COCOA RESEARCH AND DEVELOPMENT SYMPOSIUM

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

# Research and Development Initiatives in Support of Economic Diversification

**Wednesday March 15th 2017**
**Institute of Critical Thinking**
**Lecture Rooms 1 & 2**
**3rd Floor, Centre for Language Learning, UWI, St. Augustine Campus**

# PROGRAMME

**8:00 – 8:30 REGISTRATION**

8:30 – 8:35 Chair
*Mr. Winston Rudder – Chairman, Cocoa Research Advisory Board*

8:35 – 8:45 Welcome Remarks
*Prof. Rhoda Reddock – Deputy Principal, UWI St. Augustine Campus*

8:45 – 8:55 Remarks on The Strategic Planning Exercise
*Ms. Jaqueline Rawlins - CDCTT*

8:55 – 9:05 Remarks – Overview of presentations and their impact on diversification
*Prof. Pathmanathan Umaharan – Director, Cocoa Research Centre, UWI St. Augustine Campus*

9:05 – 9:15 Address by the Honourable Minister of Agriculture, Land and Fisheries
*Senator Clarence Rambharat*

9:15 – 9:45 **COCOA BREAK**

## Conservation and Exploitation of Genetic Resources

9:45 – 10:00 The International Cocoa Genebank Trinidad (ICGT) - a potential Globally Important Agricultural Heritage System (GIAHS) site.
***Frances L. Bekele**, Gillian G. Bidaisee and Junior J. Bhola*

10:00 – 10:15 Current estimates of mislabelling in CRC's cacao germplasm collections.
***Antoinette Sankar**, David Gopaulchan, Saila Ramkissoon, Amrita Mahabir, Michel Boccara, Rena K. Kalloo and Lambert A. Motilal*

10:15 – 10:30 SNP insights into Trinitario cacao.
***David Gopaulchan**, A. Mahabir, A. Sankar and L.A. Motilal*

10:30 – 10:45 Improvement of the Trinidad Selected Hybrids through breeding.
***Julia C. Parris***

## Mitigation of Risk – Frosty Pod, Cadmium Bioaccumulation

10:45 – 11:00 Frosty Pod Rot Disease: reducing the risk of its introduction to the ICGT.
***Romina Umaharan*** *and G. Martijn ten Hoopen*

11:00 – 11:15 Preventing the spread and mitigating the impact of cocoa diseases in the Caribbean.
***G. Martijn ten Hoopen*** *and Romina Umaharan*

11.15 – 11:30 Genetic variation of cadmium bioaccumulation in cocoa.
***Caleb Lewis****, Adrian Lennon, Gaius Eudoxie and P. Umaharan*

11:30 – 11:45 Mitigation of cadmium bioaccumulation in cacao through soil remediation.
***Gideon Ramtahal*** *and P. Umaharan*

## Branding, Start-up Support and Market Development

11:45 – 12:00 What's really at the end of the cocoa rainbow….lessons from the private sector.
***Ashley Parasram***

12:00 – 12:15 Building a branded and value added cocoa industry in Trinidad and Tobago.
***Darin Sukha****, Naailah Ali, Matthew Escalante, Kerry Ann Deo and S. Ramkissoon*

12:15 – 1:15 **LUNCH BREAK**

## Food Technology and Product Development

1:15 – 1:30 The impact of pollen donor on flavour in cocoa.
***D.A. Sukha****, P. Umaharan and David R. Butler*

1:30 – 1:45 An assessment of the effect of cinnamon spice on cocoa nibs: An approach to change flavour in stored roasted cocoa nibs.
***Matthew Escalante****, Gerrit Meerdink and P. Umaharan*

1:45 – 2:00 An investigation of metabolic and cognitive function in a Cafeteria Diet-Induced Obese Rodent Model.
*Aneisha R. Lewis, Farid Youssef and* ***Shamjeet Singh***

2:00 – 2:15 Exploiting the nutraceutical value of cocoa *(Theobroma cacao* L.) germplasm.
***Naailah A. Ali****, Gail S.H. Baccus-Taylor, D.A. Sukha, Saila Ramkissoon and P. Umaharan*

## Innovations in Agronomy to Improve Productivity

2:15 – 2:30 Studies on the rooting of cuttings in *Theobroma cacao* L. – The Cocoa Borlaug Experience.
***Annelle Holder-John***

2:30 – 2:45 Genetic basis of flowering time and pod development period in cocoa: relationships to yield.
***Surja Chakrabarti*** *and P. Umaharan*

**2:45 – 3:15 COCOA BREAK**

## Reducing the Cost of Production through Mechanisation – Small Holder Innovations to Support Farmer Profitability

3:15 – 3:30 Small-holder innovation to support niche marketing- A method for low input, field-based fermentation of 15-30 kg cocoa beans in Trinidad and Tobago.
***Naailah A. Ali****, G.S.H. Baccus-Taylor, D.A. Sukha, R.K. Kalloo and P. Umaharan*

3:30 – 3:45 Engineering innovation to enhance the regional cocoa industry.
***Renique Murray***

## Investment Support through Development of an Information System

3:45 – 4:00 The application of GIS modelling to aid decision making for cocoa production and management.
***Pritam Kumarsingh***

## DISCUSSION AND CLOSING REMARKS

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

# ABSTRACTS

# The International Cocoa Genebank Trinidad (ICGT) - a potential Globally Important Agricultural Heritage System (GIAHS) site.

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

The ICGT is a globally significant, diverse cacao germplasm repository, and an asset that can provide genotypes for sustainable development of the cocoa industry in the face of climate change. It satisfies, to varying degrees, the five criteria of GIAHS, as designated by the FAO. Extensive information has been collated on the valuable cacao genetic resources conserved at the ICGT. For example, of the 2,300 accessions conserved, 1887 have been characterised phenotypically along with 239 enhanced genotypes. Conservation is done in a sustainable manner; low input, with no disturbance of the ecosystem (a feature of *conservation agriculture*). Water resource management is sustainable and environmentally friendly, and involves innovative use of technology combined with traditional knowledge. Furthermore, the cacao trees have become adapted to the micro-environment over time, and some varieties may be adapted to drought and flooding (*climate-smart*). Thus this diverse collection contains genes that may safeguard against future biotic and abiotic stress in cacao. Consequently, it safeguards the livelihoods of cocoa farmers worldwide and can contribute towards ensuring resilient rural livelihoods in cacao growing countries. The ICGT also offers revenue-generating opportunities that will promote biodiversity conservation and protect this rich ecological and cultural heritage and remarkable landscape. Agro-tourism at the ICGT may be used to create public awareness of this biodiversity *hotspot* as well as the best practices for sustainable cacao cultivation. GIAHS status of the ICGT would preserve it for posterity and facilitate the maintenance of a balance between conservation and agricultural and socio-economic development. A case is presented to have the ICGT considered by the FAO for declaration as a GIAHS site.

**Keywords**: cacao, conservation, Globally Important Agricultural Heritage System (GIAHS), sustainability

# Current estimates of mislabelling in CRC's cacao germplasm collections.

Antoinette Sankar, David Gopaulchan, Saila Ramkissoon, Amrita Mahabir, Michel Boccara, Rena K. Kalloo and Lambert A. Motilal

A maximal set of 180 single nucleotide polymorphic (SNP) markers was used to assess the heterogeneity and mislabelling within cacao collections managed by the Cocoa Research Centre. Management units included the International Cocoa Genebank Trinidad (ICGT) at the University Cocoa Research Station; and campus fields and greenhouses located at The UWI. Over 2800 samples from 127 accession groups were fingerprinted and data is being collated and analysed to generate new information on the heterogeneity of plots as well as accession groups and to identify mislabelling of accessions through grouping errors. Heterogeneity per plot or accession ranged from 0 – 100% with an overall average heterogeneity of 27% among all fields. We present here a snapshot of the preliminary data for this on-going exercise.

**Keywords**: cacao collections, SNP, mislabelling, germplasm management, heterogeneous

# SNP insights into Trinitario cacao.

David Gopaulchan, A. Mahabir, A. Sankar and L.A. Motilal

Trinitario cacao represents a group of cacao that is well known for its production and flavour attributes. This traditional group has been described at the morphological and molecular level but has not yet been characterised using single nucleotide polymorphic (SNP) markers. A set of 166 SNPs was used to elucidate the genetic ancestry and relatedness of accessions commonly believed to belong to the Trinitario group. Major contributions were found from Amelonado and Criollo groups but other ancestral lines were present. The data also demonstrated that the genetic background of Trinitario cocoa differed between countries. Differentiation estimates support the existence of distinct accession and umbrella groups. These results are discussed in relation to the ancestry, conservation and flavour of Trinitario cacao.

**Keywords**: SNP, cacao genetic ancestry, Trinitario, genetic groups

# Improvement of the Trinidad Selected Hybrids through breeding.

Julia C Parris

The incidence of cacao diseases such as Black Pod and Witches Broom can result in bean losses of over 40%. Black Pod disease is one of the main factors for low productivity in farmers' fields in Trinidad and Tobago and it negatively impacts on farm incomes. Additionally, Trinidad and Tobago is faced with the threat of a possible introduction of the Frosty Pod Disease (FPR). FPR is a serious fungal disease of cocoa currently ravaging all of the cocoa producing countries in South and Central America including Venezuela and Jamaica which are the closest sites for introduction into Trinidad and Tobago. Prebreeding work for frosty pod resistance has begun. Germplasm material which have known frosty pod resistance were crossed with selected Trinidad Selected Hybrids (TSH) varieties. Crosses were made and plants have been produced for further evaluation. Black pod disease resistance breeding programme began in 2009 where TSH clones with the highest resistance was crossed with Germplasm Enhancement Clones (GEP) which were developed by Cocoa Research Centre (CRC). These clones were screened for resistance using the leaf disc test and were then planted in field trials for further evaluation.

**Keywords**: cocoa, frosty pod, breeding programme, Trinidad Selected Hybrid, germplasm enhancement, disease resistance

# Frosty Pod Rot Disease: reducing the risk of its introduction to the ICGT.

Romina Umaharan[1] and G. Martijn ten Hoopen[1,2]

[1]Cocoa Research Centre, The University of the West Indies, St. Augustine, Trinidad and Tobago.
[2]CIRAD, UPR 106 Bioagresseurs, F-34398 Montpellier, France.

Frosty Pod Rot disease caused by the basidiomycete *Moniliophthora roreri* is the most devastating disease of cocoa (*Theobroma cacao*). This disease, which targets only the pods, can reduce yields by over 80% within a few years after pathogen establishment. In recent years FPR has invaded the last hold-outs in Mesoamerica. It breached Mexico and Belize around 2005, El Salvador around 2009 and expanded its range into South America, entering Bolivia in 2012. Most recently FPR made its first incursion into the Caribbean where it was officially reported in Jamaica, in 2016. This invasive plant pathogen poses a serious threat to the cocoa industry in Trinidad and Tobago as well as the wider Caribbean. The full management cascade recommended for invasive plant pathogens is applicable to Trinidad and Tobago: prevention; early detection and rapid response; and impact mitigation using various control approaches.
This presentation addresses the actions the Cocoa Research Centre, the University of the West Indies, to avoid the arrival of the disease and the measures to be put in place by the Ministry of Agriculture, Lands and Fisheries, Trinidad and Tobago to detect and eradicate FPR if it does. It prioritises actions to be undertaken to cost-effectively manage this disease if it should become established in Trinidad and Tobago.

**Keywords**: cocoa, frosty pod rot, prevention, early detection and rapid response, *Moniliophthora roreri*, *Theobroma cacao*, Trinidad and Tobago

# Preventing the spread and mitigating the impact of cocoa diseases in the Caribbean.

G. Martijn ten Hoopen[1,2] and Romina Umaharan[2]

[1]CIRAD, UPR 106 Bioagresseurs, F-34398 Montpellier, France.
[2]Cocoa Research Centre, The University of the West Indies, St. Augustine, Trinidad and Tobago.

With the arrival of frosty pod rot (FPR, caused by *Moniliophthora roreri*) in Jamaica, the insular Caribbean is now home to three of the "big five" of cocoa (*Theobroma cacao*) diseases. Black pod disease of cocoa (caused by *Phytophthora* spp.) is ubiquitous in the region whereas witches' broom (WB, caused by *M. perniciosa*) and FPR are still restricted to a few countries. The recent arrival of FPR however, is particularly worrying since it is considered to be the most destructive of all cocoa diseases.

Even though the Caribbean contributes little to global cocoa production, it ranks second when it comes to fine flavour cocoa. Moreover, cocoa remains an important source of revenue for a large number of people in the Caribbean. Unfortunately, much of the varieties grown, known for their fine flavour qualities, have little resistance to diseases, especially FPR and/or WB. On top of that, most cocoa producing countries in the region are poorly equipped to prevent the arrival of FPR or WB or eradicate them once they do arrive. Thus, continual spread of these diseases in the Caribbean will have a severe impact on the fine flavour cocoa sector and the livelihoods of those depending on cocoa.

In order to prevent further disease spread within the Caribbean, it is necessary to implement a major programme integrating awareness raising, capacity building, and development of early detection and rapid response measures for eradication. Additionally, countries will have to prepare for when these diseases do become established. The introduction of elite, highly productive cocoa germplasm combining resistance to WB and FPR and good quality attributes is urgently needed. Good agricultural practices that enable maximal expression of these attributes should be developed with and communicated to farmers and other relevant stakeholders. Such an undertaking will have the added benefit of revitalising the sector and increasing productivity.

This can only be successfully realised, however, through a concerted effort among all cocoa producing countries bordering or in the Caribbean. There is an urgent need to make this financially and politically feasible. Only through such a concerted effort will cocoa remain a driver for the sustainable development of the Caribbean.

**Keywords**: cocoa, Caribbean, frosty pod rot, witches' broom, prevention, early detection and rapid response, *Moniliophthora perniciosa, Moniliophthora roreri, Theobroma cacao*

# Mitigation of cadmium bioaccumulation in cacao through soil remediation.

Gideon Ramtahal and Pathmanathan Umaharan

With impending EU regulations on the levels of cadmium in cocoa and chocolate products, investigations are being undertaken at the Cocoa Research Centre to explore different methods of its mitigation including genetic and agronomic approaches. For this part of the study, the effects of various amendments on the availability of cadmium in soil and its uptake in cacao trees are being evaluated. Initial studies were conducted to identify the most effective amendments and their optimal rates of application. Subsequent parallel greenhouse and field experiments were then established and are currently being monitored. The results of the greenhouse study demonstrated that ameliorants biochar and lime had a significant effect on reducing cadmium uptake in cacao plants. Though still ongoing, the field trial shows promising results thus far and could be improved with the further development of treatment application methodologies.

**Keywords:** cacao, cadmium, soil, remediation

# What's really at the end of the cocoa rainbow….lessons from the private sector.

Ashley Parasram

With the increasing demand for cocoa globally the Trinidad and Tobago Fine Cocoa Company has spent the past year investigating a range of cocoa product markets both locally and internationally. With high consumer prices, strong competition and a young fine flavour marketplace the opportunities for growth would not be easy. Together with a high bean price, production and transportation costs, there is no simple path for Trinidad and Tobago entering in the value-added arena.
Key lessons have been learnt on how Trinidad and Tobago can build a dynamic new approach through innovation, origin, branding and marketing, which can lead to a prosperous cocoa sector.

**Keywords**: value addition, branding, cocoa sector, fine flavour cocoa, Trinidad and Tobago, market opportunities

# Building a branded and value added cocoa industry in Trinidad and Tobago.

Darin Sukha, Naailah Ali, Matthew Escalante, Kerry Ann Deo and Saila Ramkissoon

Cocoa Research Centre, The University of the West Indies, St. Augustine, Trinidad and Tobago.

The new economic reality in Trinidad and Tobago has highlighted the need for a more diversified economy to sustainably generate foreign exchange. Towards this end, the Government of the Republic of Trinidad and Tobago through the Cocoa Development Company of Trinidad and Tobago has embarked on an aggressive programme to modernise, revitalise and develop the cocoa value chain to meet the needs of the growing boutique/gourmet markets in the metropolices as well as the burgeoning tourism markets within the Caribbean region. The objective of the research at the Cocoa Research Centre has been to support estates, farmers associations, cooperatives and cocoa value added businesses in Trinidad and Tobago to be able to target their products to these *ultra* niche markets. In this regard the research and innovation, technology development and training efforts have been focused on (a) developing technology toolkits to support the improvement of quality along the value chain, branding, quality certification/ traceability of estates to be able to access lucrative markets (IMPACTT project) and (b) in the training, technology incubation, product development support, start up support and market assistance to value added businesses to be able to take their products to the tourism or metropolitan markets (IFCIC project). The new business models have allowed stakeholders to access more lucrative markets and greatly improve their profitability. The development of the cocoa industry in the future depends on how well these models can be refined and mainstreamed to serve as a catalyst for development in the context of building a branded and value added cocoa industry in Trinidad and Tobago.

**Keywords**: farmer support, niche marketing, branding, quality certification

# The Impact of Pollen Donor on Flavour in Cocoa.

Darin A. Sukha[1##], Pathmanathan Umaharan[1] and David R. Butler[2]

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[2]Street D, No 71, Jardim Atlântico, Ilhéus Bahia, Brazil.

The flavour attributes of cacao (*Theobroma cacao*) is becoming an important consideration in trade specifically for fine or flavour cocoa. In this market segment, flavour along with other physical attributes, not only contributes to the quality of a cocoa lot but also the price premium obtained. Past studies have shown evidence of pollen parent effects on yield, bean size and pod characteristics but its effect on flavour attributes is not clearly understood. An incomplete diallel mating design involving five cacao cultivars, (West African Amelonado (WAA), Imperial College Selection (ICS) 1, Iquitos Mixed Calabacillo (IMC) 67 and two Trinidad Selected Hybrids (TSH) coded as CCL 200 and CCL 201) with widely differing flavour attributes, were used to investigate the magnitude of female and male parent effects on key intrinsic flavour attributes. The seeds derived from pods arising from these pollinations were fermented, dried and made into cocoa liquor according to standardised methods. Flavour evaluations were carried out by a trained sensory panel for nine flavour attributes with five repetitions and hidden flavour reference controls. The study was conducted over two cocoa crop years. The results failed to detect dominant xenia effects for important ancillary flavour attributes i.e., cocoa flavour, acidity, fruitiness and floral flavours but showed significant female parent effects for cocoa and floral flavours. Small but inconsistent male parent effects were seen for astringency. Lack of xenia effect for the major flavour attributes implies that the flavour quality of cocoa beans is determined principally by the genotype of the female parent.

**Keywords**: mating design, pollen donor, pollination, flavour assessment, terroir effect

# An assessment of the effect of cinnamon spice on cocoa nibs: An approach to change flavour in stored roasted cocoa nibs.

Matthew Escalante, Gerrit Meerdink and Pathmanathan Umaharan

The final flavour of fermented and dried cocoa has the potential to be manipulated at every stage of processing. The objective of this experiment was to determine whether the intrinsic flavour of 100g batches of roasted cocoa nibs could be altered to have a favourable cocoa cinnamon flavour by exposure of the nibs to cinnamon sticks. Nibs were surrounded with cinnamon bark sticks at different concentration levels of 2g (2%), 10g (10%) and 25g (25%) per 100 g and stored either in aerated storage containers or vacuum sealed storage bags. The time of exposure was also altered by sampling batches of nibs at five time intervals or infusion days, day 3, 7, 14, 28, 56. The treatments were arranged in factorial structure and replicated twice. A trained sensory panel was used to test the samples via descriptive sensory evaluation on a 10-point hedonic scale with an overall score and uniqueness evaluation of each sample. The "Spice" flavour note, which was identified as a distinctively cinnamon note by the panellists, showed a significant ($P<0.001$) interaction between concentration and storage condition, with the 'Spice' flavour note increasing in a much more pronounced way over concentrations in the vacuum treatment compared to the aerated storage. Infusion treatments with vacuum storage consistently showed higher mean spice flavour scores and increased significantly with storage time ($P<0.01$) with no interaction of exposure time with either concentration or storage treatment. "Floral woodsy" flavour note showed a significant ($P<0.01$) interaction between concentration and storage treatment. Vacuum storage treatment at 25% concentration had higher mean scores for the floral woodsy flavour note. The "Uniqueness" of a sample, as identified by the panellists, also showed a significant interaction ($P<0.001$) between concentration and treatment. The 25% concentration with vacuum storage gave the best uniqueness scores. The overall desirability score was significantly ($P< 0.01$) affected by concentration and was significant at 25% concentration. The outcome of the research indicated that the 25% infusion and vacuum treatment gave or created a novel favourable and unique liquor (product) that is infused with cinnamon that has market potential.

**Keywords**: cocoa nibs, flavour infusion, spice, vacuum storage

# An Investigation of Metabolic and Cognitive Function in a Cafeteria Diet-Induced Obese Rodent Model.

Aneisha R Lewis, Farid Youssef and Shamjeet Singh

Department of Preclinical Sciences, Faculty of Medical Sciences, The University of the West Indies, St. Augustine, Trinidad & Tobago.

Obesity is a global epidemic that is linked to the development of metabolic disorders, including type 2 diabetes mellitus and heart disease. Approximately 31% of the population in Trinidadian and Tobago is obese. Obesity can also inflict a negative impact on cognitive abilities such as learning and memory. These effects, and measures to reverse them, remain poorly understood. Thus the objectives of this research are:

(i) To characterise the metabolic and behavioural effects of excessive caloric intake through a high palatable diet of high-sugar and high-fat, the cafeteria (CAF) diet.

(ii) To explore the effects of chocolate on mitigating these effects.

Two trials will be conducted:

Trial 1: Male Sprague Dawley rats were maintained on control or CAF diets for 18 weeks. Feeding and metabolic variables were monitored. Behavioural tests included the Morris Water Maze (MWM), novel object recognition test and elevated plus maze (EPM).

Trial 2: Male Sprague Dawley rats were maintained on control, CAF or CAF and chocolate (CHOC) diets for 30 weeks. Feeding and metabolic variables were monitored. Behavioural tests were conducted.

The results this far are as follows:

Trial 1: CAF rats showed higher food intakes and energy consumption. The CAF phenotype was characterised by greater body weight, abdominal width and liver weight. CAF rats were pre-diabetic and dyslipidemic. Cognitive deterioration in CAF rats manifested as a decline in long-term retention and recognition memory, increased anxiety levels and decreased exploratory behaviour.

Trial 2: The effects of the CAF diet were similar to trial 1. When compared to CAF rats, CHOC rats showed decreased body weight and abdominal width. However, chocolate did not modulate the behavioural variables. Experiments to investigate the effects on chocolate on biochemical and metabolic variables are pending.

This research demonstrated the the CAF rat produces a phenotype that closely mimics the evolution and metabolic effects of human obesity. CAF diet-induced obesity promotes cognitive decline. The biochemical and metabolic effects of the chocolate require further exploration.

# Exploiting the nutraceutical value of cocoa *(Theobroma cacao* L.) germplasm.

N.A. Ali [1], G.S.H Baccus-Taylor [2], D.A. Sukha [1], S. Ramkissoon[1] and P. Umaharan [1]

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[2]Food Science and Technology Unit, Department of Chemical Engineering, Faculty of Engineering, The University of the West Indies, St. Augustine.

Cacao is an understory tree species indigenous to the Amazonian forests of Peru, Ecuador, Colombia and Brazil, grown for its beans, used in the production of chocolates, chocolate-based beverages and other non-food products. There is now considerable interest in the nutraceutical[1] value of cacao, namely the polyphenol and purine content. The catechin, epicatechin, theobromine and caffeine content of non-fermented, sundried cocoa beans comprising six of the eight genetic clusters (Contamana, Nanay, Amelonado, Iquitos, Nacional and Marañón) identified by Motamayor et al. 2008 and two hybrids (Trinitario and Refractario), all grown at The International Cocoa Genebank Trinidad (ICGT) were evaluated over three successive larger crop harvest periods (January to March) - three years. Beans belonging to the groups were also fermented for 8 days using a small-scale technique which closely mimicked recommended on-farm practices. Samples were collected for testing throughout fermentation. Results revealed interesting trends among samples and years as fermentation progressed. This information along with the improved understanding of fermentation method and time on flavour can significantly impact on the harnessing of ICGT towards genetics based branding and the development of 'health chocolates'. Studies are also underway to understand the impact of growing environment and processing on nutraceutical levels as well as the genetic basis for such differences. Accessions[2] within genetic groups are also being screened for nutraceutical content, optimisation of a protocol for the extraction of polyphenols and development of products.

**Keywords:** theobromine, caffeine, catechin, epicatechin, polyphenol, purine

[1] *"Nutraceutical" is an amalgamation of the words "nutrition" and "pharmaceutical" coined in 1989 by Dr. Stephen DeFelice, Founder and Chairman of the Foundation Innovation in Medicine (FIM). It is used to describe a food (or part of a food) that provides medical or health benefits, including the prevention and/ or treatment of a disease (Kalra, 2003).*
[2] *Accession-refers to plant/seed sample, variety or population held in a genebank or breeding programme for conservation and use.*

# Studies on the rooting of cuttings in *Theobroma cacao* L. – The Cocoa Borlaug Experience.

Annelle Holder-John

Propagation of *Theobroma cacao* L. using rooted cuttings has had a long history in Trinidad and Tobago from as early as the work of Pyke in the 1930's. Although the early work led to some important technological innovations for rooting of cuttings which has led to its commercial exploitation in Trinidad and Tobago and in other parts of the Caribbean, the generalised protocol did not work well with all cocoa accessions. Under the Cocoa Borlaug fellowship in 2016 supported by the World Cocoa Foundation and United States Department of Agriculture, I spent three months at Penn State University with the objective of optimising the rooting protocol. Subsequently in early 2017, I had the opportunity to visit and present my work in Guayaquil, Ecuador. During the fellowship, eight combinations of different rooting hormones were applied to single node cuttings of two cocoa cultivars to determine which treatments induced the most successful rooting. Proportion of cuttings rooted, number of roots and length of roots were three measurements recorded and analysed. Preliminary results indicated that there is an effect of treatment. The presentation will describe the rooting work and share the experience from visiting a number of large cocoa farms in Ecuador.

**Keywords:** propagation, rooted cuttings, rooting hormones, single node cuttings, cocoa, cultivars, treatments, farms

# Genetic basis of flowering time and pod development period in cocoa: relationships to yield.

Surja Chakrabarti and Pathmanathan Umaharan

Cocoa (*Theobroma cacao* L.) is one of the most useful crops in the world. Although chocolate is the main product, cocoa has diversified uses in the soft drink, alcohol, cosmetic and the nutraceutical industry. There is considerable diversity of the species in the Amazonian tropics including Peru, Bolivia, Brazil, Ecuador and Colombia, where cocoa originated. According to recent studies cocoa dispersed in the tropical parts of Central and South America can be grouped into 10 genetic groups. In the recent age the world is facing tremendous climate changes such as increases in temperature, scarcity of rainfall and changes in the rainfall patterns resulting in severe drought. Flowering time and pod development period are important physiological traits associated with geographical adaptation. Although these traits are genetically determined, very little is known regarding the genetic variation for those traits in cocoa and its populations. Representative accessions from the 10 genetic groups representing the various geographical populations of cocoa are present at a single location at the International Cocoa Genebank Trinidad (ICGT), which allows for a comprehensive study of genetic diversity for flowering time and pod development period without the complication of environmental influences. A minimum of 20 accessions from each of the 10 genetic groups were selected and labelled, and the flowering times in the year noted. From each accession 20 flowers were tagged and successful pod sets determined after 7 days. At least 10 pods from each accession will be followed to maturity with pod length and width measurements taken at fortnightly intervals. At pod maturity the pod dimensions, the number of beans and bean size will be determined. The accessions will be deep sequenced at BIO2DATA to obtain SNP profiles. The morpho-physiological data collected from the study will be subjected to GWAS (Genome Wide Association Studies) using the software 'Tassel' to determine loci associated with flowering time and pod development period. This study will help to understand the genetic variation for flowering time and pod development period among the geographical populations of cocoa as well as molecular markers using genome wide association studies (GWAS). The information will also be used to understand the interrelationships between pod development period and yield components, pod size, bean number and bean size in cocoa. 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, SNP profile

# Small-holder innovation to support niche marketing- A method for low input, field-based fermentation of 15-30 kg cocoa beans in Trinidad and Tobago.

N.A. Ali [1], G.S.H Baccus-Taylor [2], D.A. Sukha [1], R.K. Kalloo[1] and P. Umaharan [1]

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[2]Food Science and Technology Unit, Department of Chemical Engineering, Faculty of Engineering, The University of the West Indies, St. Augustine.

With the burgeoning of small gourmet chocolate boutiques in metropolitan regions of the world, niche or ultra-niche marketing of cacao[3] is emerging as an attractive proposition for small-holder farmers in Trinidad and Tobago and the Caribbean. Increasingly cocoa[4] and cocoa products are branded by geography (geographical indication), estate origin or genetic group. The overall objective of the study is to develop technologies, quality and sustainability certification and traceability systems to support the estate level branding and ultra-niche marketing of cocoa from small individual estates to improve the revenue and livelihood of these farmers. This study focussed on optimising small-scale fermentation, drying technologies and developing a training toolkit to support small-holder farmers to produce high quality cocoa. The innovation involved using low cost Styrofoam boxes and tunnel dryers to improve the quality of beans produced. We have carried out three years of studies to optimise fermentation of wet cacao beans, to create a flexible system to support small-holder farmers and to validate these methodologies. The fermentation method is simple, requires no costly inputs and can be executed by a farmer in an estate setting. The design process consisted of three phases; (i) assessment of the methods traditionally used; (ii) optimisation of selected method and (iii) validation of the optimised method. The presentation will describe the findings of the studies and how we intend to roll this out to farmers and possibly link them to boutique chocolate makers.

**Keywords:** fermentation, drying, niche, cacao, cocoa, small-scale, small-holder

[3] *Cacao - refers to the tree, the pods and the unfermented beans from the pods.*
[4] Cocoa- *refers to the seeds of the cacao tree that have been fermented and dried and to the manufactured product (the powder sold for drinking or food manufacturing purposes).*

# Engineering Innovation to Enhance the Regional Cocoa Industry.

Renique Murray

The lucrative and growing bean-to-bar chocolate industry is attracting entrepreneurs and farming communities in Trinidad and Tobago and there is a great demand for training in chocolate making, by foreign experts as well as the internationally recognised experts at the Cocoa Research Centre on the UWI, St Augustine Campus.

However, regional chocolate entrepreneurs have since discovered that the acquisition of equipment to produce the chocolate has prohibitive costs; approaching $1million to equip a basic factory. In most cases, these machines were made for much larger processors and scaling down is not a viable option. Alternatively, some smaller machines are currently available on the market, but were not designed for commercial chocolate making, and are little more than kitchen appliances. In other instances, the equipment simply does not exist. In keeping with this, The Department of Mechanical and Manufacturing Engineering (DMME) through its project unit, the MMERC, has embarked upon a project that seeks to design equipment to meet the needs of the regional industry in a more systematic manner. More specifically, the use of key engineering approaches including mechanical property assessments, energy integration and optimisation and standard product development methodology, are collectively being employed to produce a more reliable, energy efficient and economical machine.

Several initial working models of the equipment have already been designed and tested by the department. Others are currently at various stages of development. Ultimately, the intent of this work is to develop an integrated line of equipment at the working prototype level, which can be used for small to medium scale chocolate production. This will be collated and demonstrated at a prototype facility, which will be tested over an extended period by key stakeholders. In doing so, it will provide an evidence-based platform for future work.

**Keywords:** chocolate production, product design

# The application of GIS modelling to aid decision making for cocoa production and management

Pritam Kumarsingh

Cocoa production faces many challenges locally. These include labour shortages, climate change risks, aging farmers and declining production. Revitalisation of cocoa is generally proposed as one of the areas of diversification that can lead to increase profitability and a source of foreign exchange. The process of revitalisation requires that the smaller estates reverse their declining production, abandoned estates become active and additional land space are made available for potential investors.

Large investments for agricultural pursuits require a cost/ benefit analysis that informs the decision maker to analyse the feasibility of the project. These include the cost of operations, interest rates, return on investments, risk assessments and government policy. All of which are influenced by the site suitability. The decision maker must be satisfied that the proposed site is assessed properly to determine its potential, vulnerability and the cost of mitigation. Site suitability include endogenous physical and biophysical properties including soil analysis, topography, inter and intra seasonal rainfall, length of the growing period (LGP), temperature, humidity, evapotranspiration, pests, diseases, socio economic factors and infrastructure.

Geographic Information Systems (GIS) can store, analyse and manipulate large amounts of geographic data. Applications with a Decision Support System (DSS) can provide information that influences and guide the decision making process. This presentation will identify available technological support and demonstrate the potential use of computer modelling tools to assess the feasibility of cocoa production in Trinidad and Tobago.

**Keywords:** Geographical Information Systems, cocoa production, cocoa estate management

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# PRODUCT DEVELOPMENT

# Baking Chocolate and Drinking Chocolate Bar.

Kerry Ann Deo

## BENEFITS OF INTRODUCING THE BAKING BAR AND THE DRINKING CHOCOLATE

Most chocolate dessert/drink recipes require significant quantities of sugar apart from the added chocolate. Therefore, when sweetened chocolate is used, not only is the sweetness is of the product increased but also the caloric load.

The sugar-free cocoa products, developed at the Cocoa Research Centre (CRC) and presented here, create an avenue for persons to use our local fine or flavour chocolate in everyday cuisine in place of imported, sweetened products that may be costly and less healthy. The availability of the baking and drinking chocolate bars will contribute to building momentum regarding the use of local food and will highlight the efforts being made regarding food security, local value addition and product development.

## BAKING CHOCOLATE (unsweetened)

Unsweetened baking chocolate is well suited for food recipes as it gives the richness of cocoa without the added sweetness and fat. Additionally, it does not significantly alter the food chemistry of a product as sugar, lecithin and cocoa butter are absent. The aim is to produce a fine or flavour, unsweetened baking chocolate to be branded by CRC. The baking chocolate is ideally a 100% cocoa bar, but marketed differently. This allows the product to enter a different product category since it is unsweetened and unadulterated, and hence avoid competition with local chocolate producers.

## DRINKING CHOCOLATE BAR

There are many forms of drinking chocolate existing today, each with different sensory characteristics. The Caribbean has adapted drinking chocolate to what is known as ‘cocoa tea’. The flavour of cocoa tea varies throughout mainly due to the different spice blends used. However, the method of preparation is all the same and includes the chocolate being grated, boiled with chosen spices and strained.

The drinking chocolate bar aims to make the process more convenient, by producing a bar inclusive of spices, which can dissolve in hot liquid upon stirring. The original bar is unsweetened, and has a traditional spice blend. However, multiple alternatives can be made giving rise to a product line.

# Spice Infused Cocoa Nibs.

Matthew Escalante

Roasted cocoa nibs stored with cinnamon in vacuum sealed pouches allow for infusion to occur. The cocoa nibs are stored for a minimum of two weeks with 25% of cinnamon sticks. After the infusion process, nibs may be consumed as is or made into cocoa liquor and/or chocolate. These may then be used in an array of products.

This novel process contributes to the value addition of cocoa and chocolate products by producing various dimensions of flavour.

Cocoa Research Centre
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