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Acronyms

ACM Association of Caribbean Media Workers
ACP African, Caribbean and Pacific Group of States
AEZ Agro-Ecological Zone
AFNC Agriculture, Food and Nutrition Cluster of CARICOM
AI Artificial Insemination
APP Agriculture Policy Programme
ASTT Agricultural Society of Trinidad and Tobago
BAM Banana Accompanying Measures
BRCC Building Regional Climate Capacity in the Caribbean
BSD Black Sigatoka Disease
CABA Caribbean Agribusiness Association
CaFAN Caribbean Farmers Network
CAHPSA Caribbean Agricultural Health and Food Safety Agency
CARDI Caribbean Agricultural Research and Development Institute
CARICOM Caribbean Community
CARIFORUM The Forum of the Caribbean Group of African, Caribbean and Pacific (ACP) States
CDB Caribbean Development Bank
CFC Common Fund for Commodities
CFCS Caribbean Food Crops Society
CIF Cost, Insurance and Freight
CIMH Caribbean Institute for Meteorology and Hydrology
CLAYUCA Latin American and Caribbean Consortium to Support Cassava Research and Development
COTED Council for Trade and Economic Development of CARICOM
CPDN Caribbean Pest Diagnostic Network
CPhDF Caribbean Plant Health Directors’ Forum
CARDI Representative
CRC Cocoa Research Centre
CTA Technical Centre for Agricultural and Rural Cooperation
CTV Citrus Tristeza Virus
CWA Caribbean Week of Agriculture
CXC Caribbean Examinations Council
DOA Department of Agriculture
ECB Eastern Caribbean Dollar
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>ED</td>
<td>Executive Director</td>
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<td>EDF</td>
<td>European Development Fund</td>
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<td>EMBRAPA</td>
<td>Brazilian Agricultural Research Corporation</td>
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<td>EU</td>
<td>European Union</td>
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<td>EWISACTs</td>
<td>Early Warning Information Systems Across Timescales</td>
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<td>EWS</td>
<td>Early Warning System</td>
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<tr>
<td>F2F</td>
<td>Face to Face</td>
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<td>FAO</td>
<td>Food and Agricultural Organization of the United Nations</td>
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<td>FFS</td>
<td>Farmer Field School</td>
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<td>GAP</td>
<td>Good Agricultural Practices</td>
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<td>GIFT</td>
<td>Green Intensive Farming Technologies</td>
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<td>GMP</td>
<td>Good Manufacturing Practices</td>
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<td>HACCP</td>
<td>Hazard Analysis and Critical Control Point</td>
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<td>HPAI</td>
<td>Highly Pathogenic Avian Influenza</td>
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<td>ICT</td>
<td>Information and Communications Technology</td>
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<td>IDB</td>
<td>Inter-American Development Bank</td>
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<td>IDIF</td>
<td>Dominican Institute of Agriculture and Forestry</td>
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<td>IDM</td>
<td>Integrated Disease Management</td>
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<td>IFDC</td>
<td>International Fertilizer Development Center</td>
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<td>IICA</td>
<td>Inter-American Institute for Cooperation on Agriculture</td>
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<td>INIFAP</td>
<td>National Institute for Forestry, Agriculture and Livestock Research</td>
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<td>IPCC</td>
<td>Inter-Governmental Panel on Climate Change</td>
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<td>IPM</td>
<td>Integrated Pest Management</td>
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<td>ITC</td>
<td>International Trade Centre</td>
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<td>MICAf</td>
<td>Ministry of Industry, Commerce, Agriculture</td>
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<td>MOE</td>
<td>Multiple Ovulation Embryo Transfer</td>
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<td>MOU</td>
<td>Memorandum of Understanding</td>
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<td>NEFO</td>
<td>North Eastern Farmers Organisation</td>
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<td>NSF</td>
<td>National Stakeholder Platforms</td>
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<td>OECS</td>
<td>Organization of Eastern Caribbean States</td>
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<td>PA</td>
<td>Protected Agriculture</td>
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<td>PCJ</td>
<td>Petroleum Corporation of Jamaica</td>
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<td>PICSA</td>
<td>Participatory Integrated Climate Services for Agriculture</td>
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<td>PPRC</td>
<td>Pilot Programme for Climate Resilience</td>
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<td>R4D</td>
<td>Research for Development</td>
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<td>SAI</td>
<td>Standardized Audit Instrument</td>
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<td>SFC</td>
<td>Sugarcane Feeds Centre</td>
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<td>SMDTC</td>
<td>Sam Motta Demonstration and Training Centre</td>
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<td>SPC</td>
<td>Pacific Community (Secretariat)</td>
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<td>SPS</td>
<td>Sanitary and Phytosanitary</td>
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<td>SRC</td>
<td>Scientific Research Council</td>
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<tr>
<td>TGRHRD</td>
<td>Thematic Group for Research and Human Resource Development</td>
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<td>USAID</td>
<td>United States Agency for International Development</td>
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<tr>
<td>UTT</td>
<td>University of Trinidad and Tobago</td>
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<tr>
<td>UWI</td>
<td>The University of the West Indies</td>
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<td>WMO</td>
<td>World Meteorological Organization</td>
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<td>WUR</td>
<td>Wageningen University and Research Centre</td>
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Overview

The year 2016 was significant for CARDI. During the year, eight of the 14 projects that formed the backbone of the Institute’s programme of work were concluded. The year also marked the end of the 2014 - 2016 Medium Term Plan (MTP 2014-2016). Then, sadly, 2016 will also be remembered by the Management and Staff of CARDI as when one of its long-serving and stalwart scientists passed away. Mr Anil Kumar Sinha, CARDI Country Representative in Belize passed away on 26 February 2016. The Institute has paid a tribute to him in the first of three boxes in this report and it also wishes to dedicate the contents of this report to his memory, especially for his contribution to the success of two of the projects, namely, the “Caribbean Action under the 10th EDF Intra-ACP Agriculture Policy Programme” (APP Project) and “Improving Caribbean Food Security in the Context of Climate Change” (10th EDF Food Security Project).

There were 12 other projects that, together with the APP Project and the 10th EDF Food Security Project, constituted the bulk of the programme of work in 2016. These other projects were, “Establishment of Demonstration Pilot Plots and carrying out Training of Farmers in support of the initiative ‘Integrated Development of Cassava in the Caribbean’ (FAO Cassava Project)”, Diversification of the Caribbean Livestock Sector through the Production of Small Ruminants (CFC-CDB Small Ruminant Project), Development of Technological Packages for Selected Commodities in St Lucia (BAM St Lucia Tech Packs Project); The Conduct of Value Chain Analysis for Fruits and Vegetables and Livestock in St Vincent and the Grenadines (BAM SVG Value Chain Project); Value Chain Analysis for Specified Crop and Livestock Commodities (BAM St Lucia Value Chain Project), Assessment of the production of co-products and by-products of the conversion of the castor beans to biodiesel (PCJ Biofuels Project).

The rest of the projects, which will continue into 2017, are Repositioning the Coconut Industry within nine Caribbean countries for resuscitation and sustainable development (EU-ACP Coconut Project), Caribbean Regional Small Ruminant’s Industry Technical Support Project (New Zealand Small Ruminant Project), Adapting Clonally Propagated Crops to Climatic and Commercial Changes (SPC Taro Project), Development of an Integrated Disease Management Programme for Black Sigatoka (CDB BSD Project), the investment
plan for the Caribbean Track of the Pilot Programme for Climate Resilience (PPCR) and sundry projects under the Cooperative Programme between the Inter-American Institute for Cooperation on Agriculture (IICA) and CARDI (IICA/CARDI Cooperative Programme).

The resources from these projects, together with the core funds from the Member States (Antigua and Barbuda, The Bahamas, Barbados, Belize, Cayman Islands, Dominica, Grenada, Guyana, Jamaica, Montserrat, St Kitts and Nevis, St Lucia, St Vincent & the Grenadines (SVG) and Trinidad and Tobago), financed the 2016 programme of work.

It was noted above that 2016 marked the end of the MTP 2014-2016 but just like the prior two years, the 2016 programme of work was steered by the Vision, "The Centre of Excellence in the Caribbean conducting research for development that creates wealth and competitiveness in the Region’s agriculture", Mission, "To contribute to the sustainable development of Caribbean people by the generation, transfer and application of appropriate technologies through agricultural research for development" and Core Values, "Integrity, professionalism and excellence in everything we do" of the Institute.

The MTP 2014-2016 was structured around three Strategic Axes; Developing Sustainable Industries, Building Strategic Linkages and Institutional Strengthening. Throughout the duration of the plan, the programme of work focused on the development of sustainable industries for selected commodities of regional importance - roots and tubers, cereals and grain legumes, herbs and spices, coconut and small ruminants – and emerging and re-emerging thematic areas such as protected agriculture, plant and animal genetic resources, agro-energy, invasive species and climate change.

Highlights of report

We present below the major highlights of the achievements and outcomes of the 2016 programme of work. We draw attention to the extensive contents of the sections of the report on climate change and capacity building in stakeholders. These resulted from a large output from the APP Project.

The best varieties of cassava selected for intensification in Grenada, Guyana and Jamaica were MCol 1468, Red Stem and Rockwood, respectively.

The time for mechanised operations for cassava production was lower than for manual operations. However, yields were lower for the mechanised operation than the manual operation because there were more plants missing in the field and higher root breakage at harvesting for the mechanised fields than the fields under manual operations. We concluded that high operator competence and efficiency would be critical to achieving the intended benefits of mechanisation.

The demonstration of the effectiveness of walk-behind tractors across the Region produced a very positive response from the participants and the expression of interest to acquire one. However, the initial cost (approximately US$10,000 for the tractor and two implements) appeared to be a deterrent.

CARDI Belize demonstrated to small farmers in Belize that the CARDI selected open-pollinated corn variety, NB-6 could be a better replacement for their local variety Antonio.

In the Cayman Islands, the Institute also produced results to show that when the Cayman Seasoning Pepper was spaced 0.6 m (2 ft) between rows (BR) and 0.3 m (1 ft) within rows (WR) yields, and therefore, income would be five times higher than the traditional farmer practice of 1.2 m (4 ft) BR and 0.6 m (2 ft) WR.

For the EU-ACP funded Coconut Project implemented by CARDI and ITC, four technical bulletins on intercropping, animal production systems, coconut genetic resources, and coconut production technology were produced and disseminated across the project countries and also uploaded to the project’s website.
Between the CARDI Units in Barbados, Jamaica and Trinidad and Tobago, approximately 4,500 mulberry plants were distributed to farmers to plant as a feed source for their sheep and goats. Furthermore, the Barbados CARDI Unit demonstrated that pelleted feed made from mulberry and sweet potato and cassava by-products produced similar liveweight gains in sheep as the commercial feed.

The contracts for the bids won for value chain analyses in Dominica, St Lucia and St Vincent and the Grenadines were successfully executed. Key outputs for each country included reports on the value chain analysis and 20 stakeholders in each country trained on how to conduct value chain analysis.

The APP Project provided the opportunity for CARDI in collaboration with the University of the West Indies (UWI) Engineering Department to introduce into the Region new Protected Agriculture (PA) technologies featuring energy-efficient underground cooling system, solar powering and precision plant nutrition system under the umbrella of Green Intensive Farming Technologies (GIFT).

In Nevis, the PA system established last year was used to demonstrate Good Agricultural Practices (GAP) to produce sweet peppers. Approximately 3,000 kgs (6,500 lbs) sweet peppers were produced and marketed to high-end hotels and supermarkets in Nevis.

The taro accessions from the Pacific genetic material selected last year in St Lucia and St Vincent and the Grenadines underwent phenotypical evaluation for climate resilience. This work led to the identification of four accessions, BL/PNG/09, CE/IND/24, BL/SM/83 and BL/SM149 that showed drought tolerance.

In Dominica and Jamaica, farmers were involved in the evaluation of taro (Dominica) and sweet potato (Jamaica) varieties for climate resilience. At the end of the trials, and to promote the use of quality planting materials using GAP, 4,500 taro suckers (Dominica) and 1,000 tissue-cultured, weaned and hardened sweet potato plantlets (Jamaica) were provided to the farmers to plant on their farms.

In the Cayman Islands, we produced 870 g (31 ozs) of pure, clean virus-free seeds of the Cayman Seasoning Pepper for the Department of Agriculture (DOA) to produce seedlings which will be sold to farmers. This seed will provide more than 151,000 high-quality seedlings.

For quality animal breeding stock, 124 quality breeding stock was distributed in Jamaica and Trinidad and Tobago under the CFC-CDB Small Ruminant Project.

In 2015 in Jamaica, a follow-up work to assess the effectiveness of co-products and by-products from the conversion of castor beans to biodiesel (castor wood, castor cake and castor shell for use as biochar, vermicomposting and soil ameliorant) was started. From the studies, we concluded that castor wood is suitable for the production of biochar. As a substrate for vermi-composting, it was found that castor cake and goat manure mixture was an effective substrate. Castor wood biochar in combination with castor/goat manure vermi-compost gave highest crop produce.

In Dominica, Guyana, St Lucia and St Vincent and the Grenadines, Black Sigatoka Disease tolerant banana and plantain varieties obtained from international Musa spp. centres have been evaluated. The results indicated that all the FHIA varieties, especially the FHIA 03 (banana) and FHIA 21 (plantain) varieties performed better than the local Cavendish variety. We also observed the effects of agro-ecological zones; plants tended to take longer to bunch at high altitude than at low altitude.

In August 2015, Tropical Storm Erika disrupted the food production capacity of two farming communities in Dominica, the Colihaut and Coulibistrie communities. We bulked cereals and grain legumes seeds (yellow corn and Red Kidney bean) at our CARDI Belize Unit. In 2016 the seeds (90 kgs [200 lbs] of yellow corn and 360 kgs (800 lbs) of Red Kidney bean) were shipped to the CARDI Dominica Unit and donated to the Minister for Agriculture and the Environment, Mr Johnson Drigo who handed them over to the two farming communities.

The studies on the drought tolerance of food crops completed by CARDI during 2015 and 2016 have identified several varieties across the Region, which taken together would offer appreciable resources for resilient food production in the face of a changing climate. The varieties included corn - Pioneer P3523, Pioneer P4082W, CARDI YC-001 and NB-6 and sweet potato – 94/7, Carrot, Chicken Foot, Mandela, N3, Nina, O49, TIS 9191 and Uplifta. Some of these have been placed in ex situ conservation for short- and medium-term rejuvenation of planting material for farmers. However, for the long term the Institute would have to consider conserving, particularly the sweet potato varieties, in tissue culture.
This year, because several projects ended a greater part of the Institute’s programme of work, was focused on knowledge sharing through training and the dissemination of results from the projects, especially the APP Project. We improved the skills and knowledge of approximately 2,100 stakeholders in the development of sustainable industries for the selected commodities and of the key and emerging thematic areas. These included 1,050 farmers, 80 students, 150 extension officers and 820 agricultural professionals and technicians.

We also reflect in this report on the Institute’s systems that make it a unique institution in the Caribbean to lead the agricultural research for development agenda that contributes towards the attainment of the Region’s food and nutrition security. Our new filing system is fully implemented. We invested in a second internet service provider for Headquarters to improve communication within the Institute. The APP Project in particular but also the EU-ACP Coconut Project and the CFC-CDB Small Ruminant Project assisted immensely to improve the infrastructure both on the CARDI field stations and in the offices. We received walk-behind tractors, assorted field operations and seed production and processing equipment and tools, refurbished goat housing for breeding stock, computer hardware and software, multimedia projectors and screens, professional binocular microscope and professional camera, as well as a server to boost our network capacity.

In 2016, 42 CARDI personnel improved their knowledge and skills in technological areas relevant to the Institute’s programme of work. We delivered unique services like biometric services and literature search services to our stakeholders and promoted the “Brand CARDI” through Face to Face (F2F) interactions, Traditional Media and Web-enabled Tools mechanisms.

During the year, we expanded our partnership portfolio with new Memorandum of Understanding (MOU) with the UWI to support the development of ICT tools and a Letter of Cooperation Agreement among Caribbean Farmers Network (CaFAN), IICA and CARDI to provide quality germplasm for roots and tubers and hot pepper to the CaFAN members. And we signed the Instrument of Accession for the Bahamas to become the 14th Member State of CARDI.

The Institute generated net revenue of EC$68,332 internally to supplement the subventions from Member States and project resources from funding agencies and institutions.

Farewell – Tribute to Mr Anil Kumar Sinha

30 August 1950 – 26 February 2016
Mr Anil Sinha, CARDI Country Representative to Belize passed away on 26 February 2016 after almost 35 years of dedicated and unflinching service to CARDI and the regional agriculture sector.

Anil Kumar Sinha was born in India and after graduating from Udaipur University he migrated to Guyana in 1976, where he began working as an entomologist with the Ministry of Agriculture. In 1982 he joined the CARDI Guyana team as a Technical Officer. At the behest of his then supervisor and mentor Dr B. K. Rai he was subsequently transferred to the CARDI Belize Unit in 1983 as an agricultural scientist. In 1989, he was appointed the CARDI Country Representative to Belize, a position he held until his passing on 26 February 2016.

During his sojourn at CARDI, Anil worked tirelessly to raise the profile of agriculture and CARDI in Guyana and later in Belize, his adopted home. Although he was a trained entomologist/pathologist, Anil’s name, however, will always echo along with the breeding and development of cereals and grain legumes. His sustained pioneering research work in this area not only led to the development of new commercial varieties suited for the Caribbean conditions but more importantly contributed to Belize’s self-sufficiency in the production of these commodities. Today the country is a net exporter to the CARICOM Region.

Anil developed into a “total agriculturalist” and was often consulted for his expertise and advice on issues relating to agriculture and natural resource management, which he gave willingly and effortlessly. He represented CARDI with distinction on various national and technical advisory boards. Up until his passing, he was the Chairman of the Pesticide Control Board, Belize.

Over the 30 years of service, he mentored quite a few researchers and technicians and produced more than 40 technical publications.

His unstinting contribution to agricultural research and development was recognised by the Institute in 2009 when he was awarded the Chairman’s Award of Excellence.

Anil adored his family. He spoke proudly and tenderly of his children and more recently of his grandchildren too. Our thoughts and sympathies are with his wife Nita and their sons, his extended family and staff at the Belize Unit.

CARDI and the Region have lost a person of exemplary qualities, an eminent researcher, a diligent and humble colleague. Anil will be missed.

May he rest in eternal peace.
Sustaining Industries for Selected Commodities of Regional Importance

The 2014-2016 MTP reflected the core mandate of CARDI, as articulated from Member States and through regional positions and policies, to lead in research to improve the production and productivity of selected non-traditional and some traditional re-emerging commodities towards the development of sustainable industries for these commodities. The selected commodities are roots and tubers, cereals and grain legumes, herbs and spices, coconuts and small ruminants.

The objective is to contribute to the Region’s food and nutrition security, the ability to meet local and, especially export demands, to assist in the reduction of the Region’s food import bill, and to facilitate in wealth creation and competitiveness in the Region’s agriculture.

Developing the Roots and Tubers Industry

Roots and tubers continue to be the principal group of non-traditional commodities in the Region for their contribution to food and nutrition security and also as non-traditional export crops.

Cassava

The FAO cassava project titled, “Establishment of Demonstration Pilot Plots and carrying out Training of Farmers in support of the initiative ‘Integrated Development of Cassava in the Caribbean’” (FAO Cassava Project), in Grenada, Guyana and Jamaica was completed during the year.

The objectives of the project were to, (i) identify in Grenada, Guyana and Jamaica cassava varieties suitable for intensification, (ii) use the CARDI Technical Bulletin, “Commercial Cassava Production - SK/001/10” as a guide to assess the productivity of the identified varieties at a small-scale farm level (0.4 ha (1 ac)), with or without applied biostimulants in Grenada and Guyana and at a large-scale farm level (2-3 ha (5-7.5 ac)) with mechanisation in Guyana and Jamaica, (iii) use the Farmer Field School (FFS) approach to train farmers and extension officers in the best practices of cassava production and (iv) produce factsheets along the production cycle of cassava for dissemination.
The biostimulant trials were conducted as replicated trials on plots 85 m² (102 yd²) with two cassava varieties and four biostimulant treatments. The treatments were, no biostimulant, Cytokin 2-1-6 (Cytokin), Bountiful (Bountiful), Agrispon (Grenada), and Evergreen (Guyana). The repeat trial in Grenada was supported by the EU-funded project, “Caribbean Action under the 10th EU Intra-ACP Agriculture Policy Programme” (APP Project).

The cassava varieties identified for intensification were Grenada, MCol 1468 (early maturing) and MCub 74, Guyana, Red Stem (early maturing), Uncle Mack and Bad Woman and Jamaica, Rockwood and CM489.

In Grenada, the marketable yield (kg/ha [lb/acre]) at the small-scale farm level for MCol 1468, the early maturing variety (20,772 [18,528]), was marginally higher than MCub (17,448 [15,564]). In Guyana for similar small-scale farm level, yields (kg/ha [lb/acre]) were Red Stem (early maturing) 18,360 [16,377], Uncle Mack 16,635 [14,838], Bad Woman 15,258 [13,610].

On average, the biostimulants increased productivity (kg [lb] per plot) over the no biostimulant in Grenada by 9% (177.8 vs. 162.4 [327.8 vs. 299.4]), but the increase by the application of Bountiful was 25% (202.6 vs. 162.4 [373.5 vs. 299.4]). The early maturing variety, Mcol 1468, responded, on average (220.1 vs. 176.6 [405.7 vs. 325.5]), by 25% increase in productivity with the application of Cytokin and Bountiful.

In Guyana, on average, the biostimulants increased productivity (kg [lb] per plot) over the no biostimulant by 40% (211.0 vs. 150.7 [239.2 vs. 189.4]), but Evergreen, the best biostimulant under Guyana conditions increased productivity by 75% (263.5 vs. 150.7 [485.7 vs. 277.8]). Here too, the early maturing variety, Red Stem, responded, in increased productivity by 68% (268.1 vs. 160.0 [494.2 vs. 294.9]), 15% (183.3 vs. 160.0 [337.9 vs. 294.9]), and 31% (209.1 vs. 160.0 [385.4 vs. 294.9]) for Evergreen, Bountiful and Cytokin, respectively.

At the large-scale farm level, in Jamaica, the Rockwood variety was more productive (kg/ha [lb/acre]) than the CM489 variety (26,819 vs. 21,238 [23,922 vs. 18,944]). On average, the marketable yields (kg/ha [lb/acre]) for the manual planting and harvesting compared with the mechanised planting and harvesting were higher by 27.4% in Guyana (16,857 vs. 13,228 [15,036 vs. 11,799]) and 35.5% in Jamaica (27,651 vs. 20,406 [24,665 vs. 18,202]). There were a relatively high number of missing plants because of 'missing' cuttings at plant sites for the mechanically-planted fields. Also, there was high root breakage due to incomplete uprooting with the mechanised harvesting. These shortcomings for the mechanised fields were attributable to insufficient experience in the operation of the planter and harvester.

There was an appreciable reduction in labour required for the completion of operations per hectare with the use of mechanised planting and harvesting. In Guyana, the number of man-days required for mechanical planting (3.2 man-days) of one hectare was 77% less than that required for planting the same area manually (22.2 man-days). In Jamaica, the corresponding time requirements were 5.7 man-days and 17.3 man-days, respectively, a reduction of 76%. With respect to harvesting, in Guyana, there was an 80% reduction in labour time required using the mechanical harvester (9.9 man-days) compared with 49.4 man-days harvesting manually. The corresponding scenario in Jamaica was 20.9% reduction for mechanical (50.9 man-days) versus manual (64.2 man-days) harvesting.

The training using the FFS approach completed in 2015 were reported in the CARDI Annual Report 2015. The training done in 2016 are reported here under the sections “Building Capacity in Farmers and Rural Agricultural Communities” and “Building Capacity of Regional Agricultural Professionals and Technicians”.

A dozen Factsheets on differing areas of cassava production, including two dedicated to medium-large scale mechanised production, were produced as the final output for the Food and Agriculture Organization of the United Nations (FAO) for subsequent distribution to and use by farmers.

**Sweet potato**

In the Cayman Islands, the CARDI Unit collected 20 local sweet potato varieties, established them in the field, characterised them based on leaf, vine and tuber attributes using international descriptors and produced a photo morphological catalogue for stakeholders.

Under the EU-funded APP Project, a demonstration of the use of drip irrigation to sustain sweet potato production during the dry season was set up in St Vincent and the Grenadines. In St Vincent and the
Grenadines, root and tuber crops production depends entirely on rainfall and, therefore, low yields are obtained during the dry season and, hence, this demonstration. Two adjacent plots, 334 m² (400 yd²) each were established with the sweet potato variety Beauregard, one with drip irrigation and the other without irrigation. Total fresh tuber yield on the irrigated plot, 320 kgs (704 lbs) per plot was approximately 35% higher than the non-irrigated plot, 237 kgs (521 lbs) per plot. It was concluded that in the predominantly dry areas where sweet potato is produced, irrigation when and where possible, should be practised during the dry season to sustain yields.

Nine (9) walk-behind tractors were procured under the APP Project for the CARDI Units in Antigua and Barbuda, Barbados, Dominica, Grenada, Jamaica, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines and Trinidad and Tobago to demonstrate improved productivity and production for roots and tubers crops, particularly sweet potato. Evaluation of the potential productivity improvement from the use of the tractor showed positive results. Time and motion exercises for tilling a piece of land using the walk-behind tractor versus manually using garden forks and hoes were conducted. For example, in Dominica, students of the Dominica State College took one-quarter of the time on the tractor compared to using forks and hoes, 1.4 min/m² (1.2 min/yd²) for the manual tilling. Similarly, in Grenada, a group of farmers tilling with the walk-behind tractor took four times (5 min/m² vs. 20 min/m²) longer with manual tilling. However, in St Lucia where the CARDI Technician who operated the tractor was trained and had the opportunity to practice on it prior to the demonstration the time taken to complete the tilling was eight times faster for the tractor (0.26 min/m² vs. (2.1 min/m²) for the manual tilling.

The response from the participants to the demonstrations was very positive and many expressed interest in acquiring one. However, the initial cost (approximately US$10,000 for the tractor and two implements) appeared to be a deterrent. It was suggested that perhaps farmers’ groups and institutions may approach donor agencies to procure one for them.

**Developing the Cereals and Grain Legumes Industry**

Corn (Zea mays L.) is one of the most cultivated crops by both large and small farmers in Belize. Small farmers, however, tend to depend on the local varieties from which they recoup seeds. CARDI has selected a corn variety, NB-6, with good yielding characteristics. It is also open-pollinated like the local varieties that farmers use. However, before NB-6 can be accepted in the small-holder farming communities its high yielding capabilities must be demonstrated to them. A demonstration/validation trial comparing NB-6 with the most popular local corn variety, Antonio, was therefore established on a farmer’s holding on 0.01 ha (0.25 acre) plots.

NB-6 matured 12 days earlier (108 vs. 120 days for Antonio). Average grain yield per plot (at 13% moisture level) for NB-6 (42.8 kgs [94.4 lbs]) was higher than that of Antonio (30.9 kgs [68.1 lbs]) by 38.5%. It was concluded that NB-6 has a great potential to be recommended to small farmers in Belize, and CARDI can also rejuvenate seeds for the farmers. The APP Project funded the demonstration/validation trial.

**Developing the Herbs and Spices**

Several studies by CARDI has shown that planting hot peppers at the optimum density increases production considerably. The Cayman Seasoning Pepper is unique to the Cayman Islands but it has not been subjected to many agronomic studies. Therefore, a field trial aimed at identifying the optimum planting density for the Cayman Seasoning Pepper was conducted by the CARDI Unit in the Cayman Islands.

The peppers were established at between row (BR) spacing of 0.6, 0.9 and 1.2 m (2, 3 and 4 ft) and within row spacing (WR) of 0.3 and 0.6 m (1 and 2 ft). The results were promising; they indicated that after...
five pickings, yields and, therefore, income were, on average, five times higher when the plants were spaced at 0.6 m BR x 0.3 m WR (2 ft BR x 1 ft WR) compared with the traditional farmer practice of 1.2 m BR x 0.6 m WR (4 ft BR x 2 ft WR). This trial was a collaboration between the CARDI Cayman Islands Unit and the Department of Agriculture (DOA), Cayman Islands.

Under the Memorandum of Understanding (MOU) signed between CARDI and Baron Foods Ltd. in 2015, the CARDI St Lucia Unit coordinated the production by the 25-member hot pepper cluster that supplied Baron Foods Ltd. with 2,300 kgs (5,000 lbs) of berries weekly during the production season.

Seasoning pepper density trial, Cayman Islands.

Other herbal crops

In Jamaica, a three year study was undertaken on the production and post-harvest practices of five herbal crops under the IICA-CARDI Cooperative Programme. The herbal crops were, blackmint (Mentha spicata, syn M. viridis), cerasee (Momordica charantia L.), lemon grass (Cymbopogon spp.), peppermint (Satureja vimeina) and sorrel (Hibiscus sabdariffa). The studies were completed in 2015 and the output, "Technical Manual of Agronomic and Post-harvest Practices of Five Herbal Crops" was published in 2016 and e-copies posted on CARDI and IICA websites.

Developing the Regional Coconut Industry

The full implementation of the European Union (EU) and the African, Caribbean and Pacific Group of States (ACP) funded project titled "Coconut Industry Development for the Caribbean" (EU-ACP Coconut Project) started this year. The International Trade Centre (ITC) is partnering with CARDI to implement the project in nine CARIFORUM countries (Belize, Dominica, Dominican Republic, Guyana, Jamaica, St Lucia, St Vincent and the Grenadines, Suriname and Trinidad and Tobago).

During the year, National Stakeholder Platforms (NSPs) were established to oversee the implementation of the project and the mapping and characterisation of producers and processors, which began at the latter part of 2015, were completed in the project countries. The NSPs offer an example of Public-Private Sector partnership for projects execution.

Also, the Biotechnologist attached to the project assessed coconut tissue culture laboratory facilities in Belize, Guyana, Jamaica, St Lucia, St Vincent and the Grenadines and Trinidad and Tobago and efforts were initiated to acquire coconut germplasm from Mexico.

Additionally, an Agribusiness Specialist was contracted to start developing investment profiles for key coconut products including water, oil and grated coconut meat.

Then, four technical bulletins on intercropping, animal production systems, coconut genetic resources, and coconut production technology were produced and dissemination across the project countries and also uploaded to the project’s website.

Across the Region, great efforts are being made to promote agriculture to the youth for them to move forward with and sustain the food and nutrition security of the Region. Emerging and re-emerging technologies such as the use of ICTs, high-end protected agriculture systems, drip irrigation, water harvesting and value-adding are being used to entice them into agriculture. However, at the production end, the unavailability of and the drudgery of labour remain a great deterrent to the involvement of the youth in agriculture. The mechanisation of the production process could be one way of addressing the labour issue.

Caribbean agriculture has involved mechanised production for several years, particularly for the traditional export crops and to a limited extent for the non-traditional crops such as cassava production. In the 1980s, CARDI, in collaboration with the Caribbean Agro Industries Limited (CAIL) researched, developed and disseminated mechanised cassava production using cassava planter and digger fabricated by CAIL.

More than three decades on, the current generation of young farmers and small farmers, in general, are mostly unaware of the technologies developed in the 1980s and, therefore, continue to use manual processes for cassava production.
During 2015-2016, the Institute revisited the mechanisation of cassava production, using funds from both the APP Project and the FAO Cassava Project. Tractor-drawn cassava planters and harvesters were procured for each CARDI Unit in Guyana and Jamaica to demonstrate, generally what is possible for the mechanisation of cassava production. Additionally, a walk-behind motorised tractor and land-tilling implements were acquired for each CARDI Unit. These were used to demonstrate to farmers groups the efficiencies and cost-saving for land preparation. Time and motion exercises showed that for the tractor-drawn implements, the time for the mechanised operations was 46%-77% lower than the manual operations (4.5 vs. 19.8 man-days for planting and 30.4 vs. 56.8 man-days for harvesting). However, yields were lower for the mechanised operation because there were more plants missing in the field and higher root breakage at harvesting for the mechanised fields than the fields under manual operations. These were attributable to insufficient experience in the operation of the planter and harvester. For the walk-behind tractor, time efficiency was 4-8 times better than manual tilling depending on the prior training and practice of the operator (0.26-3.2 times better than manual tilling depending on the prior training and practice of the operator (0.26-3.2 vs. 1.70-11.5 min/m2 [0.22-2.85 vs. 1.07-11.5 min/yd2]).

Developing the Small Ruminants Industry

The Institute’s efforts to lead the development of a sustainable small ruminants industry continued during the year utilising resources provided by three projects.

In Jamaica, a survey of farmer traditional knowledge and innovative practices conducted by the CARDI Jamaica Unit identified the botanicals, neem (Azadirachta indica), Aloe vera (Aloe vera), Moringa (Moringa oleifera) and garlic (Allium sativum) used by farmers as anthelmintic for small ruminants. Three repeat validation trials were, therefore, set up to compare their efficacy against that of the commercial anthelmintic, Benvet (albendazole). Results from the first trial indicated that neem was the most efficacious among the botanicals in maintaining the health and productivity of small ruminants. The percentage reduction in faecal egg count (a measure of worm burden) 21 days after the treatment was 94 ± 2 for Benvet and 64 ± 12 for neem. The faecal egg count increased for aloe vera (-58 ± 10), garlic (-58 ± 19) and moringa (-164 ± 56). The data was being analysed from second and third trials and the results will be available in 2017. The study was supported by the APP Project.

In Barbados, also through the APP Project, mulberry (Morus spp.) was promoted as the forage of choice for sheep production. More than 1,000 potted seedlings were produced and distributed to sheep farmers by the CARDI Unit in Barbados. Furthermore, a preliminary feeding trial of the mulberry-based feed (MBP) feed produced using project-acquired chipper shredder, hammer mill and the pelleting machine was conducted. Lambs were fed for 105 days on three feeds, 100% commercial feed, 20/80% (commercial/MBP) and 50/50% (commercial/MBP). The average daily liveweight gain for the MBP-based feeds, 20/80% (193.7 g [6.83 ozs]) and 50/50% (207.9 g [7.33 ozs]) was as good as the commercial feed (204.8 g [7.22 ozs]).

In Jamaica and Trinidad and Tobago through the CFC-CDB-funded project, “Diversification of the Caribbean Livestock Sector through the Production of Small Ruminants” (CFC-CDB Small Ruminant Project) the CARDI Units made available to 75 stakeholders approximately 3,500 plants of multi-purpose trees, 790 ruminants. The beneficiaries included farmers, extension and livestock officers and institutions. In addition, in Jamaica, 11 ha (27 acres) of predominantly Mulato II pastures and 2 ha (5 acres) of corn and sorghum fodder were established at the Hounslow and Bodles stations to provide superior quality forage for the breeding stock. Furthermore, 2 kgs (4.4 lbs) of Mulato II seeds and 10 kgs (22 lbs) Mombasa Guinea Grass seeds were delivered to the satellite farmers selected at the start of the project to be the producers of improved stock. Also, under the same project, a total of 89 animals were distributed as fatteners to farmers for meat production in the two project countries (Jamaica, 49 and Trinidad and Tobago, 40). The CARDI-CFC-CDB Small Ruminant Project is among those that concluded at the end of the year. The final project report would be completed early next year for submission to the funding agencies.

Under the “Caribbean Regional Small Ruminant’s Industry Technical Support Project” (New Zealand Small Ruminant Project), a 25-doe small ruminant training/demonstration production unit was set up by the CARDI Jamaica Unit at Hounslow. The system included a model stock housing facility and a silvo-pastoral system, for which a 4-ha (10-acres) Mulato II pasture and a supporting automated irrigation system were completed. The beneficiaries included farmers, extension and livestock officers and institutions. In addition, in Jamaica, 11 ha (27 acres) of predominantly Mulato II pastures and 2 ha (5 acres) of corn and sorghum fodder were established at the Hounslow and Bodles stations to provide superior quality forage for the breeding stock. Furthermore, 2 kgs (4.4 lbs) of Mulato II seeds and 10 kgs (22 lbs) Mombasa Guinea Grass seeds were delivered to the satellite farmers selected at the start of the project to be the producers of improved stock. Also, under the same project, a total of 89 animals were distributed as fatteners to farmers for meat production in the two project countries (Jamaica, 49 and Trinidad and Tobago, 40). The CFC-CDB Small Ruminant Project is among those that concluded at the end of the year. The final project report would be completed early next year for submission to the funding agencies.

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grasses (*Panicum* spp., 7.9%). Mulato II grass also showed greater persistence over time. Mulato II is a Brachiaria hybrid developed by the International Center for Tropical Agriculture (CIAT) in Colombia, which CARDI has been promoting in the Region for forage-based feeding systems for ruminant livestock.

**Strengthening Value Chains for Commodities Development**

In 2015, CARDI successfully won bids to conduct value chain analysis for specified crops and livestock in St Lucia and St Vincent and the Grenadines, and to review and update existing ‘tech-packs’ or develop new ones for identified commodities in St Lucia. The exercises began in January 2015 in St Lucia and March 2015 in St Vincent and the Grenadines. The chains for analyses were - tomatoes, cassava, honey, table eggs and small ruminants (St Lucia) and tomatoes, sweet peppers, lettuce, small ruminants (St Vincent and the Grenadines). The targeted categories of commodities for the ‘tech-pack’ development in St Lucia were, Food and Root Crops, Fruits and Vegetables, Cut Flowers, Tree Crops and Livestock. In 2016, we won a similar bid to conduct value chain analysis for dasheen, banana, cocoa, pork and goats in Dominica.

All four assignments were successfully completed this year and the following deliverables were made available to the contracting Governments. For the value chain analysis, (i) Report on the analysis of the value chain for each commodity, (ii) 20 stakeholders in each country trained on how to conduct value chain analysis and (iii) a comprehensive manual for each country on value chain analysis. For the ‘tech-pack’ development, 40 ‘tech-packs’ were delivered to the Government of St Lucia; Food and Root Crops (5), Fruits and Vegetables (18), Cut Flowers (4), Tree Crops (7) and Livestock (6).

All four contracts were funded under the Banana Accompanying Measures (BAM) programme.
CARDI, over the years, has been at the forefront of developing and promoting Protected Agriculture (PA) technologies for the increased production and productivity of crop plants, from the use of exclusion cages to conventional PA structures.

This year, we went further on the technology scale. The APP Project provided the opportunity to introduce into the Region new PA technologies under the umbrella of Green Intensive Farming Technologies (GIFT). In Trinidad and Tobago, CARDI is collaborating with UWI Engineering Department to establish a PA system featuring energy-efficient underground cooling system, solar powering and precision plant nutrition system. The construction of the structure was completed and arrangements were being made to start production under the system when the year came to an end.

The PA system established in Nevis (St Kitts and Nevis) through the IICA/CARDI Cooperative Programme under a project titled, "Protected Agriculture Construction and Capacity Building of Farmers And Youths In Nevis", continued to be used to train local farmers and secondary school students, consistent with its objectives.

Equally important, the facility was used to demonstrate Good Agricultural Practices (GAP) in PA systems to produce sweet peppers. Approximately 3,000 kgs (6,500 lbs) sweet peppers were produced and marketed to high-end hotels and supermarkets in Nevis.
Clean, quality planting material and high-quality breeding stock are essential for the successful sustainable development of the industries of the target commodities that the Region has identified as critical for food and nutrition security. Consequently, CARDI continues to champion the development, conservation, and distribution for use of plant and animal genetic resources, especially in the wake of the threats of climate change.

**Plant genetic resources**

**Sweet potato**

One of the important factors to boost sweet potato production and productivity is small farmers’ ability to access disease-free quality planting material. Subsequently, and to popularise the use of clean planting material by small farmers, 1,000 tissue-cultured, weaned and hardened sweet potato plantlets were purchased from Scientific Research Council (SRC) and distributed to 35 youths and women who had participated in the sweet potato ‘climate-ready’ demonstration/evaluation trials at Bernard Lodge and Ebony Park for planting on their farms.

**Taro/Dasheen**

In 2015 we reported that under the project, “Adapting Clonally Propagated Crops to Climatic and Commercial Changes” (SPC Taro Project), up to 25 of the 50 accessions received from the Pacific had been selected based on adaptability, corm characteristics, yield potential and taste in St Lucia and St Vincent and the Grenadines and that these were undergoing phenotypical evaluation for climate resilience. This work led to the identification of four accessions, BL/PNG/09, CE/IND/24, BL/SM/83 and BL/SM149 that showed drought tolerance. These genotypes were also the highest yielding. Molecular tests to confirm the genetic basis for the drought tolerance was almost completed. Accordingly, we produced 870 g (31 ozs) of pure, clean virus-free seeds of the Cayman Seasoning Pepper for the DOA to produce seedlings which will be sold to farmers. This seed will provide more than 151,000 high-quality seedlings.

**Animal genetic resources**

The ultimate goal of the reproductive facility and the capacity building exercises undertaken under the CFC-CDB Small Ruminant Project was to help produce quality stock for producers. In that context, in Jamaica 97 animals were distributed as breeding stock while in Trinidad and Tobago 27 animals were distributed.

Additionally, in Jamaica, the improved breeding stock that had been distributed to six satellite groups/institutions in 2015 started producing offspring totalling 98 improved animals.
**Safe movement of germplasm in the Region**

A major factor for the successful realisation of the benefits of the technology and know-how from germplasm improvement is the ability to safely move germplasm for use across the Region and CARDI continued to fine-tune the processes for that through the FAO Cassava Project and the APP Project. We updated the standards for the movement of cassava germplasm developed under the FAO Cassava project with virus indexation. Through the APP project, standards for the movement of sweet potato, yam, corn, beans, pigeon pea and hot pepper were produced. All standards were delivered to the Caribbean Agricultural Health and Food Safety Agency (CAHFSA) for processing and onward submission to the Council for Trade and Economic Development of CARICOM (COTED).

**Supporting the Regional Agro-Energy Thrust**

Standards for the safe movement of several commodities including hot peppers were developed under the APP project. They are under consideration by COTED.
Since 2011 CARDI and the Petroleum Corporation of Jamaica (PCJ) have been collaborating to assess the viability of producing biodiesel from locally grown feedstocks of castor under a project titled, “Assessment of the production of co-products and by-products of the conversion of the castor beans to biodiesel” (PCJ Biofuels Project). The first assessment evaluated the feedstocks production potential of different varieties of castor, which was reported on in the 2014 CARDI Annual Report. A series of follow-up studies to assess the feasibility of using co-products and by-products from the conversion of castor beans to biodiesel as soil ameliorant was started. The co-products and by-products evaluated were: castor bean trees converted to biochar for soil amelioration, and castor bean cake and castor bean shells used as a substrate to produce vermi compost for soil amelioration.

The results with respect to biochar production, the effectiveness of castor by-products as substrate for vermi-composting and as soil ameliorant were as follows:

The total biochar produced from the 225 kgs (496 lbs) of castor wood harvested was 62.5 kgs (138 lbs). This translates to approximately 1 kg (2.2 lbs) biochar for every 3.5 kgs (8 lbs) of castor wood produced or a conversion rate of 29% yield of biochar from the raw wood. This yield is fairly consistent with biochar which is produced by wood at a pyrolysis temperature of about 500°C. Castor wood is therefore relatively suitable for the production of biochar.

As a substrate for vermi composting, castor cake and castor shell were compared with goat manure. Goat manure only was the most effective dry compost, P<0.05, (11.27 kgs/m³ [14.8 lbs/yd³]) but castor cake and goat manure, without castor shell (8.79 kgs/m³ [14.1 lbs/yd³]) or with castor shell (8.36 kgs/m³ [19.0 lbs/yd³]) also appeared quite effective as substrate mixture. Castor shells alone (4.67 kgs/m³ [7.9 lbs/yd³]), however, was not a good substrate for vermi composting.

Trials on amelioration of reclaimed bauxite soil with castor wood biochar and castor cake/goat manure vermi-compost indicated that the biochar in combination with vermi-compost significantly (P<0.05) produced higher pak choi (test crop) yield (1.31 kgs/m² [2.41 lbs/yd²]) compared with vermi-compost alone (1.02 kgs/m² [1.88 lbs/yd²]), which in turn was higher than biochar alone (0.83 kg/m² [1.53 lbs/yd²]).
CARDI’s current major focus as far as the management of invasive species is concerned is on Black Sigatoka Disease (BSD, *Pseudocercospora fijiensis* (M. Morelet) Deighton). However, we still pay attention to other existing and emerging invasive species threats such as Moko Disease (*Ralstonia solanacearum* Race 2), Citrus Tristeza Virus (CTV), Black Pod disease (*Phytophthora megakarya*) and Fusarium Wilt (*Fusarium oxysporum* f. sp. *cubense* TR4). Red Palm Mite (*Raioella indica*, Hirst) also remains of great interest because of the Region’s push to revitalise the coconut industry.

The Caribbean Development Bank (CDB)-funded project titled, “Development of an Integrated Disease Management Programme for Black Sigatoka Disease” (CDB BSD Project), aimed at developing management strategies for BSD, was structured to achieve three main outcomes. These were, (i) the identification and selection of BSD tolerant hybrid banana and plantain varieties to be grown in the Region, (ii) a cadre of trained regional agricultural technicians about an Integrated Disease Management (IDM) framework for the BSD management and (iii) a cadre of trained stakeholders, especially farmers in FFS practices on the integrated management of BSD. Outcomes (ii) and (iii) were achieved by end of 2015. The pursuant of the achievement of outcome (i) continued in 2016.

Selecting BSD tolerant banana and plantain varieties

The four varietal evaluation blocks of 16 varieties for BSD tolerance under the CDB BSD Project were all established in Dominica, St Lucia and St Vincent and the Grenadines, and preliminary results of the tolerance performance, including an organoleptic test in Dominica, were analysed.

The results indicated that all the FHIA varieties tended to show higher tolerance to the disease than the local Cavendish variety. The FHIA 03 (banana) and FHIA 21 (plantain) varieties seemed to perform better than the other BSD tolerant varieties under evaluation for the mother plants. Performance trends were also observed in the different agro-ecological zones; plants tended to take longer to bunch at high altitude than at low altitude.

In November 2015, the tissue culture bananas and plantain at the tissue culture facility at the National Agricultural Research and Extension Institute (NAREI), Guyana, were transferred to the Orange Hill Tissue Culture Laboratory, St Vincent and the Grenadines to be multiplied. The extra plantlets following the transfer were used to establish a museum plot in June 2016. This was done to maintain the momentum and continued visibility of the project in Guyana. The plot contained the following varieties: FHIA-02, FHIA-03, FHIA-21, Grand Naine, PIT A 17, PIT A 23, PITA 27 and the local banana plants. The museum plot established very well.

The multiplied tissue culture material were returned from the Orange Hill Tissue Culture Laboratory, St Vincent and the Grenadines and established in the evaluation plots in four agro-ecological zones at five sites in active *Musa* growing areas: Parkia (Region 3), Canal No. 1 (Region 3), Mon Repos (Region 4), and two sites at Little Biaboo, Mahaica (Region 5). BSD incidence, agronomic and yield data will be collected from the mother plants and first suckers in 2017.

**Citrus Tristeza Virus disease still a threat**

Citrus Tristeza Virus (CTV) disease continued to be a latent disease in the Region, particularly in St Lucia. The CARDI Unit in St Lucia, therefore, continued to maintain at its field station CTV tolerant rootstock varieties (Volkameriana, Swingle citrumelo and Carrizo citrange) for the production of seed for the propagation of CTV tolerant rootstocks for farmers.

**Caribbean Pest Diagnostic Network facilitating regional food safety**

CARDI continued to chair the Caribbean Pest Diagnostic Network (CPDN) of the Caribbean Plant Health Directors Forum (CPHDF). The role of the CPDN is to coordinate regional safeguarding mechanisms that would protect the Region from invasive pests and help Member States meet international Sanitary and Phytosanitary (SPS) reporting requirements.

During the year, a regional project to strengthen laboratory networks and build diagnostic capacity and capability of the plant health services through training and sharing of expertise was submitted for funding to the INTERREG V (European Territorial Cooperation programme period five (2014-2020). This was as a result of the review of laboratory facilities carried out in 2015.
Responding to a Changing Climate

The climate is changing and in the Caribbean, the effects of climate change and climate variability are manifested by natural phenomena such as high temperatures, prolonged drought periods and intense hurricanes. The human tragedy of loss of life, dwellings and other infrastructure associated with intense hurricanes is exacerbated by the compromise of the food and nutrition security of the affected population. CARDI has a role to play in ensuring that food production returns quickly to normalcy after natural disasters. This was demonstrated by CARDI’s significant contribution to the recovery of food and nutrition security of two farming communities in Dominica following Tropical Storm Erika.

Building resilience in farming communities

In August 2015, Tropical Storm Erika hit the Region. Two farming communities in Dominica, the Colihaut and Coulibistrie communities, were affected and their farming operations were severely disrupted. Soon after the passage of the storm, CARDI began to bulk, at its Belize Unit, seeds for open-pollinated yellow corn, hybrid yellow corn and Red Kidney bean. The bulking was completed and the seeds were shipped to the CARDI Dominica Unit early 2016. CARDI donated the seeds to the Minister for Agriculture and the Environment, Mr Johnson Drigo who handed them over to the two farming communities. The 90 kgs (200 lbs) of corn and 360 kgs (800 lbs) of Red Kidney bean seeds can potentially establish 4 ha (10 acres) and 8 ha (20 acres), respectively. The CARDI Belize Unit is the Institute’s centre for the production of the cereals and grain legumes.

We also assisted with the on-farm establishment of these crops by facilitating the transfer of technologies developed in Belize to Dominica. The production and supply of these seeds were supported under the APP Project.

Selecting resilient food crops varieties

In the reporting period, we continued to emphasise the identification, selection, characterisation, multiplication and conservation of germplasm of root and tuber and cereal and grain legume crops important to the Region’s food and nutrition security as an adaptation strategy to the changing climate. This was done primarily through two projects, namely the 10th EDF Food Security Project and the APP Project.
Last year, for the 10th EDF Food Security Project, we reported on the identification and selection of drought-resilient hybrid corn varieties, Pioneer P3523 and Pioneer P4082W and open-pollinated varieties such as CARDI YC-001 and NB-6 in both Belize and Trinidad and Tobago. We started multiplying them to have sufficient quantities to distribute to farmers.

This year, the Institute focused on roots and tubers, beans and peas. Twenty-one sweet potato and 11 cassava (CARDI Barbados Unit) and up to 11 pigeon pea accessions (CARDI Units in St Kitts and Nevis and Trinidad and Tobago) were identified and characterised for drought tolerance and placed in ex-situ conservation plots.

The mutually beneficial international relationship forged with the Wageningen University and Research Centre (WUR) continued. Through this collaboration, Deoxyribonucleic acid (DNA) fingerprinting of 105 sweet potato accessions from Barbados, St Kitts and Nevis and Trinidad and Tobago was completed. This is very important as it will allow for genetic characterisation for climate resilience of these accessions.

The resilience of several varieties of sweet potato and cassava to drought conditions, as well as mulching as a climate change adaptation strategy, were evaluated at the CARDI Units in Antigua and Barbuda, Barbados, Dominica, Jamaica, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines and Trinidad and Tobago.

Sweet potato, *Ipomoea batatas* (L.) Lam is a crop that is adapted to diverse climatic conditions, relatively easy to cultivate and requires minimal inputs, yet, it is still susceptible to certain conditions such as severe drought. Sweet potato requires at least 750-1,250 mm (30-50 in) of water during the growing season to be able to successfully produce a good yield. Thus, with changing climate characterised by low amounts and frequency of rainfall, this minimum water requirement is becoming more difficult to attain. In this context, the search for drought-tolerant sweet potato varieties that could contribute to the food and nutrition security of the Region has become very necessary. It is against this background that the Institute undertook several evaluations across the Region to identify sweet potato varieties tolerant to drought and could be classified as ‘climate-ready’.

In Antigua and Barbuda, four varieties of sweet potato, Catch Me, Hurricane, King Crown and Mandela, were evaluated in open field under simulated continuous water (irrigation) and drought (non-irrigation) conditions. Mandela performed best, and even under simulated drought condition (non-irrigation) it yielded 400 g (14.1 ozs) per plant which was the same as Catch Me under irrigation and higher than Hurricane and King Crown (200 g [7.1 ozs] per plant and 100 g [3.5 ozs] per plant, respectively) under irrigation.

The resilience to water stress (No irrigation vs. Irrigation) of nine local sweet potato varieties was evaluated in a trial with three replications in Barbados. The unit plot size was 8.4 m² (90 ft²). The nine varieties were, C105, R, M, O, C49, Caroline Lee, 94/7, C104 and Q. The variety 94/7 was exceptional. The overall average yield was 1.89 kg (4.1 lbs) per plot and demonstrated resilience to water stress conditions. Under no irrigation the yield of 0.98 kg (2.2 lbs) per plot was equal to the irrigated yields for Caroline Lee (0.94 kg [2.1 lbs] per plot), C49 and Q (1.11 kgs [2.4 lbs] per plot) and C104 (1.07 kgs [2.3 lbs] per plot). This is a variety that should be considered for multiplication for farmers.

In Jamaica, five local varieties of sweet potato, Clarendon, Fire on Land, Ganja, Yellow Belly and Upifta were evaluated under irrigation or rain-fed conditions (‘climate-ready’ simulation) at two locations, Bernard Lodge and Ebony Park on plots 165 m² (198 yd²) each. The trial coincided with a severe drought period. At the Bernard Lodge, the total rainfall was only 13.7 mm (0.54 in) with only two rain days whereas at Ebony Park there were five rain days with 431.8 mm (17 in) of total rainfall. Tuber yield was generally low and at Bernard Lodge, there was no tuber production under rain-fed conditions. The results from Ebony Park showed that Upifta (235 g [8.3 ozs] per plot) and to some extent Fire-on-Land (200 g [7.1 ozs] per plot) were the varieties with some tolerance to water stress and, therefore, with ‘climate-ready’ potential.

In Trinidad and Tobago, ten locally grown sweet potato varieties were evaluated in a replicated field trial on plots 11 m² (13 yd²) over four months under two water availability conditions; (1) drip irrigation calibrated to deliver approximately 3-4 L (5-7 pints) of water per plant every other day (regime 1) and (2) rain fed conditions (regime 2). The varieties were, Carrot, Certain, Chicken Foot, John, Maggie, Marigita, Nina, O49, R368, TIS 9191.
Based on the performance of the ten sweet potato varieties under watering regime 2, it was concluded that the variety TIS 9191 (6.5 kgs [14.3 lbs] per plot), in particular, and to some extent varieties Nina (5.9 kgs [13.0 lbs] per plot), O49 (5.5 kgs [12.1 lbs] per plot), Carrot (5.3 kgs [11.7 lbs] per plot) and Chicken Foot (3.8 kgs [8.4 lbs]) per plot have the potential for good production in drought or water stress conditions ('climate-ready').

The Beauregard sweet potato variety is becoming very popular in the Region for local and export markets. In St Vincent and the Grenadines, it is normally grown in the low altitude areas where its yield also becomes susceptible to drought conditions. CARDI, therefore, conducted a study during the dry season to evaluate its productivity at the normally high rainfall high altitude areas (366 m [1,200 ft] above sea level). A cluster of eight farmers in the Richland Park area who normally plant dasheen came together to plant three plots of 334 m^2 (400 yd^2), a total of 0.1 ha (0.25 acre) of the Beauregard sweet potato variety.

The total yield of tubers recorded at the harvest was 380 kgs (838 lbs) per plot. This was 60% higher than the production during the dry season in the low altitude traditional sweet potato growing areas without irrigation (237 kgs [521 lbs] per plot). It was concluded that with the suitable variety of sweet potato high yields can be obtained at the high rainfall, high altitude areas normally grown under dasheen.

Mulching as a climate change adaptation strategy for sweet potato production was studied in St Kitts and Nevis and St Lucia. The Beauregard sweet potato variety recently introduced into St Lucia is known to give high yields but in St Lucia, it has not been compared with the popular "local" variety, Mandela. Mulching as a climate change adaptation strategy is also recognised in many parts of the world. However, this practice has not been validated in sweet potato production in St Lucia. Therefore, a split-plot design validation trial on plots 21 m^2 (25 yd^2) was set up to compare the productivity of Beauregard and Mandela, each with or without grass mulch.

The results indicated that the crops grown under mulch (average 23.9 kgs [52.7 lbs] per plot) yielded 25.5% more tubers than those grown without mulch (average 19.1 kgs [42.2 lbs] per plot) and the average yield of Beauregard (25.5 kgs [56.2 lbs] per plot) was 45.6% more than for Mandela (17.5 kgs [38.6 lbs] per plot). The superiority of Beauregard over Mandela was, therefore, validated.

A similar validation trial comparing the sweet potato varieties, N3 and Viola, and with or without grass mulch was conducted in St Kitts and Nevis on plots of 40 plants each. Mulching improved the tuber fresh weight of N3 (3.8 kgs [8.4 lbs] per plot) by approximately sevenfold compared with the non-mulched (0.53 kg [1.2 lbs] per plot). For Viola, the improvement in fresh tuber weight as result of mulching (0.60 kg [1.3 lbs] per plot) was approximately fivefold compared with the non-mulched (0.13 kg [0.29 lb] per plot). Here again, the N3 variety demonstrated that it could be beneficial in the fight against unpredictable weather patterns.

In Dominica, dasheen is generally cultivated throughout the year on small plots by farm families mainly in the agro-ecological zones (AEZ) where annual rainfall is between 3,800 and 5,000 mm (150 and 197 inches). In the recent past, however, there have been marked periods of dry season that are atypical of the
AEZ where the crop is grown. The changed climatic pattern has impacted negatively on dasheen production and productivity with farmers and traders reporting increasing levels of harvested corms falling below the minimum export market requirement of 1,360 g. This is attributable to the poor absorption and utilisation of the normally applied granular fertilizer.

Therefore, trials were established on 0.2 ha (0.5 acre) plots on three farms to evaluate two fertilizer regimes. The fertilizer regimes applied were granular NPK 16-28-16 applied as a surface dressing (57 g [2 ozs] per plant, the standard farmer practice, and granular NPK 16-28-16 applied as a surface dressing at the farmer standard rate + liquid formulation NPK 0-21-25 (24 mL [0.85 fl. oz] per plant) applied at the base of the petiole of the crop.

The results showed that plants that received NPK 16-28-16 applied as a surface dressing + liquid formulation NPK 0-21-25 at the base of the petiole produced corms that were consistently heavier with 46% weighing 1,360 g and above compared with 27% for only NPK 16-28-16 applied as a surface dressing. It was concluded that granular NPK 16-28-16 applied as a surface dressing + liquid formulation NPK 0-21-25 could contribute to the production of dasheen to market acceptable levels.

Cassava (Manihot esculenta, Crantz) is also well known for its inherent tolerance to stresses such as drought and with increasing occurrences of drought in the Region, there is a need to evaluate local varieties for tolerance to such conditions. In Trinidad and Tobago, we evaluated five local cassava varieties (MMex, Maracas Blue Stick, Maracas Black Stick, Butter Stick, and Pickney Muma) in a repeat potted trial over two nine-month periods under two water availability conditions; (1) 4 L (7 pints) of water per plant every other day (regime 1) and (2) 2 L (3.5 pints) of water per plant every other day (regime 2, simulated water stress).

Based on the results of the five varieties under water regime 2, simulated water stress conditions, it may be concluded that the varieties Butter Stick (0.98 kg [2.2 lbs] per plant) and Blue Stick (0.50 kg [1.1 lbs] per plant) have the potential for good production in areas prone to drought or water stress conditions (‘climate-ready’).

All the foregoing evaluations were done with funding from the APP Project.

Multiplication and conservation of resilient food crops varieties

Last year, for the 10th EDF Food Security Project, we reported on the identification and selection of drought-resilient hybrid corn varieties, Pioneer P3523 and Pioneer P4082W and open-pollinated varieties such as CARDI YC-001 and NB-6 in both Belize and Trinidad and Tobago. We started multiplying them to have sufficient quantities to distribute to farmers. This year the Institute focused on roots and tubers, beans and peas. Twenty-one sweet potato and 11 cassava (CARDI Barbados Unit) and up to 11 pigeon peas accessions (CARDI Units in St Kitts and Nevis and Trinidad and Tobago) were identified and characterised for drought tolerance and placed in ex-situ conservation plots.

Also, under the APP Project, ex-situ conservation plots were established for sweet potato (Antigua and Barbuda), hot pepper (Barbados) and corn (Belize). These would provide a quick response for planting material post-disaster and a readily available source of material for distribution to producers.

The studies on the drought tolerance of food crops completed by CARDI during 2015 and 2016 have identified several varieties across the Region, which taken together would offer appreciable resources for resilient food production in the face of a changing climate. The varieties included corn - Pioneer P3523, Pioneer P4082W, CARDI YC-001 and NB-6, sweet potato – 94/7, Carrot, Chicken Foot, Mandela, N3, Nina, O49, TIS 9191 and Uplifta, and cassava – Butter Stick and Blue Stick. Some of these have been placed in ex situ conservation for short- and medium-term rejuvenation of planting material for farmers. However, for the long term the Institute would have to consider conserving, particularly the sweet potato varieties, in tissue culture.
Pilot Programme for Climate Resilience (PPCR)

"The investment plan for the Caribbean Track of the Pilot Programme for Climate Resilience" (PPCR Project) is a five-year project that is being supported through grant funding by the Inter-American Development Bank (IDB). The programme is being executed by the UWI. The PPCR Project is being piloted in six countries, Dominica, Grenada, Haiti, Jamaica, St Lucia and St Vincent and the Grenadines.

CARDI is one of the co-implementers of “Component 4: Applied Adaptation Initiatives”, under which adaptation strategies such as climate modelling for crop production and pest and disease management areas would be studied. A sensitization forum on the “Agriculture Sub-component” of Component 4 was held as one of the events for the Caribbean Week of Agriculture (CWA) 2016, held in the Cayman Islands. More than 50 persons from the agricultural and scientific communities across the Region participated in the forum.

Modelling climate resilience

Caribbean climate modellers meeting

A meeting was held at the UWI, Mona during 8 – 12 August 2016 to consult with the Caribbean Climate Modellers’ Consortium and representatives of key sectors/lead executing agencies to determine and review information available in the Region on climate variability and change. One output of the meeting was that the sector groups would provide a draft/outline of an article under the 1.5- vs. 2- vs. 2.5-degree global warming initiative. This was completed for the Inter-Governmental Panel on Climate Change (IPCC) event that was convened in Jamaica in October 2016, CARDI through representation by Rasheeda Hall-Hanson was part of the agriculture sector team that drafted a paper titled: “Quantifying future agricultural production in the Caribbean in a warmer world.”

Regional plans and strategies to respond to climate change threats

A consultation was held in St Lucia, during 22 - 23 September 2016, on strengthening the integration of climate change disaster and risk management considerations in the agriculture sector. The participants for this consultation were drawn from representatives of the CARICOM countries and regional organisations involved in Agriculture and Disaster Risk Management as well as a wide range of pertinent national, regional and international agencies.

The overall objective of the meeting was to consult with national and regional experts on how to make the Standardized Audit Instrument (SAI) more useful. The specific objectives were to review the instrument, critique the instrument in terms of deficiencies and make recommendations for improving the efficiency of the instrument.

Programme for Building Regional Climate Capacity in the Caribbean (BRCCC)

Another collaborative initiative geared towards bolstering the Region’s efforts with respect to expected climate change impacts is the programme, “Building Regional Climate Capacity in the Caribbean” (BRCCC). The project is a three-year programme (2014-2017) that is funded by the United States Agency for International Development (USAID) and executed by the Caribbean Institute for Meteorology and Hydrology (CIMH) in partnership with the World Meteorological Organization (WMO).

Through the BRCCC, the use of Early Warning Systems (EWS) is expected to be improved based on the addition of the appropriate timescales. A Consortium of Regional Sectoral Early Warning Information Systems Across Timescales (EWISACTs) was set up for this purpose. CARDI is an official member of the Consortium of Regional Sectoral EWISACTs and it is responsible for facilitating the development of consultancies for: (i) utilizing climate information to determine the early warning for heat stress in poultry in the Caribbean, (ii) enhancing irrigation use efficiency in the Caribbean and (iii) employing the use of the Participatory Integrated Climate Services for Agriculture (PICSA) for the Caribbean. This will be done in collaboration with the University of Reading.
The enhancement of the knowledge and skills of stakeholders along the value chain is one of CARDI’s comparative advantages and the Institute takes all the necessary steps to include capacity building in all of its projects, and this year, because several projects ended, a greater part of the Institute’s programme of work, was focused on knowledge sharing through training and the dissemination of results from the projects.

The APP Project had a specific line item/activity titled, “Disseminate traditional knowledge/innovative practices”. Under this activity and across the Region stakeholders were exposed to mechanisation in small farming systems and also made au fait with some of the significant results from various demonstration/validation trials on the focused commodities in the project. These exercises were conducted mostly during November – December 2016.

Approximately 165 stakeholders, comprising 65% males, 35% females, and including overall 21% farmers and 43% students, participated in the demonstration and had hands-on experience in the use of the walk-behind tractors.

There was also knowledge sharing through the dissemination of the results of validation trials. Information was shared and discussed in seven thematic areas as follows: (i) Identification of drought-tolerant (‘climate-ready’) sweet potato, cassava and corn varieties (Antigua and Barbuda, Barbados, Belize, Jamaica and Trinidad and Tobago); (ii) Mulching as climate change adaptation strategy for growing sweet potato (St Kitts and Nevis and St Lucia); (iii) Soil nutrient manipulation as climate change adaptation strategy for optimisation of taro production (Dominica); (iv) Potential for growing sweet potato in a non-traditional sweet potato growing area as climate change adaptation strategy (St Vincent and the Grenadines). The remaining three thematic areas were, (i) Use of biostimulants in cassava production (Grenada), (ii) Pelletised total mixed ration for small ruminants based on mulberry and sweet potato and cassava by-products (Barbados) and (iii) Evaluation of botanicals as dewormers for small ruminants (Jamaica).

More than 155 stakeholders in total participated in the dissemination workshops. These included 34% females. The workshops were pitched more towards extension and agricultural officers (56%); farmers and students made up the remaining 44%.

In addition to these regional exercises, in Jamaica, 35 youths and women became knowledgeable in Integrated Pest Management (IPM) of sweet potato pests, as well as in the calibration of spraying equipment used as part of the IPM system.
Improving skills and knowledge in production and productivity

During 2016, under the FAO Cassava Project, 32 farmers, 18 in Guyana and 14 in Jamaica were imparted with knowledge in IPM through FFS, and mechanisation (setup, calibration, maintenance, and demonstration and use of cassava planter and harvester). Dr Bernardo Ospina Patino, Executive Director of CLAVUCA and Mr Vinicius Dalla Rosa, Managing Director, Planti Center, Brazil, suppliers of the equipment, facilitated the setup, calibration and maintenance training.

In Trinidad and Tobago, approximately 190 members of the Agricultural Society of Trinidad and Tobago (ASTT) became more knowledgeable in risk-mitigating techniques and improved production practices for hot pepper. This training was done under the umbrella of the CaFAN-ICA-CARDI Letter of Cooperation Agreement signed under the implementation of the APP Project.

In St Lucia, in collaboration with Baron Foods Ltd., we enhanced the knowledge and skills of approximately 30 farmers in modern techniques for planting and harvesting of hot peppers. Baron Foods Ltd. sponsored this training. Also, in the Cayman Islands, we collaborated with the Cayman Islands Agricultural Society (CIAS) and the DOA to share knowledge with approximately 20 farmers on the benefits of increasing the plant density in seasoning pepper production. The utilisation of drip irrigation systems to optimise water use efficiency and “sticky traps” to monitor pest levels in the field were also demonstrated.

Under the EU-ACP Coconut Project, 140 farmers from Belize, Dominica, Guyana, Jamaica, St Lucia, St Vincent and the Grenadines, Suriname and Trinidad and Tobago gained knowledge in the production of high-quality coconut planting materials, GAP, IPM and coconut niche product development.

In Jamaica, under the APP Project, 65 stakeholders from eight rural communities improved their knowledge and skills in group dynamics, preventative health, feeds and feeding and husbandry practices. Furthermore, under the New Zealand Small Ruminant Project, a manual on small ruminants production best practices in Jamaica was completed.

Again, in the Cayman Islands for small ruminant production, 18 farmers gained knowledge, through a field day, on the potential of the newly introduced Mulato II grass in improving the nutrition for sheep, goats and cattle on the islands.

Under the IICA/CARDI Cooperative Programme, two training sessions were conducted in Nevis, using the PA structure constructed in 2015 and with the CARDI PA Manual as the resource material. Twenty-seven persons: 15 men and 12 women attended the sessions and each person was presented with a copy of the CARDI PA Manual at the end of the sessions. The outcome of the demonstration from the one PA structure is that there are now 5 greenhouses constructed by farmers, a high school and a primary school.

Enhancing skills in germplasm production and management

Empowering members of small farmers’ groups to produce and manage their crops germplasm for continuous production was one of the principal objectives of the APP Project. Accordingly, during the year approximately 183 farmers from six farmers’ groups were empowered as follows:

In Antigua and Barbuda, 51 CaFAN farmers learnt sweet potato germplasm multiplication. Fifty thousand slips, capable of planting 4 ha (10 acres) were distributed among farmers. Also, 53 CaFAN farmers in St Vincent and the Grenadines learnt cassava rapid propagation from 2- and 4-node cuttings.

Twenty-four farmers of the North Eastern Farmers Organization (NEFO) in Grenada were assisted to construct their own germplasm propagation shed and taught how to propagate sweet potato germplasm.
In St Lucia, 31 farmers of the Sunrise Farmers Group (11), the Babonneau Cluster (10) and the Micoud Cluster (10) gained the capacity for germplasm multiplication for sweet potato and cassava.

Capacity building in value-adding

In 2015, through the APP Project and in collaboration with Caribbean Agribusiness Association (CABA), composite bakery products made from local starchy commodities mash (40% mash:60% wheat flour) were demonstrated and introduced in Dominica, Grenada and St Vincent and the Grenadines. In 2016, the demonstration and production were extended to Antigua and Barbuda using sweet potato and cassava. A dozen bakers benefited from the exposure.

Under the APP Project, capacity, especially in Good Manufacturing Practices (GMP/HACCP) and also in GAP for roots and tubers and small ruminants was built in 16 stakeholders from across the CARIFORUM in St Vincent and the Grenadines.

A similar but localised training in Food Safety (HACCP) was conducted in Grenada. Twenty-three persons benefited, with the majority of them being bakers trained in composite bread making in 2015. In parallel, 26 dairy goat producers and processors were imparted with knowledge in HACCP for goat milk production and processing.

Last year we reported that under the CFC-CDB Small Ruminant Project, the refurbishment of the training abattoir at Hounslow, Jamaica was completed. In 2016, it was used to conduct training on meat science, meat fabrication, craft and value-added, as well as for a Food Safety Workshop for a total of 80 participants, including persons from Trinidad and Tobago.
Technologies for enhancing agricultural production and productivity continue to evolve all over the world and the Caribbean is no exception. We have already noted under the section, “Developing the Protected Agriculture Industry” the introduction and development of high-end, high-tech PA systems in the Region. Such evolving technologies will require capable agricultural professionals and technicians to drive them. Accordingly, CARDI continues to include in its programme of work structured capacity building for technical professionals. In 2016, the projects that facilitated these capacity-building efforts were the APP Project, FAO Cassava Project, EU-ACP Coconut Project, CFC-CDB Small Ruminant Project, New Zealand Small Ruminant Project and the 10th EDF Food Security Project.

APP Project building technical competencies

In 2015, equipment needs for the seed production and processing facility of the Jamaica Ministry of Industry, Commerce, Agriculture and Fisheries (MICAF) were identified through an audit. These pieces of equipment were procured and handed over to MICAF this year. Some of the key pieces of equipment were seed extractor, precision balance, convection oven, germination chamber and laminar flow hood. The total value of the equipment was US$20,000. In addition, CARDI gave two varieties of sweet potato namely; Clarendon and Fire on Land to add to the germplasm bank at the SRC. Previously, these popular varieties were not available at the tissue culture facility.

Also in Jamaica, the capacity of SRC to produce quality planting material for the farming communities through tissue culture was enhanced with the provision of a reverse osmosis water purification system and solution bottles. Clean, filtered water is very critical in the tissue culture process. The installation of the items led to the total elimination of the need for SRC to acquire filtered water from commercial sources at the cost of approximately J$200,000 per month.

During 25 – 29 July 2016, eighteen (18) small ruminant scientists and technicians from six CARIFORUM countries (The Bahamas, Grenada, Guyana, Jamaica, St Vincent and the Grenadines and Trinidad and Tobago) gained valuable experience on breeding techniques and practical field husbandry management for small ruminants in the Dominican Republic. The visit was facilitated by the Dominican Institute of Agriculture and Forestry Research (Instituto Dominicano de Investigaciones Agropecuarias y Forestales (IDIAF)).

FAO Cassava Project building technical competencies

Eleven technicians/extension officers from Guyana (two) and Jamaica (nine) benefited from the training in IPM using the FFS mechanism and farm mechanisation under the FAO Cassava Project.

EU-ACP Coconut Project building technical competencies

The EU-ACP Coconut Project collaborated with the Mexican Government, through the Centre for Crops Research for the Yucatan, (CICY) and the National Institute for Forestry, Agriculture and Livestock Research (INIFAP) to impart valuable know-how on coconut tissue culture management and coconut production and processing to four scientists from Belize, Jamaica, St Lucia and Trinidad and Tobago.

Also under the same project, strategies for strengthening technical linkages and collaboration between regional and national institutions along the value chain were explored at a workshop in Guyana. Fifty-nine stakeholders from the public and private sectors from the nine project countries participated in the workshop. Additionally, 172 technical personnel from Belize, Dominica, Guyana, Jamaica, St Lucia, St Vincent and the Grenadines, Suriname and Trinidad and Tobago improved their knowledge in coconut niche product development, the production of high-quality coconut planting materials, and in GAP and IPM.
Again, through the EU-ACP Coconut Project, the Brazilian Agricultural Research Corporation (EMBRAPA) accommodated four technical personnel, one each from national institutions in Jamaica, Suriname and St Vincent and the Grenadines, and one from CARDI at its facilities at Aracaju, Brazil to share their knowledge, especially on coconut germplasm management.

CFC-CDB Small Ruminant Project building technical competencies

The CARDI Jamaica Unit and the Research Division of the Ministry of Agriculture collaborated with the Veterinary Services Division and the Public Health Office to use the refurbished abattoir at Hounslow to train and license six officers of the Bodles Research Station. They received Butcher’s and Food Handler’s Permits at the end of the training. In 2015, ten trainers of trainers were certified under the CFC-CDB Small Ruminant Project in Jamaica. An additional seven trainers of trainers were trained in breeding/reproductive technologies – artificial insemination (AI) and multiple ovulation embryo transfer (MOET) - in sheep and goats in 2016. These trainers collaborated with the CARDI project team to conduct eleven training sessions; four on husbandry, two on AI, one on MOET and two on meat science and value-adding reported above. There were approximately 200 beneficiaries of these capacity-building efforts. These included Livestock and Extension Officers, Veterinarians, Lead Farmers and other selected technicians and students. There was a relatively high representation of women (26%) and youths (23%) in the sessions.

All the above-mentioned capacity building efforts in Jamaica were done in collaboration with the New Zealand Small Ruminant project.

Additionally, through the combined support of the CFC-CDB Small Ruminant Project and the New Zealand Small Ruminant Project, the Sam Motta Demonstration and Training Centre (SMDTC) in Jamaica hosted over 100 individuals and groups on study visits to the integrated crop and livestock system established on mined-out bauxite soils at the Centre. The overseas visitors included representatives of the United Kingdom chapter of Projects Abroad, one of the world’s largest volunteer organisations.

In Trinidad and Tobago, a training seminar on best practices in small ruminant production through the use of ICTs was undertaken for 38 practitioners made up of Livestock Officers, Researchers and Lead Farmers.

New Zealand Small Ruminant Project building technical competencies

The New Zealand-Small Ruminant Project introduced the Moodle e-learning platform with a supporting mobile app as a novel way of enhancing skills and knowledge in small ruminant production. The e-learning platform is a web-based self-training facility, which in this case was populated with learning resource materials on small ruminants from the Caribbean. Approximately 130 persons from Antigua and Barbuda, Barbados, Dominica, Grenada, Guyana, Jamaica, St Lucia, St Vincent and the Grenadines, St. Kitts and Nevis and Trinidad and Tobago enrolled.

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They also visited key root crops value-added facilities - UWI Industrial Facility cassava flour project, Red Stripe cassava beer initiatives, and RADA Twickenham Industries bammy making facility.

In Trinidad and Tobago, they experienced making composite bread and other bakery products with roots crops mash (40%) and wheat flour (60%). At the Cocoa Research Center (CRC), the learning experiences included cocoa germplasm conservation, management and utilization, research and development in utilization of genetic diversity and a visit to the International Cocoa Genebank.

The mobile app allows users to link the e-learning platform with their smartphones so that the training materials may be available as needed online and offline.

In addition to the mobile app that supports the e-learning platform, another app was developed by the team led by CARDI to connect buyers and sellers to facilitate the sale of small ruminants, value-added products, tools and equipment, etc. These two Apps, “CARDI SR Learn” and “CARDI SR Market” are available at the Google Play Store for the Android platform.

10th EDF Food Security Project building technical competencies

In collaboration with WUR, the knowledge and skills for the conservation of plant genetic resources, GAP and germplasm management were imparted to 115 stakeholders in Barbados, St Kitts and Nevis and Trinidad and Tobago. This was done under the 10th EDF Food Security Project.
Looking inwards! In this section of the report, we reflect and report on the Institute’s systems that make it a unique institution in the Caribbean to lead the agricultural research for development agenda that contributes towards the attainment of the Region’s food and nutrition security.

Institutional structures - Systems

Registry services

Our new filing system is in full implementation now and throughout the year, we continued to seek the requisite resources to enable us to fully computerise the Registry system.

Outreach and Communications Services

The Institute invested in a second internet service provider, DIGICEL, (in addition to FLOW) with the view to averting any disruption of internet service to Headquarters and improving communication between Headquarters and the country units.

There was also a migration of institute-wide computer operating systems to Windows 10 Operating Systems for capable machines.

Financial administration

Consistent with our plans, the training of the finance and accounting staff on the Institute revised Accounting Manual was effected during the year.

Monitoring and Evaluation

The implementation of projects through effective management of the required technical and administrative components continues to be a critical function. Hence, efforts to promote the use of implementation/management systems and tools (such as the logical framework and Gantt software and results matrix) by project managers within the Institute are being accelerated. This is necessary as it is recognized that timely and effective project implementation contributes to the Institute’s project management in-house skills and the adoption of efficient management systems. More importantly, this leads to the establishment of the Institute as a partner of choice for implementation and conduct of research and development related activities.

Monitoring and Evaluation activities have been accelerated in light of the expanding size of the Institute’s project portfolio and consequently, the need to ensure that reporting (technical and financial) systems are implemented on schedule, maintained and in keeping with the Contractual Agreements. In this context, the Resource Mobilisation and Planning programme continued to be supported by a project officer whose assignment includes inter alia the monitoring of institutional systems, the maintenance of up-to-date project status reports and the conducting of ex-post evaluations. In addition, since the last quarter of 2015, the Institute has contributed to the implementation of the CARICOM Strategic Plan by providing monitoring reports of the Institute’s interventions that are in fulfilment of the regional strategic focus.

Institutional structures – Infrastructure

The APP Project assisted the Institute immensely to improve the infrastructure both on the CARDI field stations and in the offices.

The field stations of the CARDI Units in Antigua and Barbuda, Barbados, Dominica, Grenada, Jamaica, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines and Trinidad and Tobago were all endowed with walk-behind tractors. These will help with the preparation of experimental plots, as well as to be available to farmers to promote the mechanisation for small farming systems.

Assorted field equipment and tools were provided to enhance field operations. These included harrow, water pump, and water tank for the Belize Unit, and brush cutter, lawn mower and mist blower for the St Kitts and Nevis Unit.

The goat housing for the breeding stock at the Sam Motta Demonstration and Training Center (SMDTC) in Jamaica was refurbished so as to maintain CARDI’s capacity to produce quality small ruminant breeding stock.
The seed production capacity at the CARDI Units in Belize and Grenada was improved with assorted seed production and processing equipment and tools.

For the offices, computer hardware (desktop computer, laptops, printers) was provided for the CARDI Units in Antigua and Barbuda, Barbados, Belize, Guyana and St Lucia and IBM SPSS Statistical software for the Biometrics Unit at CARDI headquarters.

The Institute also benefited from the provision of opticals; multimedia projector (Grenada Unit), professional binocular microscope (Trinidad and Tobago Unit), Nikon AF-S camera body with 200mm lens and speedlight (Outreach and Communications Unit).

Under the ITC Coconut Project, a new server was acquired, configured and integrated with the existing network to boost network capacity.

The CFC-CDB Small Ruminants Project provided an Epson PowerLite projector and 86" projector screen for the CARDI Jamaica Unit to assist with outreach activities.

**Human resource development**

The development of the capacity of the human resources, the most important asset in CARDI, is of high priority and it is an on-going process. Thus, whenever possible, capacity building for the staff of CARDI and our partners and stakeholders is included in our projects.

This year, 40 CARDI personnel improved their knowledge and skills through the support of the EU-ACP Coconut Project and the APP Project.

Under the EU-ACP Coconut Project, 15 staff members from the CARDI Units in Belize, Dominica, Jamaica, St Lucia, St Vincent and the Grenadines, and Trinidad and Tobago improved their knowledge and skills in the production of high-quality coconut planting materials, GAP, IPM and coconut niche product development.

**Resources from the APP Project were used to organise a training of trainers’ workshop in Tobago for 20 CARDI technicians on the functioning, use and maintenance of the walk-behind tractors acquired under the project.**

Two persons from CARDI (Paul Lucas and Gregory Linton) were among 17 professionals and technicians from ten CARICOM states who gained invaluable experiences in technology advances in agricultural production, water and nutrient management during a ten-day study visit to the United States from 22 August 2016 to 3 September 2016. The primary beneficiaries of the study visit were from Antigua and Barbuda (2), The Bahamas (1), Barbados (1), Dominica (3), Guyana (1), Haiti (2), Jamaica (1), St Lucia (2), Suriname (3) and Trinidad and Tobago (1).

Their experiences were further enriched by the presentations and interactions with professionals and technicians from Australia, China, Ethiopia, India, Kenya, Morocco, Nigeria, South Sudan, Thailand, Uganda, United States and Uruguay.

The study visit was organised by the International Fertilizer Development Center (IFDC) and funded under the APP Project. See also the section, “Building Capacity of Regional Agricultural Professionals and Technicians.” (page 46)

During 2016, the CARDI Biometrics Unit advised on aspects of trials being conducted at CARDI, and prepared and analysed data for CARDI as well as a Ph.D. student and also reviewed surveys and sampling needs for trials as well as designed survey for coconut farmers. Seventeen designs for experiments and surveys and five data analysis with reports and advice were completed for 11 CARDI scientists, a UWI Ph.D. student and the coconut cluster.
The Outreach and Communications Unit delivered to CARDI staff 36 customised literature searches. They also received 88 Agriculture Information Alerts which covered the latest news items, journal articles, research reports/publications and event notices pertaining to CARDI’s priority commodity and thematic areas.

**Dependable deliverer of unique services**

Over the years, regional stakeholders have come to depend on CARDI for the delivery of unique services that they know CARDI is capable of, and more importantly, willing to deliver.

Our Literature/Reference Services also supported several farmers, students and researchers from other institutions, and agro-processors seeking information on, irrigation systems in the Caribbean, sweet potato varieties in the Caribbean, sweet potato-based flour, protected agriculture, hydroponics, aquaponics, honey, coconut production and garlic.

The researcher from the Ministry of Agriculture in Dominica acknowledged receipt of the information on garlic production as follows: “I wish to thank you very much for providing this much information in keeping with our inquiry. It represents an important starting point into our investigations on the potential for garlic production here in Dominica.” Such feedback encourages us to continue to provide the services.

Twenty-five copies of the CARDI book, “Land and Water Resources in the Caribbean” were also distributed to stakeholders.

**Promotion**

A robust Outreach and Communications strategy was pursued in 2016 to make “Brand CARDI” the preferred agricultural research and development agency in the Region. The “Brand CARDI” strategy was implemented using Face to Face (F2F) interactions, Traditional Media and Web-enabled Tools mechanisms.

**Face to Face**

In 2016, the Caribbean Week of Agriculture (CWA) and the CARDI Open Days were the primary channels for F2F interaction with our stakeholders.

The CWA2016 was held in the Cayman Islands. The “Brand CARDI” was very visible through our participation in the exhibition. We also organised a special visit to our new office and field station for some of the officials to CWA2016, including Ambassador Irwin LaRocque, Secretary-General of CARICOM and Hon. Alden McLaughlin, Premier of the Cayman Islands.

The 5th of December has been dedicated “CARDI Day” to commemorate the signing of the Agreement Establishing CARDI on 5th December 1974. CARDI Day offers the Institute’s first official F2F opportunity to display to stakeholders its contribution to the regional agricultural development. In 2016, all CARDI Units undertook any combination of activities including, field days, exhibitions, public lectures, seminars, media engagement – radio/television interviews, print and digital media features, school tours, etc.

Also, we took advantage of other national F2F interaction opportunities to showcase CARDI’s efforts towards the Region achieving food and nutrition security. Thus, we highlighted the Institute’s achievements at national World Food Day celebrations and national agricultural shows and exhibitions. For example, CARDI participated in the National Expo in Antigua and Barbuda, AgroFest in Barbados, National Agriculture and Trade Show in Belize, the 49th Agricultural Show in Grand Cayman and Denbigh Agricultural and Industrial Show in Jamaica.
Specifically for the AgroFest in Barbados, the forage-based feeding system for small ruminants developed with funding from the APP Project was highlighted. Fifty-two persons (farmers, MOA personnel, students) were introduced to the mulberry-based pellet feed with great interest. Also, the processing and pelleting of the forage-based feed was demonstrated to participants from The Bahamas, Dominica, Grenada, Guyana, St Vincent and the Grenadines and Suriname at a regional FAO workshop in managing livestock. The participants expressed great interest in having the machinery in their respective countries.

Traditional media

In 2016, there were approximately 20 Media Releases on the projects, CDB-BSD, EU-ACP Coconuts and APP, the handing over of seed in Dominica to assist in post-tropical storm Erika recovery, signing of instrument of accession with The Bahamas Government, CARDI Executive Director, Barton Clarke’s interview with the Trinidad Business Guardian, “Taking regional food production to the next level”, Executive Director’s meeting with Guyana’s President, His Excellency David Granger.

In 2016, the Institute published and circulated the CARDI Prospectus, CARDI’s Achievements, 1980s – 2014, BSD Calendar “An integrated approach to BSD Management”, approximately 30 issues of the newsletter, Agriculture in the News: issues affecting Caribbean agriculture, six issues of “CARDI Bi-Weekly: Happenings in CARDI” and six issues of “CARDI Ministerial Brief”, which since June 2016 replaced the “CARDI Bi-Weekly”. For the scientific community, we also published Issues 14 and 15 of our internal scientific publication, “CARDI Review”.

Since the publication of the BSD Calendar, Jamaica has requested for the calendar to be reprinted as it provides valuable, easy to understand information on the control and management of the Black Sigatoka Disease.

All the above-listed publications were produced internally.

Externally, we continued to use our mutually beneficial partnership with the Association of Caribbean Media Workers (ACM) network to provide the link to national, regional and international traditional media houses to showcase our work and achievements. Some notable examples are provided via hyperlinks here.

Baron Foods Ltd. supports training farmers (St Lucia Times, 18 June 2016) https://stluciatimes.com/baron-foods-limited-supports-training-farmers/

Cassava: another promising industry in Guyana (Guyana Chronicle, 2 July 2016) http://guyanachronicle.com/2016/07/02/cassava-another-promising-industry-in-guyana

Stakeholders must work together to promote agriculture (Barbados Advocate, 20 July 2016) https://www.barbadosadvocate.com/news/stakeholders-must-work-together-promote-agriculture

CARDI Open Day shines light on agricultural milestones (Cayman27, 5 December 2016) http://cayman27.ky/2016/12/cardi-open-day-shines-light-on-agricultural-milestones/7bc1d-1w4r11jqbd6fkrh0sfqiytsN96pl_HwGF_YBChFWUQGQehMENpPRR384
New variety of banana to be introduced to Dominica (Gis, Dominica, 8 December 2016) http://news.gov.dm/index.php/news/4176-new-variety-of-banana-to-be-introduced-to-dominica
SRC to produce more disease-free planting material (Jamaica Observer, 21 December 2016) http://www.jamaicaobserver.com/news/SRC-to-produce-more-disease-free-planting-material

Partnerships

Partnerships and collaboration are effective ways to avoid duplication and also share scarce resources to achieve greater goals. We approach partnerships and collaboration in several ways. We bring together partners to develop research for development (R4D) strategies, develop new partnerships or renew existing ones and try to expand the membership base of CARDI. These are all pursued with the view to having greater support for the Institute's mandate and objectives.

Bringing together partners to develop R4D strategies

CARDI continued to chair, lead and bring focus to the activities of the CARICOM Agriculture and Food and Nutrition Cluster (AFNC). The AFNC met monthly (virtually). Some of the significant achievements from its deliberations were:

- Incorporation of the Organisation of the Eastern Caribbean States (OECS) Task Force to ensure synergy between programmes and initiatives at the regional level with those at the sub-regional level.
- Submitted, in partnership with the Caribbean Poultry Association, for the consideration and decision of the 41st Regular Meeting of COTED, a paper on the preparations by the regional poultry industry for the Highly Pathogenic Avian Influenza (HPAI) Virus.

CARDI also continued to provide direction, as co-chair with UWI, for the Thematic Group for Research and Human Resource Development (TGRHRD). The Caribbean Institute of Meteorology and Hydrology (CIMH), the Ministries of Agriculture were co-opted to the TGRHRD.

In the Cayman Islands, a "Situational Analysis Report" arising from a consultancy facilitated by CARDI was submitted to the Government. The report would provide background and context to the development of the National Food and Nutrition Security Policy and Strategy for the Cayman Islands.

New partnerships in support of CARDI’s mandate

This year, CARDI signed a Memorandum of Agreement (MOU) with UWI, St Augustine Campus to support the development of ICT tools for the EU-ACP Coconut and New Zealand Small Ruminant Projects and cooperate on applied research for GIFT.

A Letter of Cooperation Agreement was also signed among CaFAN, IICA and CARDI to provide quality germplasm for roots and tubers and hot pepper, and transfer improved technologies for the production of these commodities to CaFAN members under the APP Project.

Expansion of membership base in support of CARDI's mandate

The Bahamas

The Bahamas formally became the 14th Member State of CARDI with the signing of the Instrument of Accession on 20 June 2016.
CARDI Publications in 2016

CARDI. 2016. Toward traditional knowledge transfer for resilient small farming systems in the Caribbean. St Augustine, Trinidad and Tobago: Caribbean Agricultural Research and Development Institute
http://www.cardi.org/cardipublications/virtual-library/?did=663

http://www.cardi.org/cardipublications/virtual-library/?did=648


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http://ccidp.cardi.org/media/filer_public/5c/28/5c28e29b-0413-4d80-b492-9a627681f491/manual_on_coconut_nursery_establishment_and_maintenance_ver_kurt_roberts.pdf

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http://ccidp.cardi.org/media/filer_public/d1/e7/d1e7b37a-55d1-46e8-bb90-d6d2ea8db73a/coconut_animal_production_systems_caps_6_sept_2016.pdf

*CARDI

Staff and Organisation

Headquarters

Professional staff
Clarke, Barton, Executive Director
Alvarez, Tristan, Project Management Specialist
Asiedu, Francis Dr, Manager, Technical Services
Besai, Denise, Outreach and Communication Officer
Glean, Allister, Senior Project Officer
Jagroo, Videsh, Biometrician (From 1 October 2016)
Lauckner, Bruce, Biometrician/Head Strategic Alliance
Maharaj, Debra, Executive Assistant
Malcolm, Margo, Head, Institutional Capacity Building Unit
Mohammed, Aziz, Value Chain and Marketing Specialist
Morris, Opal, Librarian
Nero, Curtis, Head, Finance Unit
Petersen, Joan, Scientist 1
Ramkisson, Suresh, Accountant
Shah, Fayaz, Head, Commercial Unit

Technical staff
Baptiste, Marva, Senior Accounting Assistant
Bassant, Ramsaran, Senior Information Assistant
Boodram, Karla, Accounting Assistant
Brathwaite, Laticher, IT Coordinator
Butler, Sharnim, Maid Cleaner
Cyrus, Nathifa, Administrative Secretary (From 15 November 2016)
Daly-Vire, Cyndi-Anne, Administrative Secretary
De Coteau, Siona, Accounting Assistant
Dookie-Hamil, Rajdaye, Junior Accounting Assistant
Kaloo, Leslie-Anne, Snr. Accounting Assistant
Kassie, Amanda, Receptionist
Moo, Simon, Graduate Assistant
Ramroop, Renea, Accounting Assistant
Redhead, Margaret, Senior Administrative Secretary
Stephen, Melissa, Information Assistant

Antigua & Barbuda

Technical staff
Browne, Bradbury, Technical Assistant/Officer in Charge
Batchelor, Delvin, Technical Assistant (Retired 16 September 2016)
Bowman, Donnet, Administrative Assistant
Josiah, Carol, Laboratory Assistant

Barbados

Technical staff
Best, Paul, Field Assistant
Lucas, Paul, Graduate Assistant
Mayers, Deborah, Administrative Assistant (From 24 October 2016)
Niles, Marcia, Administrative Assistant (Retired 13 August 2016)
Waithe, Jennifer, Laboratory Assistant

Bahamas

Professional staff
Singh, Michele, Animal Productionist (From 1 October 2016)

Belize

Professional staff
Sinha, Anil, Agronomist/CARDI Country Representative (Deceased 20 February 2016)
Rostant, Omaira Bernadett Avila, Biotechnologist/CARDI Country Representative (From 1 October 2016)

Technical staff
Garcia, Angel, General Farm Worker
Lindo, Martin, Technician
Reyes, Hector, Graduate Assistant (Officer-in-Charge 1 March 2016 – 30 September 2016)
Reynolds, Tenesha, Administrative Assistant
Robateau, Leroy, General Farm Worker (Resigned 18 November 2016)
Tzib, Cornelio, Technician
Vanegas, Ambrocio, General Farm Worker

Cayman Islands

Professional staff
Hosein, Ansari, Animal Scientist/CARDI Country Representative

Technical staff
Forrester, Rico, Technician (From 10 October 2016)
Dominica

Technical staff
Etienne, Dorian, Technician/Officer-in-Charge
Augustus, Dionne, Administrative Assistant
Registe, Krishna, Technician (From 25 February 2016)

Grenada

Professional staff
Andall, Reginald, Agronomist/CARDI Country Representative

Technical staff
Bruno, Janelle, Administrative Assistant
Raymond, Reuben, Field Assistant

Guyana

Professional staff
Roberts, Cyril, Dr, Biotechnologist-Breeder/CARDI Country Representative (From 1 September 2016)

Technical staff
Alleyne, Dawn, Administrative Assistant
Iwans, Basdeo, Driver

Jamaica

Professional staff
Simpson, Leslie Dr, Soil Scientist/CARDI Country Representative (Ag.) (Post-retirement from 31 August 2016)
Clarke-Harris, Dionne, Entomologist
Fearon, Albert, Animal Productionist

Technical staff
Asiedu, Elizabeth, Accounting Assistant
Barnes, Ralston, Technical Assistant
Davis, Winsome, Accounts Clerk (Mandeville)
Gordon-Sangster, Andrea, Secretary
Hanson-Hall, Rasheeda, Graduate Assistant
Hanson, Norman, Farm Supervisor
Jones, Desmond, Technical Assistant
Matherson-Powell, Sandra, Receptionist
Maxwell, Ervin, Agricultural Labourer (Retired May 2016)
Morris, Caroline, Office Assistant
Morris, Erna, Administrative Assistant
Robinson, Kenrick, Technical Assistant
Smith, Rohan, Technician
Temple, Renea, Administrative Assistant (Resigned December 2016)

Montserrat

Technical staff
Murraine, Robert, Technician

St Kitts and Nevis

Professional staff
Flemming, Kristian, Climate Change and Development Specialist/CARDI Country Representative (From 1 October 2016)

Technical staff
Browne, Roderic, Field Assistant
Dunrod, Vashni, Administrative Assistant
Eddy, Kerown, Technician (From 1 February 2016)
Knight, Laurence, Technician (From 1 January 2016)

St Lucia

Professional staff
Pilgrim, Ronald, Post-Harvest Technologist/CARDI Country Representative (Retired 31 December 2016)

Technical staff
George, Emmanuel, Research Assistant (Officer-in-Charge from 1 September 2016)
O’Brien, Sharon, Administrative Assistant
Thomas, Jacob, Field Assistant

St Vincent & the Grenadines

Professional staff
Robin, Gregory Dr, Agronomist/CARDI Country Representative

Technical staff
Joseph, Rose Marie, Technician
O’Loughlin, Janice, Administrative Assistant (From 24 October 2016)

Trinidad and Tobago

Professional staff
Gibson, Norman, Animal Scientist/Head Trinidad and Tobago Unit
Jack, Heidi, Scientist (Officer-in-Charge Tobago Unit From 1 September 2016)
Adams, Herman, Plant Breeder (Post-retirement from 30 September 2016)
Minott, Annika Dr, Scientist I

Technical staff
Ali, Nazir, Field Assistant
Ferreira, Nandi, Technician (To 30 September 2016)
Hudson, Rachel, Secretary
Leith, Hendrickson, Administrative Assistant
Mahabir, Lawrence, Technician (From 1 February 2016)
Quashie, Selby, Technician