. A few other countries maintain observer status (see annex 2).

## Agriculture within the overall economy

Most countries in the Caribbean have undergone a profound economic transformation over the past 40 years, from an essentially agricultural economy towards a predominantly service-oriented one. Traditionally, agricultural economies in the region were based on one or two major export crops such as sugar or bananas. These exports provided the foreign exchange needed to import consumer goods. Over time, tourism and offshore banking have taken over as the principal economic activities in the region, particularly in the smaller countries. The larger countries have somewhat more diversified economies and have developed some manufacturing industry. Not all countries have succeeded in this transition towards a modern economy. Agriculture still constitutes more than 25% of GDP in Dominica, Guyana, and Haiti. These are also among the poorer countries in the region.

For most countries in the region, the modernization of agriculture has significantly lagged behind the rest of the economy. This has not only resulted in a relative decline of agriculture as an economic activity but in many cases also in an absolute decline.[4] As a consequence, many Caribbean countries nowadays run major agricultural trade deficits.[5] A dozen countries in the region ran an agricultural trade deficit of more than US$ 400 per capita in 1997 (table 2), notably the smaller and richer countries in the region. Some countries have even dispensed with agriculture almost entirely, as income opportunities in other sectors of the economy are far more attractive.

3. Haiti, once a French colony, had already liberated itself by the end of the 18th century.
4. This is in contrast to most developed countries that have maintained their level of agricultural production relative to population growth while expanding into other economic activities.
5. These agricultural trade statistics cover crop and livestock products (including processed products), but exclude fishery and forestry products.

**Table 2: Share of Agriculture in the Caribbean Economies and the Relative Dependency on Agricultural Imports, 1997**

| Import dependency agricultural products: | Share of agriculture in GDP: 5%< | 5–10% | 10–25% | >25% |
|---|---|---|---|---|
| Agricultural export surplus | | Cuba | St. Vincent and the Grenadines<br>Belize | Guyana |
| Moderately agricultural import dependent (deficit per capita per annum: US$ 0–99) | | St. Kitts – Nevis<br>Jamaica | Dominican Republic<br>Suriname | Haiti |
| Highly agricultural import dependent (deficit per capita per annum: US$ 100–399) | Trinidad and Tobago | Barbados | Grenada<br>St. Lucia | Dominica |
| Extremely agricultural import dependent (deficit per capita per annum: >US$ 400) | Antigua and Barbuda<br>Aruba<br>Bahamas<br>British Virgin Islands<br>Cayman Islands<br>Montserrat<br>Netherlands Antilles<br>Virgin Islands (US) | French Guiana<br>Guadeloupe<br>Martinique | | |

*Sources:* CIA (1999) and FAO (1999).
*Note:* Anguilla, Puerto Rico, and Turks and Caicos Islands are not included due to lack of data.

The Caribbean region as a whole ran an agricultural trade deficit of US$ 1.4 billion in 1997, or US$ 40 per capita (FAO 1999). Food self-sufficiency is a global need, but, as the numbers show in table 2, this is not a binding constraint for the small-but-rich Caribbean countries. One could even argue that a further specialization in their niche activities (tourism and off-shore banking) makes sense from an economic point of view. However, for some of the poorer countries, even relatively small agricultural trade deficits are a major reason for concern because they lack other substantial sources of foreign exchange to pay for imports.

Cuba is a special case. It ran a huge agricultural trade surplus of about US$ 3-4 billion throughout the 1970s and 1980s, due to its status as preferential supplier of sugar to the USSR. With the collapse of the USSR in the early 1990s, the country lost its major export market and saw its agricultural trade surplus drop from US$ 3,700 million in 1990 to US$ 117 million in 1995.

Time-series data on agricultural import-export for the period 1961-95 are presented in figure 2 for Cuba, as well as for 5 other Caribbean countries with populations between 0.5 and 10 million, and for 21 Caribbean countries with populations of less than 0.5 million. The agricultural trade deficit of the latter group has steadily increased from about zero in the early 1960s to US$ 1.1 billion in 1995. The five Caribbean countries with populations between 0.5 and 10 million (Dominican Republic, Haiti, Jamaica, Trinidad & Tobago, and Guyana) have moved from a situation of a substantial agricultural trade surplus during the 1960s to a deficit in the 1990s. Of these five, only Guyana has maintained its agricultural trade surplus.

## Agricultural production characteristics

Agricultural production statistics for the Caribbean are problematic. In the smaller countries in particular, the volume of output for specific commodities is often so small that they do not appear in national or international statistics. For the following five countries, no crop production was reported whatsoever: Anguilla, Aruba, Netherlands Antilles, Turks and Caicos Islands, and Virgin Islands (U.S.).

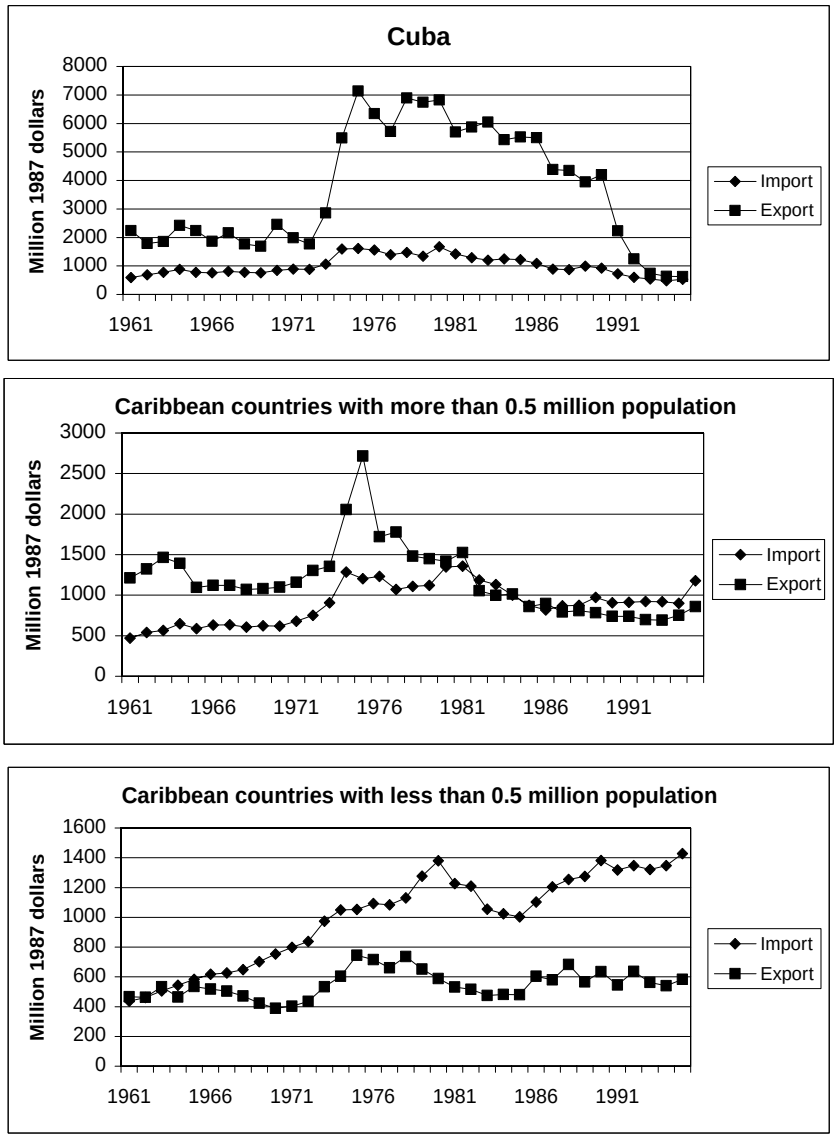


**Figure 2: Agricultural import and export trends in the Caribbean, 1961–95**

*Source:* FAO (1999).

*Note:* The second graph includes the following Caribbean countries (except Cuba) with a population of more than 0.5 million: Dominican Republic, Guyana, Haiti, Jamaica, and Trinidad & Tobago. The third graph includes the Caribbean countries with a population of less than 0.5 million: Antigua and Babuda, Aruba, Bahamas, Barbados, Belize, British Virgin Islands, Dominica, French Guiana, Guadeloupe, Martinique, Montserrat, Netherlands Antilles, St. Kitts-Nevis, St. Lucia, St. Vincent, and Suriname.

Table 3 provides a detailed overview of agricultural production in the region. Of all crops, sugarcane is still the most important in the region, representing 27% of total crop output. Cuba is by far the largest sugarcane producer, producing some 69% of the region's sugarcane. Despite the dramatic collapse of Cuban sugar export and production in the early 1990s, sugarcane still represents about 50% of Cuba's crop output. Other countries with a substantial sugarcane industry are the Dominican Republic, Guyana, Jamaica, Belize, Trinidad & Tobago, and Haiti (between $10 to $100 million each).

A striking characteristic of crop production in most Caribbean countries is the relative specialization in one or two major crops. Bananas and plantains are the dominant crops in seven countries, sugarcane in four, citrus fruit in four, rice in three, and nutmeg in one. In the smaller countries, agricultural production typically revolves around one or two major export crops. Transportation (in particular for fresh products) and preferential access to markets

play a crucial role in specialization. For example, many of the Caribbean sugar and banana producers have preferential access to the European market, and command higher than world-market prices.

Such arrangements, however, are increasingly under threat due to the more liberal trade policies agreed upon under the World Trade Organization (WTO). The U.S.A., for example, has been fighting the preferential treatment of banana exporters from ACP countries by the European Union for quite some time and apparently with success. Losing this preferential treatment is an enormous blow to the region's agricultural sector and may destabilize some smaller islands economically. In fact, Cuba serves as a striking example of what can happen to a country that loses its preferential market access.

Livestock, forestry, and fisheries production in the region is mainly for local consumption. Livestock production, in particular, has grown quite rapidly because of a rapid growth in local demand. More than two-thirds of forestry production consists of fuel wood and charcoal. In Belize, Cuba, French Guiana, and Haiti, and to a lesser extent in the Dominican Republic and Jamaica, fuel wood and charcoal constitute an important source of energy. This is probably the case as well for some of the smaller and poorer island states for which no production data were reported. The value of marine fisheries is strikingly low, given that all the countries in the region are surrounded by sea or have access to it.

Two types of farm holdings dominate in the Caribbean: small family farms and plantations. The latter are quite significant in terms of production (i.e., sugarcane), but not in numbers. Most family farms are small (less than 2 hectares) and, on the smaller islands, are often on scattered plots in very challenging mountainous terrain.

Typical for modern agriculture is the increasing importance of agricultural input and processing industries relative to primary agricultural production. Whereas in primary agriculture, economies-of-scale effects tend to level off early (hence the predominance of family-operated farms in most countries), these effects are usually far more significant in agricultural input and processing industries. Therefore, small, local processing industries in the Caribbean have a very difficult time competing with the well-established, large-scale food processing industries of North America. By the same token, the development of local agricultural input industries is severely hampered by the lack of economies of scale. Looking for economies of scope, for example by focusing on just one or two export commodities, can compensate for the lack of economies of scale to some extent, but in most instances small countries remain disadvantaged when it comes to producing bulk products at competitive world-market prices.

## Agricultural trade characteristics

Table 4 provides an overview of the region's relative trade position for specific agricultural commodities. For some commodities, the Caribbean is a net exporter, while for others it is a major importer. The rich Caribbean countries with a very small agricultural sector and a high agricultural trade deficit per capita usually import across the whole range of agricultural products. Small countries with agricultural sectors of some importance tend to specialize in one or two major export crops, but also import quite a diverse range of products.

North America and the European Union are the principal agricultural trading partners for the Caribbean. Intra-regional trade is relatively modest, while trade with Latin America, given its geographical proximity, is surprisingly low. New Zealand is an important exporter of meat and dairy products to the Caribbean.

**Table 3a: Value of Agricultural Production, 1998 or Latest Year Available (in millions of dollars, international 1989–91 prices)**

| | Crop production | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | Sugar Cane | Fruit | Cereals | Bananas/ plantains | Vege- tables | Roots & tubers | Coffee | Tobacco | Legumes | Coconuts | Cocoa | Spices | Oil crops | Other crops | Total crops |
| Anguilla | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Antigua and Barbuda | 0.00 | 1.79 | 0.01 | 0.02 | 0.31 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 | 2.20 |
| Aruba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Bahamas, The | 0.67 | 5.39 | 0.05 | 0.14 | 3.50 | 0.06 | 0.00 | 0.00 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.91 |
| Barbados | 9.63 | 0.65 | 0.25 | 0.08 | 2.63 | 0.65 | 0.00 | 0.00 | 0.30 | 0.16 | 0.00 | 0.00 | 0.04 | 0.00 | 14.39 |
| Belize | 20.37 | 39.14 | 7.82 | 12.49 | 0.84 | 0.56 | 0.00 | 0.00 | 2.68 | 0.34 | 0.03 | 0.00 | 0.00 | 0.00 | 84.28 |
| British Virgin Islands | 0.00 | 0.01 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 |
| Cayman Islands | 0.00 | 0.02 | 0.00 | 0.03 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 |
| Cuba | 590.29 | 192.91 | 89.48 | 70.96 | 67.51 | 70.41 | 20.43 | 45.97 | 8.46 | 2.75 | 1.46 | 0.00 | 7.36 | 8.40 | 1176.39 |
| Dominica | 0.08 | 6.80 | 0.02 | 6.78 | 1.10 | 3.22 | 0.35 | 0.00 | 0.03 | 1.76 | 0.13 | 0.14 | 0.00 | 0.00 | 20.40 |
| Dominican Republic | 85.96 | 160.61 | 97.48 | 88.30 | 64.63 | 20.56 | 54.61 | 63.91 | 30.51 | 16.96 | 39.32 | 1.99 | 5.39 | 0.69 | 730.94 |
| French Guiana | 0.08 | 1.42 | 5.89 | 0.94 | 3.86 | 1.22 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 13.44 |
| Grenada | 0.11 | 3.06 | 0.04 | 0.75 | 0.40 | 0.56 | 0.00 | 0.00 | 0.47 | 0.72 | 0.66 | 7.78 | 0.00 | 0.02 | 14.57 |
| Guadeloupe | 10.76 | 3.03 | 0.00 | 22.34 | 3.79 | 1.99 | 0.02 | 0.00 | 0.04 | 0.03 | 0.00 | 0.07 | 0.00 | 0.01 | 42.09 |
| Guyana | 43.85 | 2.70 | 101.44 | 3.04 | 1.42 | 4.20 | 0.13 | 0.15 | 0.37 | 5.97 | 0.03 | 0.00 | 1.23 | 0.15 | 164.68 |
| Haiti | 16.87 | 90.44 | 56.68 | 72.34 | 34.91 | 68.36 | 26.12 | 0.82 | 30.81 | 3.18 | 2.98 | 0.00 | 12.69 | 2.05 | 418.24 |
| Jamaica | 40.70 | 51.93 | 0.40 | 23.28 | 32.61 | 40.06 | 2.30 | 3.59 | 2.24 | 12.17 | 0.99 | 23.37 | 1.74 | 0.15 | 235.55 |
| Martinique | 3.18 | 4.07 | 0.00 | 50.84 | 5.64 | 2.52 | 0.03 | 0.00 | 0.48 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 66.89 |
| Montserrat | 0.00 | 0.11 | 0.00 | 0.02 | 0.09 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.26 |
| Netherlands Antilles | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Puerto Rico | 5.18 | 12.21 | 0.00 | 13.24 | 6.67 | 1.11 | 11.09 | 0.00 | 0.33 | 0.60 | 0.00 | 0.00 | 0.00 | 0.00 | 50.45 |
| St. Kitts and Nevis | 4.12 | 0.31 | 0.00 | 0.00 | 0.15 | 0.15 | 0.00 | 0.00 | 0.08 | 0.18 | 0.00 | 0.00 | 0.05 | 0.00 | 5.04 |
| St. Lucia | 0.00 | 7.04 | 0.01 | 11.97 | 0.15 | 0.86 | 0.00 | 0.00 | 0.02 | 1.27 | 0.02 | 0.55 | 0.00 | 0.00 | 21.87 |
| St. Vincent and the Grenadines | 0.34 | 1.06 | 0.25 | 8.58 | 0.67 | 1.67 | 0.15 | 0.13 | 0.11 | 2.43 | 0.11 | 1.19 | 0.00 | 0.00 | 16.71 |
| Suriname | 1.52 | 3.21 | 40.48 | 7.55 | 4.25 | 0.42 | 0.01 | 0.00 | 0.06 | 0.99 | 0.01 | 0.00 | 0.15 | 0.00 | 58.66 |
| Trinidad and Tobago | 16.87 | 12.34 | 2.43 | 1.30 | 3.94 | 1.37 | 0.92 | 0.00 | 2.44 | 2.12 | 1.19 | 0.33 | 0.00 | 0.00 | 45.24 |
| Turks and Caicos Islands | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Virgin Islands (U.S.) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Total* | *850.59* | *600.27* | *402.73* | *395.04* | *239.12* | *219.98* | *116.17* | *114.58* | *79.53* | *51.77* | *46.94* | *35.43* | *28.66* | *11.54* | *3192.34* |

**Table 3b: Value of Agricultural Production, 1998 or Latest Year Available (in millions of dollars, international 1989–91 prices)**

| | Livestock production | | | | | | | | | Forestry production | | | Fisheries production (1996) | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | Beef and Veal | Poultry meat | Milk | Pigmeat | Eggs | Goat and sheep meat | Honey | Other meat | Live-stock total | Ind. Round-wood | Fuel-wood & charcoal | Forestry total | Inland fish | Marine fish | Fisheries total | |
| Anguilla | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.16 | 0.24 | 0.24 |
| Antigua and Barbuda | 1.17 | 0.24 | 1.54 | 0.10 | 0.15 | 0.14 | 0.00 | 0.00 | 3.34 | 0.00 | 0.00 | 0.00 | 0.09 | 0.23 | 0.32 | 11.40 |
| Aruba | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 | 0.09 | 0.09 |
| Bahamas, The | 0.04 | 13.09 | 0.44 | 0.22 | 1.06 | 0.19 | 0.00 | 0.00 | 15.03 | 13.22 | 0.00 | 13.22 | 6.54 | 0.86 | 7.40 | 83.72 |
| Barbados | 1.17 | 14.02 | 2.19 | 5.23 | 0.80 | 0.34 | 0.00 | 0.00 | 23.76 | 0.57 | 0.00 | 0.57 | 0.00 | 2.16 | 2.16 | 79.58 |
| Belize | 3.29 | 9.25 | 1.80 | 1.55 | 1.59 | 0.03 | 0.16 | 0.00 | 17.68 | 6.96 | 6.93 | 13.89 | 1.58 | 0.11 | 1.69 | 233.38 |
| British Virgin Islands | 0.32 | 0.00 | 0.00 | 0.03 | 0.00 | 0.22 | 0.00 | 0.00 | 0.57 | 0.00 | 0.00 | 0.00 | 0.12 | 0.56 | 0.68 | 1.96 |
| Cayman Islands | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.39 | 0.07 | 0.47 | 0.65 |
| Cuba | 176.03 | 73.64 | 169.80 | 94.64 | 56.28 | 3.14 | 8.31 | 1.89 | 583.73 | 69.04 | 139.76 | 208.80 | 40.86 | 37.28 | 78.14 | 4015.98 |
| Dominica | 1.23 | 0.37 | 1.57 | 0.56 | 0.23 | 0.13 | 0.00 | 0.00 | 4.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 | 0.55 | 49.51 |
| Dominican Republic | 180.21 | 207.38 | 92.19 | 85.92 | 50.60 | 5.13 | 2.33 | 0.00 | 623.76 | 0.71 | 53.68 | 54.39 | 5.89 | 8.35 | 14.23 | 2832.42 |
| French Guiana | 0.94 | 0.71 | 0.06 | 1.58 | 0.45 | 0.06 | 0.00 | 0.00 | 3.81 | 6.78 | 3.94 | 10.72 | 3.25 | 2.37 | 5.62 | 61.55 |
| Grenada | 0.32 | 0.59 | 0.13 | 0.23 | 0.92 | 0.19 | 0.00 | 0.08 | 2.46 | 0.00 | 0.00 | 0.00 | 0.03 | 1.01 | 1.04 | 35.10 |
| Guadeloupe | 8.03 | 0.78 | 0.03 | 1.42 | 1.66 | 0.40 | 0.26 | 0.07 | 12.65 | 0.03 | 0.83 | 0.86 | 0.47 | 5.92 | 6.39 | 117.60 |
| Guyana | 6.81 | 13.83 | 3.34 | 0.67 | 6.83 | 1.62 | 0.13 | 0.00 | 33.24 | 61.16 | 0.84 | 61.99 | 5.93 | 24.64 | 30.57 | 550.39 |
| Haiti | 72.29 | 9.38 | 15.27 | 36.06 | 4.28 | 11.66 | 0.94 | 10.25 | 160.12 | 27.01 | 349.91 | 376.92 | 1.57 | 2.63 | 4.20 | 1914.75 |
| Jamaica | 34.12 | 72.79 | 13.64 | 8.79 | 28.14 | 3.29 | 1.73 | 0.06 | 162.57 | 4.83 | 17.16 | 21.99 | 5.60 | 5.80 | 11.40 | 851.60 |
| Martinique | 6.04 | 1.16 | 0.53 | 2.01 | 1.51 | 0.68 | 0.00 | 0.16 | 12.09 | 0.23 | 0.55 | 0.78 | 0.10 | 2.10 | 2.20 | 161.72 |
| Montserrat | 1.69 | 0.09 | 0.58 | 0.08 | 0.06 | 0.10 | 0.00 | 0.00 | 2.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 0.12 | 5.83 |
| Netherlands Antilles | 0.02 | 0.47 | 0.10 | 0.17 | 0.51 | 0.16 | 0.00 | 0.00 | 1.42 | 0.00 | 0.00 | 0.00 | 0.01 | 0.65 | 0.66 | 3.50 |
| Puerto Rico | 36.88 | 73.50 | 91.87 | 17.70 | 15.22 | 0.32 | 0.08 | 0.22 | 235.79 | 0.00 | 0.00 | 0.00 | 0.38 | 1.28 | 1.66 | 574.13 |
| St. Kitts and Nevis | 0.24 | 0.19 | 0.00 | 0.26 | 0.30 | 0.18 | 0.00 | 0.00 | 1.17 | 0.00 | 0.00 | 0.00 | 0.04 | 0.12 | 0.15 | 12.57 |
| St. Lucia | 0.33 | 0.77 | 0.23 | 0.96 | 0.52 | 0.31 | 0.00 | 0.00 | 3.11 | 0.00 | 0.00 | 0.00 | 0.02 | 0.82 | 0.84 | 50.80 |
| St. Vincent and the Grenadines | 0.53 | 0.52 | 0.35 | 0.77 | 0.64 | 0.17 | 0.00 | 0.00 | 2.98 | 0.00 | 0.00 | 0.00 | 0.02 | 0.84 | 0.86 | 40.23 |
| Suriname | 4.76 | 3.80 | 4.12 | 1.48 | 3.01 | 0.14 | 0.15 | 0.00 | 17.46 | 20.57 | 1.05 | 21.61 | 0.31 | 8.40 | 8.70 | 204.17 |
| Trinidad and Tobago | 2.58 | 30.68 | 2.52 | 1.61 | 9.04 | 0.92 | 0.07 | 0.00 | 47.43 | 8.41 | 1.21 | 9.62 | 0.78 | 7.77 | 8.55 | 213.13 |
| Turks and Caicos Islands | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.82 | 0.20 | 1.02 | 1.02 |
| Virgin Islands (U.S.) | 1.20 | 0.09 | 0.50 | 0.14 | 0.16 | 0.07 | 0.00 | 0.00 | 2.16 | 0.00 | 0.00 | 0.00 | 0.09 | 0.51 | 0.61 | 4.92 |
| *Total* | *540.22* | *527.34* | *402.81* | *262.19* | *183.98* | *29.58* | *14.15* | *12.73* | *1973.01* | *219.50* | *575.84* | *795.34* | *74.98* | *115.58* | *190.56* | *12111.94* |

*Note for Table 3:* FAO usually publishes production data only. In order to construct aggregate production volumes, we multiplied the FAO production data with a set of international agricultural prices. This set was obtained from the FAO WAICENT database via the TAC Secretariat in 1997. These international prices pertain to the years 1989–91, which is the base-year period over which FAO calculates its aggregate production indices. For the calculation of these "international prices," see Rao (1993). For charcoal and fuelwood, a shadow price was obtained from the TAC Secretariat.

**Table 4: Caribbean Import-Export Profile per Commodity Group, 1998**

| Product group | Trade surplus / deficit | Specific comments |
|---|---|---|
| Sugar | Surplus: US$ 896 million. | Sugar exporting countries are: Barbados, Belize, Cuba, Dominican Republic, Guadeloupe, Guyana, Jamaica, St. Kitts-Nevis, and T&T. |
| Coffee, cacao, tea and spices | Surplus: US$ 176 million. | Cuba, Dominican Republic, Haiti and Jamaica are major exporters of coffee; the Dominican Republic of cacao; and Grenada of nutmeg. |
| Fruit and vegetables | Surplus: US$ 158 million. Trade surplus due to export of bananas and, to a lesser extent, citrus fruit. Some countries import large quantities of fruit juice. | Bananas are a major export commodity for: Belize, Dominica, Dominican Republic, Grenada, Jamaica, Martinique, St. Lucia, St. Vincent, and Suriname. Citrus fruit is an important export commodity for Belize and Cuba. |
| Tobacco | Surplus: US$ 83 million. | Only Cuba and the Dominican Republic export tobacco. |
| Fisheries products | Surplus: US$ 16 million (1996). | Trade volumes are small, but quite volatile. |
| Crude materials | Deficit: US$ 111 million. | Only the Dominican Republic has a trade surplus (sisal). |
| Beverages | Deficit: US$ 153 million. | Important exporters of alcoholic beverages (i.e., rum) are Guyana, Jamaica, and T&T. The Bahamas, Barbados, Guadeloupe, Martinique, and St. Lucia are also major exporters, but this is largely based on imports and not local production. |
| Miscellaneous foods | Deficit: US$ 170 million. | All countries in the region have a trade deficit. |
| Animal Feed | Deficit: US$ 183 million. | All countries in the region have a trade deficit. |
| Animal and vegetable oils | Deficit: US$ 284 million. | Only T&T runs a small trade surplus. Major importers are Cuba, the Dominican Republic, and Haiti. |
| Meat and meat products | Deficit: US$ 484 million. | All countries have a trade deficit except the Dominican Republic. Demand for livestock products has risen faster than demand for other agricultural products. |
| Dairy and eggs | Deficit: US$ 522 million. | All countries have a trade deficit. Demand for livestock products has risen faster than demand for other agricultural products. |
| Forestry products | Deficit: US$ 528 million (1997). | The only three countries with a forestry trade surplus are Guyana, Suriname, and French Guiana. Most countries, however, run a forestry trade deficit of US$ 50-150 per capita per annum. |
| Cereals | Deficit: US$ 797 million. | All countries have a trade deficit, except French Guiana, Guyana and Suriname, which are important rice producers and exporters. The Netherlands Antilles and St. Vincent are also major rice exporters, but this is based on import of rice, not on local production. The Caribbean climate is not very suitable for wheat production. |

*Source*: FAO (1999).

## Agricultural input markets

Acquisition of technology through purchased inputs constitutes an important source of technological innovation in agriculture (Roseboom 1999). Some of these inputs, such as seeds and animal feed, have their origins within agriculture, while others, such as fertilizers, agrochemicals, and agricultural machinery, are produced by other industries. Given the rather small and geographically fragmented agricultural input markets in the Caribbean, local production of agricultural inputs is relatively underdeveloped. For some agricultural inputs, such as agrochemicals and agricultural machinery, the region is almost completely dependent on imports. For fertilizers, some local production capacity exists in the Dominican Republic and Trinidad & Tobago.

Establishing a local supply of good quality seeds and planting materials is problematic in many parts of the Caribbean. Well-established plant breeding programs in the region exist only for sugarcane, cocoa, and rice. For most other crops, research is limited to the screening and selection of imported materials. Vegetable production, for example, depends almost completely on imported hybrid seeds.

# 3. Agricultural Research Institutions

## Historical development

Colonial relationships have shaped the institutional development of agricultural research in most Caribbean countries, and in many instances, they still play a major role. Only Cuba, Haiti, and the Dominican Republic were politically independent prior to the local inception of formal agricultural research in the early 1900s. However, the Caribbean was already an important experimental site for new crops and new agricultural production technologies long before formal agricultural research took off. By the 18th century, the region had become an important sugar producer within the world economy. Because disease and repression had decimated the Caribbean's indigenous population, sugar plantations and factories imported slave labor from Africa on a large scale. Being on the route between Europe, Africa, and the Americas, many new plant species were introduced to the Caribbean, giving the region an enormous variety of cultivated plant species. This process became more structured and formalized with the establishment of botanical gardens in the 19th century. It is only in the 20th century that better transport and preservation technologies allowed the region to export more of its abundant plant species, in particular bananas and other fruits.

As mentioned earlier, 17 out of 28 countries in the region have historical ties with Great Britain. As a result, the British agricultural research legacy is the most pronounced in the region.

### *The British agricultural research legacy*

During the 19th century, a dense network of botanical gardens was established throughout the British Empire, including the British Caribbean. These gardens were not research stations as we know them today, but they laid the institutional foundation for future agricultural research activities. According to Wilson (1985) and Parasram (1990), formal public agricultural research in the British Caribbean colonies goes back to 1898, when the Imperial Department of Agriculture for the West Indies (IDA) was established at Barbados. In 1921–22, IDA was moved to Trinidad, forming the nucleus of the newly established Imperial College of Tropical Agriculture (ICTA), whose staff engaged in an integrated program of research and teaching. The major research thrusts of the College involved breeding programs for the principal plantation crops (sugar, cacao, bananas, citrus) as well as a strong soil science program. Over the 1921–51 period, ICTA was the only center in the British Commonwealth offering postgraduate training in tropical agriculture, and it played a role that went far beyond Caribbean agriculture.

Beginning around 1940, ICTA's research and teaching operations became functionally separate, and in 1955 a Regional Research Center (RRC) was founded that absorbed the research functions of ICTA. The College continued as a teaching institution until 1960, when it was closed and its assets transferred to the newly constituted University College of the West Indies (UCWI). UCWI opened on the St. Augustine campus in 1961, and in 1962 it became the University of the West Indies (UWI) with its own charter. RRC continued as an autonomous research institute until 1965, when it was integrated into UWI's Faculty of Agriculture. Subsequently, it was institutionally separated from the university to form the Caribbean Agricultural Research and Development Institute in 1975. CARDI is an autonomous institute, with a regional research and development mandate (including extension) whose budget is funded, in part, by the 13 member states of the Caribbean Community (CARICOM). CARDI's Board of Governors consists of the Ministers of Agriculture of the member states, while its Board of Directors is drawn from member governments and regional agencies.

These institutional changes reflect a transfer of control and financial responsibility for the conduct of (publicly sponsored) regional research initiatives to the respective local governments. ICTA's operations (1924–1960) were entirely in the hands of the British Colonial Office and the private commodity associations and boards that provided the institute with substantial resources. Local governments gained increasing control with the formation of RRC, and then assumed full control of the research agenda with the formation of CARDI in 1975. While initially most CARDI researchers were located at the St. Augustine campus in Trinidad, they were distributed over all member countries in the late 1970s. Although this has brought the researchers closer to their ultimate client group (the farmers) and to their paymasters (the local governments), it has also resulted in a highly fragmented research infrastructure, with researchers who have to work in relative isolation. In most member countries, the CARDI research team has less than five researchers, and, in some cases, just one researcher. This emphasis on local presence has been further strengthened with the integration of the Caribbean Agricultural Rural Development and Advisory Training Service (CARDATS) into CARDI in 1988. This has shifted the emphasis of CARDI's work in the direction of technology transfer.

The other successor of ICTA is the University of the West Indies (UWI). In addition to the campus at the old ICTA location at St. Augustine (Trinidad), UWI also established campuses at Cave Hill (Barbados) and Mona (Jamaica). The latter also serves as UWI's headquarters. Initially, UWI had a rather centralized structure, with faculties that included facilities and faculty staff across the different campuses. In more recent years, it has adopted an approach wherein each UWI campus operates as an independent university. UWI's Faculty of Agriculture has always operated from one campus only (St. Augustine), although occasionally it had one or more faculty members located at both Cave Hill and Mona. However, Faculties of Sciences or Natural Sciences can be found at all three campuses, and their life science departments are of growing importance to agricultural research. The Life Science department at the Mona campus in Jamaica, for example, houses the Biotechnology Centre (established in 1989) and the Centre for Marine Science (established in 1990). Most recently, in 1996, the Faculty of Agriculture and the Faculty of Natural Sciences at the St. Augustine campus merged to form the Faculty of Agriculture and Natural Sciences (FANS). In addition, the Trinidad branch of UWI has maintained a School of Veterinary Medicine since 1989.

In addition to CARDI and UWI, many other local and regional agricultural research initiatives have emerged in the (former) British colonies over time. While the British took a strong regional approach to agricultural research during their administration, the balance shifted to more local approaches as countries gained independence. In most countries, the Ministry of Agriculture assumed responsibility for agricultural research, by either: (a) contracting research out to CARDI, (b) attracting bilateral research support from donors, or (c) establishing their own research facilities. Given the small size of most Ministries of Agriculture in the British Caribbean, research is often not organized as a separate activity but as part and parcel of a portfolio of activities implemented by a small team of technical generalists. The emphasis is usually more on technology transfer than research, the research itself tends to be ad hoc and short-term, and the capacity to conduct research is usually very limited. Only 5 out of 17 (former) British colonies have research programs operated by their Ministry of Agriculture that exceeds 10 FTE researchers (the Bahamas, Barbados, Guyana, Jamaica, and T&T). In Jamaica and Trinidad & Tobago, the first research activities within the Ministries of Agriculture date from 1933 and 1945, respectively. In all other countries, such initiatives are considerably more recent (1960s and 1970s).

Parallel to these public research initiatives by the Ministries of Agriculture, CARDI, and UWI, the British Caribbean has a long and strong tradition of commodity boards, producer associations, and private companies conducting research on the most important export crops. The West Indies Central Sugar Cane Breeding Station at Barbados is one of the oldest such initiatives (dating back to the 1880s) and is part of the West Indies Sugar Cane Breeding and Evaluation Network. The station is financed by the regional sugar industry through its Sugar Association of the Caribbean. While basic sugar cane breeding work is done collectively, sugar companies in Barbados, Belize, Guyana, St. Kitts, and T&T also have their own research facilities to tackle local agronomic and technical problems in sugar cane production or processing. The Sugar Industry Research Institute (SIRI) of the Sugar Industry Authority of Jamaica services the Jamaican sugar industry. SIRI was the direct successor of the Sugar Research Department of the Jamaican Sugar Manufacturers' Association, which had been in operation since 1942.

For many years, the banana producer associations of Dominica, Grenada, St. Lucia, and St. Vincent banded together as the Windward Islands Banana Association (WINBAN), which operated a modest research facility on St. Lucia. It serviced banana growers on all four islands. With the transformation of WINBAN into the Windward Islands Banana Development and Export Company (WIBDECO) in 1994, its research branch was restructured into a Technical Services Division and all research activities were phased out. This decision was influenced also by the fact the St. Lucia research facilities were severely damaged at about that time by a hurricane. Given the current crisis in the banana business in the region, industry-supported banana research has come to a halt on the Windward Islands. The Jamaica Banana Board has operated its own Research Department since the mid-1950s.

Other crops that are supported by research financed and organized through producer associations or commodity boards are citrus (Belize and Jamaica), cacao (Grenada), coconut (Jamaica), nutmeg (Grenada), and tobacco (Jamaica).

### *The French agricultural research legacy*

Agricultural research in the French Caribbean did not take place until after World War II. Therefore, Haiti, which became independent from France in the late 18th century, never inherited any agricultural research institutions. Its history of agricultural research is still fairly short and largely influenced by external donors, in particular USAID.

Since the 1950s, the three French territories in the region (French Guiana, Guadeloupe, Martinique) have been receiving substantial research support through three French organizations, namely INRA, CIRAD, and IRD (previously ORSTOM).

In 1949, the National Agricultural Research Institute of France (INRA) established a regional research center for the Antilles and French Guiana in Guadeloupe. This was despite the existence of several specialized French institutes already dealing with tropical agricultural research, creating a major political dispute between the various French agencies. INRA's ambitions to further expand into tropical agriculture were abandoned, but it kept its overseas center in Guadeloupe. Most of this center's research activities are located in Guadeloupe, but a Forest Research Unit is located in French Guiana, and there are some trial sites in Martinique.

CIRAD, a merger of a group of French institutes for tropical agricultural research, can trace its activities in the region back to the 1950s. At that time, the French Research Institute for Tropical Fruits (IFAC, later on IRFA, and now the fruit and horticulture department of CIRAD) began to undertake research on bananas and pineapple as well as other fruits. Experiment stations were set up in all three territories. CTFT, the French Tropical Forestry

Research Center, also made an early start with forestry research in French Guiana. IRAT, the French Research Institute for Tropical Agriculture, started multi-site experiments in the Antilles in the early 1960s. It focused on market crops (tomatoes, beans, lettuce) and food crops (yam, cassava, sweet potatoes, maize). In addition, the *Centre Technique de la Canne et du Sucre* (CTCS) provided research support to the sugar industry on Guadeloupe. More recently, the forestry, animal health, and food processing branches of CIRAD have also launched research activities in the French Caribbean.

IRD, the French Research Institute for Development (previously ORSTOM), established a permanent mission in French Guiana in 1949. It became the *Institut Français d'Amerique Tropicale* (IFAT) in 1954, and ORSTOM-Cayenne in 1964. It was renamed IRD-Cayenne in 1998. IRD-Cayenne's research focuses mainly on forestry, ecology, hydrology, medicinal plants, and social sciences, with a strong emphasis on basic research along disciplinary lines. IRD's predecessors began research activities in the French Antilles in collaboration with INRA, IFAC, and IRAT in the early 1960s. These activities focused mainly on soil mapping and soil analysis through the *Bureau des Sols des Antilles*, which was managed jointly by INRA and ORSTOM. Nowadays, IRD-Antilles maintains its presence in Guadeloupe and Martinique by posting staff to the research facilities of INRA and CIRAD.

### *The Dutch agricultural research legacy*

Even in the 1930s, agriculture constituted only a minor component of the local economy of Aruba and the Netherlands Antilles.[6] These Dutch territories do not have much of a comparative advantage in terms of agriculture, and therefore they opted early on to focus on other economic activities such as oil refining, and more recently offshore banking and tourism. As a consequence, these countries never developed an agricultural research capacity of any significance. In contrast, agriculture has always played a far more dominant role in the economy of Suriname. While experiments were conducted sporadically throughout the 18th and 19th centuries by plantation owners, it was only with the establishment of the Agricultural Experiment Station in 1903 that agricultural research took off in earnest in Suriname. During the first 45 years of the agricultural experiment station, it was staffed with only 2 to 4 scientists and focused primarily on crop production, plant diseases, and soil science.

With the independence of Indonesia in 1948, the Netherlands shifted its attention to the development of Suriname. As part of a strategy to boost agricultural production, a rapid expansion of agricultural research capacity took place between 1948 and 1975, the year that Suriname became independent. The agricultural experiment station under the Ministry of Agriculture expanded its activities and staff, and several semi-private research initiatives were also launched as autonomous foundations.[7] Most of these foundations, however, have led a dormant existence since the early 1980s. On the academic front, the University of Suriname, in collaboration with Wageningen Agricultural University in the Netherlands, opened the Center for Agricultural Research (CELOS) in 1968. In 1975, when Suriname became independent, it inherited a rather fragmented agricultural research infrastructure that has fragmented even further. In the 1980s, political relations between the Netherlands and Suriname deteriorated sharply, and most official development assistance was frozen.[8]

6. Aruba separated from the Netherlands Antilles in 1986, and since then, has had its own government under the Dutch crown.
7. Foundation for Mechanical Agriculture (SML), established in 1949; Foundation for Experimental Farms (SEL), established in 1955; Foundation for Experimental Gardens (STIPRIS), established in 1970; Foundation for the Agricultural Development of Commewijn (SLOC), established in 1976; Foundation National Rice Research Institute (SNRI), established in 1987.
8. A new government was inaugurated in Suriname in August 2000, and there is a good chance that development relations with the Netherlands will be restored.

### *The American agricultural research legacy*

The first recorded agricultural research activities in Puerto Rico date back to the period immediately after it became a U.S. territory in 1898. In 1901, a Federal Experiment Station opened its doors in Puerto Rico, while in 1910, the Sugar Producers' Association of Puerto Rico established its own private agricultural experiment station. In 1914, the latter station was handed over to the government, and it became part of the Department of Agriculture as the Insular Experiment Station. Higher education in the agricultural sciences began in Puerto Rico when the College of Agriculture and Mechanic Arts was established by the University of Puerto Rico in 1911.

In 1931, the jurisdiction of the Hatch Act was extended to Puerto Rico. This Act, passed by the U.S. Congress in 1887, is the legal basis for the U.S. system of state agricultural experiment stations embedded in land-grant universities. Consequently, the Insular Experiment Station was transferred to the University of Puerto Rico, and it was eventually transformed into the state agricultural experiment station of Puerto Rico in 1933. A major advantage of this change was the fact that Puerto Rico gained access to federal funding for its state agricultural experiment station.

In addition to a state agricultural experiment station, Puerto Rico also houses two federal research institutes administered directly by the U.S. Department of Agriculture (USDA), namely the Tropical Agriculture Research Station (established in 1901 as the Federal Experiment Station), and the International Institute of Tropical Forestry (established by the Forestry Service of USDA in 1939).

The University of the Virgin Islands established a state agricultural experiment station as recently as the early 1970s. The Universities of Puerto Rico and the Virgin Islands also house several other research entities dealing with water resources and marine sciences that are also of relevance to agriculture.

### *Cuba, the Dominican Republic, and Haiti*

While colonial ties have shaped agricultural research in most Caribbean countries, this is less clearly so for Cuba, the Dominican Republic, and Haiti, as these countries gained independence before formal agricultural research really took off. Even so, external influence on the development of agricultural research has been significant in these countries. The U.S., in particular, has played an important role in establishing the first experiment stations in all three countries by providing technical expertise and training. The U.S. occupations of the Dominican Republic (1916–1925) and Haiti (1915–1934) were also significant in this regard. In both countries, the first experiment stations and agricultural schools date back to this period of occupation. In more recent years, both countries have received considerable assistance for the development of their agricultural research capacity through USAID, private foundations (e.g., Ford, Kellogg, Rockefeller), and partnerships with U.S. universities.

In Cuba, U.S. influence ended with the Revolution of 1959 and was replaced by influence from the Soviet bloc. Examples of Soviet influence include the relatively high priority given to science and technology, and the dominant position of the Academy of Sciences in the Cuban science structure. As in the former USSR, Cuba exceeds most of its developing country neighbors in terms of the number of scientists per million population[9] and produces high-class science (e.g., biotechnology), but it has major difficulties translating this into economic advancement. Over the years, Cuba has developed an agricultural research capacity that is

9. In 1995, Cuba employed 1612 researchers per million population, Chile 445, and Mexico 214 (UNESCO 1999). Moreover, Cuba's figure increased about threefold between 1980 and 1995.

greater than that of all other Caribbean countries put together, at least in terms of scientific staff. This is in great contrast to the Dominican Republic and Haiti—number two and three in the region in terms of population—which both have rather underdeveloped research systems. Per million population, Cuba employs approximately 100–150 agricultural researchers, the Dominican Republic 25, Haiti about 20, and the other Caribbean countries, on average, about 70.

## Current organizational structure of agricultural research

Due to the geographical and political fragmentation of the region, the organizational structure of agricultural research is also very much fragmented. With the exception of Cuba—which has some 60 different agricultural research agencies of its own—approximately 150 different agencies were identified as conducting research in support of crop, livestock, forestry, and fisheries production in the Caribbean. The majority of these research entities only employ between 1 and 10 (full-time equivalent) researchers. In addition, research is often organized not as a separate, stand-alone activity, but undertaken in combination with education or other agricultural service activities (e.g., extension, technology transfer).

In table 5, which provides an overview of agencies conducting agricultural research in the Caribbean, the agencies have been divided into six distinct categories.[10]

1. *Agencies operating within the jurisdiction of a Ministry of Agriculture*. In most countries, the Ministry of Agriculture has the primary responsibility for agricultural research, but other ministries may hold responsibility for some specific components of the agricultural research agenda (e.g., forestry, fisheries, food processing) or have overall responsibility for the Science & Technology policy of the country. In many Caribbean countries, the Ministry of Agriculture is too small to have its own research department or organization or even its own research program. In quite a number of countries the Ministry of Agriculture has instead delegated the implementation of agricultural research to bilateral and regional agencies.

2. *Agencies operating within the jurisdiction of other government ministries*. As mentioned above, other government ministries may hold the responsibility for some components of the agricultural research agenda. For example, several of the larger Caribbean countries have government-supported industrial research institutes whose research agendas are relevant to agriculture (e.g., post-harvest storage and processing, agricultural machinery).

3. *Regional and bilateral agencies*. This category includes all agencies that are controlled by supra-national bodies or by a non-local government. The first category includes agencies such as CARDI and the CARICOM Fisheries Unit, while the second category comprises agencies such as CIRAD, INRA, and IRD that have major research facilities in the French Caribbean territories, but which are controlled and mainly financed by France. This category also includes the local research facilities of the U.S. Department of Agriculture in Puerto Rico and the U.S. Virgin Islands, as well as the permanent technical missions of France and Taiwan located in several of the smaller islands states.[11]

10. These 6 institutional groups correspond to the general Science & Technology classification of research organizations as follows: groups 1–3 fall into the category "government agencies", group 4 into "establishments of higher education," and groups 5–6 into "business enterprises" (OECD 1994).
11. Recently, some of the Taiwanese technical missions were closed as the host countries changed their foreign policy and established diplomatic relations with the People's Republic of China.

**Table 5: Overview of Agricultural Research Executing Agencies in the Caribbean**

| Country | Ministry of Agriculture | Other ministries and government agencies | Bilateral or regional government agencies | Higher education | Commodity boards or producers associations | Business enterprise |
|---|---|---|---|---|---|---|
| Anguilla (UK) | *No research reported* | | | | | |
| Antigua and Barbuda | · Research Division<br>· Fisheries Division | | · CARDI unit | | | |
| Aruba (NL) | | · Ministry of Economic Affairs and Tourism – Department of Agriculture, Husbandry and Fisheries | | | | |
| Bahamas | · Department of Agriculture<br>· Department of Fisheries | · Office of the Prime Minister – Department of Lands and Surveys, Forestry Section | · Govt. of Taiwan – Agricultural Technical Mission | | | |
| Barbados | · Technical Division | | · CARDI unit | · UWI – Faculty of Science and Technology, Department of Biological and Chemical Sciences<br>· UWI – Centre for Resource Management and Environmental Studies<br>· McGill University – Bellairs Research Institute | · West Indies Sugar Cane Breeding Station | · BAMCO – Sugar Technology Research Unit<br>· BAMCO – Agronomic Research and Variety Testing Unit |
| Belize | · Central Farm Agricultural Research Station | | · CARDI unit<br>· Govt. of Taiwan – Agricultural Technical Mission<br>· CARICOM – Fisheries Resources Assessment and Management Program | · University College of Belize – Marine Research Centre<br>· Belize College of Agriculture | · Belize Citrus Growers Association – Citrus Research and Education Institute | · BelSIL – Research Centre for Sugar Cane<br>· BABCO |
| British Virgin Islands | | | · CARDI unit | | | |
| Cayman Islands (UK) | *No research reported* | | | | | |
| Cuba (a) | · Ministry of Agriculture (oversees 20 agricultural research agencies) | · Ministry of Sugar (oversees seven research entities)<br>· Ministry of Fisheries – Fisheries Research Center<br>· Ministry of Food – Food Industry Research Institute<br>· Ministry of Science and Technology and the Environment (oversees several research institutes, seven of which are of partial relevance to agriculture) | | In addition to ISCAH, another seven universities and two university centers conduct agricultural research. | | |

*Note:* Annex 4 provides more detailed institutional information.

| Country | Ministry of Agriculture | Other ministries and government agencies | Bilateral or regional government agencies | Higher education | Commodity boards or producers associations | Business enterprise |
|---|---|---|---|---|---|---|
| | | · Ministry of Higher Education (oversees the National Center for Scientific Research (CNIC) and the Higher Institute for Agricultural Sciences of Havana (ISCAH)) | | | | |
| Dominica | · Division of Agriculture<br>· Division of Fisheries Development | | · CARDI unit<br>· Government of Taiwan – Technical Mission<br>· Government of France – Technical Mission | | | |
| Dominican Republic | · Agricultural Research Department (oversees eight research centers and one experiment station)<br>· Tobacco Department – Tobacco Institute<br>· Coffee Department – Coffee Station La Cumbre | · Central Bank – National Institute for Industrial Technology (INDOTEC)<br>· National Water Resources Institute (INDHRI) | | · UASD: Faculty of Agricultural and Veterinary Sciences; Faculty of Sciences – Research Center for Marine Biology<br>· ISA (incl. CENDA)<br>· UNPHU: Faculty of Agricultural Sciences and Natural Resources<br>· UN: Faculty of Agriculture<br>· UEMH: School of Veterinary Medicine | | · CEA – Sugarcane Research Center<br>· Central Romana – Agricultural Research Department |
| French Guiana (France) | | | · CIRAD<br>· INRA (forestry unit)<br>· IRD – Cayenne Center | | | |
| Grenada | · no specific research division | | · CARDI unit<br>· Government of Taiwan – Technical Mission<br>· Government of France – Technical Mission | | · Grenada Cooperative Nutmeg Association<br>· Grenada Cocoa Association – Cocoa Research Board | |
| Guadeloupe (France) | | | · CIRAD<br>· INRA – Antilles / Guiana Research Center | | | |
| Guyana | · National Agricultural Research Institute | · Office of the President – Institute of Applied Science and Technology<br>· Guyana Forestry Commission | · CARDI unit | · University of Guyana – Faculty of Agriculture | · Guyana Rice Development Board – Rice Research Station, Burma | · Guyana Sugar Corporation – Agricultural Research Center<br>· Livestock Development Company |

| Country | Ministry of Agriculture | Other ministries and government agencies | Bilateral or regional government agencies | Higher education | Commodity boards or producers associations | Business enterprise |
|---|---|---|---|---|---|---|
| Haiti | · Agricultural Research and Documentation Center<br>· Forestry Service | · several regional development projects | | · State University of Haiti – Faculty of Agriculture and Veterinary Sciences<br>· University Quisqueya – Faculty of Agricultural and Environmental Sciences<br>· University "Roi Henri Christophe" – Faculty of Agricultural Sciences | | · Agrisupply Co.<br>· Darbouco S.A.<br>· Agrotechnique S.A. |
| Jamaica | · Agricultural Research and Development Division<br>· Fisheries Division | · Ministry of Commerce and Technology – Food Storage and Prevention of Infestation Department<br>· Ministry of Commerce and Technology – Scientific Research Council (incl. Food Technology Institute) | · CARDI unit | · UWI – Faculty of Pure and Applied Sciences, Department of Life Sciences<br>· UWI – Biotechnology Centre<br>· UWI—Centre for Marine Sciences<br>· UWI – Centre for Environment and Development | · Banana Board – Research Department<br>· Cocoa Industry Board – Research and Extension Division<br>· Coconut Industry Board – Research Unit<br>· Coffee Industry Board – subcontracts research<br>· Sugar Industry Authority – Sugar Industry Research Institute<br>· Tobacco Industry Central Authority<br>· Citrus Growers Association Limited | · Pioneer Hi-Bred International Inc. – Tropical Research Station<br>· Jamaica Broilers Group Ltd<br>· Alcan |
| Martinique (France) | | | · CIRAD<br>· IRD – Antilles Center | | | |
| Montserrat (UK) | | | · CARDI unit | | | |
| Netherlands Antilles (NL) | | · Caribbean Marine Biological Institute<br>· Foundation for the Promotion of Agriculture in the Netherlands Antilles (SOLTUNA) | | | | |
| Puerto Rico (US) | | | · USDA – Agricultural Research Service: Tropical Agriculture Research Station<br>· USDA – Forestry Service: International Institute of Tropical Forestry | · UPR – College of Agricultural Sciences: State Agricultural Experiment Station<br>· UPR – College of Arts and Sciences: Department of Marine Sciences<br>· UPR – Engineering College: Puerto Rico Water Resources Research Institute | | |

| Country | Ministry of Agriculture | Other ministries and government agencies | Bilateral or regional government agencies | Higher education | Commodity boards or producers associations | Business enterprise |
|---|---|---|---|---|---|---|
| St. Kitts-Nevis | · Crops Research Unit | | · CARDI unit<br>· Government of Taiwan – Technical Mission<br>· Government of France – Technical Mission | | | · St. Kitts Sugar Manufacturing Corporation – Agronomy and Research Department |
| St. Lucia | · Research and Development Division | | · CARDI unit<br>· Government of Taiwan – Technical Mission (closed in 1999)<br>· Government of France – Technical Mission | | | · Windward Islands Banana Development and Exporting Company Ltd – Technical Services Division |
| St. Vincent and the Grenadines | · R&D unit<br>· Fisheries Division | | · CARDI unit<br>· Government of Taiwan – Technical Mission<br>· Government of France – Technical Mission<br>· CARICOM Fisheries Unit – Regional Assessment Centre | | | |
| Suriname | · Agronomy and Horticulture Department: Agricultural Experiment Station and Palm Research Center<br>· Livestock Department<br>· Fisheries Department: Section Fisheries Research and Statistics | · Ministry of Natural Resources and Energy – National Forest Service | | · University of Suriname — Faculty of Technological Sciences, Department of Agriculture<br>· University of Suriname — Center for Agricultural Research in Suriname. | · Foundation for Rice Research in Suriname – Rice Research Center "Anne van Dijk"<br>· Foundation for the Mechanization of Agriculture (SML) – Rice Research and Breeding Station + Station for Applied Rice Research | · Surland Banana Company |
| Trinidad and Tobago | Research Division<br>Animal Production and Health Division – Veterinary Diagnostic Laboratory<br>Forestry Division<br>Fisheries Division | Office of the Prime Minister – Institute of Marine Affairs<br>Ministry of Finance – Caribbean Industrial Research Institute | CARDI headquarters<br>CARDI unit (local)<br>CABI Bioscience – Caribbean and Latin American Centre<br>CARICOM Fisheries Unit – Field Office | UWI - Faculty of Agriculture and Natural Sciences<br>UWI – Faculty of Engineering, Dept of Agr. Engineering<br>UWI – School of Veterinary Medicine<br>UWI – Cocoa Research Unit | | Caroni Ltd – Caroni Research Station and Sugarcane Feed Centre |
| Turks and Caicos Islands (UK) | *No research reported* | | | | | |
| Virgin Islands (US) | | | · USDA – ARS – Germplasm Introduction and Research Unit | UVI – Agricultural Experiment Station<br>UVI – Water Resources Research Institute<br>UVI – Marine Science Center<br>UVI – Eastern Caribbean Center | | |

4. *Higher education*. The following Caribbean countries have one or more Faculties of Agriculture: Cuba (6), Dominican Republic (4), Guyana (1), Haiti (3), Puerto Rico (1), Suriname (1), and Trinidad & Tobago (1). The Faculty of Agriculture and Natural Sciences of the University of the West Indies, based in T&T, plays an important regional role within the English-speaking Caribbean. Most of the Faculties of Agriculture conduct research, while several have organized their research in separate research centers or experiment stations adjacent to the Faculty. In addition to these Faculties of Agriculture, several Faculties of (Natural) Sciences conduct research relevant to agriculture. They contribute in particular to research in biotechnology and marine science.

5. *Agencies belonging to commodity boards or producers' associations*. This type of research agency has a long and vested history in the Caribbean, and in the (former) British colonies in particular. In all cases, the agencies conduct research on important export crops, such as sugar, coffee, cocoa, bananas, citrus fruit, and rice. One drawback of these research schemes is that they often lack critical mass. The largest agency in this category, the Guyana Rice Development Board, employs 14 FTE researchers, but the average size of these research schemes is about 4 or 5 FTE researchers, and their emphasis is often technology transfer rather than research.

6. *R&D units belonging to private or public (state-owned) enterprises*. Most prominent in this category are the research units of major sugar companies throughout the region. They usually conduct agronomic research as well as research on sugar processing. Few other businesses in the agricultural input, production, or processing industries in the Caribbean can afford their own R&D units due to the small size of local markets.

In addition to these six categories of implementing agencies, there are several research networks that try to link research activities across different countries. Some of these networks are region-specific, while others have a larger geographical coverage. We will focus here on the region-specific networks only.

PROCICARIBE, the Program for Cooperation of Institutes of Agricultural Science and Technology in the Caribbean, brings together most of the Caribbean countries (except for the U.S. territories) to integrate and coordinate their agricultural research activities at the national and regional levels. Moreover, it takes care of linkages with international organizations and represents the Caribbean in regional and global fora on agricultural research.

PROCICARIBE was established with support from CARDI, IDB, and IICA in 1996, and is comprised of some eight commodity or thematic regional networks (table 6). Each of these regional networks consists of a regional coordinator and a group of national coordinators representing the national networks or programs. Not every country is member of every network. As such, the networks do not add to the total research capacity in the region, but they are instrumental in the exchange of information and research results, the avoidance of duplication of research efforts, and other matters that may affect research capacity.

Other network activities that do not fall under the PROCICARIBE banner are the Caribbean Agricultural Technical Assistance Service (CTAS) and the Caribbean Agricultural Information System (CAIS). The latter activity is a joint project of CARDI and CTA.

**Table 6: Regional Networks Operating under PROCICARIBE**

| Network name | Acronym | Regional coordinator | Membership |
|---|---|---|---|
| Caribbean Fruit Network | CARIFRUIT | IICA, T&T | Antigua and Barbuda, British Virgin Islands, Cuba, Dominica, Dominican Republic, Grenada, Guyana, Haiti, Jamaica, St. Kitts and Nevis, St. Lucia, St. Vincent, Suriname, T&T |
| Caribbean Rice Industry Network | CRIDNET | CARDI, Guyana | Belize, Cuba, Dominican Republic, Guyana, Haiti, Suriname, T&T |
| Caribbean Integrated Pest Management Network | CIPMNET | CARDI, Jamaica | Antigua and Barbuda, the Bahamas, Barbados, Belize, British Virgin Islands, Cuba, Dominica, Dominican Republic, Grenada, Guyana, Jamaica, Haiti, St. Lucia, St. Kitts, St. Vincent, T&T |
| Caribbean Plant Genetic Resources Network | CAPGERNET | SEA-DIA, Dominican Republic | Antigua and Barbuda, Barbados, Belize, British Virgin Islands, Cuba, Dominica, Dominican Republic, Grenada, Guadeloupe, Guyana, Haiti, Jamaica, Nevis, St. Kitts, St. Lucia, T&T |
| Caribbean Loop of BioNET International | CARINET | CABI, T&T | The Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, St. Lucia, St. Vincent, Suriname, T&T, Venezuela |
| Caribbean Small Ruminants Network | CASRUNET | CARDI, Jamaica | Antigua and Barbuda, Barbados, Curaçao (Netherlands Antilles), T&T |
| Caribbean Post-Harvest Technology Network | CAPHNET | UWI, T&T | In the process of being established. |
| Caribbean Land and Water Resources Network | CLAWRENET | | In the process of being established. |

*Source:* PROCICARIBE (2000).

The Inter-American Institute for Agricultural Cooperation (IICA) is another important supporter and facilitator of agricultural research throughout the Americas. In the Caribbean region, its activities are implemented through a regional office in Trinidad & Tobago and country representatives in 15 of the 28 Caribbean countries.[12] With about 40 professionals working throughout the region, IICA is involved in a wide range of activities, including support of agricultural research. IICA's Regional Office provides financial support to both CARDI and PROCICARIBE, and publishes four newsletters, namely: *IICA Caribbean News*, *Tropical Fruits Newsletter*, *Quarterly Newsletter on Economic Policy and Sustainable Rural Development*, and *CARAPHIN News: Newsletter of the Caribbean Animal and Plant Health Information Network*. IICA's technological innovation activities in the region focus on the development of tropical fruits in particular as part of CARICOM's strategy to diversify agricultural exports, and on the development of agricultural science and technology capacity in general.

The FAO Regional Office for Latin America and the Caribbean (based in Chile), with a subregional office for the Caribbean based in Barbados, has a mandate similar to IICA. FAO's Regional Office manages several thematic networks,[13] some of which have a research component. Spanish is the dominant working language in these networks, which precludes the participation of most Caribbean countries, except Cuba and the Dominican Republic.

12. Antigua, Bahamas, Barbados, Belize, Dominica, Dominican Republic, Grenada, Guyana, Haiti, Jamaica, St. Kitts-Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, and Trinidad & Tobago.
13. Such as "Red de Cooperación Técnica entre Laboratorios de Investigación y Diagnostico Veterinario" (REDLAB), "Red en Manejo de Cuencas Hidrográficas," "Red en Parques Nacionales, Otras Areas Protegidas, Flora y Fauna Silvestre," "La Red de Cooperación Técnica sobre Sistemas de Vigilancia Alimentaria y Nutricional" (SISVAN), "Red de Cooperación Técnica en Biotecnología Vegetal" (REDBIO), and "Red de Cooperación Técnica de Instituciones y Organismos de Apoyo a la Mujer Rural."

## Research focus

Agricultural research capacity in the Caribbean is extremely fragmented due to geographical and political boundaries, in addition to the usual subject-matter specialization. Most research units in the region are small (about three-quarters have less than 10 FTE researchers) and often have mandates that are substantially broader than simply research. In such cases, emphasis is usually placed on the applied end of the research spectrum. Moreover, it is our impression that, in recent years, more emphasis has been placed on technology acquisition and transfer throughout the region, as opposed to technology generation. Several agencies that were surveyed reported that they no longer conduct research.

Figure 3 provides a breakdown of research staff according to research focus. Of the approximately 1000 full-time equivalent agricultural researchers working in the Caribbean (excluding Cuba and Haiti) in 1996, about 56% worked on crops, 13% on livestock, 3% on forestry, 5% on fisheries, 14% on NRM, 5% on post-harvest, and 4% on other topics.[14]

About a third of crop research capacity in the Caribbean focuses on the traditional export crops: sugar, cocoa, coffee, and bananas (figure 4). Another third focuses on vegetables, fruits, and ornamentals, all of which are crops with export potential. The remaining third consists of food crops such as rice and root crops, as well as a broad range of other crops including maize, beans, soybean, tobacco, and cotton.

The relatively small capacity for livestock research in the region focuses on small ruminants (26%), cattle (24%), pigs (19%), animal health (13%), animal feed (9%), and poultry (9%). The considerable importance given to research on small ruminants is striking given the fact that it represents less than 2% of the value of livestock production in the region (see table 3). This phenomenon is also quite widespread; almost all countries undertake some research on small ruminants. In contrast, poultry production receives considerably less research attention in comparison to its economic importance, which is more than a third of livestock output. These incongruencies are due in part to the availability of foreign technology (in the case of poultry production), as well as a political agenda to focus public research on the production systems of poor farmers.

NRM research in the Caribbean focuses on marine biology and ecology. It is a relatively new research area in which universities and university-based research agencies have taken the lead. Regional collaboration in this area is quite substantial.

For every 100 million dollars of crop, livestock, forestry, and fisheries production, the region employed, respectively, 33.6, 10.9, 13.0, and 48.9 FTE researchers. Assuming that the innovation possibilities are of the same intensity across different types of production, the congruency ratio suggests that livestock and forestry production receive considerably less research support than crop and fisheries production.

The congruency ratios for specific crops (table 7) indicate that bananas, coffeea, and rice are relatively neglected, while cocoa and vegetables receive above-average research support. Cocoa research is undertaken by six agencies across five countries. One agency, the Cocoa Research Unit at the University of the West Indies, represents 60% of cocoa research capacity in the region. In contrast, vegetable research is highly dispersed and undertaken by 37 agencies across 19 countries. The privatization of banana companies and the uncertain

14. In terms of research entities, out of 113 agencies sampled, 81 are involved in crop research, 34 in livestock research, 11 in forestry research, 16 in fisheries research, 23 in NRM, 22 in post-harvest research, and 10 in other research. Of these 113 agencies, 48 have research activities that cover more than one category. The most common combination is crop and livestock research.

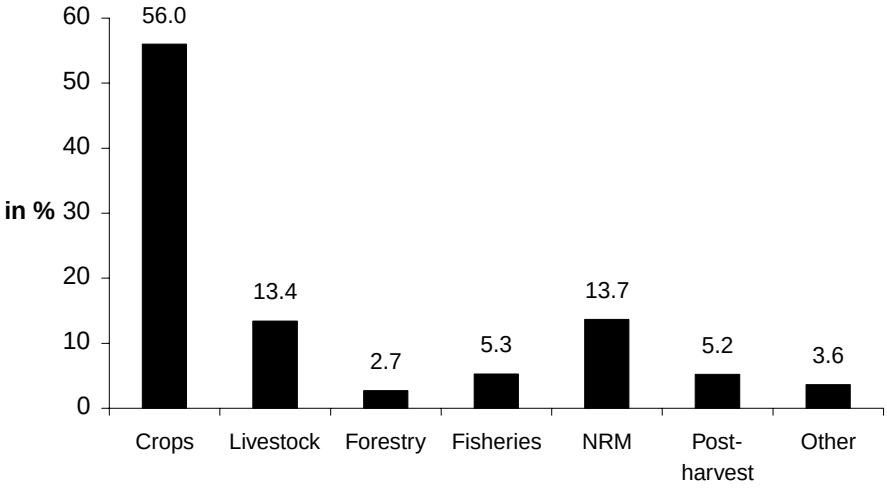


**Figure 3: Caribbean research staff, according to research focus, 1996**

*Sources:* Based on survey results, annual reports, etc.
*Note:* Based on the research orientation of research staff across 113 agricultural research agencies in 21 countries. Another five countries did not employ permanent research staff.

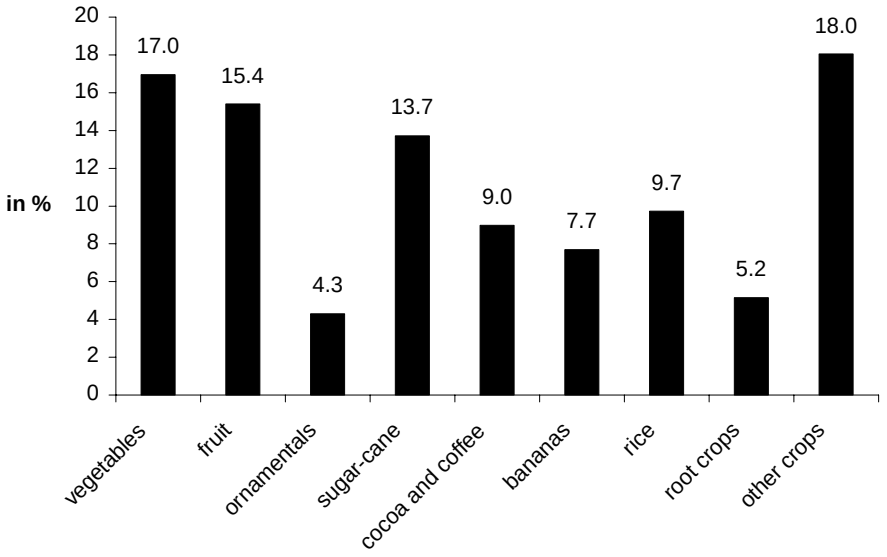


**Figure 4: Foci of crop research in the Caribbean, 1996**

*Sources:* Based on survey results, annual reports, etc.
*Note:* Based on research staff data.

**Table 7: Caribbean Agricultural Research Congruency Ratios, 1996**

| Crop | Researchers (FTE) | Production (in millions of dollars, international 1989–91 prices) | Researchers per US$ 100 million production (FTE) |
|---|---|---|---|
| Vegetables | 94.9 | 137 | 69.5 |
| Fruit | 86.2 | 317 | 27.2 |
| Ornamentals | 24.1 | NA | NA |
| Sugar cane | 76.8 | 243 | 31.6 |
| Cocoa | 36.8 | 42 | 86.5 |
| Coffee | 13.5 | 70 | 19.4 |
| Bananas | 43.1 | 252 | 17.1 |
| Rice | 54.5 | 243 | 22.5 |
| Root crops | 28.9 | 81 | 35.6 |
| Other crops | 101.1 | 213 | 47.5 |
| *Total* | *560.0* | *1598* | *33.6* |

*Sources:* Based on survey results, annual reports, etc.
*Note:* Excludes Cuba and Haiti.

future of the banana export to Europe have led to a major decline in banana research in recent years. CIRAD, which represents about 40% of banana research capacity in the region, is said to have plans to hand over its banana research to a private banana company.

# 4. Human and Financial Research Resources

## Regional overview

Table 8 is a snapshot of agricultural research staffing and expenditure in the Caribbean in 1996. It covers 26 of the 28 Caribbean countries. Cuba and Haiti are excluded due to incomplete or dissimilar data that impede cross-country comparisons.[15] Together, these 26 countries employed close to 1000 FTE researchers and spent some 106 million dollars (1993 PPPs) in 1996.

Of these 26 countries, 12 had less than 10 FTE researchers, and 20 had less than 50 FTE researchers. Only the Dominican Republic, French Guiana, Guadeloupe, Guyana, Jamaica, Puerto Rico, and Trinidad & Tobago employed more than 50 FTE researchers, and none had more than 200 FTE researchers. The overall picture that emerges is one of highly fragmented agricultural research capacity due to political and geographical boundaries. In addition, there is also considerable institutional fragmentation of research capacity within countries. Of the 116 agricultural research agencies for which data were obtained, 84 employ less than 10 FTE researchers, and 62 less than 5 FTE researchers. The two largest agricultural research agencies in the region are INRA-CRAAG (based in Guadeloupe, but servicing all three French territories in the region) and the R&D Division of the Ministry of Agriculture of Trinidad & Tobago, each employing some 60 FTE researchers. CARDI might be considered in the same league, but it is physically very fragmented, being dispersed over all its member countries.

In addition to research agencies with country-specific research mandates, there are several agencies that have a regional research mandate. Together they make up close to 10% of all research capacity in the region. They include all agricultural and agriculture-related research activities by the University of the West Indies at its locations in Barbados, Jamaica, and T&T, CARDI headquarters (CARDI country units have been classified as country-specific), CABI, CARICOM Fisheries Unit, WIBDECO, and WICSCBS.

In addition to the standard classification of research agencies into government, higher education, and business enterprise categories (see OECD 1994), a further distinction can be made between government agencies controlled and financed mainly by the local government, and government agencies controlled and managed by supra-national bodies or non-local governments (table 8). Local, bilateral, and regional government agencies combined represent about two-thirds of the region's agricultural research capacity. Within this group, bilateral and regional agencies represent a major share, namely 45% of the research staff and 60% of research expenditure. Four agencies—CARDI, CIRAD, INRA, and IRD—account for most (80%) of the research capacity in this category. In most other regions of the world, bilateral and regional agencies play a far less prominent role in agricultural research.

Research activities at universities and university-related research institutes comprise about 20% of agricultural research capacity in the region. The relative importance of universities is influenced in part by Puerto Rico and the U.S. Virgin Islands, which operate state agricultural experiment stations within the premises of their local universities. The University of

15. Cuban expenditure data, for example, cannot be compared easily with data from other countries due to lack of reliable deflator and exchange rate data. Cuba's method of classifying researchers is also considerably different from that shared by other countries. Nevertheless, Cuba's research capacity may be as large as 1500–2000 FTE researchers.

**Table 8: Snapshot of Caribbean Agricultural Research Capacity, 1996**

| Country | Agricultural Research Staff (full-time equivalents) | | | | | Agricultural Research Expenditures (million 1993 PPP dollars) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Local government | Bilateral and regional government | Higher education | Business enterprise | Total | Local government | Bilateral and regional government | Higher education | Business enterprise | Total |
| Anguilla | | | | | 0.0 | | | | | 0.000 |
| Antigua and Barbuda | 3.0 | 4.0 | | | 7.0 | 0.188 | 0.389 | | | 0.577 |
| Aruba | 1.0 | | | | 1.0 | 0.125 | | | | 0.125 |
| Bahamas, The | 17.2 | 8.0 | | | 25.2 | 2.105 | 0.990 | | | 3.095 |
| Barbados | 26.0 | 5.0 | (a) | 4.0 | 35.0 | 1.494 | 0.656 | (a) | 0.409 | 2.559 |
| Belize | 2.7 | 2.0 | 0.5 | 9.2 | 14.4 | 0.126 | 0.246 | 0.050 | 1.340 | 1.762 |
| British Virgin Islands | | 1.0 | | | 1.0 | | 0.122 | | | 0.122 |
| Cayman Islands | | | | | 0.0 | | | | | 0.000 |
| Dominica | | 11.0 | | | 11.0 | | 1.356 | | | 1.356 |
| Dominican Republic | 122.0 | | 42.0 | 14.0 | 178.0 | 6.313 | | 2.173 | 0.724 | 9.210 |
| French Guiana | | 69.4 | | | 69.4 | | 8.533 | | | 8.533 |
| Grenada | 0.5 | 6.5 | | 0.5 | 7.5 | 0.064 | 1.113 | | 0.046 | 1.223 |
| Guadeloupe | | 97.2 | | | 97.2 | | 13.169 | | | 13.169 |
| Guyana | 35.0 | 8.0 | 6.0 | 31.5 | 80.5 | 4.113 | 0.979 | 0.600 | 2.941 | 8.634 |
| Jamaica | 38.3 | 9.0 | (a) | 33.0 | 80.3 | 3.719 | 1.213 | (a) | 2.983 | 7.916 |
| Martinique | | 32.0 | | | 32.0 | | 3.700 | | | 3.700 |
| Montserrat | | | | | 0.0 | | | | | 0.000 |
| Netherlands Antilles | | | | | 0.0 | | | | | 0.000 |
| Puerto Rico | | 9.0 | 60.1 | | 69.1 | | 1.800 | 13.718 | | 15.518 |
| St. Kitts and Nevis | 2.0 | 2.0 | | 1.0 | 5.0 | 0.042 | 0.233 | | 0.248 | 0.523 |
| St. Lucia | 6.0 | 2.0 | | | 8.0 | 0.480 | 0.229 | | | 0.709 |
| St. Vincent and the Grenadines | 2.0 | 12.0 | | | 14.0 | 0.160 | 2.448 | | | 2.608 |
| Suriname | 8.0 | | 2.5 | 4.0 | 14.5 | 0.308 | | 0.034 | 0.320 | 0.662 |
| Trinidad and Tobago | 104.5 | 7.0 | (a) | 16.0 | 127.5 | 9.301 | 0.875 | (a) | 2.181 | 12.357 |
| Turks and Caicos Islands | | | | | 0.0 | | | | | 0.000 |
| Virgin Islands (U.S.) | | 1.0 | 8.3 | | 9.3 | | 0.200 | 1.765 | | 1.965 |
| Regional | | 21.0 | 72.5 | 10.0 | 103.5 | | 2.925 | 5.200 | 1.224 | 9.349 |
| *Total* | *368.2* | *307.1* | *191.9* | *123.2* | *990.4* | *28.537* | *41.178* | *23.541* | *12.417* | *105.672* |

*Note:* Cuba and Haiti are excluded due to incomplete data. The authors estimate that Haiti has approximately 100-150 FTE agricultural researchers, and Cuba probably as much as 2000 FTE agricultural researchers.
(a) Research activities by the University of the West Indies are reported under regional agencies.

the West Indies, with campuses in Barbados, Jamaica, and Trinidad & Tobago, is an important regional player.

The business sector makes up the remaining 12% of research capacity in the region. Most of its research is on specific export commodities, and is financed either by commodity boards or growers' associations (bananas, cocoa, citrus fruit, rice) or by processing industries (sugar). Business sector activity in agricultural research in the Caribbean is concentrated mainly in Barbados,[16] Belize, the Dominican Republic, Guyana, Jamaica, and Trinidad & Tobago.

Relating agricultural research expenditure to AgGDP and to population size gives some indication of the relative weight of this expenditure in the context of the agricultural sector it serves and the overall economy. As shown in table 9, agricultural research expenditure, as a percentage of AgGDP and per capita, may vary substantially from country to country. In some of the smaller countries in particular, exceptionally high intensities can be noted due to donor support or an affluent non-agricultural sector.

With the exception of the Dominican Republic, which invests relatively little in agricultural R&D but has a large agricultural sector, the group of 22 Caribbean countries, all with populations of less than 4 million, spent, on average, 2.6% of its AgGDP on agricultural research. This ratio is considerably higher than the developing country average of approximately 0.5% (1991) and only half a percentage point lower than the average intensity ratio for developed countries (3.1% in 1993, including R&D expenditure by business enterprises classified as agriculture, forestry, and fisheries).[17] Intensity ratios that stand out as exceptionally high are those for Guadeloupe (5.9%) and Trinidad & Tobago (8.3%). In the case of Trinidad & Tobago, research expenditure by regional agencies located in T&T (CARDI, UWI, etc.) was excluded, so the high intensity ratio reflects local research activities that target a relatively small and shrinking agricultural sector in terms of AgGDP. The relative wealth of the non-agricultural sector (in particular its oil industry) makes it affordable. In the case of Guadeloupe, France pays most of the research expenses. Moreover, the research activities undertaken in Guadeloupe also target other French overseas departments in the Caribbean (Martinique and French Guiana).

With the exception of the Dominican Republic, the average research spending per capita was $ 8.4 (1993 PPP) in 1996. This is about two-thirds of the per capita spending by developed countries in 1993 (estimated at $12.4 [1993 PPP]).[18] However, external donors fund a substantial portion (estimated at 39%) of research spending in the region. As a result, the actual *local* spending per capita that is paid by local taxpayers or businesses is considerably lower. As argued and documented by Pardey, Roseboom, and Anderson (1991), most measures of research intensity diminish progressively with increasing population size, especially in developing countries. This inverse relation between population size and research intensity can be attributed to two factors: (a) lack of economies of scale, which makes the provision of technology in small countries substantially more expensive, and (b) mobilization of rather

16. Housing the West Indies Sugar Cane Breeding Station, which has a regional mandate.
17. Alston, Pardey, and Roseboom (1998).
18. Pardey, Roseboom, and Craig (1999). In order to make the OECD data comparable to the Caribbean data, public and private R&D expenditure by agriculture, forestry, and fisheries was combined. Both data sets do not include private R&D expenditure by food processing industries and non-agricultural input industries (chemicals, machinery, etc.) The U.S. GDP deflator index was used to adjust the OECD expenditure from 1985 PPPs to 1993 PPPs.

**Table 9: Agricultural Research Expenditures Relative to Agricultural GDP and Total Population, 1996**

| Country | Agricultural research expenditures (million 1993 PPP$) | Agricultural GDP (million 1993 PPP$) | Agricultural research intensity (%) | Total population (thousand) | Agr. research expenditures per capita (1993 PPP$) |
|---|---|---|---|---|---|
| Anguilla | 0.000 | 3.6 | 0.00 | 8 | 0.00 |
| Antigua and Barbuda | 0.577 | 19.6 | 2.94 | 66 | 8.74 |
| Aruba | 0.125 | 14.1 | 0.89 | 71 | 1.76 |
| Bahamas, The | 3.095 | 86.5 | 3.58 | 284 | 10.90 |
| Barbados | 2.559 | 152.3 | 1.60 | 261 | 9.80 |
| Belize | 1.762 | 160.1 | 1.06 | 219 | 8.05 |
| British Virgin Islands | 0.122 | 5.9 | 2.07 | 19 | 6.44 |
| Cayman Islands | 0.000 | 10.1 | 0.00 | 32 | 0.00 |
| Cuba | NA | NA | NA | 11,018 | NA |
| Dominica | 1.356 | 52.5 | 2.58 | 71 | 19.09 |
| Dominican Republic | 9.210 | 4439.5 | 0.21 | 7,961 | 1.16 |
| French Guiana | 8.533 | NA | NA | 153 | 55.77 |
| Grenada | 1.223 | 31.1 | 3.94 | 92 | 13.30 |
| Guadeloupe | 13.169 | 224.9 | 5.86 | 431 | 30.55 |
| Guyana | 8.634 | 702.0 | 1.23 | 838 | 10.30 |
| Haiti | NA | NA | NA | 7,259 | NA |
| Jamaica | 7.916 | 709.7 | 1.12 | 2,491 | 3.18 |
| Martinique | 3.700 | 217.8 | 1.70 | 384 | 9.64 |
| Montserrat | 0.000 | 2.8 | 0.00 | 11 | 0.00 |
| Netherlands Antilles | 0.000 | 21.2 | 0.00 | 195 | 0.00 |
| Puerto Rico | 15.518 | 415.9 | 3.73 | 3,736 | 4.15 |
| St. Kitts and Nevis | 0.523 | 13.3 | 3.92 | 41 | 12.75 |
| St. Lucia | 0.709 | 56.9 | 1.25 | 144 | 4.92 |
| St. Vincent and the Grenadines | 2.608 | 46.9 | 5.56 | 113 | 23.08 |
| Suriname | 0.662 | 215.2 | 0.31 | 432 | 1.53 |
| Trinidad and Tobago | 12.357 | 148.4 | 8.32 | 1,297 | 9.53 |
| Turks and Caicos Islands | 0.000 | NA | 0.00 | 15 | 0.00 |
| Virgin Islands (U.S.) | 1.965 | NA | NA | 106 | 18.54 |
| Regional | 9.349 | — | — | — | — |
| Regional total / average [a] | 95.799 | 7764.6 | 1.23 | 19,471 | 5.43 |
| Regional total / average, excluding Dominican Republic | 86.589 | 3325.0 | 2.60 | 11,510 | 8.38 |

*Sources:* AgGDP: World Bank (1999a), ECLAC (1998), and CIA (1999); Total population: FAO (1999) and CIA (1999).

[a] Regional total / average in columns 1, 4, and 5 covers 26 countries (all Caribbean countries except Cuba and Haiti), while columns 2 and 3 cover only 23 countries due to lack of AgGDP data for three countries.

generous support from external donors or a relatively rich non-agricultural sector. Whereas in developed countries high (and rapidly increasing) agricultural research intensity ratios are mainly profit-driven (such high investments payoff handsomely both privately and socially), in small developing countries, they are probably driven more by equity arguments than expected profitability.

A major difficulty with the above comparisons is that there is no unique, optimal level of investment to which all countries should adhere. Profitable innovation opportunities differ significantly across countries, and so does the optimal level of investment in agricultural R&D. While conditions such as climate, soil, and infrastructure are relatively favorable for agricultural production in most Caribbean countries, it is the small size of the agricultural sectors in most countries that limits the profitability of local agricultural research projects in a significant way. Solving a problem for 1,000 farmers or 100,000 farmers makes a lot of difference in terms a research project's expected rate of return.

Small countries have three options for overcoming this problem: (1) import technology from elsewhere, (2) specialize in just a few commodities (reduce scope and thereby increase scale), and (3) cluster research activities with other countries so that the research benefits have enough volume to pay for the research investment. This is the idea behind CARDI, PROCICARIBE, and other collaborative efforts in the region.[19]

## Research staffing trends and characteristics

In addition to our 1996 snapshot (table 8), we have compiled several other data sets that provide additional information on staffing characteristics such as educational qualifications, gender, and support staff ratios, as well as on the development of research staff capacity over time.

### *Staffing trend*

The overall regional trend in research staffing is one of very slow growth (on average, less than 1% per annum between 1981 and 1996). Differentiated by institutional category, research staff in all categories stagnated or contracted during this period, except for bilateral government agencies (figure 5). This latter category experienced an annual growth in research staff of 5.9% per annum over the period 1981–96, growth that was driven almost completely by a boost in research staff employed by the French agencies CIRAD, INRA, and IRD.

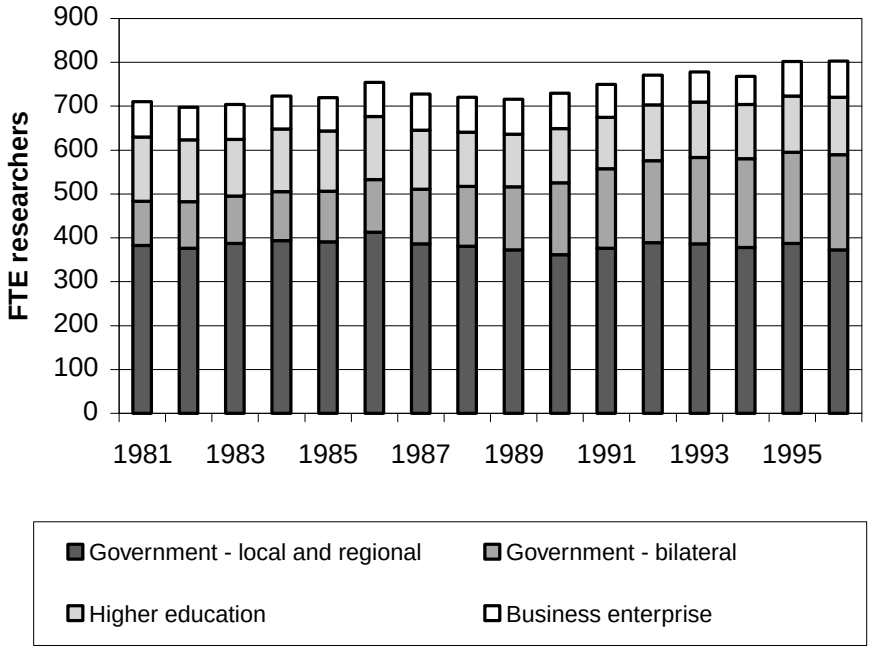


**Figure 5: Development of agricultural research staff in the Caribbean, 1981-96**

*Note:* Based on data from 81 agricultural research agencies representing 80% of research staff in 26 countries (excluding Cuba and Haiti) in 1996.

19. See Eyzaguirre (1996) for a more in-depth analysis of the specific characteristics and problems of agricultural research in small countries.

The number of FTE research staff employed by local and regional government agencies, universities, and businesses has, on average, been fairly constant throughout the whole period. Most universities in the region saw an expansion of their agricultural and agriculture-related research capacity between 1981 and 1996. However, this expansion was counterbalanced by developments at the state agricultural experiment station operating under the University of Puerto Rico which, during the same period, reduced its research staff from 91 to 45 FTE researchers.

Most research agencies in the category of business enterprises also saw their research capacity decline. Only the creation of one new entity (the Guyana Rice Development Board) in 1994 ensured that the number of research staff in this category remained about constant.

As shown in table 10, changes in research staff capacity over the period 1981–1996 also differ significantly across countries. Some countries experienced major declines in their research staff, while others experienced major increases.

### *Educational qualifications*

Not only quantity, but also quality matters. It is for this reason that we have tried to further differentiate research staff counts according to educational attainment. Based on data for about half of all researchers in the region, table 11 provides a breakdown of local agricul-

**Table 10: Percentage Increase or Decrease in Research Staff, 1981–96**

| Major decline (>-25%) | Relative stagnation (-25%/+25%) | Major increase (>+25%) |
|---|---|---|
| Jamaica (-26%) | Antigua (2%) | Bahamas (39%) |
| Montserrat (-100%) | Barbados (6%) | Dominica (60%) |
| Puerto Rico (-50%) | Belize (-20%) | French Guiana (115%) |
| St. Kitts-Nevis (-46%) | Dominican Republic (1%) | Grenada (413%) |
| St. Lucia (-59%) | St. Vincent (2%) | Guadeloupe (73%) |
| Suriname (-36%) | US Virgin Island (15%) | Guyana (61%) |
| | | Martinique (260%) |
| | | Trinidad and Tobago (42%) |

*Note:* Between 1981 and 1996, no agricultural researchers were employed by the following countries: Anguilla, Cayman Islands, Netherlands Antilles, and Turks and Caicos Islands. No time series data are available for Aruba, the British Virgin Islands, Cuba, and Haiti. Keep in mind that small changes in research staff numbers can result in considerable percentage changes when the numbers of researchers employed are low. For example, Grenada saw its research capacity grow from 1.4 FTE researchers in 1981 to 7.0 researchers in 1996, an increase of 413%.

**Table 11: Research Staff in Selected Caribbean Agricultural Research Agencies, According to Highest Educational Attainment**

| Agency | 1986 | 1991 | 1996 | Agency | 1986 | 1991 | 1996 |
|---|---|---|---|---|---|---|---|
| Government agencies | % | % | % | Business enterprises | % | % | % |
| PhD | 11 | 9 | 8 | PhD | 17 | 19 | 21 |
| MSc | 26 | 29 | 38 | MSc | 25 | 27 | 34 |
| BSc | 64 | 62 | 54 | BSc | 58 | 55 | 45 |
| *Total* | *100* | *100* | *100* | *Total* | *100* | *100* | *100* |
| | | | | | | | |
| Higher education | % | % | % | **All agencies** | **%** | **%** | **%** |
| PhD | 37 | 45 | 46 | PhD | 18 | 20 | 21 |
| MSc | 35 | 31 | 25 | MSc | 28 | 29 | 34 |
| BSc | 28 | 25 | 29 | BSc | 54 | 51 | 45 |
| *Total* | *100* | *100* | *100* | ***Total*** | ***100*** | ***100*** | ***100*** |

*Source:* Survey responses.

*Note:* Based on information for approximately half of all research staff in the region (except Cuba and Haiti).

tural research staff according to the highest educational qualification they obtained. All bilateral research agencies are excluded from these figures because they employ mainly expatriates.

Across the board, there are important differences in qualification profiles between the different research agency categories. Government research agencies stand out as employing relatively few post-graduates in comparison to universities. Research agencies and programs by the business sector are somewhere in between. This contrast in qualification profiles between government agencies and universities is consistent with findings elsewhere.

Despite stagnation in the growth of agricultural research staff and contracting budgets per researcher, the qualification profiles of research staff have improved over the period 1986–96. The only exception is a decline in the percentage of doctorates among research staff at government agencies. However, this is compensated for by a considerable improvement in the number of research staff with a M.Sc. degree or equivalent.

The qualification profile of agricultural research staff at government agencies in the Caribbean is more or less the same as those found in the smaller Latin American countries, but substantially lower than the qualification profiles of some of the larger Latin American countries.[20] Both demand and supply factors may explain these differences in qualification profiles. Large countries tend to conduct relatively more basic research, which requires better qualified and more specialized research staff. Similarly, the pool from which large countries can draw such staff is much larger than in small countries.

### *Gender characteristics*

In the past, the participation of women in (agricultural) sciences has been abysmally low in many parts of the world. In recent years, many governments have actively sought to increase the participation of women in (agricultural) sciences as well as in senior government positions. Progress on this aspect of research staffing differs quite substantially from country to country. On average, about 31% of agricultural researchers in the Caribbean in 1996 were female (table 12). This is a relatively high score when compared to other regions, both in the South and North: 17% in sub-Saharan Africa (1991); 15% in Latin America (1991–95 average); and 17% in the Netherlands.

A large number of female researchers can be found across all institutional categories, except bilateral and regional government agencies. This may be due to the international character of these organizations, which require extensive traveling and/or relocation. Women profession-

**Table 12: Research Staff in Selected Caribbean Agricultural Research Agencies, According to Gender, 1996**

| Type of research agency | Total researchers (no.) | Male researchers (no.) | Female researchers (no.) | Male researchers (%) | Female researchers (%) | Coverage (FTEs, %) |
|---|---|---|---|---|---|---|
| Government: local | 332.0 | 218.0 | 114.0 | 65.7 | 34.3 | 90.2 |
| Government: regional | 51.0 | 40.0 | 11.0 | 78.4 | 21.6 | 72.9 |
| Government: bilateral | 76.0 | 67.0 | 9.0 | 88.2 | 11.8 | 32.1 |
| Higher education | 75.3 | 49.8 | 25.5 | 66.1 | 33.9 | 39.3 |
| Business enterprise | 59.0 | 37.0 | 22.0 | 62.7 | 37.3 | 47.9 |
| *Total* | *593.3* | *411.8* | *181.5* | *69.4* | *30.6* | *59.9* |

*Source:* Survey results.

*Notes:* Sample represents staff in selected institutes for which data were available on total research FTEs in the region. Coverage is low for bilateral agencies because the French institutes CIRAD, IRD, and INRA are not covered.

20. In 1991, 13.8, 17.8, 21.1, and 28.6% of the research staff in the principal government agricultural research agencies in Mexico, Chile, Colombia, and Brazil, respectively, held a doctorate (Cremers and Roseboom 1997).

als often find it more difficult to pursue an overseas career if they have spouses who may have professional careers of their own.

*Support staff ratios*

On average, agricultural research agencies in the Caribbean employ about 3.7 support staff per researcher. Support staff ratios are somewhat lower among regional and bilateral research agencies, and higher among establishments of higher education and business enterprises (table 13). The average Caribbean support staff ratio does not differ much from that of Latin America (3.6 support staff per researcher [Cremers and Roseboom 1997]). Support staff ratios tend to be somewhat lower in developed countries (e.g., 2.6 support staff per researcher in the U.S.A. in 1991 [USDA 1992]), but are, for example, substantially higher in sub-Saharan Africa (on average, 9.7 support staff per researcher [Pardey, Roseboom, Beintema, Chang-Kang 1998]).

Among the Caribbean agencies, the spread in support staff ratios is quite large, ranging from 0.3 to 29.0 support staff per researcher. This is due in part to the rather small size of many Caribbean research agencies, which may cause atypical support staff ratios. However, there are also agricultural research organizations that employ large numbers of agricultural laborers, as they are involved in agricultural production at a level that is far beyond what is needed for experimentation.

Broken down by support staff category, 28% of the support staff can be classified as technical, 14% as administrative, and 58% as other. Bilateral and regional government agencies and universities employ relatively more support staff in technical and administrative positions than do local government agencies and business enterprises.

## Research expenditure trends and characteristics

It is not only important to know how much is spent on agricultural research in the region, but also to gain insight into funding sources and cost structures, and to determine whether spending is increasing or declining. In this section, a summary is presented of our major findings pertaining to these factors.

*Expenditure trend*

The time series on agricultural research expenditure depicted by the bars in figure 6 covers close to 60% of total agricultural research expenditure in 1996 (estimated at $106 million, see table 8). On aggregate, it shows a rather erratic but declining trend in agricultural research expenditure over the period 1986–96. During this period, agricultural research expenditure declined by 9% in real terms. Average expenditure per researcher, represented

**Table 13: Support Staff Ratios in Selected Caribbean Agricultural Research Agencies, 1996**

| | Support staff (FTE) | Research staff (FTE) | Support staff per researcher |
|---|---|---|---|
| Government: local | 1239 | 323 | 2.0 |
| Government: regional | 145 | 55 | 2.6 |
| Government: bilateral | 376 | 182 | 2.1 |
| Higher education | 421 | 106 | 4.0 |
| Business enterprise | 562 | 80 | 7.0 |
| *Total* | *2742* | *745* | *3.7* |

*Source:* Survey results.

*Note:* Based on data obtained from 83 agencies, covering approximately 75% of all research staff in the region (except Cuba and Haiti). Coverage ranges from 56% of FTE researchers for universities to 88% for local government agencies.

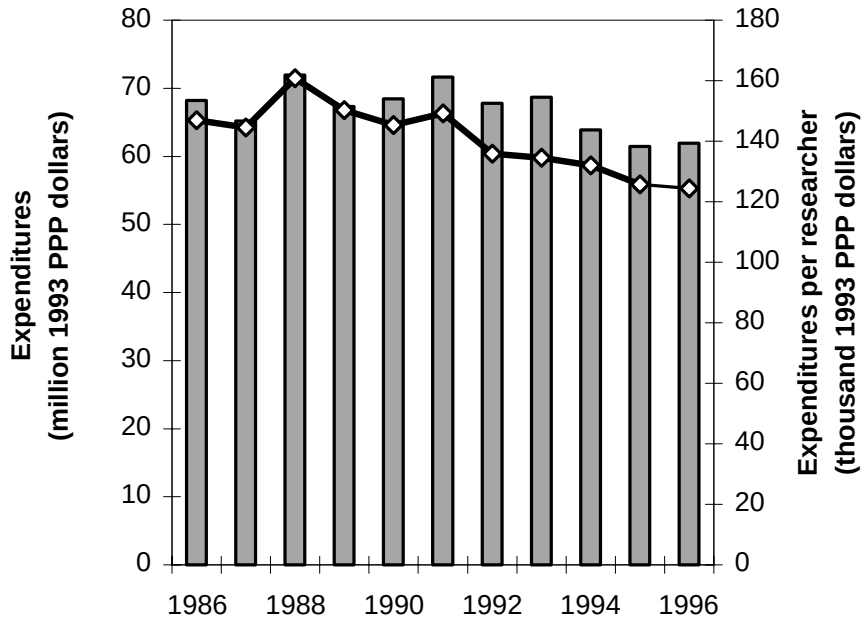


**Figure 6: Trend in agricultural research spending (absolute and per researcher) in the Caribbean, 1986–96**

*Note*: The bars represent total expenditures against the left-hand scale. The line represents expenditures per researcher against the right-hand scale. The trend is based on a subset of all agricultural research agencies and represents close to 60% of total expenditures in 1996.

by the line in figure 6, contracted even more sharply from $147,000 to $124,000 (1993 PPP dollars)— a decline of 15%.

Of the four institutional categories, the contraction in research expenditure between 1986 and 1996 has been most pronounced in local and regional government agencies (34%), followed by business enterprises (27%) and universities (10%). In contrast, bilateral agencies increased their expenditure by 73% over this period, which compensated to a large extent for the substantial declines observed in other institutional categories. The growth in research expenditure by bilateral agencies is almost entirely due to French research institutes working in the French Caribbean countries. In that sense, there is also a geographical dichotomy in the development of research spending between the French Caribbean and the rest of the region.[21]

Bilateral agencies saw their expenditure per researcher decline by about 21% between 1986 and 1996, as the expansion of their research staff exceeded that of their expenditure. For local and regional government agencies, the cut in expenditure per researcher was even deeper at 28%. In this instance, cuts in research expenditure were less-than-equally matched by cuts in research staff. Only universities saw a slight increase in expenditure per researcher between 1986 and 1996, but this was mainly driven by developments at the state agricultural experiment station of the University of Puerto Rico.

The average expenditure per researcher for the group of research agencies included in the trend analysis is about 20% higher than for the entire sample. This suggests a bias in the sample towards the financially stronger research organizations in the region (possibly

21. Except for the Bahamas and the U.S. Virgin Islands, all other countries with a research expenditure of 0.5 million or more saw their agricultural research expenditure decline between 1986 and 1996.

because they are better at reporting financial data), which leads us to believe that the actual decline in expenditure and expenditure per researcher may have been even more dramatic.

*Funding sources*

The institutional complexity of agricultural research in the Caribbean is also reflected in the diversity of funding sources for agricultural research. In table 14, different funding sources have been identified per institutional category. Each institutional category has its own distinct funding profile.

Among government agencies, the share of donor funding increases from low, to moderate, to high for local, regional, and bilateral agencies, respectively. Due to a lack of detailed data, we classified all expenditure by bilateral research agencies as donor-funded, while in reality various other funding sources may have contributed as well, although only in small amounts. Most local government agencies did not receive any donor funding in 1996. Only in a few instances did government agencies report donor contributions in excess of 25% of total expenditure.

Although we have insufficient data to construct a meaningful time series on trends in donor funding, the overall impression is one of declining donor support for agricultural research conducted by local and regional government agencies. CARDI, for example, has seen donor contributions decline steadily throughout the 1990s—donor contributions dropped from close to 50% of total expenditure in 1991 to 22% in 1998. The current emphasis of donors on poverty alleviation bypasses most Caribbean countries, as they have relatively high incomes per capita. In contrast, the two major providers of bilateral agricultural research in the region (France and Taiwan) act because of geopolitical reasons.

Research budgets at universities usually consist of two distinct components: funding from the core budget of the university (labeled here as government funding), and funding from research contracts and grants. Both funding categories most likely include some unidentified donor funding. Only in the case of the state agricultural experiment stations of Puerto Rico

**Table 14: Sources of Funding for Caribbean Agricultural Research Agencies, 1996**

| | Funding source: (percentages) | | | | | |
|---|---|---|---|---|---|---|
| Institutional category | Government | Donors[a] | Specific taxes/levies | Research contracts | Sales | Other[b] |
| Government | 45.4 | 52.9 | 0.3 | 0.4 | 0.5 | 0.5 |
| Local (19) | 91.5 | 5.8 | 0.8 | 1.0 | 1.0 | 0.0 |
| Regional (1) | 66.1 | 28.9 | 0.0 | 0.3 | 1.1 | 3.6 |
| Bilateral (11) | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Higher education | 47.3 | 18.7 | 0.0 | 31.7 | 1.0 | 1.3 |
| SAES (2) | 57.7 | 35.6 | 0.0 | 4.6 | 2.0 | 0.0 |
| Other (8) | 35.8 | 0.0 | 0.0 | 61.5 | 0.0 | 2.7 |
| Business | 0.9 | 0.2 | 75.8 | 1.6 | 2.6 | 18.7 |
| Commodity boards (9) | 1.1 | 0.3 | 93.3 | 2.0 | 3.3 | 0.0 |
| Enterprises (5) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| *Average*[c] | *40.6* | *39.0* | *9.2* | *7.5* | *0.9* | *2.8* |

Note: Based on data obtained from 55 agricultural research agencies across the region.

[a] Also included in this category are funds provided by central or federal governments outside the region.

[b] Unspecified; Business enterprises use their own funds.

[c] Weighted by the total expenditures of each institutional sub-category.

and U.S. Virgin Islands have we been able to identify the significant (donor) contribution made by the U.S. federal government.

In the business sector, two distinct funding profiles stand out as well: private and public enterprises that operate and finance their own research, and agencies that conduct research on behalf of a particular group of producers or processors and are financed mainly through specific taxes, levies, or voluntary contributions.

### *Cost structure*

To gain better insight into the cost structure of agricultural research, research agencies were asked to provide a breakdown of their expenditure according to the following cost categories: salaries, operating expenditures, and capital expenditures. Despite the poor response to this question (only 28 agencies provided data), the results reveal a cost structure that is relatively biased towards salaries at the expense of capital and operating expenditures (table 15).[22] As pointed out by Pardey, Roseboom, and Anderson (1991), expanding agricultural research agencies spend relatively more on capital than those that have reached maturity. In the early 1980s, when most agricultural research agencies in developing countries were still growing rapidly, the share of capital in total expenditure averaged 19%. This is substantially higher than in the U.S., where agricultural research agencies spent, on average, only 8% of their expenditure on capital.

The stagnation or decline in spending experienced by most agricultural research agencies in the region between 1986 and 1996 manifests itself in a relatively low level of capital investment in agricultural research in 1996. Similarly, declining expenditure per researcher has placed major upward pressure on the share of salaries in total expenditure. This is particularly true for local government agencies which, on average, spent nearly 80% of their expenditure on salaries in 1996.

**Table 15: Research Expenditures by Cost Category, 1996**

| Region | Salaries | Operating expenditures | Capital expenditures |
|---|---|---|---|
| Caribbean (1996) | 68.9 | 22.9 | 8.2 |
| Developing countries (1981-85) | 57.0 | 25.0 | 19.0 |
| USA (1981-85) | 69.0 | 23.0 | 8.0 |

*Sources:* Pardey, Roseboom, and Anderson (1991); survey results.

22. Comparing cost structures across countries and over time is problematic because of the interaction between price and use of inputs. For example, countries with low salaries do not necessarily spend proportionately less on personnel costs as they may simply employ more staff.

# 5. The Future of Agriculture and Agricultural Research in the Caribbean

In most Caribbean countries, agriculture has lost its position as the dominant economic activity over the past 30–40 years. Moreover, because of sluggish modernization and productivity growth in agriculture, Caribbean agriculture has lost much of its competitiveness in world markets. Its traditional agricultural trade surplus has turned into a steadily growing deficit, reaching US$ 1.4 billion or US$ 40 per capita in 1997.

A common complaint by Caribbean countries is that high agricultural subsidies and other market interventions in developed countries distort and obscure the region's comparative advantage in agricultural production. In the 1970s, Sir Arthur Lewis expressed concern that Caribbean sugar and banana producers were no longer competitive and could stay in business only because of preferential access to the European market. He warned that it was unrealistic to rely on such preferential treatment indefinitely. Despite his warning, the modernization of sugar and banana production has remained sluggish, and producers dread the day that they will lose their preferential position and be forced to compete at world market prices. An alternative strategy, adopted by the CARICOM countries in the 1980s, is not to rely exclusively on traditional export crops but to diversify into non-traditional export crops such as fruits, vegetables, and ornamentals.[23] This strategy has produced some results, but not enough. Establishing new export markets is a complicated and difficult task that requires major entrepreneurial skill, as well as a supportive institutional setting. Another variant of the agricultural diversification strategy is that of import-substitution, targeting in particular the products imported by the rapidly expanding tourist industry. In this strategy, volume, quality, and year-round supply are the major stumbling blocks to local production.

Smaller countries do not necessarily have smaller farms, but in modern and industrialized food systems, external economies-of-scale are playing an increasingly important role in the provision of research, extension, and training, the procurement and distribution of inputs, and the transportation, processing and marketing of output (Griffith 1990). For example, local processing industries are finding it increasingly difficult to compete with large and well-established North American and European food companies. Small local industries not only have a difficult time gaining access to supermarket shelf space in export markets, but even in their own home markets they are continually under threat of being pushed off the supermarket shelf.[24] Moreover, the standard conventional processing plant is often far too big for the small and irregular amounts of raw material supplied by local farmers.

Product specialization and regional cooperation offer some scope for alleviating economy-of-scale problems (Griffith 1990; Eyzaguirre 1996). These are strategies that have a long tradition in the Caribbean.[25] The issue is whether they have been exploited to the fullest or whether there is still a lot of mileage to be gained from exploring these approaches further. Assuming the latter, it remains debatable whether it will be enough to offset the unfavorable economies-of-scale conditions for all Caribbean countries. The recent establishment of PROCICARIBE is a good example of enhanced regional cooperation in research, in particular because it tries to reach beyond long-standing language barriers. CARDI's declining

23. See, for example, Walmsley (1990).
24. See, for example, the homepage of the Caribbean Basin Agricultural Trade Office of the U.S. Department of Agriculture (http://www.cbato.fas.usda.gov/). It provides detailed analyses of consumer food markets across the region and of export opportunities for U.S. food companies.
25. The West Indies Sugar Cane Breeding Station, for example, is one of the oldest experiment stations in the world.

budget, however, indicates the opposite trend. While product specialization makes sense from an economy-of-scope perspective, it increases a country's vulnerability to changes in production and trade conditions. The WTO agreements on agriculture, which are currently being phased in, are opening up new and favorable prospects for developing country exports, but, at the same time, they threaten the region's traditional export of bananas and sugar under preferential trade schemes (Antoine 1999). While there may be new opportunities, it remains to be seen whether Caribbean countries can capture them.

Small is not beautiful when it hinders the full exploitation of the region's comparative climatic advantage in agricultural production. An alternative approach advocated by some is not to jump on the industrialization-and-globalization bandwagon, but instead to support small-scale production cum cottage industry for local consumption.[26] In Europe, for example, there are small but flourishing markets for regional and organic food products that largely bypass the big food processors and supermarket chains. It is an alternative that may work for some producers in certain niche markets, but it is still debatable whether such a strategy can be applied across an entire agricultural sector.[27] Contradictory as it may seem, the large sugar estates and industries that dominate the agricultural sectors in several Caribbean countries constitute another structural problem in reorienting agricultural production. These large, often state-owned companies lack the flexibility and entrepreneurship to diversify into new activities.

Caribbean agriculture is facing some very difficult questions regarding its future. Where does it fit in a rapidly globalizing and industrializing food system, and how will this position affect those making a living from agriculture? For some of the small and rich Caribbean countries, the answer is clear: there is no real future in agriculture (other than some home gardening) because other economic opportunities are much more promising. For most Caribbean countries, the poorer ones in particular, this is not an option as a considerable proportion of the population still depends on agriculture for its income, and, at the macro level, revenues from other economic activities are insufficient to pay for imports. Nevertheless, from the perspective of a comparative advantage, the odds are against modern agricultural production in most Caribbean countries, particularly in the smaller ones. Three policy interventions that may confront this problem come to mind : (1) reorient and restructure the economy towards other, more promising economic activities; (2) reorient and restructure agriculture towards other, more promising commodities; and (3) modernize agricultural production so that it can compete in a (more) open world market. Establishing and securing new agricultural markets both at home and abroad requires a continuous effort to stay at the competitive edge of that market. Such efforts generally include investments in agricultural R&D and technology acquisition.

Tourism seems to be the best bet for the future prosperity of the Caribbean region. It is certainly the fastest growing economic activity in the region. Several studies have pointed to the opportunities this offers to the agricultural sector. Until now, however, much of the demand for agricultural products by the tourist industry has been met by imports. In this sense, most Caribbean countries fail to fully capture the backward linkages of the tourist industry. To capture these highly demanding markets, local farmers must produce the right products, with the right quality, at the right time (preferably year-round), and at competitive prices

26. For example, by providing local producers with market space and facilities at attractive locations such as shopping malls.
27. John Vidal reported, in the British newspaper *The Guardian* (19 January 2000), that agents of Sainsbury's, a major British supermarket chain, are exploring the possibility of setting up the organic production of tropical fruits in the Caribbean. They are now considering both Grenada and St. Lucia as possible locations. Local producers will produce organically grown bananas, mangoes, coconuts, and passion fruit on a contract basis. However, there were concerns that local producers would be at a disadvantage vis-à-vis Sainsbury's when it comes to negotiating a good price.

(Springer 1999). The link between agriculture and tourism is not only one of supply. Agriculture also plays an important role when it comes to landscape, environment, and culture, all of which are important ingredients of the attractiveness of the Caribbean islands to tourists.

Recent investment trends in agricultural research give reason for concern: both research staff and research expenditure have been stagnant or declining in many parts of the Caribbean agricultural research system for the past decade. At the same time, many of the region's agricultural problems remained unresolved. Traditional export crops are not competitive enough in world markets, while diversification into new export crops develops only very slowly. Even in the local markets for food staples, local farmers are finding it increasingly difficult to compete with (cheaper) imports. As a consequence, many countries see their agricultural trade deficit widening. Policymakers in countries with relatively high R&D intensities may think that they already have more than enough invested in agricultural R&D; they may even question its profitability. At the same time, however, they need to realize that the lack of economies of scale severely reduces the impact of such investments, in terms of the technologies that are made available to farmers. The competitiveness of the agricultural sector may, therefore, remain substandard. As mentioned earlier, product specialization and regional cooperation may offset some of the economies-of-scale problems in agricultural R&D (as well as other supportive activities) encountered by smaller Caribbean countries. More important perhaps is the idea that small countries should focus on technology acquisition rather than on technology generation.

While much of the above pertains to problems that are specific to small Caribbean countries, the situation for agriculture and agricultural R&D is quite different for medium-sized countries such as Cuba, the Dominican Republic, and Haiti. Their agricultural sectors and agricultural R&D investments are less constrained by economies-of-scale factors. However, any other similarity between the three countries ends there. For Cuba, the bottleneck is not its research capacity (it has, at least on paper, the most impressive agricultural research system of the region), but how to exploit its research capacity for economic purposes. In contrast, the Dominican Republic and Haiti are both lacking in agricultural research capacity. R&D in Haiti is an uncertain and risky undertaking, given the political and economic instability of the country. Despite the enormous needs of an impoverished population, the conditions for profitable investment in R&D are very weak or nonexistent. In the Dominican Republic, the meager investment in agricultural R&D (as well as other agricultural support services) is of a different nature—it is a clear case of missed opportunities.

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# Annex 1. Concepts and definitions used in data collection

*Measuring National Agricultural R&D Efforts*

The construction of quantitative and internationally comparable expenditure, personnel, and related measures for national agricultural research activities requires a precise idea of what is actually being measured. Since these activities are subject to a variety of interpretations, it is necessary to define very precisely the concepts used in this paper. The ASTI project's approach adheres, whenever possible, to the internationally accepted statistical procedures and definitions developed by the OECD and UNESCO for compiling R&D statistics (OECD 1994 and UNESCO 1984). For statistical purposes, we adhered to the following norms:

**National.** The concept of "national" research refers to all domestically targeted research activities by all public and private agencies. The research activities of supranational research agencies are excluded unless they are executed by national agencies.

**Agricultural.** Agricultural research includes research on crops, livestock, forestry, fisheries, the use of agricultural inputs (but not research on the development of agricultural inputs other than those originating from within agriculture), natural resources, and the socioeconomic aspects of primary agricultural production. Also included is research concerning the storage and processing of agricultural products, commonly referred to as post-harvest or food-processing research. Such research usually deals with both on-farm and off-farm issues. Ideally, only the research activities dealing with on-farm storage and processing should be included, while research on off-farm issues should be attributed to the food processing industry. In practice, however, it is not always possible to make this distinction, and the off-farm component may have been included as well.

**Research.** Research is often performed in conjunction with other activities such as technology transfer, extension, education, and production. To the extent possible, research activities (in terms of expenditures and staff) are differentiated from these other activities. However, if non-research activities are an integral part of an institute's research activities and account for less than 20% of the resources of the institute, it is expedient to classify all the activities of the institute as research-related. Occasional or ad hoc research activities by agencies without a clear research mandate are excluded.

*Institutional Classification*

The Frascati Manual (OECD 1994) identifies five institutional categories of executing research agencies, three of which are relevant to this study:[28]

**Government agencies.** This category includes all agencies that are controlled and financed mainly by the government. Agencies that are not directly controlled by the government, but are financed in large part by the government, are also categorized as government agencies.

28. The two institutional categories not included are "private non-profit" and "abroad." In the 1993 version of the Frascati Manual, the former category was reduced substantially and now includes only: non-market, private, nonprofit institutions serving households; and private individuals and households. Research agencies that are not directly controlled by but receive more than 50% of their funding from government, universities, or business enterprises should be assigned accordingly. As a result, the private nonprofit category has become almost negligible as a research-executing category, although it is still a source of research funding. The institutional category "abroad" is not relevant, as the survey is restricted to "national" research.

Consequently, most national agricultural research organizations are classified as government agencies despite their "autonomous" status.

**Higher education agencies.** This category includes all public and private universities, colleges of technology, and other higher education institutes. Also included are all research institutes and experimental stations that are controlled directly by, administered by, or associated with higher education agencies.

**Business enterprises.** This category comprises the following three subcategories: (a) public enterprises, (b) private enterprises, and (c) nonprofit institutions. The first two subcategories cover all research activities undertaken within enterprises, while the third subcategory covers research activities that are undertaken in the collective interest of a group of business enterprises, and which are controlled and financed by such a collective. Within agricultural research, this subcategory includes research activities controlled and financed by commodity boards and farmer organizations. A further distinction made between private enterprises is that of national versus multinational (i.e., with at least 50% foreign ownership of capital).

*Full-Time Equivalent (FTE)*

A full-time-equivalent researcher is a person who holds a full-time position as a researcher during the entire year. Adjustments to full-time equivalents have been made only when (a) a research position was part-time, (b) a research position was not filled for the entire year, and (c) the position explicitly involved tasks other than agricultural research. In the latter case, an estimate was made of the time spent on agricultural research. No adjustments were made, however, for vacation or sick leave, nor for time spent on administration, meetings, travel, or other activities that form part of the normal duties required to support a research endeavor. Following this logic, professional staff in management positions were also classified as research staff. Research staff that were on study leave, but remained fully supported in terms of salaries and benefits, were also included.

The degree status of researchers is classified as follows: 3–4 years full-time university education (BSc), 5-6 years (MSc), and more than 6 years plus doctorate thesis (PhD).[29]

*Deflators and Exchange Rates*

All expenditure figures were first compiled in current local currency units. In order to facilitate comparisons over time and across countries, these figures were deflated with a local GDP deflator to the base year 1993, and then converted to a common currency (U.S. dollars) using the 1993 Purchasing Power Parity (PPP) over GDP. PPPs are synthetic exchange rates that attempt to reflect the purchasing power of a country's currency. The PPPs used here are derived from the 1999 World Development Indicators (World Bank 1999a). For additional information on currency conversion methods for the purpose of international comparisons, see Pardey, Roseboom, and Craig (1992).

*Nomenclature for Tables in Text*

A zero indicates an actual observation of zero, a dash indicates that an observation is not relevant (due to institutional mergers, closures, and so on), while "na" indicates an observation that is not available.

In the text, we note any marked deviations from these data compilation norms and include points of clarification when warranted.

29. Although the study programs of "ingeniero" and "licenciado" often take more than 4 years, they are classified as BSc degrees.

# Annex 2. Caribbean countries, by formal status and CARICOM membership

| Country | Formal status | CARICOM Membership |
|---|---|---|
| Anguilla | Dependent territory of the UK | Observer |
| Antigua and Barbuda | Independent (previously British) [a] | Member |
| Aruba | Autonomous status within the Kingdom of the Netherlands | Observer |
| Bahamas, The | Independent (previously British) [a] | Member |
| Barbados | Independent (previously British) [a] | Member |
| Belize | Independent (previously British) [a] | Member |
| British Virgin Islands | Independent (previously British) [a] | Associate |
| Cayman Islands | Dependent territory of the UK | Observer |
| Cuba | Independent (previously Spanish) | No |
| Dominica | Independent (previously British) | Member |
| Dominican Republic | Independent (previously Spanish) | Observer |
| French Guiana | Overseas department of France | No |
| Grenada | Independent (previously British) [a] | Member |
| Guadeloupe | Overseas department of France | No |
| Guyana | Independent (previously British) | Member |
| Haiti | Independent (previously French) | Provisional member |
| Jamaica | Independent (previously British) [a] | Member |
| Martinique | Overseas department of France | No |
| Montserrat | Dependent territory of the UK | Member |
| Netherlands Antilles | Autonomous status within the Kingdom of the Netherlands | Observer |
| Puerto Rico | Commonwealth associated with the USA (previously Spanish) | Observer |
| St. Kitts and Nevis | Independent (previously British) [a] | Member |
| St. Lucia | Independent (previously British) [a] | Member |
| St. Vincent and the Grenadines | Independent (previously British) [a] | Member |
| Suriname | Independent (previously Dutch) | Member |
| Trinidad and Tobago | Independent (previously British) | Member |
| Turks and Caicos Islands | Dependent territory of the UK | Associate |
| Virgin Islands (U.S.) | Unincorporated territory of the US (previously Danish) | No |

*Note:* The Bahamas are a member of the Caribbean Community but not of the Market. Bermuda, Colombia, Venezuela, and Mexico have observer status in the CARICOM.

[a] In these countries, the British monarch is still the formal head of state.

# Annex 3. Names and addresses of agricultural research organizations

| | | |
|---|---|---|
| **Antigua** | | |
| Research Division<br>Ministry of Agriculture, Fisheries and Lands<br>Research Station, Dunbars | St. John's<br>Antigua | Tel: (1-268) 462-4962; 462-1213<br>Fax: (1-268) 462-4962 |
| Fisheries Division<br>Ministry of Agriculture, Fisheries, and Lands | St. John's<br>Antigua | |
| CARDI - Antigua Unit | PO Box 766<br>St. John's<br>Antigua | Tel: (1-268) 462-0661<br>Fax: (1-268) 462-1666<br>E-mail: cardi@candw.ag<br>Web site: www.cardi.org/ |
| **Aruba** | | |
| Department of Agriculture, Husbandry and Fisheries<br>Ministry of Economic Affairs and Tourism | Piedra Plat 114A<br>Aruba | Tel: (1-297) 8-58102<br>Fax: (1-297) 8-55639<br>E-mail: dirlvvm@toaruba.com<br>Web site: http://www.arubagricultureandfish.com/ |
| **Bahamas** | | |
| Department of Fisheries<br>Ministry of Agriculture, Trade and Industry | PO Box N3028<br>Nassau<br>Bahamas | Tel: (1-242) 393-1777; 393-1014<br>Fax: (1-242) 393-0328<br>E-mail: mbraynen@batelnet.bs |
| Gladstone Road Agricultural Complex,<br>Department of Agriculture<br>Ministry of Agriculture, Trade and Industry | PO Box N3028<br>Nassau<br>Bahamas | Tel: (1-242) 361-3264<br>Fax: (1-242) 361-4236 |
| Forestry Unit,<br>Department of Lands and Surveys<br>Office of the Prime Minister | PO Box N592<br>Nassau<br>Bahamas | Tel: (1-242) 325-6581; 325-6425<br>Fax: (1-242) 322-5830 |
| Caribbean Marine Research Center<br>p/a Perry Foundation, Inc. | 1501 Northpoint Parkway, Suite 101<br>West Palm Beach, FL 33407<br>USA | E-mail: cmrc@gate.net<br>Web site: www.cmrc.org/ |
| **Barbados** | | |
| Technical Division<br>Ministry of Agriculture, Food and Fisheries | P.O. Box 505<br>Bridgetown<br>Barbados | Tel: (1-246) 428-4150<br>Fax: (1-246) 420-8444 |
| CARDI - Barbados Unit<br>P.O. Box 64 | Bridgetown<br>Barbados | Tel: (1-246) 425-1334; 425-1335<br>Fax:(1-246) 424-8793<br>E-mail: cardibds@sunbeach.net<br>Web site: www.cardi.org/ |
| Bellairs Research Institute<br>McGill University, Canada | Holetown<br>St. James<br>Barbados | Tel: (1-246) 422-2087<br>Fax: (1-246) 422-0692<br>E-mail: bellairs@sunbeach.net<br>Web site: www.mcgill.ca/Biology/research/bellairs.htm |
| Centre for Resource Management and Environmental Studies<br>University of the West Indies | PO Box 64<br>Bridgetown<br>Barbados | Tel: (1-246) 425-1310<br>Fax: (1-246) 425-1327 |
| Department of Biological and Chemical Science<br>Faculty of Science and Technology<br>University of the West Indies | PO Box 64<br>Bridgetown<br>Barbados | Tel: (1-246) 417-4322/23/24<br>Fax: (1-246) 417-4597; 425-1327<br>E-mail: bcs@uwichill.edu.bb<br>Web site: www.uwichill.edu.bb/index.htm |
| Agronomic Research and Variety Testing Unit<br>Barbados Agricultural Management Company Ltd | Groves<br>St. George<br>Barbados | Tel: (1-246) 433-4157<br>Fax: (1-246) 433-4158 |

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| Sugar Technology Research Unit<br>Barbados Agricultural Management Company Ltd | P.O. Box 719 c<br>Bridgetown<br>Barbados | Tel: (1-246) 228-5005<br>Fax: (1-246) 426-1695<br>E-mail: stru@ndlc |
| West Indies Central Sugar Cane Breeding Station<br>Sugar Association of the Caribbean / West Indies Sugar Cane Breeding and Evaluation Network | Groves<br>St. George<br>Barbados | Tel: (1-246) 433-1308<br>Fax: (1-246) 433-1308 |
| **Belize** | | |
| Agricultural Research Centre and Belize College of Agriculture<br>Central Farm<br>Ministry of Agriculture, Fisheries and Cooperatives | Cayo District<br>Belmopan<br>Belize | Tel: (501) 9-22131/37/39<br>Fax: (501) 8-22409<br>Web site: http://www.belize.gov.bz/ |
| CARDI - Belize Unit | P.O. Box 2<br>Belmopan<br>Belize | Tel: (501) 8-22602<br>Fax: (501) 8-23143<br>E-mail: cardi@btl.net<br>Web site: www.cardi.org |
| CARICOM Fisheries Unit | PO Box 642<br>Belize City<br>Belize | Tel: (501) 2-34443<br>Fax: (501) 2-34446<br>E-mail: cframp@btl.net<br>Web site: www.caricom-fisheries.com |
| Marine Research Centre<br>University College of Belize | P.O. Box 990<br>Belize City<br>Belize | Tel: (501) 2-32732<br>Fax: (501) 2-30225<br>E-mail: vpalacio@ucb.edu.bz<br>Web site: www.ucb.edu.bz/ |
| Belize Agri-Business Company (BABCO) | P.O. Box 92<br>Orange Walk<br>Belize | Tel: (501) 3-22585; 22849 |
| Citrus Research and Education Institute<br>Belize Citrus Growers Association (CGA) | PO Box 72; Dangriga<br>Stann Creek<br>Belize | Tel: (501) 5-23535<br>Fax: (501) 5-23511<br>E-mail: crei@btl.net<br>Web site: http://www.citripro.org.bz/ |
| R&D Unit<br>Belize Sugar Industries Ltd | P.O. Box 29<br>Orange Walk District<br>Belize | Tel: (501) 3-22150<br>Fax: (501) 3-23247<br>E-mail: bsires@btl.net |
| **British Virgin Islands** | | |
| CARDI - British Virgin Islands Unit | PO Box 3023<br>Roadtown<br>Tortola<br>British Virgin Islands | Tel: (1-284) 495-1929<br>Fax: (1-284) 495-1936<br>E-mail: cardibvi@caribsurf.com<br>Web site: www.cardi.org |
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| Instituto de Investigaciones en Riego y Drenaje<br>Ministerio de la Agricultura | Apartado Postal 6090<br>Arroyo Naranjo<br>Ciudad de la Habana<br>Cuba | Tel: (53) 7-911038<br>Fax: (53) 7-335086 |
| Instituto de Investigaciones en Mecanización Agropecuaria<br>Ministerio de la Agricultura | Avenida de las 3 Palmas No. 13926<br>Capdevila<br>La Habana<br>Cuba | |
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| Instituto de Investigaciones del Arroz<br>Ministerio de la Agricultura | Apartado Postal 1<br>Bauta<br>La Habana<br>Cuba | Tel: (53) 7-294111<br>Fax: (53) 7-294275 |
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| Instituto de Investigaciones en Cítricos y Frutales<br>Ministerio de la Agricultura | La Habana<br>Cuba | Tel: (53) 7-293585<br>Fax: (53) 7-246794<br>E-mail: iicit@ceniai.inf.cu |
| Instituto de Investigaciones Forestales<br>Ministerio de la Agricultura | Calle 174, No. 1723 entre 17B y 17C<br>Siboney, Municipio 11600<br>Ciudad de la Habana<br>Cuba | Tel: (53) 7-219960; (53) 7-210501<br>Fax: (53) 7-335086 |
| Instituto de Investigaciones Avícolas<br>Ministerio de la Agricultura | Calle 15, No. 853 e/ 4 y 6 or: Loma del Cacahual<br>Vedado/Santiago de<br>La Habana<br>Cuba | Tel: (53) 7-579080<br>Fax: (53) 7-579034;<br>E-mail: viiacan@ceniai.inf.cu<br>Web site: www1.cuba.cu:8084/ciencia/avicultura/ |
| Instituto de Investigaciones de Pastos y Forrajes "Indio Hatuey"<br>Ministerio de la Agricultura | Central España Republicana<br>Perico<br>Matanzas<br>Cuba | Web site: www.mes.edu.cu/ |
| Instituto de Investigaciones del Tabaco | Ministerio de la Agricultura<br>Cuba | |
| Instituto de Investigaciones Hortícolas "Liliana Dimitrova"<br>Ministerio de la Agricultura | Carretera Bejucal-Quivicán km 33<br>Quivicán<br>Ciudad de la Habana<br>Cuba | Tel:(53) 67-57795; (53) 66-82600<br>Fax:(53) 66-82601<br>Web site: www.2cuba.cu/POLO/centros/centros/dimitro.htm |
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| Empresa Cubana de Productos Veterinarios<br>Ministerio de la Agricultura | Avenida Independencia km 16<br>Boyeros<br>Ciudad de la Habana<br>Cuba | |

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| Instituto Tecnológico de la Caña de Azúcar 'Carlos M. de Cespedes'<br>Ministerio del Azúcar | Apartado Postal 164<br>Guantánamo<br>Cuba | |
| Centro de Semillas e Investigaciones de Caña de Azúcar<br>Ministerio del Azúcar | Apartado Postal 14<br>Jatibonico 6220055<br>Cuba | Tel: (53) 41-82527 |
| Instituto Cubano de Investigaciones Azucareras<br>Ministerio del Azúcar | Apartado Postal 10<br>Quivican 33500<br>Ciudad de la Habana<br>Cuba | Tel: (53) 67-55445 |
| Instituto Nacional de Investigaciones de la Caña de Azúcar<br>Ministerio del Azúcar | Avenida Van Troi No. 17203<br>Boyeros 19210<br>Ciudad de la Habana<br>Cuba | |
| Instituto Cubano de Investigaciones de los Derivados de la Caña de Azúcar<br>Ministerio del Azúcar | Apartado Postal 4026<br>San Miguel de Padrón 11000<br>La Habana<br>Cuba | Tel: (53) 7-982369; 982883<br>Fax: (53) 7-338236<br>E-mail: icidca@ceniai.cu<br>Web site: www2.cuba.cu/POLO/centros/icidca.htm |
| La Unión de Investigación Producción de la Celulosa del Bagazo, Cuba 9<br>Ministerio del Azúcar | Apartado Postal 8<br>Quivicán<br>Ciudad de la Habana<br>Cuba | Tel: (53) 67-54915; (53) 67-53455<br>Fax: (53) 7-333193;<br>Web site: www.2cuba.cu/economia/bagazo/body.htm |
| Instituto de Investigaciones para la Industria Alimenticia<br>Ministerio de Alimentos | Cuba | |
| Instituto de Investigaciones Agrícolas 'Jorge Dimitrov'<br>Ministerio de Ciencia, Tecnología y Medio Ambiente | Apartado Postal 2140<br>Bayamo 85100<br>Granma<br>Cuba | Tel: (53) 23-5239<br>E-mail: dimitrov@granma.cu |
| Centro de Biotecnología Vegetal<br>Ministerio de Ciencia, Tecnología y Medio Ambiente | Apartado Postal 41<br>Holguín 80100<br>Holguín<br>Cuba | Tel: (53) 24-481538<br>E-mail: cbv@cpcmho.sld.cu |
| Instituto Nacional de Recursos Hidráulicos<br>Ministerio de Ciencia, Tecnología y Medio Ambiente | Monserrate 258, e/Neptuno y Animas<br>La Habana<br>Cuba | |
| Instituto de Ecología y Sistemática<br>Ministerio de Ciencia, Tecnología y Medio Ambiente | Apartado Postal 8029<br>Capdevila Boyeros14200/10800<br>La Habana<br>Cuba | Tel: (53) 7-446927; (53) 7-446920<br>Fax: (53) 7-339117<br>E-mail: ecología@ceniai.cu<br>Web site: www.latinsynergy.org/inst_de_ecologia_y_Sistem |
| Centro de Ingeniería Genética y Biotecnología<br>Ministerio de Ciencia, Tecnología y Medio Ambiente | Apartado Postal 6162<br>La Habana 10600<br>Cuba | Tel: (53) 7-218008; (53) 7-218675<br>Fax: (53) 7-218070;<br>E-mail: postmaster@cigb.edu.cu or<br>Web site: www.cigb.edu.cu/ |

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| Centro de Desarrollo Científico de Montañas<br>Ministerio de Ciencia, Tecnología y Medio Ambiente | Matazón, Sabaneta,<br>Cuba | |
| Instituto Superior de Ciencias Agropecuarias de La Habana<br>Ministerio de Educación Superior | Autopista Nacional y Carretera de Tapaste<br>San José de las Lajas<br>La Habana<br>Cuba | Tel: (53) 64-62908; (53) 64-63013; 63395<br>Fax: (53) 7-330942<br>E-mail: iscah@reduniv.edu.cu<br>Web site: www.mes.edu.cu/ |
| Centro Nacional de Investigaciones Científicas<br>Ministerio de Educación Superior | Apartado Postal 6990 y 6880<br>Cubanacán, Playa<br>Ciudad de la Habana<br>Cuba | Tel: (53) 7-219446; (53) 7-336376<br>Fax: (53) 7-218875;<br>E-mail: cnic@reduniv.edu.cu<br>Web site: www.mes.edu.cu/ |
| Instituto Nacional de Ciencias Agrícolas<br>Instituto Superior de Ciencias Agropecuarias de la Habana | Carretera de Tapaste km 3.5<br>San José de Las Lajas<br>La Habana<br>Cuba | Tel: (53) 64-63157; (53) 64-63867<br>Fax: (53) 64-63773;<br>E-mail: inca@reduniv.cu<br>Web site: www.mes.edu.cu/ |
| Instituto de Ciencia Animal<br>Instituto Superior de Ciencias Agropecuarias de la Habana | Apartado Postal 24<br>San José de Las Lajas<br>La Habana<br>Cuba | Tel: (53) 62-99167; (53) 62-99433; 24773<br>Fax: (53) 7-335382<br>E-mail: ica@reduniv.edu.cu or ica@ceniai.inf.cu<br>Web site: www.mes.edu.cu/ |
| Centro Nacional de Sanidad Agropecuaria<br>Instituto Superior de Ciencias Agropecuarias de la Habana | Apartado Postal 10<br>San José de Las Lajas<br>La Habana<br>Cuba | Tel: (53) 64-62752; (53) 64-63014; 63206<br>Fax: (53) 64-63206;<br>E-mail: censa@reduniv.edu.cu or censa@ceniai.cu<br>Web site: www.mes.edu.cu/ |
| Facultad de Medicina Veterinaria<br>Instituto Superior de Ciencias Agropecuarias de la Habana | Autopista Nacional y Carretera de Tapaste<br>San José de Las Lajas<br>La Habana<br>Cuba | |
| Facultad de Agronomía<br>Instituto Superior de Ciencias Agropecuarias de la Habana | Autopista Nacional y Carretera de Tapaste<br>San José de Las Lajas<br>La Habana<br>Cuba | |
| Facultad de Mecanización de la Producción Agropecuaria<br>Instituto Superior de Ciencias Agropecuarias de la Habana | Autopista Nacional y Carretera de Tapaste<br>San José de Las Lajas<br>La Habana<br>Cuba | |
| Sede Universitaria del Instituto de Ciencias Agropecuarias de La Habana - Facultad de<br>Instituto Superior de Ciencias Agropecuarias de la Habana<br>Ministerio de Educación Superior | Nueva Gerona<br>Isla de la Juventud<br>Cuba | Tel: (53) 61-22409;<br>Web site: www.mes.edu.cu/ |
| Facultad de Ciencias Agropecuarias<br>Universidad Central de Las Villas | Carretera de Camajuani km 5.5<br>Santa Clara 510100<br>Villa Clara<br>Cuba | Tel: (53) 422-81178; (53) 422-81682<br>Fax: (53) 422-81602<br>E-mail: uclv@reduniv.edu.cu<br>Web site: www.mes.edu.cu/ |
| Sede Universitaria de la UCLV "José Martí" - Facultad de Agropecuaria<br>Universidad Central de Las Villas | Avenida de los Mártires No. 360, esq. A Bartolomé Masó<br>Sancti Spiritus<br>Cuba | Tel: (53) 41-23677 |

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| Facultad Agropecuaria de Montaña<br>Universidad Central de Las Villas | Carretera de Camajuani km 5.5<br>Santa Clara 510100<br>Villa Clara<br>Cuba | |
| Centro de Estudios para el Desarrollo de la Producción Animal<br>Universidad de Camagüey | Carretera de Circunvalación Norte km 5<br>Camagüey 74650<br>Cuba | Tel: (53) 322-61667<br>E-mail: uc@reduniv.edu.cu<br>Web site: www.mes.edu.cu/ |
| Facultad de Medicina Veterinaria<br>Universidad de Camagüey | Carretera de Circunvalación Norte Km 5<br>Camagüey 74650<br>Cuba | Tel: (53) 322-61229,<br>Fax: (53) 322-61126,<br>E-mail: uc@reduniv.edu.cu<br>Web site: www.mes.edu.cu/ |
| Centro de Bioplantas<br>Universidad de Ciego de Avila | Carretera de Morón km 9.5<br>Ciego de Avila<br>Cuba | Fax: (53) 7-335040 |
| Facultad de Agronomía<br>Universidad de Ciego de Avila | Carretera de Morón km 9.5<br>Ciego de Avila<br>Cuba | Tel: (53) 33-24544; (53) 33-25702; 25724<br>Fax: (53) 7-301365;<br>E-mail: unica@reduniv.edu.cu<br>Web site: www.mes.edu.cu/ |
| Facultad de Mecanización de la Producción Agropecuaria<br>Universidad de Ciego de Avila | Carretera de Morón km 9.5<br>Ciego de Avila<br>Cuba | Tel: (53) 33-24544;<br>Fax: (53) 7-301365;<br>E-mail: unica@reduniv.edu.cu<br>Web site: www.mes.edu.cu/ |
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| Facultad de Farmacia y Alimentos<br>Universidad de la Habana | Avenida 23 21425<br>La Lisa13600<br>Ciudad de la Habana<br>Cuba | Tel: (53) 7-213131; (53) 7-216244; 216676<br>Fax: (53) 7-336811<br>E-mail: ifal@biotec.cu or ffram@comuh.uh.cu<br>Web site: www.uh.cu/ |
| Facultad de Biología<br>Universidad de la Habana | Avenida 25 455 e/ J e L Vedado<br>La Habana<br>Cuba | Tel: (53) 7-705896; (53) 7-783231<br>Fax: (53) 7-335774<br>E-mail: rector@red.uh.cu<br>Web site: www.uh.cu/ |
| Jardín Botánico Nacional<br>Universidad de la Habana | Carretera del Rocío km 3.5<br>Calabazar 19230<br>Ciudad de la Habana<br>Cuba | Tel: (53) 7-544096/99<br>Fax: (53) 7-544184<br>E-mail: hajb@ceniai.inf.cu<br>Web site: www.uh.cu/ |
| Centro de Investigaciones Marinas<br>Universidad de la Habana | Calle 16 114<br>Miramar, Playa<br>Ciudad de la Habana<br>Cuba | Tel: (53) 7-221676<br>Fax: (53) 7-330807<br>E-mail: cim@comuh.uh.cu<br>Web site: www.uh.cu/ |
| Facultad de Agronomía<br>Universidad de Matanzas "Camilo Cienfuegos" | Carretera Vía Blanca km 3.5<br>Matanzas<br>Cuba | Tel: (53) 52-61013; (53) 52-61924<br>Fax: (53) 52-53101<br>E-mail: umcc@reduniv.edu.cu<br>Web site: www.mes.edu.cu/ |
| Facultad de Agronomía y Forestal<br>Universidad de Pinar del Río "Hermanos Saíz" | Calle Martí 270 esq. a 27 de Noviembre<br>Pinar del Río 20100<br>Pinar del Río<br>Cuba | Tel: (53) 82-5479; 5813<br>Fax: (53) 82-5813<br>E-mail: univpr@reduniv.edu.cu<br>Web site: www.mes.edu.cu/ |

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| Departamento de Agronomía<br>Centro Universitario de Las Tunas | Indalecio Pérez s/n<br>Las Tunas<br>Cuba | Tel: (53) 31-43362; (53) 31-45352<br>Fax: (53) 31-44987<br>E-mail: cult@reduniv.edu.cu<br>Web site: www.mes.edu.cu/ |
| **Dominica** | | |
| Division of Fisheries Development<br>Ministry of Agriculture, Lands and Fisheries | Dominica | Fax: (1-767) 448-0140 |
| Research Unit, Division of Agriculture<br>Ministry of Agriculture, Lands and Fisheries | PO Box 346<br>Roseau<br>Dominica | Tel: (1-767) 448-2401; 2731<br>Fax: (1-767) 448-5200 |
| CARDI - Dominica Unit | PO Box 346<br>Roseau<br>Dominica | Tel: (1-767) 448-2715; 448-4715<br>Fax: (1-767) 448-5690<br>E-mail: cardi@tod.dm or cardi@cwdom.dm<br>Web site: www.cardi.org |
| French Technical Cooperation<br>Botanical Garden | Roseau<br>Dominica | Tel: (1-767) 448-0204; 448-0456<br>Fax: (1-767) 448-0456 |
| Agricultural Technical Mission of Taiwan | PO Box 362<br>Roseau<br>Dominica | Tel: (1-767) 448-4250<br>Fax: (1-767) 449-9459 |
| **Dominican Republic** | | |
| Centro Nacional de Biotecnología Vegetal<br>Departamento de Investigaciones Agropecuarias<br>Secretaría de Estado de Agricultura | Santo Domingo<br>República Dominicana | Tel: (1-809) 564-4401; 564-4402<br>Fax: (1-809) 564-4400<br>E-mail: b.castillo@codetel.net.do |
| Centro de Investigaciones Arroceras<br>Departamento de Investigaciones Agropecuarias<br>Secretaría de Estado de Agricultura | Juma<br>Bonao<br>República Dominicana | Tel: (1-809) 525-2894<br>Fax: (1-809) 525-2893 |
| Centro de Investigaciones Agrícolas del Sudoeste<br>Departamento de Investigaciones Agropecuarias<br>Secretaría de Estado de Agricultura | Apartado Postal 188<br>Arroyo Loro<br>República Dominicana | Tel: (1-809) 557-3458; 696-1527<br>Fax: (1-809) 248-4215 |
| Centro Nacional de Investigaciones Pecuarias<br>Departamento de Investigaciones Agropecuarias<br>Secretaría de Estado de Agricultura | Km 23 de la Autopista Duarte<br>República Dominicana | Tel: (1-809) 559-8763 |
| Centro Nordeste de Desarrollo Tecnológico Agropecuario<br>Departamento de Investigaciones Agropecuarias<br>Secretaría de Estado de Agricultura | Carretera Salida de Nagua, Mata Larga<br>San Francisco de Macorís<br>República Dominicana | Tel: (1-809) 588-8699<br>Fax: (1-809) 588-8699 |
| Centro de Servicios para el Desarrollo Agropecuario<br>Departamento de Investigaciones Agropecuarias<br>Secretaría de Estado de Agricultura | Apartado Postal 24<br>San Cristóbal<br>República Dominicana | Tel: (1-809) 528-7317<br>Fax: (1-809) 528-1899 |
| Estación Experimental Hortícola de Constanza<br>Departamento de Investigaciones Agropecuarias<br>Secretaría de Estado de Agricultura | Calle General Luperon s/n<br>Constanza<br>República Dominicana | Tel: (1-809) 539-2791<br>Fax: (1-809) 227-1186 |
| Centro de Investigaciones Aplicadas a Zonas Aridas<br>Departamento de Investigaciones Agropecuarias<br>Secretaría de Estado de Agricultura | Apartado Postal 139<br>El Sisal<br>República Dominicana | Tel: (1-809) 521-3548<br>Fax: (1-809) 521-3094 |
| Estación Cafetalera “La Cumbre”<br>Departamento del Café<br>Secretaría de Estado de Agricultura | Puerto Plata<br>República Dominicana | |
| Instituto del Tabaco<br>Departamento del Tabaco<br>Secretaría de Estado de Agricultura | Apartado Postal 163<br>Santiago de los Caballeros<br>República Dominicana | Tel: (1-809) 580-0066; 580-0038<br>Fax: (1-809) 580-0076 |

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| Servicios de Investigación y Desarrollo<br>Instituto Dominicano de Tecnología Industrial | Av. Nuñez de Caceres, Esq. Oloff Palmer, Los Prados<br>Santo Domingo<br>República Dominicana | Tel: (1-809) 566-8121; 227-8810<br>Fax: (1-809) 227-8808<br>E-mail: indotec@codetel.net.do or indotec@aacr.net<br>Web site: www.indotec.gov.do |
| Instituto Nacional de Recursos Hidráulicos | Avenida Winston Churchill, Centro de los Héroes<br>Santo Domingo<br>República Dominicana | Tel: (1-809) 532-3271<br>Fax: (1-809) 508-2741<br>E-mail: informacion@indrhi.gov.do<br>Web site: www.indrhi.gov.do |
| Instituto Superior de Agricultura<br>Asociación para el Desarrollo de Santiago, Inc | Apartado de Correos 166<br>Santiago de los Caballeros<br>República Dominicana | Tel: (1-809) 247-2000<br>Fax: (1-809) 247-2626<br>E-mail: i.agricultura@codetel.net.do<br>Web site: http://members.tripod.com/~isadom/index.html |
| Instituto Agronómico "San Ignacio de Loyola" | Calle Duarte No. 70<br>Dajabón<br>República Dominicana | Tel: (1-809) 579-8229<br>Fax: (1-809) 579-8501 |
| Instituto Agronómico Salesiano | Autopista Duarte Km. 3<br>La Vega<br>República Dominicana | Tel: (1-809) 573-2687<br>Fax: (1-809) 573-3657 |
| Instituto Polytecnico Loyola | Calle Rvdo. Padre Angel Arias 1<br>San Cristóbal<br>República Dominicana | Tel: (1-809) 528-3503; 528-3504<br>Fax: (1-809) 528-9229 |
| Centro de Investigaciones de Biología Marina<br>Universidad Autónoma de Santo Domingo | Apartado Postal 191<br>Santo Domingo<br>República Dominicana | Tel: (1-809) 686-3250; 698-4080<br>Fax: (1-809) 687-0721<br>E-mail: cibima@aacr.net<br>Web site: www.aacr.net./gef/cibima/cibima.html |
| Facultad de Ciencias Agronómicas y Veterinarias<br>Universidad Autónoma de Santo Domingo | Apartado Postal 1355<br>Santo Domingo<br>República Dominicana | Tel: (1-809) 533-1104<br>Fax: (1-809) 533-1106<br>Web site: www.uasd.edu.do |
| Escuela de Medicinas Veterinarias<br>Universidad Eugenio Maria de Hostos | Apartado Postal 2694<br>Santo Domingo<br>República Dominicana | |
| Facultad de Ciencias Agropecuarias y Recursos Naturales<br>Universidad Nacional 'Pedro Henríquez Urena' | Apartado Postal 1423<br>Santo Domingo<br>República Dominicana | Tel: (1-809) 562-6601; 563-1282<br>Fax: (1-809) 563-2529<br>E-mail: jespaillat@unphu.edu.do<br>Web site: www.unphu.edu.do |
| Facultad de Agricultura<br>Universidad Nordestrana | Apartado Postal 239<br>San Francisco de Macorís<br>República Dominicana | Tel: (1-809) 588-3239; 588-3505<br>Fax: (1-809) 244-1647 |
| Centro de Investigación y Mejoramiento de la Producción Animal<br>Asociación para el Desarrollo de Santiago, Inc | Apartado Postal 762<br>Santiago de los Caballeros<br>República Dominicana | Tel: (1-809) 233-0532; 710-9003<br>Fax: (1-809) 223-0447 |
| Departamento de Investigaciones Agrícolas<br>Central Romana Corporation | Oficinas Hotel Santo Domingo Sur<br>Santo Domingo<br>República Dominicana | Tel: (1-809) 687-7787; 689-1779<br>Fax: (1-809) 687-9740<br>E-mail: francis.redman@codetel.net.do |
| Fertilizantes Santo Domingo C. por A. | Santo Domingo<br>República Dominicana | Tel: (1-809) 227-1717<br>E-mail: webmaster@fersan.com.do<br>Web site: www.fersan.com.do |
| División / Estación Experimental Duquesa<br>Consejo Estatal de Azúcar (CEA) | Apartado Postal 235-9, Los Jardines<br>Santo Domingo<br>República Dominicana | Tel: (1-809) 533-1161; 533-2565<br>Fax: (1-809) 533-4822 |
| **French Guiana** | | |
| CIRAD - Guyane | BP 701<br>Kourou – Cedex 97387<br>French Guiana | Tel: (594) 327-350<br>Fax: (594) 327-351<br>Web site: www.cirad.fr |

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| INRA - Groupe Régional de Guyane | BP 709<br>Kourou—Cedex 97387<br>French Guiana | Tel: (594) 329-300<br>Fax: (594) 322-318<br>Web site: www.inra.fr |
| IRD - Centre en Cayenne | IBP 165<br>Cayenne—Cedex 97323<br>French Guiana | Tel: (594) 299-261; 302-785<br>Fax: (594) 319-855<br>E-mail: postmaster@cayenne.orstom.fr<br>Web site: www.cayenne.ird.fr |
| **Grenada** | | |
| Agronomy Division; Pest Management Division; Veterinary and Livestock Division; Produce Chemist Laboratory<br>Ministry of Agriculture, Lands, Forestry and Fisheries | Mt. Wheldale<br>St. George's<br>Grenada | Tel: (1-473) 440 2708; 440 3708<br>Fax: (1-473) 440 4191 |
| CARDI - Grenada Unit | PO Box 270<br>St. Georges<br>Grenada | Tel: (1-473) 443-5459<br>Fax: (1-473) 443-2939<br>E-mail: cardignd@caribsurf.com<br>Web site: www.cardi.org |
| French Agricultural Mission<br>p/a Ministry of Agriculture | Mt. Helicon<br>St. George's<br>Grenada | Tel: (1-473) 440-5710 |
| Agricultural Technical Mission of Taiwan | PO Box 740<br>St. George's<br>Grenada | Tel: (1-473) 440-2391<br>Fax: (1-473) 440-6405<br>E-mail: atm@caribsurf.com |
| Technical Department<br>Grenada Cocoa Association | Mt. Horne<br>St. Andrew's<br>Grenada | Tel: (1-473) 442-7757; 442-7216<br>Fax: (1-473) 440-1470 |
| Technical Unit<br>Grenada Cooperative Nutmeg Association | The Carenage<br>St George's<br>Grenada | Tel: (1-473) 440-2312 |
| **Guadeloupe** | | |
| CIRAD - Guadeloupe | BP 2386<br>Jarry – Cedex 97002<br>Guadeloupe | Tel: (590) 252-490; 863-021<br>Fax: (590) 252-492<br>Web site: www.cirad.fr |
| INRA - Centre Antilles-Guyane | BP 1232<br>Pointe-a-Pitre – Cedex 97185<br>Guadeloupe | Tel: (590) 255-900; 942-040<br>Fax: (590) 255-924<br>Web site: www.inra.fr |
| **Guyana** | | |
| Guyana Forestry Commission | Guyana | |
| National Agricultural Research Institute<br>Ministry of Agriculture | Mon Repos<br>Guyana | Tel: (592) 202841; 202249<br>Fax: (592) 204481<br>E-mail: nari@guyana.net.gy |
| Agricultural Division<br>Institute of Applied Science and Technology | PO Box 101050<br>Georgetown<br>Guyana | Tel: (592) 253922 |
| CARDI - Guyana Unit | Carnegie Building, University of Guyana Campus<br>Turkeyen<br>Guyana | Tel: (592) 224430 /31<br>Fax: (592) 224433<br>E-mail: cardigeo@guyana.net.gy<br>Web site: www.cardi.org |
| Faculty of Agriculture<br>University of Guyana | PO Box 101110<br>Georgetown<br>Guyana | Tel: (592) 254841<br>Fax: (592) 254885 |
| Burma Rice Research Station<br>Guyana Rice Development Board | 117 Cowan Street<br>Georgetown<br>Guyana | Tel: (592) 212646<br>Fax: (592) 256486<br>E-mail: grdb@gol.net.gy |
| Agricultural Research Centre<br>Guyana Sugar Corporation | LBI Estate Compound, East Coast Demerara<br>Georgetown<br>Guyana | Tel: (592) 273940; 266171 |

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| **Haiti** | | |
| Centre de la Recherche et Documentation Agronomique<br>Ministère de l'Agriculture et Ressources Naturelles | Haiti | |
| Service de Ressources Forestales<br>Division de Ressources Naturelles<br>Ministère de l'Agriculture et Ressources Naturelles | Haiti | |
| Faculté d'Agronomie et Médecine Vétérinaire<br>Université d'État d'Haiti | BP 1441<br>Port-au-Prince<br>Haiti | Tel: (509) 222-4592; 222-4781<br>E-mail: famv@ht.refer.org<br>Web site: www.ht.refer.org/haiti_ct/edu/ueh/agro/agro.htm |
| Faculté d'Agriculture et les Environs<br>Université Quisqueya | BP 796<br>Port-au-Prince<br>Haiti | Tel: (509) 229-103; 229-902<br>Fax: (509) 237-430 |
| Faculté d'Agriculture<br>Université Roi Henri Christophe | BP 98<br>Cap Haïtien<br>Haiti | Tel: (509) 21316 |
| **Jamaica** | | |
| Fisheries Division<br>Ministry of Agriculture | PO Box 470, General Post Office<br>Kingston 13<br>Jamaica | Tel: (1-876) 923-8811; 923-7571 |
| Agricultural Research and Development Division<br>Department of Science, Technology and Research<br>Ministry of Agriculture | PO Box 480<br>Kingston 6<br>Jamaica | Tel: (1-876) 927-1263; 974-4714 |
| Scientific Research Council<br>Ministry of Commerce and Technology | P.O. Box 350<br>Kingston 6<br>Jamaica | Tel: (1-876) 927-1771; 977-2189 to 91<br>Fax: (1-876) 927-1990<br>E-mail: adminsrc@cwjamaica.com<br>Web site: www.src-jamaica.org |
| Food Technology Institute<br>Scientific Research Council | P.O. Box 350<br>Kingston 6<br>Jamaica | Tel: (1-876) 927-1771<br>Fax: (1-876) 977-2194<br>E-mail: fti@uwimona.edu.jm<br>Web site: www.src-jamaica.org/ |
| Food Storage and Prevention of Infestation Division<br>Ministry of Commerce and Technology | 15 Gordon Town Road<br>Kingston 6<br>Jamaica | Tel: (1-876) 927-1929; 927-6816 to 20<br>Fax: (1-876) 977-7515<br>E-mail: fspid@cwjamaica.com<br>Web site: www.mct.goc.jm/fspid/ |
| CARDI - Jamaica Unit | P.O. Box 113<br>Kingston 7<br>Jamaica | Tel: (1-876) 927-1231; 977-4140<br>Fax: (1-876) 927- 2099<br>E-mail: cardi2@cwjamaica.com<br>Web site: www.cardi.org |
| Discovery Bay Marine Laboratory<br>University of the West Indies | Discovery Bay<br>St. Ann<br>Jamaica | Tel: (809) 973-2241<br>Fax: (809) 973-3091<br>E-mail: postmaster@uwimona.edu<br>Web site: http://uwimona.edu.jm/ |
| Department of Life Sciences<br>Faculty of Pure and Applied Sciences<br>University of the West Indies | Mona Campus, Mona<br>Kingston 7<br>Jamaica | Tel: (1-876) 927-1661<br>Fax: (1-876) 927-2765<br>E-mail: postmaster@uwimona.edu<br>Web site: www.uwimona.edu.jm/ |
| Centre for Environment and Development<br>University of the West Indies | 3 Gibraltar Camp Road<br>Kingston 7<br>Jamaica | Tel: (1-876) 977-1659; 927-1660-9<br>Fax: (1-876) 977-1658<br>E-mail: postmaster@uwimona.edu<br>Web site: www.uwimona.edu.jm/ |

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| Biotechnology Centre<br>University of the West Indies | Mona Campus, Mona<br>Kingston 7<br>Jamaica | Tel: (1-876) 977-1828; 935-8520<br>Fax: (1-876) 977-3331<br>E-mail: postmaster@uwimona.edu<br>Web site: www.uwimona.edu.jm/ |
| Centre for Marine Sciences<br>University of the West Indies | Mona Campus, Mona<br>Kingston 7<br>Jamaica | Tel: (1-876) 977-1609; 935-8276<br>Fax: (1-876) 927-1033<br>E-mail: postmaster@uwimona.edu<br>Web site: www.uwimona.edu.jm/ |
| Master Blend Feeds R&D Department<br>Jamaica Broilers' Group Limited | P.O. Box 24<br>Old Harbour, St.<br>Jamaica | Tel: (1-876) 983-2305; 983-2306<br>Fax: (1-876) 983-9241<br>E-mail: fhanley@cwjamaica.com |
| Tropical Research Station<br>Pioneer Hi-Bred International Inc. | P.O. Box 197<br>Kingston 11<br>Jamaica | Tel: (1-876) 984-3234<br>Fax: (1-876) 907-1994<br>Web site: www.pioneer.com/ |
| Research Department<br>Banana Board | 10 South Avenue, Kingston Gardens<br>Kingston 4<br>Jamaica | Tel: (1-876) 922-2083; 5347 |
| Citrus Growers' Association Ltd | Bog Walk<br>Jamaica | Tel: (1-876) 708-2050/4; 985-1065; 985-1357 |
| Research and Extension Division<br>Cocoa Industry Board | PO Box 68<br>Kingston 15<br>Jamaica | Tel: (1-867) 923-6411/3; 923-3059 |
| Research Unit<br>Coconut Industry Board | PO Box 204<br>Kingston<br>Jamaica | Tel: (1-876) 926-1770 |
| Coffee Industry Board | PO Box 508<br>Kingston<br>Jamaica | Tel: (1-876) 923-5850<br>Fax: (1-876) 923-7587<br>E-mail: coffeeboard@jamaicancoffee.gov.jm<br>Web site: www.jamaicancoffee.gov.jm |
| Sugar Industry Research Institute<br>Sugar Industry Authority | Kendal Road<br>Mandeville<br>Jamaica | Tel: (1-876) 962-2241<br>Fax: (1-876) 962-1288 |
| Tobacco Industry Central Authority | Jamaica | |
| **Martinique** | | |
| CIRAD - Martinique | BP 153<br>Fort de France—Cedex 97202<br>Martinique | Tel: (596) 719-201; 511-705<br>Fax: (596) 600-924<br>Web site: www.cirad.fr |
| IRD - Centre Martinique | BP 8006<br>Fort de France—Cedex 97259<br>Martinique | Tel: (596) 702-872<br>Fax: (596) 717-316<br>E-mail: lordinot@outremer.com<br>Web site: www.ird.fr |
| **Montserrat** | | |
| CARDI - Montserrat Unit | PO Box 272<br>Plymouth<br>Montserrat | Tel: (1-664) 491-4499<br>Fax: (1-664) 491-4485<br>Web site: www.cardi.org |
| **Netherlands Antilles** | | |
| Stichting Promotie van Landbouw in de Nederlandse Antillen | Netherlands Antilles | |
| Caribisch Maritiem Biologisch Instituut<br>Stichting Carmabi | PO Box 2090<br>Netherlands Antilles | Tel: (599) 9624-242<br>Fax: (599) 9627-680<br>E-mail: carmabi@ibm.net<br>Web site:<br>www.tnc.org/infield/intprograms/cdc.html |
| **Puerto Rico (USA)** | | |
| Tropical Agriculture Research Station<br>Agricultural Research Service<br>United States Department of Agriculture | 2200 Avenue Pedro Albizu-Campos, Suite 201<br>Mayagüez, PR 00680-5470<br>USA | Tel: (1-787) 831-3435<br>Fax: (1-787) 831-3386<br>Web site: www.ars-grin.gov/ars/SoAtlantic/Mayaguez/maya |

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| International Institute of Tropical Forestry<br>Forestry Service<br>United States Department of Agriculture | PO Box 25000<br>Rio Piedras, PR 00928-2500<br>USA | Tel: (1-787) 766-5335<br>Fax: (1-787) 250-6924<br>Web site: www.fs.fed.us/global/iitf/ |
| Estación Experimental Agrícola<br>Colegio de Ciencias Agrícolas<br>Universidad de Puerto Rico | PO Box 9030<br>Mayagüez, PR 00681-9030<br>USA | Tel: (1-787) 832-4040; 265-3850<br>Fax: (1-787) 265-0860<br>Web site: www.upr.clu.edu |
| Department of Marine Sciences<br>College of Arts and Sciences<br>University of Puerto Rico | PO Box 9013<br>Mayagüez, PR 00681-9013<br>USA | Tel: (1-787) 265-3838<br>Fax: (1-787) 265-5408<br>E-mail: cima@136.145.165.24<br>Web site: http://rmocfis.upr.clu.edu/~cima/ |
| Puerto Rico Water Resources Research Institute<br>Engineering College<br>University of Puerto Rico | P.O. Box 9040<br>Mayagüez, PR 00681-9040<br>USA | Tel: (1-787) 265 - 3826<br>Fax: (1-787) 832 – 0119<br>E-mail: WRRI_RUM@rumac.upr.clu.edu<br>Web site: http://exodo.upr.clu.edu/rumhp/prwrri/ |
| **St. Kitts-Nevis** | | |
| Crop Research Unit<br>Department of Agriculture<br>Ministry of Agriculture | PO Box 39<br>Basseterre<br>St. Kitts-Nevis | Tel: (1-869) 465-2335; 2521<br>Fax: (1-869) 465-5202<br>E-mail: doastk@caribsurf.com |
| CARDI - St.Kitts Unit | P.O. Box 479<br>Basseterre<br>St. Kitts-Nevis | Tel: (1-869) 465-2846; 465-1498<br>Fax: (1-869) 465-3285<br>E-mail: cardiskn@caribsurf.com<br>Web site: www.cardi.org/ |
| Agricultural Technical Mission of Taiwan | PO Box 113<br>Basseterre<br>St. Kitts-Nevis | Tel: (1-869) 465-2372<br>Fax: (1-869) 465-4356<br>E-mail: catmkits@caribsurf.com |
| Agronomy and Research Department<br>St. Kitts Sugar Manufacturing Corporation | PO Box 96<br>Brasseterre<br>St. Kitts-Nevis | Tel: (1-869) 465-2337<br>Fax: (1-869) 465-1059 |
| **St. Lucia** | | |
| Research and Development Division<br>Department of Agriculture<br>Ministry of Agriculture, Land, Fisheries and Cooperatives | Waterfront, NIS Building, Block A, fifth floor<br>Castires<br>St. Lucia | Tel: (1-758) 452-2526<br>Fax: (1-758) 453-6314<br>E-mail: moaffl@candw.lc (min) |
| CARDI - St.Lucia Unit | P.O. Box 971<br>Castries<br>St. Lucia | Tel: (1-758) 452-4160; 453-3317<br>Fax: (1-758) 453-3495<br>E-mail: cardi@candw.lc<br>Web site: www.cardi.org/ |
| French Mission for Cooperation<br>French Embassy | Vigie Box 937<br>Castries<br>St. Lucia | Tel: (1-758) 452-3988; 5697<br>Fax: (1-758) 453-1572 |
| Technical Services<br>Windward Islands Banana Development and Exporting Company Limited (WIBDECO) | Castries<br>St. Lucia | Tel: (1-758) 452-2411; 2561; 2563<br>Fax: (1-758) 453-1638; 451-4601<br>E-mail: wibdeco@candw.lc |
| **St. Vincent & the Grenadines** | | |
| Fisheries Division<br>Ministry of Agriculture, Industry and Labour | St. Vincent & the Grenadines | Tel: (1-784) 456-2738<br>Fax: (1-784) 457-2112<br>E-mail: fishdiv@caribsurf.com<br>Web site: http://www.vincy.com/fisheries/ |
| Research and Development Unit<br>Ministry of Agriculture, Industry and Labour | Richmond Hill<br>Kingstown<br>St. Vincent & the Grenadines | Tel: (1-784) 456-1410<br>Fax: (1-784) 457-1688 |
| Reef and Pelagic Fishes Regional Assessment Centre<br>CARICOM Fisheries Resource Assessment and Management Program | Tyrell Street<br>Kingstown<br>St. Vincent and the Grenadines | Tel: (809) 457 1904<br>Fax: (809) 457 2414<br>Web site: www.caricom-fisheries.com/ |

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| CARDI - St. Vincent Unit | PO Box 594<br>Kingstown<br>St. Vincent & the Grenadines | Tel: (1-784) 457-1535<br>Fax: (1-784) 456-2420<br>E-mail: cardisvj@caribsurf.com<br>Web site: www.cardi.org/ |
| French Agricultural Mission | PO Box 560<br>Kingstown<br>St. Vincent & the Grenadines | Tel: (1-784) 457-2357<br>Fax: (1-784) 457-2357<br>E-mail: frog@caribsurf.com |
| Agricultural Technical Mission of Taiwan | PO Box 21<br>Kingstown<br>St. Vincent & the Grenadines | Tel: (1-784) 458-7447<br>Fax: (1-784) 456-7387<br>E-mail: svgcatm@caribsurf.com |
| **Surinam** | | |
| Landbouwproefstation<br>Ministerie van Landbouw, Veeteelt and Visserij | PO Box 1807<br>Paramaribo<br>Surinam | Tel: (597) 472-442<br>Fax: (597) 470-301<br>E-mail: min.lvv@sr.net |
| Stichting Experimentele Landbouwbedrijven<br>Ministerie van Landbouw, Veeteelt and Visserij | Schietbaanweg 75<br>Paramaribo<br>Surinam | Tel: (597) 477-041 |
| Stichting Proeftuinen in Suriname<br>Ministerie van Landbouw, Veeteelt and Visserij | PO Box 160<br>Paramaribo<br>Surinam | Tel: (597) 470-143<br>E-mail: gerda@sr.net |
| Stichting Landbouwkundige Ontwikkeling in Commewijne<br>Ministerie van Landbouw, Veeteelt and Visserij | Tamanredjo Km 20<br>District Commewijne<br>Surinam | Tel: (597) 803-096 |
| Palmen Onderzoekscentrum<br>Directoraat voor Agronomie en Tuinbouw<br>Ministerie van Landbouw, Veeteelt and Visserij | PO Box 1807<br>Paramaribo<br>Surinam | Tel: (597) 425-022<br>Fax: (597) 470-301 |
| Afdeling Visserijonderzoek en Statistiek<br>Departement van Visserij<br>Ministerie van Landbouw, Veeteelt and Visserij | Anton Dragsenweg<br>Paramaribo<br>Surinam | Tel: (597) 477-641<br>Fax: (597) 477-641 |
| Departement van Veehouderij<br>Ministerie van Landbouw, Veeteelt and Visserij | Abattoirstraat; Beekhuizen<br>Paramaribo<br>Surinam | Tel: (597) 402-329<br>Fax: (597) 404-407<br>E-mail: veeteelt@cq-link.sr |
| Onderzoeksafdeling / Station voor Toegepast Onderzoek naar Rijst<br>Stichting Machinale Landbouw (SML)<br>Ministerie van Landbouw, Veeteelt and Visserij | Hoofdweg 1<br>Wageningen<br>Surinam | Tel: (597) 233-111<br>Fax: (597) 233-000 |
| Kweekafdeling / Rijstonderzoek- en Teeltstation<br>Stichting Machinale Landbouw (SML)<br>Ministerie van Landbouw, Veeteelt and Visserij | Hoofdweg 1<br>Wageningen<br>Surinam | Tel: (597) 233-111<br>Fax: (597) 233-000 |
| Anne van Dijk Rijst Onderzoekscentrum Nickerie<br>Stichting Nationaal Rijstonderzoeks Instituut<br>Ministerie van Landbouw, Veeteelt and Visserij | Letitia Vriesdelaan<br>Paramaribo<br>Surinam | Tel: (597) 804-535<br>Fax: (597) 804-575<br>E-mail: adron@sr.net<br>Web site:<br>www.cgiar.org/isnar/hostes/ADRON/adron.htm |
| Dienst 's Lands Bosbeheer<br>Ministerie van Natuurlijke Hulpbronnen en Energie | Cornelis Jongbawstraat 10-12<br>Paramaribo<br>Surinam | Tel: (597) 476-118<br>Fax: (597) 410-256 |
| Centrum voor Landbouwkundig Onderzoek in Suriname<br>Anton de Kom Universiteit van Suriname | P.O. Box 1914<br>Paramaribo<br>Surinam | Tel: (597) 490-889<br>Fax: (597) 498-069 |
| Subrichting voor Agrarische Productie<br>Faculteit der Technologische Wetenschappen<br>Anton de Kom Universiteit van Suriname | P.O. Box 9212<br>Paramaribo<br>Surinam | Tel: (597) 465-558<br>Fax: (597) 462-291 |
| SURLAND Banana Company | Surinam | |

| Trinidad & Tobago | | |
|---|---|---|
| Caribbean Industrial Research Institute of T&T | c/o Tunapuna Post Office<br>St. Augustine<br>Trinidad & Tobago | Tel: (1-868) 662-7161; 662 7171/72 /73<br>Fax: (1-868) 662 7177<br>E-mail: cariri@trinidad.net<br>Web site: www.cariri.com/ |
| Institute of Marine Affairs | PO Box 3160<br>Carenage<br>Trinidad & Tobago | Tel: (1-868) 634-4291<br>Fax: (1-868) 634-4433<br>E-mail: infocentre@ima.gov.tt or ima.carib@link.net<br>Web site: www.unesco.org/ioc/states/trinidad/ima.html |
| Research Division / Central Experiment Station<br>Ministry of Agriculture, Land and Marine Resources | Arima P.O.<br>Centeno<br>Trinidad & Tobago | Tel: (1-868) 646-4334<br>Fax: (1-868) 646-1646 |
| Forestry Division<br>Ministry of Agriculture, Land and Marine Resources | Long Circular Road<br>St. James<br>Trinidad & Tobago | Tel: (1-868) 662-4521; 662-3217<br>Fax: (1-868) 628-5503 |
| Marine Fisheries Analysis Unit, Fisheries Division<br>Ministry of Agriculture, Land and Marine Resources | St. Clair Circle<br>St. Clair<br>Trinidad & Tobago | Tel: (1-868) 634-4504; 634-4505<br>Fax: (1-868) 634-4488<br>E-mail: mfau2fd@tstt.net.tt |
| Caribbean Agricultural Research and Development Institute - Headquarters and T&T Unit | PO Box 212<br>St. Augustine<br>Trinidad & Tobago | Tel: (1-868) 645-1205; 645-1209<br>Fax: (1-868) 645-1208<br>E-mail: infocentre@cardi.org or executive@cardi.org or ttcardi@cardi.org<br>Web site: www.cardi.org/ |
| T&T Field Office<br>CARICOM Fisheries Unit | P.O. Box 3150<br>Carenage<br>Trinidad & Tobago | Tel: (1-868) 634-4528<br>Fax: (1-868) 634-4549<br>E-mail: tphilips@wow.net or renton@tstt.net.tt<br>Web site: www.caricom-fisheries.com/ |
| CABI Bioscience - Caribbean and Latin American Centre<br>Commonwealth Agricultural Bureaux International | Gordon Street<br>Curepe<br>Trinidad & Tobago | Tel: (1-868) 662-4173<br>Fax:(1-868) 663-2859<br>E-mail: cabi-bio@carib-link.net |
| Veterinary Diagnostic Laboratory<br>Animal Production and Health Division<br>Ministry of Agriculture, Land and Marine Resources | Building 49; School of Veterinary Medicine<br>Eric Williams Medical Sciences Complex<br>Champs Fleurs<br>Trinidad & Tobago | Tel: (1-868) 662-5678<br>Fax: (1-868) 645-4593 |
| School of Veterinary Medicine<br>Faculty of Medical Sciences<br>University of the West Indies | Eric Williams Medical Sciences Complex<br>Champs Fleurs<br>Trinidad & Tobago | Tel: (1-868) 645-2640<br>Fax: (1-868) 645-7428 |
| School of Natural Sciences<br>Faculty of Agriculture and Natural Sciences<br>University of the West Indies | St. Augustine<br>Trinidad & Tobago | Tel: (1-868) 662-2002; 645-3162<br>Fax: (1-868) 645-7132<br>Web site: www.uwi.tt/ |
| School of Agriculture<br>Faculty of Agriculture and Natural Sciences<br>University of the West Indies | St. Augustine<br>Trinidad & Tobago | Tel: (1-868) 662-2002; 663-1334<br>Fax:(1-868) 663-9686<br>Web site: www.uwi.tt/ |
| Cocoa Research Unit<br>University of the West Indies | St. Augustine<br>Trinidad & Tobago | Tel: (1-868) 662-8788; 662-4996 ext.2155<br>Fax: (1-868) 662-8788<br>E-mail: cru@cablenett.net<br>Web site: www.uwi.tt/ |
| Caroni Sugarcane Feeds Centre<br>Caroni (1975) Ltd | Trinidad & Tobago | |
| Caroni Research Station<br>Caroni (1975) Ltd | Waterloo Road<br>Carapichaima<br>Trinidad & Tobago | Tel: (1-868) 673-0027; 673-0028<br>Fax: (1-868) 673-0373<br>E-mail: research@tstt.net.tt |

| US Virgin Islands | | |
|---|---|---|
| Germplasm Introduction and Research Unit<br>Agricultural Research Service<br>United States Department of Agriculture | P.O. Box 3008<br>Kingshill<br>St. Croix, VI 00851-3008<br>USA | Tel: (1-340) 778-1312<br>Fax: (1-340) 778-2986 |
| Agricultural Experiment Station<br>University of the Virgin Islands | RR-02, Box 10,000<br>Kingshill<br>St. Croix, VI 00851<br>USA | Tel: (1-340) 692-4020<br>Fax: (1-340) 692-4035<br>Web site: http://rps.uvi.edu/AES/aes_home.html |
| The William P. MacLean Marine Science Center<br>University of the Virgin Islands | 2 John Brewers Bay<br>St. Thomas, VI 00802<br>USA | Tel: (1-809) 693-1381<br>Fax: (1-809) 693-1385<br>E-mail: jbattey@uvi.edu<br>Web site: www.uvi.edu/MarSci/index.html |
| Water Resources Research Institute<br>University of the Virgin Islands | PO Box 9990<br>St. Thomas, VI 00802-9990<br>USA | Tel: (1-340) 693-1020<br>Fax: (1-340) 693-1025<br>E-mail: hsmith@uvi.edu<br>Web site: http://rps.uvi.edu/WRRI/wrri.htm |
| Eastern Caribbean Center<br>University of the Virgin Islands | PO Box 9990<br>St. Thomas, VI 00802-9990<br>USA | Tel: (1-340) 693-1020<br>Fax: (1-340) 693-1025<br>E-mail: postmaster@uvi.edu<br>Web site: http://manta.uvi.edu/ECC |

# Annex 4. Institutional overview of agricultural research organizations in the Caribbean

| Country/Category [a] | Supervising agency | Department / Institute | Research focus [b] | Researched items [c] | Res. staff [d] |
|---|---|---|---|---|---|
| **Antigua and Barbuda** | | | | | |
| Government-local | Ministry of Agriculture, Fisheries and Lands | Research Division | crops, livestock | cotton, fruit, vegetables, small ruminants, cattle | 2.0 |
| | | Fisheries Division | fishery | | 1.0 |
| Government-regional | CARDI | Antigua Unit | crops, livestock | vegetables, small ruminants | 4.0 |
| **Aruba (NL)** | | | | | |
| Government-local | Ministry of Economic Affairs and Tourism | Department of Agriculture, Husbandry and Fisheries | crops, livestock, fisheries, NRM | dryland agriculture, horticulture, small ruminants, pigs, marine resources | 1.0 |
| **Bahamas** | | | | | |
| Government-local | Ministry of Agriculture, Trade and Industry | Department of Agriculture-Gladstone road Agricultural Complex | crops, livestock, post-harvest | vegetables, bananas, fruit, root crops, pigs, animal health, small ruminants | 16.0 |
| | | Department of Fisheries | fishery | | 1.0 |
| | Office of the Prime Minister | Department of Lands and Surveys, Forestry Section | forestry | | 0.2 |
| Government-bilateral | Govt. of Taiwan | Agricultural Technical Mission | crops, livestock, fishery | vegetables, ornamentals, pigs, shrimps | 8.0 |
| **Barbados** | | | | | |
| Government-local | Ministry of Agriculture, Food and Fisheries | Technical Division | crops, livestock, NRM | cotton, vegetables, ornamentals, fruit, root crops, small ruminants, cattle | 26.0 |
| Government-regional | CARDI | Barbados Unit | crops, livestock | vegetables, ornamentals, root crops, sugar cane, small ruminants, cattle, poultry | 5.0 |
| Higher education | University of the West Indies | Faculty of Science and Technology, Department of Biological and Chemical Sciences | crops | | 1.9 |
| | | Centre for Resource Management and Environmental Studies | NRM | | 6.0 |
| | McGill University (Canada) | Bellairs Research Institute | fishery, NRM | | 0.0 |
| Business enterprises-nonprofit | Sugar Association of the West Indies | West Indies Central Sugar Cane Breeding Station | crops | sugar cane | 5.0 |
| Business enterprises-public | Barbados Agricultural Management Company Ltd. | Sugar Technology Research Unit | post-harvest | sugar products | 1.0 |
| | | Agronomic Research and Variety Testing Unit | crops | sugar cane | 3.0 |
| **Belize** | | | | | |
| Government-local | Ministry of Agriculture, Fisheries and Cooperatives | Central Farm Agricultural Research Station | crops | vegetables, rice, roots crops, cattle, pigs | 2.7 |

| Country/Category [a] | Supervising agency | Department / Institute | Research focus [b] | Researched items [c] | Res. staff [d] |
|---|---|---|---|---|---|
| Government-regional | CARDI | Belize Unit | crops | rice, other | 2.0 |
| | CARICOM | CARICOM Fisheries Unit | fisheries | | 9.0 |
| Government-bilateral | Govt. of Taiwan | Agricultural Technical Mission | | | na |
| Higher education | University College of Belize | Marine Research Centre | fishery, NRM | | 0.5 |
| | Ministry of Agriculture, Fisheries and Cooperatives | Belize College of Agriculture | | | 0.0 |
| Business enterprises-nonprofit | Belize Citrus Growers Association | Citrus Research and Education Institute | crops | citrus fruit | 4.2 |
| Business enterprises-private | Belize Sugar Industries Ltd (BelSIL) | Research Centre for Sugar Cane | crops, post-harvest | sugar cane | 2.0 |
| | Belize Agri-Business Company (BABCO) | Research Program | crops, post-harvest | fruit | 3.0 |
| **British Virgin Islands** | | | | | |
| Government-regional | CARDI | BVI Unit | crops, livestock | vegetables, fruit, small ruminants | 1.0 |
| **Cuba** | | | | | |
| Government-local | Ministerio de la Agricultura | Centro de Investigaciones para el Mejoramiento Animal | livestock | | |
| | | Empresa Cubana de Productos Veterinarios | livestock | animal health | |
| | | Empresa Pecuaria Genética 'Los Naranjos' | livestock | | |
| | | Grupo de Reproducción Acelerada de la Papa | crops | potatoes | |
| | | Instituto de Investigaciones Avícolas | livestock | poultry | |
| | | Instituto de Investigaciones de Pastos y Forrajes 'Indio Hatuey' | crops | animal feed | |
| | | Instituto de Investigaciones de Sanidad Vegetal | crops | plant protection | |
| | | Instituto de Investigaciones de Viandas Tropicales 'Fructuoso Rodríguez' | crops | roots and tubers | |
| | | Instituto de Investigaciones del Arroz | crops | rice | |
| | | Instituto de Investigaciones del Tobaco | crops | tobacco | |
| | | Instituto de Investigaciones en Cítricos y Frutales | crops | (citrus) fruits | |
| | | Instituto de Investigaciones en Mecanización Agropecuaria | other | agricultural mechanization | |
| | | Instituto de Investigaciones en Riego y Drenaje | other | irrigation and drainage | |
| | | Instituto de Investigaciones Forestales | forestry | | |
| | | Instituto de Investigaciones Fundamentales en Agricultura Tropical 'Alejandro de Humboldt' | crops | | |
| | | Instituto de Investigaciones Hortícolas 'Liliana Dimitrova' | crops | horticulture | |

| Country/Category [a] | Supervising agency | Department / Institute | Research focus [b] | Researched items [c] | Res. staff [d] |
|---|---|---|---|---|---|
| | | Instituto de Investigaciones Porcinas | livestock | pigs | |
| | | Instituto de Suelos y Fertilizantes | NRM | soils, fertilizer | |
| | | Laboratorio de Investigaciones de la Nutrición y Zootecnia Aviar | livestock | animal feed | |
| | | Laboratorio de Investigaciones y Diagnóstico Avícola | livestock | poultry | |
| | Ministerio del Azúcar | Centro para el Desarrollo Integrado de la Caña de Azúcar | crops | sugar cane | |
| | | Centro de Semillas e Investigaciones de Caña de Azúcar | crops | sugar cane | |
| | | Instituto Cubano de Investigaciones Azucareras | post-harvest | sugar products | |
| | | Instituto Cubano de Investigaciones de los Derivados de la Caña de Azúcar | post-harvest | sugar products | |
| | | Instituto Nacional de Investigaciones de la Caña de Azúcar | crops | sugar cane | |
| | | Instituto Tecnológico de la Caña de Azúcar 'Carlos M. de Cespedes' | crops | sugar cane | |
| | | La Unión de Investigación Producción de la Celulosa del Bagazo, Cuba 9 | post-harvest | | |
| | Ministerio de Pesca | Centro de Investigaciones Pesqueras | fishery | | |
| | Ministerio de Alimentos | Instituto de Investigaciones de la Indústria Alimenticia | post-harvest | | |
| | Ministerio de Ciencia, Tecnología y Medio Ambiente | Centro de Biotecnología Vegetal | crops | biotechnology | |
| | | Centro de Desarrollo Científico de Montañas | other | | |
| | | Centro de Ingeniería Genética y Biotecnología | crops | biotechnology | |
| | | Instituto de Ecología y Sistemática | NRM | | |
| | | Instituto de Investigaciones Agrícolas 'Jorge Dimitrov' | | | |
| | | Instituto de Oceanología | fishery, NRM | | |
| | | Instituto Nacional de Recursos Hidráulicos | NRM | | |
| Higher education | Ministerio de Educación Superior | Centro Nacional de Investigaciones Científicas | biotechnology, NRM | | |
| | Instituto Superior de Ciencias Agropecuarias de la Habana | Centro Nacional de Sanidad Agropecuaria | livestock; NRM | veterinary and human medicine, integrated pest management, biological control, diagnostics | |
| | | Instituto Nacional de Ciencias Agrícolas | crops | | |
| | | Instituto de Ciencia Animal | livestock | | |
| | | Facultad de Agronomía | crops | | |

| Country/Category [a] | Supervising agency | Department / Institute | Research focus [b] | Researched items [c] | Res. staff [d] |
|---|---|---|---|---|---|
| | | Facultad de Medicina Veterinaria | livestock | animal health | |
| | | Facultad de Mecanización de la Producción Agropecuaria | other | agricultural mechanization | |
| | | Sede Universitaria del Instituto de Ciencias Agropecuarias de La Habana – Facultad de Agropecuaria | agriculture | | |
| | Centro Universitario de Guantánamo | Facultad de Montaña de Sabaneta | other | | |
| | Centro Universitario de Las Tunas | Departamento de Agronomía | crops | | |
| | Universidad Central de Las Villas | Facultad de Ciencias Agropecuarias | crops, livestock | | |
| | | Instituto de Biotecnología de las Plantas | crops | biotechnology | |
| | | Sede Universitaria de la UCLV 'José Martí' - Facultad de Agropecuaria | crops, livestock | | |
| | Universidad de Camagüey | Centro de Estudios para el Desarrollo de la Producción Animal | livestock | | |
| | | Facultad de Medicina Veterinaria | livestock | animal health | |
| | Universidad de Ciego de Avila | Facultad de Agronomía | crops | | |
| | | Facultad de Mecanización de la Producción Agropecuaria | other | agricultural mechanization | |
| | | Centro de Bioplantas | crops | biotechnology | |
| | Universidad de Granma | Facultad de Ciencias Agrícolas | crops, livestock | | |
| | | Facultad de Veterinaria | livestock | animal health | |
| | Universidad de la Habana | Centro de Investigaciones Marinas | fishery, NRM | | |
| | | Facultad de Biología | crops, livestock, NRM | | |
| | | Facultad de Farmacia y Alimentos | other | | |
| | | Jardín Botánico Nacional | other | | |
| | Universidad de Matanzas 'Camilo Cienfuegos' | Facultad de Agronomía | crops | | |
| | Universidad de Pinar del Río 'Hermanos Saíz' | Facultad de Agronomía y Forestal | crops, forestry | | |
| **Dominica** | | | | | |
| Government-regional | CARDI | Dominica Unit | crops, post-harvest | root crops, fruit, vegetables, ornamentals | 5.0 |
| Government-bilateral | Govt. of Taiwan | Agricultural Technical Mission | crops, fishery | fruit, vegetables | 5.0 |
| | Govt. of France | French Technical Cooperation | crops, livestock, NRM, post-harvest | fruit, vegetables, ornamentals, pigs, small ruminants | 1.0 |
| **Dominican Republic** | | | | | |
| Government-local | Secretaria de Estado de Agricultura - Departamento de Investigaciones Agropecuarias | Centro Nordeste de Desarrollo Tecnológico Agropecuario | crops, post-harvest | cacao, other | 13.0 |
| | | Centro de Servicios para el Desarrollo Agropecuario | crops | fruit, vegetables, bananas, root crops | 38.0 |

| Country/Category [a] | Supervising agency | Department / Institute | Research focus [b] | Researched items [c] | Res. staff [d] |
|---|---|---|---|---|---|
| | | Centro Nacional de Investigaciones Pecuarias | livestock | animal feed | 6.0 |
| | | Centro de Investigaciones Aplicadas a Zonas Aridas | crops | bananas, vegetables, root crops, fruit | 9.0 |
| | | Centro de Investigaciones Agrícolas del Sudoeste | crops | | 12.0 |
| | | Centro de Investigaciones Arroceras | crops | rice | 18.0 |
| | | Centro Nacional de Tecnología Apropiada | other | agricultural mechanization | 3.0 |
| | | Centro Nacional de Biotecnología Vegetal | crops | biotechnology | 1.0 |
| | | Estación Experimental Hortícola de Constanza | crops | horticulture | 2.0 |
| | Secretaria de Estado de Agricultura - Departamento del Tabaco | Instituto del Tabaco | crops | tobacco | 3.0 |
| | Secretaria de Estado de Agricultura - Departamento del Café | Estación Cafetalera "La Cumbre" | crops | coffee | 3.0 |
| | NA | Instituto Nacional de Recursos Hidráulicos | NRM | water | 2.0 |
| | Banco Central de la República Dominicana | Instituto Dominicano de Tecnología Industrial – Servicios de Investigación y Desarrollo | fishery, post-harvest | | 12.0 |
| Higher education | Universidad Autónoma de Santo Domingo | Facultad de Ciencias Agronómicas y Veterinarias | crops, livestock | animal health | 17.0 |
| | | Facultad de Ciencias - Centro de Investigaciones de Biología Marina | fishery, NRM | | 14.0 |
| | NA | Instituto Superior de Agricultura | crops, livestock, forestry, NRM | vegetables, rice, bananas, poultry, cattle, small ruminants, pigs | 6.0 |
| | Universidad Nacional 'Pedro Henriquez Urena' | Facultad de Ciencias Agropecuarias y Recursos Naturales | crops, livestock, NRM | fruit, vegetables, ornamentals, cattle, small ruminants, poultry | 2.0 |
| | Universidad Nordestrana | Facultad de Agricultura | | | na |
| | Universidad Eugenio María de Hostos | Escuela de Medicinas Veterinarias | livestock | animal health | na |
| | NA | Instituto Agronómico Salesiano | crops | | na |
| | NA | Colegio Agrícola San Ignacio de Loyola | crops | | na |
| | NA | Instituto Politécnico Loyola | crops | bananas, vegetables | 3.0 |
| Business enterprises-public | Consejo Estatal del Azúcar | División / Estación Experimental Duquesa | crops | sugar cane | 0.0 |
| Business enterprises-private | Central Romana Corporation | Departamento de Investigaciones Agrícolas | crops | sugar cane | 14.0 |
| **French Guiana (France)** | | | | | |
| Government-bilateral | CIRAD | Guyane Centre | crops, livestock, forestry | rice, cacao, coffee, fruit, animal feed | 30.0 |
| | INRA | Centre Antilles-Guyana – Unité de Recherches Forestières | forestry | | 5.0 |
| | IRD | Centre à Cayenne | NRM | | 34.4 |
| **Grenada** | | | | | |

| Country/Category [a] | Supervising agency | Department / Institute | Research focus [b] | Researched items [c] | Res. staff [d] |
|---|---|---|---|---|---|
| Government-local | Ministry of Agriculture, Lands, Forestry and Fisheries | No specific research units, research activities spread over various divisions | | | 0.5 |
| Government-regional | CARDI | Grenada Unit | crops, other | fruit, vegetables | 4.0 |
| Government-bilateral | Govt. of France | French Agricultural Mission | | | na |
| | Govt. of Taiwan | Agricultural Technical Mission | crops | fruit, vegetables, ornamentals | 2.5 |
| Business enterprises-nonprofit | Grenada Cooperative Nutmeg Association | Technical Unit | crops | nutmeg | na |
| | Grenada Cocoa Association | Technical Department | crops | cocoa | 0.5 |
| **Guadeloupe (France)** | | | | | |
| Government-bilateral | CIRAD | Centre Guadeloupe | crops, livestock | sugar cane, bananas, fruit, animal health | 38.0 |
| | INRA | Centre Antilles-Guyana | crops, livestock, NRM, post-harvest | vegetables, root crops, fruit, cattle, small ruminants, pigs | 59.2 |
| **Guyana** | | | | | |
| Government-local | Ministry of Agriculture | National Agricultural Research Institute | crops, livestock, NRM, post-harvest | root crops, fruit, vegetables, bananas, cattle, small ruminants, poultry | 32.0 |
| | Office of the President | Institute of Applied Science and Technology | | | na |
| | NA | Guyana Forestry Commission | forestry | | 3.0 |
| Government-regional | CARDI | Guyana Unit | crops, livestock, NRM | rice, fruit, other, cattle, small ruminants | 8.0 |
| Higher education | University of Guyana | Faculty of Agriculture | | | 6.0 |
| Business enterprises-nonprofit | Guyana Rice Development Board | Burma Rice Research Station | crops | rice | 14.0 |
| Business enterprises | Guyana Sugar Corporation | Agricultural Research Center | crops | sugar | 17.5 |
| | Livestock Development Company | | livestock | | na |
| **Haiti [e]** | | | | | |
| Government-local | Ministère de l'Agriculture et Ressources Naturelles | Centre de la Recherche et Documentation Agronomique | other | | |
| | | Division de Ressources Naturelles, Service de Ressources Forestales | forestry | | |
| | Organisation de Développement de la Plaine du Nord | | | | |
| | Organisation de Développement de la Vallée de l'Arbonite | | | | |
| | Projet de Développement Régional Intègre de l'Asille | | | | |
| | Organisation de Développement de la Plaine des Gonaives | | | | |
| Higher education | Université d'État d'Haïti | Faculté d'Agronomie et Médecine Vétérinaire | crops, livestock | animal health | |
| | Université Quisqueya | Faculté d'Agriculture et les Environs | crops, livestock, NRM | | |
| | Université Roi Henri Christophe | Faculté d'Agriculture | | | |

| Country/Category [a] | Supervising agency | Department / Institute | Research focus [b] | Researched items [c] | Res. staff [d] |
|---|---|---|---|---|---|
| **Jamaica** | | | | | |
| Government-local | Ministry of Agriculture, Department of Science, Technology and Research | Agricultural Research and Development Division | | | 22.0 |
| | Ministry of Commerce and Technology | Food Storage and Prevention of Infestation Division | other | | 1.0 |
| | | Scientific Research Council (incl. Food Technology Institute) | post-harvest | | 15.3 |
| Government-regional | CARDI | Jamaica Unit | crops, livestock, NRM | coffee, small ruminants | 9.0 |
| Higher education | University of the West Indies | Faculty of Pure and Applied Sciences, Department of Life Sciences | crops, forestry, fishery, NRM | root crops, vegetables, ornamentals | 12.5 |
| | | Centre of Biotechnology | crops | biotechnology | 3.5 |
| | | Centre of Marine Sciences | fishery, NRM | | na |
| | | Centre for Environment and Development | NRM | | na |
| Business enterprises-nonprofit | Banana Board | Research Department | crops | banana | 4.0 |
| | Cocoa Industry Board | Research and Extension Division | crops | cocoa | 3.0 |
| | Coconut Industry Board | Research Unit | crops | coconut | 4.0 |
| | Coffee Industry Board | (subcontracts research) | crops | coffee | 0.0 |
| | Sugar Industry Authority | Sugar Industry Research Institute | crops, post-harvest | sugar cane | 13.0 |
| | Tobacco Industry Central Authority | NA | crops | tobacco | 1.0 |
| | Citrus Growers Association Limited | NA | crops | citrus | 2.0 |
| Business enterprises-private | Pioneer Hi-Bred International Inc. | Tropical Research Station | crops | maize | 1.0 |
| | Jamaica Broilers Group Ltd | Master Blend Feeds R&D Department | livestock | animal feed | 3.0 |
| | Alcan Jamaica Company | NA | livestock | dairy | 2.0 |
| **Martinique (France)** | | | | | |
| Government-bilateral | CIRAD | CIRAD – Martinique | crops | bananas, fruit, vegetables, ornamentals | 27.0 |
| | IRD | Centre en Martinique | NRM | | 5.0 |
| **Montserrat (UK)** | | | | | |
| Government-regional | CARDI | Montserrat Unit | | | 0.0 |
| **Netherlands Antilles (NL)** | | | | | |
| Government-local | Caribbean Marine Biological Institute Foundation | | fishery, NRM | | 0.0 |
| | Foundation for the Promotion of Agriculture in the Netherlands Antilles | | | | 0.0 |
| **Puerto Rico (US)** | | | | | |
| Government-bilateral | Agricultural Research Service, USDA | Tropical Agriculture Research Station | crops | fruit, other | 9.0 |
| | Forestry Service, USDA | International Institute of Tropical Forestry | forestry | | na |
| Higher education | University of Puerto Rico | College of Agricultural Sciences and State Agricultural Experiment Station | crops, livestock | fruit, vegetables, bananas, coffee, sugar cane, rice, ornamentals, cattle, pigs, poultry | 45.1 |

| Country/Category [a] | Supervising agency | Department / Institute | Research focus [b] | Researched items [c] | Res. staff [d] |
|---|---|---|---|---|---|
| | | College of Arts and Sciences: Department of Marine Sciences | fishery, NRM | | 13.0 |
| | | Engineering College: Puerto Rico Water Resources Research Institute | NRM | water | 2.0 |
| **St. Kitts-Nevis** | | | | | |
| Government-local | Ministry of Agriculture | Crops Research Unit, Department of Agriculture | crops | vegetables, root crops | 2.0 |
| Government-regional | CARDI | St. Kitts Unit | crops | vegetables, root crops | 1.0 |
| Government-bilateral | Govt. of France | French Technical Mission | | | na |
| | Govt. of Taiwan | Agricultural Technical Mission | crops | rice, vegetables | 1.0 |
| Business enterprises | St. Kitts Sugar Manufacturing Corporation | Agronomy and Research Department | crops, post-harvest | sugar cane | 1.0 |
| **St. Lucia** | | | | | |
| Government-local | Ministry of Agriculture, Land, Fisheries and Cooperatives | Research and Development Division, Department of Agriculture | | | na |
| Government-regional | CARDI | St. Lucia Unit | crops, livestock | vegetables, fruit, root crops, bananas, small ruminants | 2.0 |
| Government-bilateral | Govt. of France | French Mission for Cooperation | | | na |
| | Govt. of Taiwan | Agricultural Technical Mission (closed in 1999) | | | na |
| Business enterprises-public/private | Windward Islands Banana Development and Exporting Company Ltd | Technical Services Division | crops | bananas | 5.0 |
| **St. Vincent and the Grenadines** | | | | | |
| Government-local | Ministry of Agriculture, Industry and Labour | Research and Development Unit | | | 2.0 |
| | | Fisheries Division | fishery | | 0.0 |
| Government-regional | CARDI | St. Vincent Unit | | | 1.0 |
| | CARICOM Fisheries Unit | Regional Assessment Centre | fishery, NRM | | |
| Government-bilateral | Govt. of France | French Agricultural Mission | crops, fisheries, NRM, post-harvest | vegetables | 3.0 |
| | Govt. of Taiwan | Agricultural Technical Mission | crops, livestock | fruit, vegetables, ornamentals, pigs | 8.0 |
| **Suriname** | | | | | |
| Government-local | Ministry of Agriculture, Livestock and Fisheries | Agronomy and Horticulture Department: Agricultural Experiment Station | crops | fruit, vegetables | 5.0 |
| | | Agronomy and Horticulture Department: Palm Research Center | crops | coconut | 1.0 |
| | | Livestock Department | livestock | cattle | 1.0 |
| | | Fisheries Department: Section Fisheries Research and Statistics | fisheries | | 1.0 |
| | Ministry of Natural Resources and Energy | National Forest Service | forestry | | na |
| | Foundation for Rice Research in Suriname | Rice Research Center “Anne van Dijk” | crops | rice | 2.0 |

| Country/Category [a] | Supervising agency | Department / Institute | Research focus [b] | Researched items [c] | Res. staff [d] |
|---|---|---|---|---|---|
| | Foundation for the Mechanization of Agriculture | Rice Research and Breeding Station | crops | rice | 1.0 |
| | | Station for Applied Rice Research | crops | rice | 1.0 |
| Higher education | University of Suriname | Department of Agriculture, Faculty of Technological Sciences | crops | vegetables | 1.5 |
| | | Center for Agricultural Research in Suriname | crops, forestry | | 1.0 |
| **Trinidad and Tobago** | | | | | |
| Government-local | Ministry of Agriculture, Land and Marine Resources | Research Division | crops, livestock, post-harvest | vegetables, ornamentals, rice, fruit, cacao, coffee, root crops, cattle, pigs | 60.0 |
| | | Animal Production and Health Division: Veterinary Diagnostic Laboratory | livestock | animal health | 0.0 |
| | | Forestry Division | forestry | | 2.0 |
| | | Fisheries Division: Marine Fisheries Analysis Unit | fishery | | 8.0 |
| | Ministry of Finance | Caribbean Industrial Research Institute | post-harvest, other | agricultural mechanization | 17.0 |
| | Office of the Prime Minister | Institute of Marine Affairs | fishery, NRM | | 37.0 |
| Government-regional | CARDI | T&T Unit | crops, livestock | vegetables, ornamentals, small ruminants | 7.0 |
| | CARICOM Fisheries Unit | T&T Field Office | fishery, NRM | | na |

*Sources*: Questionnaire returns and various reports listed in annex 5.

[a] Research organizations have been classified into three major institutional categories: government, higher education, and business enterprises. Government agencies have been further differentiated into local, bilateral, and regional government agencies. Research agencies owned and financed by business enterprises have been differentiated according to public or private ownership, while research agencies operating on the collective behalf of a particular industry have been classified as business enterprises- nonprofit.

[b] The following broad research focus categories have been used: crops, livestock, forestry, fishery, NRM, post-harvest, and other.

[c] Covers only crop and livestock research.

[d] Measured in terms of full-time equivalent researchers.

[e] Incomplete listing.

# Annex 5. Data sources for agricultural research expenditure and staffing data

In addition to data obtained through our survey (source code 2000), we consulted and used a large number of other sources. Only references from which we actually used data are listed. The source codes correspond with the source codes reported in the electronic data files.


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