2020

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COCOA RESEARCH CENTRE
ANNUAL RESEARCH AND
DEVELOPMENT SYMPOSIUM

Cocoa Research Centre
The University of the West Indies, St. Augustine Campus

RESEARCH AND DEVELOPMENT IN SUPPORT OF THE GLOBAL COCOA INDUSTRY

Wednesday 19th August 2020
Zoom Webinar
9:00 am – 4:00 pm
https://bit.ly/cards2k20

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FEDERATION OF COCOA COMMERCE

PROGRAMME

9:00 – 9:15 Opening Remarks
Prof. Pathmanathan Umaharan *– Director, Cocoa Research Centre, The UWI St. Augustine Campus*

LEVERAGING GENETIC RESOURCES TO SUPPORT THE GLOBAL COCOA INDUSTRY

9:15 – 9:45 CRC for cocoa fingerprinting - Helping conservation and practical use of genetic resources.
Lambert A. Motilal *and Antoinette Sankar*

9:45 – 10:15 Using Geographic Information Systems and Remote Sensing to aid genetic conservation at the International Cocoa Genebank, Trinidad.
Marvin Lewis

10:15 – 10:45 Phenotypic characterisation of cacao conserved by the Cocoa Research Centre.
Frances L. Bekele*, Gillian G. Bidaisee and Junior J. Bhola*

10:45 – 11:00 Exploiting genetic variation for flowering and pod development period for climate adaptation.
Surja Chakrabarti *and Pathmanathan Umaharan*

11:00 – 11:30 Exploiting genetic variation for disease resistance to support cocoa breeding.
Romina Umaharan

11:30 – 12:10 Genetic, seasonal and developmental stage variation of cadmium in *Theobroma cacao* L.
Caleb Lewis*, Adrian Lennon, Gauis Eudoxie and Pathmanathan Umaharan*

IMPROVING MARKETING, PRODUCTIVITY AND QUALITY OF ARTISANAL COCOA

1:00 – 1:30 An evidence-based approach to cadmium mitigation - A case study of Trinidad.
Gideon Ramtahal *and Pathmanathan Umaharan*

1:30 – 2:15 A nuanced approach to fertility management of cocoa farms in Trinidad.
Kamaldeo Maharaj*, Marvin Lewis and Pathmanathan Umaharan*

2:15 – 2:45 Fermentation behaviour and quality of selected cacao (*Theobroma cacao* L.) genetic groups.
Naailah A. Ali*, Darin A. Sukha, Saheeda Mujaffar and Pathmanathan Umaharan*

2:45 – 3:20 Controlling cocoa bean fermentation for enhanced chocolate flavour - Unravelling the microbial community dynamics using Nanopore sequencing technology.
David Gopaulchan*, Gabriel Castrillo, Christopher Moore, Naailah Ali, Michael Wilson, Tristan Dew, Darin Sukha, Sergio Leonardo Florez Gonzalez, Annie Soraya María Zamora Pulecio, Carlos Mauricio Rivera Lozano, Hector Hugo Olarte, Pathmanathan Umaharan and David Salt*

3:20 – 4:00 Sensory quality mapping and branding - Building technology toolkits to support niche marketing of cocoa (*Theobroma cacao* L.).
Darin A. Sukha*, Naailah A. Ali, Vickeisha Lall, Saila Ramkissoon, Krystal Daniel, Lincoln McDonald, Anna Toussaint and Pathmanathan Umaharan*

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ABSTRACTS

CRC for cocoa fingerprinting - Helping conservation and practical use of genetic resources.

Lambert A. Motilal and Antoinette Sankar

Cocoa originated in the Amazon Basin and was moved throughout the tropics and semi-tropics. Trinidad lying just off Venezuela became an important waypoint in the early days leading to an accumulation of early cocoa germplasm in Trinidad. Collation of the cocoa germplasm from various field sites into one central location was formally started in 1982 with the establishment of the International Cocoa Genebank, Trinidad (ICGT). The ICGT contains about 2400 accessions in five main fields. These represent the original collected material and therefore serve as the primary reference material. Cocoa Research Centre has undertaken DNA fingerprinting to determine the correct type trees for each accession.

This cocoa fingerprint database is then leveraged for our client services. We have identified a working panel of 96 single nucleotide polymorphism markers (SNPs) which can reliably discriminate among one thousand varieties. At present, we employ a maximum of 192 SNPs which have led to the identification of over 4000 varieties in our reference database.

Genotyping services for 32 clients have been conducted on samples originating from 19 countries. Clients required decisions on whether their planting material were of the expected type, the number of different types, a best match to known varieties, ancestral background and identification of trees with high Criollo ancestry. Genetic analyses have also helped to identify core collections; supported decisions for community, regional or national batching of cocoa beans; and supported the differences among cocoa producing countries.

CRC is committed to serving the international cocoa community and welcomes requests from all stakeholders in the genetic analyses of cocoa samples collected in the wild, on farms or from *ex situ* genebank collections.

Keywords: ancestry, core collection, DNA fingerprinting, identity, International Cocoa Genebank Trinidad, primary reference, single nucleotide polymorphism

Using Geographic Information Systems and Remote Sensing to aid genetic conservation at the International Cocoa Genebank, Trinidad.

Marvin Lewis

The International Cocoa Genebank Trinidad (ICGT) is reputed to contain the largest and most diverse live collection of cocoa accessions internationally. The ICGT has over 2400 accessions presently on a relatively homogeneous 100-acre expanse, situated at Centeno. Activities at the ICGT include field exploration, agronomic operations, defining core collections, identification of collection gaps, germplasm characterisation, evaluation and the use of plant genetic resources (PGR). The curator of the ICGT is the Cocoa Research Centre of The University of the West Indies (CRC-UWI). The curation of the ICGT is challenged by genetic erosion and also the management of PGR which is a multifaceted process made up of a series of interdependent activities that generates and use geo-referenced data.

Geographic Information Systems (GIS) are progressively playing an important role in the management of the large and complex datasets associated with PGR. GIS can enable complex analyses and output concise results by means of cartographic visualisations. This Maximising Opportunity for Coffee and Cacao in the Americas (MOCCA) Biodiversity Project seeks to establish an ICGT spatial database (one of four initiatives) with the aim of developing a curated information system, funded by the MOCCA Project. The curated information system will allow researchers, staff and users of genetic resources to access, analyse, generate and disseminate ICGT information in a more efficient and robust manner. The ICGT spatial database can also be useful for effective gene bank management, facilitating decision making by informing CRC-UWI of future collections and conservation strategies.

The data will be acquired from existing publications, databases, projects and current census surveys. Field reconnaissance would be undertaken using GNSS receivers to establish the locations of tree and plot accessions and remotely sensed imagery would be captured from both thermal and multispectral equipped drones. In addition, satellite imagery would be used to provide more extensive temporal data. The methodology will involve the ICGT spatial database supporting the Data Application Programming Interface (API) and the Web Map Tile Service (WMTS). Both interfaces would be linked to the tree and plot accession via a primary key for geospatial analysis, modelling and visualisation.

The information products derived from the ICGT spatial database would be disseminated through remotely accessed web portals, supporting prebreeding programmes and the development of molecular markers for cocoa breeding programmes by CRC-UWI and cocoa growing countries. The project is intended to produce a curated information system to aid developmental projects and research, hosted by Campus Information Technology Services of the University of the West Indies (CITS-UWI).

Keywords: Geographic Information System, Remote Sensing, plant genetic resources, genetic conservation

Phenotypic characterisation of cacao conserved by the Cocoa Research Centre.

Frances L. Bekele, Gillian G. Bidaisee and Junior J. Bhola

Morphological characterisation has been a core activity at Cocoa Research Centre (CRC) for more than 28 years. It has facilitated an understanding and universal appreciation of the rich cacao genetic diversity conserved at the International Cocoa Genebank Trinidad (ICGT). There are several superior genotypes (primary and enhanced) that combine favourable yield potential, seed size and other desirable traits. These genotypes and the diverse cacao collection are at the disposal of the international cocoa community. They can be used to improve cacao planting material to increase production and productivity and, subsequently, living income generation within cocoa communities. This presentation focuses on the value of morphological characterisation of cacao at the ICGT and considers the way forward to maximise the benefit of this activity as it pertains to safeguarding the future of the global cocoa and chocolate industry.

Keywords: cacao, cocoa, cocoa improvement, living income, morphological characterisation, production, productivity, yield potential

Exploiting genetic variation for flowering and pod development period for climate adaptation.

Surja Chakrabarti and Pathmanathan Umaharan

Cocoa (*Theobroma cacao* L) is indigenous to the tropical belt of South America from the upper Amazon regions of Peru, Ecuador, in the West Coast of South America to Brazil and the Guianas in the East Coast; and has been classified into 10 genetic groups. Its wide distribution has led to geographical adaptation to various habitats. Cocoa cultivation now extends into most parts of the tropics including West Africa, South and South East Asia, the Pacific and Latin America and the Caribbean region. The climate change predictions for West Africa, in particular, has been adverse and its impact can threaten the supply of cocoa to the chocolate and cocoa based beverage industries.

The current study investigates the genetic diversity for pod development period and flowering time that can provide an escape mechanism during dry periods. Representative accessions from the 10 genetic groups are present at a single location at the International Cocoa Genebank, Trinidad (ICGT), which allows for a study of genetic diversity for flowering time and pod development period without the complication of environmental influences. For two consecutive years (2016-2017 and 2017-2018), a minimum of 10 accessions from each of the 10 genetic groups as well as accessions from two hybrid populations were selected for the study. For each accession 2-3 trees were labelled in March- April (dry season) and flowering times were noted. From each accession 20-40 flowers were tagged and successful pod sets determined after 7 days. At least 10 pods from each accession were followed to maturity with pod length and width measurements taken at fortnightly intervals. At pod maturity the pod dimensions, the number of beans, bean size and bean weight (10 beans) were determined.

The study showed considerable diversity in flowering time following early rains and considerable diversity for pod development period. The study also demonstrated that relationships between bean number and bean size to be not strong indicating that pod development period was not strongly associated with yield characteristics. Further studies on 300 accessions are on-going with the attempt to investigate the genetic control of pod development period. Together this information along with geographical information could provide interesting insights into the evolutionary mechanisms that govern flowering time and pod development period, which in the future will be useful in developing accessions for climate change adaptation.

Keywords: *Theobroma cacao* L., flowering time, pod development period

Exploiting genetic variation for disease resistance to support cocoa breeding.

Romina Umaharan

Black pod and Witches' Broom diseases caused by *Phytophthora palmivora* and *Moniliophthora perniciosa*, respectively are the two major diseases that affect cocoa production in the Caribbean. Along with frosty pod disease caused by *Moniliophthora rorei*, these diseases contribute to over 40% yield losses in Latin America and the Caribbean. In the quest for resistance to black pod and witches' broom disease, the Cocoa Research Centre developed reliable and reproducible screening methods and successfully employed these methods to identify resistance in the International Cocoa Genebank, Trinidad (ICGT). In addition, these screening methods were used in replicated MxN breeding trials, to elucidate the genetic basis of resistance to the two diseases. The identified sources of resistance were employed in a pre-breeding programme to develop two enhanced populations one for black pod resistance and one for witches' broom resistance. Two recombinant cycles of selection using both leaf and pod screening has been completed for the black pod enhanced population. In collaboration with the Ministry of Agriculture, Land and Fisheries the highly resistant individuals from the enhanced population for black pod resistance were mated with the best of the Trinidad Selected Hybrids (TSH) to initiate a breeding programme. The established populations were subjected to leaf screening to identify the most resistant progeny to be planted. The breeding population, upon maturity was again screened for resistance to black pod disease using the pod screening method. The results show high levels of resistance in the progeny population. The population is currently being evaluated by the MALF for yield and yield components for release to farmers. This illustrates a methodology through which the genetic diversity held within the ICGT, can be used to support farmers through a collaborative approach between institutions.

Keywords: Black pod disease, Witches' Broom disease, screening, cocoa breeding, *Phytophthora palmivora*, *Moniliophthora perniciosa*

Genetic, seasonal and developmental stage variation of cadmium in *Theobroma cacao* L.

Caleb Lewis, Adrian Lennon, Gauis Eudoxie and Pathmanathan Umaharan

Cacao (Theobroma cacao L.) is a cash-crop of which the beans are used to make chocolate products. Cadmium (Cd) accumulation in cacao and downstream chocolate products have been identified as a health concern as this metal accumulates in the body and can cause health complications over time. Cadmium accumulation in cacao is affected by factors such as 1) seasonal variation of uptake and accumulation, and 2) genetic traits like the length of pod development. There are no reported studies in cacao on long-term Cd accumulation or how the length of pod development affects Cd accumulation. Identifying seasonal variations in Cd accumulation can result in more efficient application of amelioration efforts to when uptake is highest. Determining how the length of pod development influences Cd accumulation can be used to breed new varieties that produce pods over a time period that supports low bean Cd accumulation. To address these gaps, two studies were performed aimed at 1) assessing how cadmium accumulation varies over a year-long period, and 2) to determine if length of pod development affects Cd accumulation.
In the first study, five high Cd accumulating accessions at the International Cocoa Genebank, Trinidad were sampled for leaves at two-month intervals, beginning April 2019, for a period of a year. Pod samples were also collected during the pod season (beginning in November) of that year. For the second study, six accessions were selected which ranged in length of time for pod development from short (under 120 days) to long (greater than 180 days). Pods were collected from each accession at maturity. Samples from both studies were analysed for four metals (Cd, Mn, Ni, Zn). Results from both studies are discussed.

Keywords: Nickel, leaf development, cocoa, plant metals, contaminants

An evidence-based approach to cadmium mitigation - A case study of Trinidad.

Gideon Ramtahal and Pathmanathan Umaharan

A number of countries within the Latin American and Caribbean region are looking for ways to ensure that their cocoa beans can meet recently enforced EU food safety limits and the proposed CODEX ALIMENTARIUS regulations for cadmium in chocolates and cocoa-based products. To get an understanding of their cadmium issue, some of these countries have done partial research on the distribution and origin of cadmium in their soils and beans in cocoa-growing communities whereas few have conducted thorough studies on factors affecting cadmium uptake and measures of its mitigation. It is thus clear that gaps in cadmium knowledge exist in a number of these countries which are essential for the development of a proper cadmium reduction strategy for cocoa. With over 10 years of experience working on the mitigation of cadmium in cocoa, the Cocoa Research Centre of The University of the West Indies (CRC-UWI) has developed a nuanced approach to this issue. Using research data generated in Trinidad, CRC-UWI has created an evidence-based methodological framework to mitigate cadmium in cocoa which can be extended to affected countries within the region.

Keywords: Cadmium, cocoa, mitigation, evidence-based, method

A nuanced approach to fertility management of cocoa farms in Trinidad.

Kamaldeo Maharaj, Marvin Lewis and Pathmanathan Umaharan

There is a wide productivity gap between the current average cocoa yield of 150 kg ha^{-1} and the potential yield of 1500 kg ha^{-1}. With improved management such as pruning, shade and disease control, cocoa farms have achieved over 300 kg ha^{-1}. It is important to understand the soil deficiencies and replenish the deficient nutrients to further improve yields. Between 2018 and 2019 the Cocoa Research Centre tested soil samples from 172 farms located across the 6 agro-ecological zones (AEZ) and the constituent 43 cocoa communities (CGC) in Trinidad to investigate their fertility status. The approach taken to maximise the results from the soil testing exercise are as follows:

1. A compendium was developed of nutrient analysis (primary, secondary and micro nutrients) and other soil factors (pH, CEC, OM, drainage) by CGC for each AEZ.
2. Nutrient availability status was identified as low, optimum or high and soil factors as satisfactory or not in the compendia.
3. Using the compendia, recommendations are made for improving fertility status and correcting soil factors such as low pH.
4. This allowed for the development of an intervention matrix for all of the CGCs.
5. The existing soil series information was overlaid on the CGC/AEZ GIS maps to provide further information on soil texture, relief and drainage.
6. CRC participated with the CDCTTL and MALF to guide the establishment of ten on-farm and one on-station fertiliser trials using an optimum plane of nutrition for the crop based on the individual soil test results.

The results of the soil testing identified general trends that were common across the country and specific soil fertility issues which were peculiar to individual AEZs or cocoa communities.

- Declining soil pH and CEC values in most AEZs
- Low soil organic matter levels
- Critically low levels of soil nitrogen and potassium (all samples)
- Low levels of Boron (over 95% of samples) and Mg.
- Many instances of low and borderline Phosphorous content
- Inadequate Ca:Mg and Mg:K ratios
- Some cases of low Sulphur, Zinc and Copper

The IMPACTT project initiated training of all its 40 plus beneficiary farmers in good soil fertility management and the development of specific fertiliser recommendation packages for farms based on local availability and cadmium content testing of fertilisers. Preliminary results from the on farm trials are showing a marked yield response to fertiliser use. Practices for field preparation pre-fertiliser use and post application follow up must be well explained to farmers.

Keywords: soil testing, nutrient depletion, fertility management

Fermentation behaviour and quality of selected cacao (*Theobroma cacao* L.) genetic groups.

Naailah Ali, Darin Sukha, Saheeda Mujaffar and Pathmanathan Umaharan

In Trinidad and Tobago, fermentation of Trinitario cacao beans is carried out for 7-8 days with varying degrees of turning to achieve bean death and to elicit flavour precursors responsible for its reputed sensory quality. There is considerable genetic diversity for cacao, with ten recognised genetic clusters, each possessing distinctive bean and pulp characteristics that may require variable fermentation conditions to express their distinctive flavour potentials. The objective of the study was to use an optimised small-scale fermentation protocol developed to determine fermentation behaviour and distinctive quality attributes of six genetic clusters (Contamana, Nanay, Amelonado, Iquitos, Nacional and Marañón) and two hybrid populations (Trinitario and Refractario) over a four-year study period.

The effect of fermentation time on quality attributes of each of these eight groups[1] grown and processed at the same location, was assessed and the following parameters were monitored; temperature progression, pH changes (mass, testa, cotyledon), time to fissuring of cotyledons (cut test) and soluble solids (°Brix) as fermentation progressed. External bean colour during fermentation and after drying, dried bean characteristics (bean count, weight, length, width and thickness) and chemical constituents (selected polyphenols, methylxanthines, acids, sugars, fats and proteins). Bean samples collected throughout fermentation were also dried for assessment of aroma volatiles and processed into cocoa liquors for sensory assessment by a trained panel. Results revealed that (i) Optimum fermentation time for groups varied, with Marañón requiring the most time among the clusters, while Nacional and Contamana required a shorter fermentation time than the other clusters. For hybrids, Refractario required a longer fermentation time than Trinitario. (ii) Fermentation year had an impact on quality, with a significant effect on fresh fruit and browned fruit ($P \leq 0.05$) attributes for all groups across the years. Trends in terms of flavour profiles at optimum fermentation, showed that Nacional varied in terms of floral attribute among the clusters. Whereas at optimum fermentation time, hybrids were less distinct in terms of flavour of cocoa liquors but exhibited varied trends in presence or absence of flavour volatile compounds. For nutraceuticals, among the genetic clusters, there was a significant ($P \leq 0.05$) fermentation day effect for (-)-epicatechin. However, between hybrids there was no difference. With the evolution of the ultra-niche and speciality cocoa markets, this study shows the flavour diversity resident in the various genetic groups can be exploited through fermentation manipulation and provides evidence for a genetics-based branding.

Keywords: cacao, cocoa, genetic cluster, hybrid, postharvest, fermentation, cocoa quality

[1] Genetic group- term used in this study to describe a genetic cluster or hybrid.

Controlling cocoa bean fermentation for enhanced chocolate flavour - Unravelling the microbial community dynamics using Nanopore sequencing technology.

David Gopaulchan, Gabriel Castrillo, Christopher Moore, Naailah Ali, Michael Wilson, Tristan Dew, Darin Sukha, Sergio Leonardo Florez Gonzalez, Annie Soraya María Zamora Pulecio, Carlos Mauricio Rivera Lozano, Hector Hugo Olarte, Pathmanathan Umaharan and David Salt

Quality and flavour of cacao beans are important for the value of chocolate. A number of factors influence the quality and flavour of beans, however bean fermentation is one of the critical steps. During fermentation, many of the flavour compounds are formed while undesirable compounds are broken down. Microorganisms, from the surrounding environment, are mainly responsible for these changes. This study focused on understanding the fermentation process, using genomic, metagenomic and metabolomic approaches, to elucidate the microbial communities and how they influence the flavours in chocolate. Fermentations were analysed from cacao farms in three cocoa growing regions in Colombia (Huila, Santander and Antioquia), that are well known for their unique flavours. 16S rRNA gene and shotgun metagenomic sequencing showed that the microbial communities in the fermenting beans had lower levels of species diversity compared to the microbial communities from the surrounding environment that were potential sources of inoculum. Additionally, the microbial communities from the fermentation and the surrounding environment could be separated into three distinct clusters. The microbial genomes were assembled and annotated using de novo metagenome-assembly approaches and genes were characterised using functional and network analysis. Furthermore, flavour profiling of cocoa liquors from the 3 fermentations showed distinct profiles. The findings are being used to develop a model to predict flavour.

Keywords: *Theobroma cacao* L., fine or flavour cacao, shotgun metagenomic sequencing, long read sequencing, flavour profiling

Sensory quality mapping and branding - Building technology toolkits to support niche marketing of cocoa (*Theobroma cacao* L.).

Darin Sukha, Naailah Ali, Vickeisha Lall, Saila Ramkissoon,
Krystal Daniel, Lincoln McDonald, Anna Toussaint and Pathmanathan Umaharan

The numbers of micro batch chocolate makers operating in boutique markets have grown significantly in the last decade. Premium quality raw materials and meticulous attention to detail are hallmarks of this market segment. Meeting the stringent quality requirements to supply cocoa bean micro lots for this market segment can create many challenges at origin where cocoa supply and value chains are often disjointed, production systems sub optimal and the notion of cocoa quality is sometimes nebulous. To overcome these challenges, the Cocoa Research Centre embarked on a suite of actions as part of the project towards Improving the Marketing and Production of Artisanal Cocoa from Trinidad and Tobago (IMPACTT) to provide a scientific basis behind branding in support of niche marketing of cocoa. This included a 2-year study to characterise the flavour potentials of optimally fermented and dried cocoa bean micro lots from 36 different estates represented in 22 cocoa growing communities across Trinidad. The study employed a stratified sampling approach to source bean samples from farms within cocoa growing communities which in turn were nested within agro-ecological zones. The results indicate considerable flavour diversity within Trinidad that can be leveraged in various branding approaches based on the geographical variation in flavour at the country, regional, estate and even varietal levels. Branding toolkits were also developed using the information generated during this project viz. a farm and processing facility KPI toolkit, as well as comprehensive product certification and traceability toolkits to support building trust in the brand value. These, along with the history, unique story and technical product specifications were used to develop several brands that were marketed using B2B interactions. Sensory quality mapping and geographical based branding together with careful quality control, certification, and traceability forms an integral part of a science-based technology toolkit. These toolkits build trust and support niche marketing of cocoa micro lots from different regions giving farmers a competitive advantage when targeting international boutique markets. This approach can also be extended to other countries to market their fine or flavour cocoa.

Keywords: cacao, cocoa, geographic indications, cocoa quality, flavour, traceability

Cocoa Research Centre
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ABOUT COCOA RESEARCH CENTRE

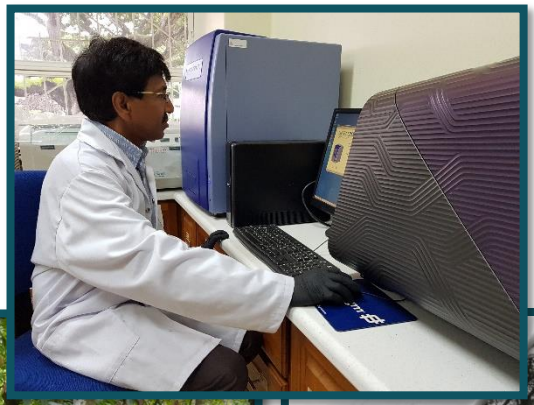
Cocoa Research Centre (CRC) of the University of the West Indies is a research and development Centre within the University of the West Indies (UWI), St. Augustine campus in Trinidad and Tobago. The Centre has a triple mandate to (a) support conservation of cocoa genetic resources, (b) research to improve productivity and quality and to overcome constraints to cocoa production and (c) to support development through a variety of outreach activities. A Cocoa Research Scheme was established in 1930 as part of the predecessor institution to the University of the West Indies, the Imperial College of Tropical Agriculture, which has over time morphed into the Cocoa Research Centre. It has continued its research and development mandate unabatedly over the past 90 years; and is regarded as one of the oldest cocoa research institutions, worldwide.

CRC is the custodian of the International Cocoa Genebank Trinidad (ICGT), consisting of 2400 cocoa varieties maintained in a 100-acre estate in Centeno (**https://sta.uwi.edu/cru**). This is recognised as the largest and most diverse cocoa collection in the world. The genebank offers a range of germplasm services including distribution of primary genetic material, enhanced material and a global DNA fingerprinting service.

In research, CRC is recognised for its early work that led to the development of cocoa varieties tolerant to black pod and witches' broom diseases. Its present work on fermentation and drying, cocoa quality standards, cocoa flavour characterisation, branding and traceability as well as its work on genome wide association studies to develop molecular markers, climate resilience and mitigation of cadmium contamination of cocoa is well known. CRC also works with global chocolate companies, industry organisations such as industry organisation such as the International Cocoa Organisation (ICCO), World Cocoa Foundation (WCF) and European Cocoa Industry Associations such as ECA, CAOBISCO. CRC also supports work in Latin America directly or through NGOs such as Technoserve and Lutheran World Relief.

CRC has set up the International Fine Cocoa Innovation Centre (IFCIC) as a coordinated outreach mechanism to support the fine/flavour sector in the LAC region through a range of training products, technology products and support services. The physical hub will consist of a model cocoa orchard, a modern cocoa postharvest facility, a flexible cocoa processing facility, as well as technology and business incubators to provide support SME development. CRC also offers introductory and advanced chocolate making training host of technology services, apprenticeship training and start- up support.

CONSERVATION, RESEARCH, OUTREACH
COCOA RESEARCH CENTRE







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