eca european cocoa association

CAOBISCO Chocolate, Biscuits and Confectionery of Europe

FCC FEDERATION OF COCOA COMMERCE

JOINT COCOA RESEARCH FUND

Joint Cocoa Research Fund
Bulletin Information

November 2021

Contents

Mitigation of Cadmium Bioaccumulation in Theobroma cacao L.

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Research Institute

- Cocoa Research Centre of the University of the West Indies
- Researchers working in the project: Path Umaharan; Gideon Ramtahal; Caleb Lewis

Framework

- Phase II Cd Project State Date: January 2019
- Project End Date: December 2021
- Expected date of completion: to be discussed
- Reporting Period: April, 2021 to October, 2021 (6 months)

Background

Rationale: The project was initiated in response to the growing global concern of contaminants in food in general and cadmium in cocoa, in particular. Early studies had shown that cadmium in cocoa was particularly a problem in young tropical soils of volcanic origin in the neotropics.

The overall objective of the project was to understand factors affecting cadmium bioaccumulation in cocoa, develop genetic, cultural, and soil amelioration strategies to mitigate against cadmium bioaccumulation in *Theobroma cacao* L

Milestones and Progress

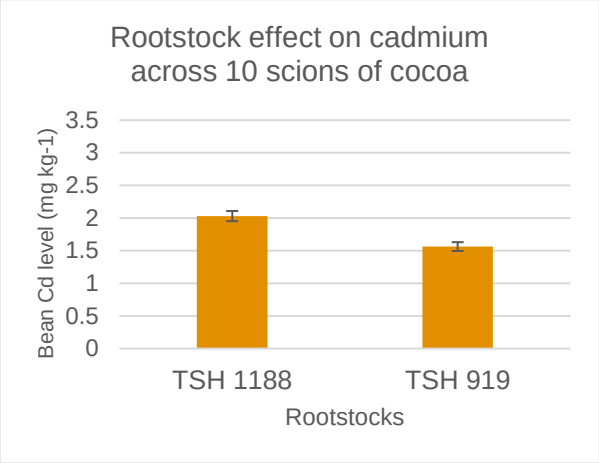
Milestone-2: Stock-Scion Relationship
Objective: Delineate the effect of stock and scion in greenhouse and field experiments

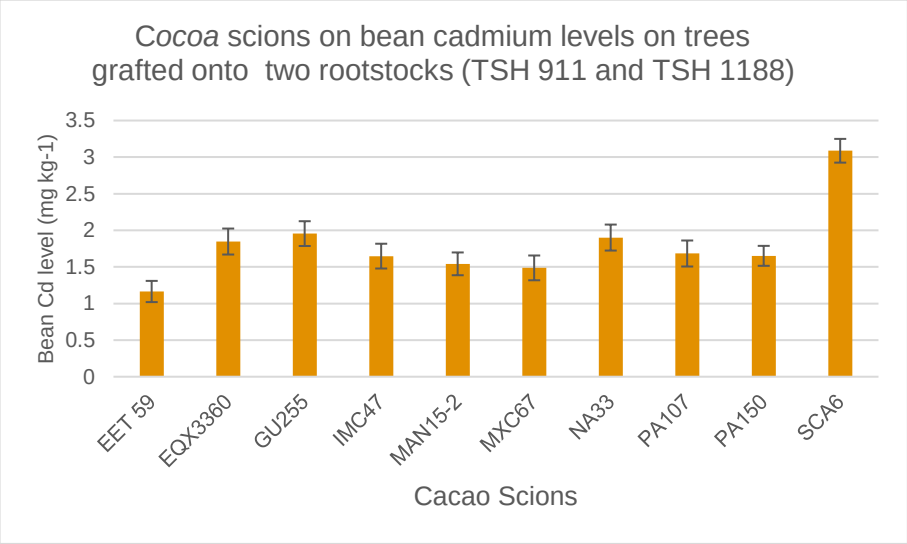
a) Greenhouse experiment
Rooted cuttings of two high and two low cadmium bioaccumulators were selected from a previous field study and were grown for six months of age in a pot trial with high cadmium soil obtained from Biche. They were grafted reciprocally with controls (LL, HH, LH, HL) during April, 2021 and were to be followed for six months.

During the COVID-19 lockdown (May- August) a number of these grafts died although arrangements for watering was made. These are now being rooted for grafting again.

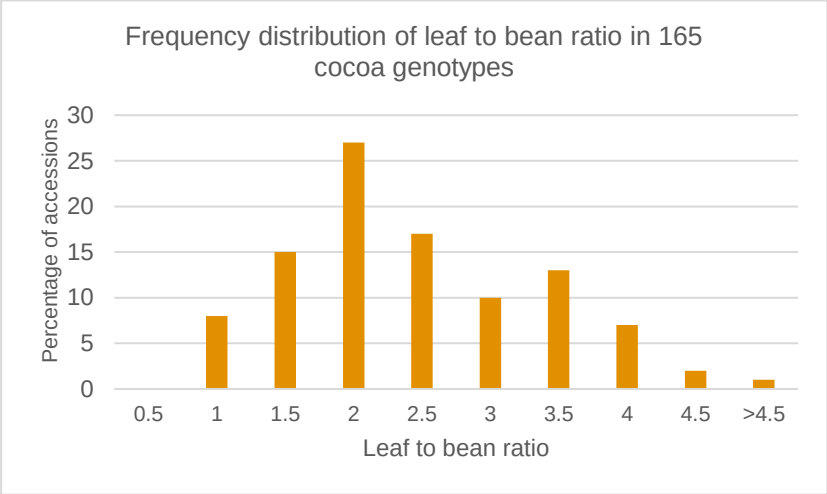
(b) Field experiment:
A field study in a high Cd soil involving 10 scions grafted onto two rootstocks. The 20 treatment combinations were arranged in a randomized complete block design with three replications (plot size 8 trees). An analysis of variance of bean Cd showed significant

differences between rootstocks (33% decrease with TSH 919 rootstock) and between scions (3-fold). Soil analysis data is still pending.



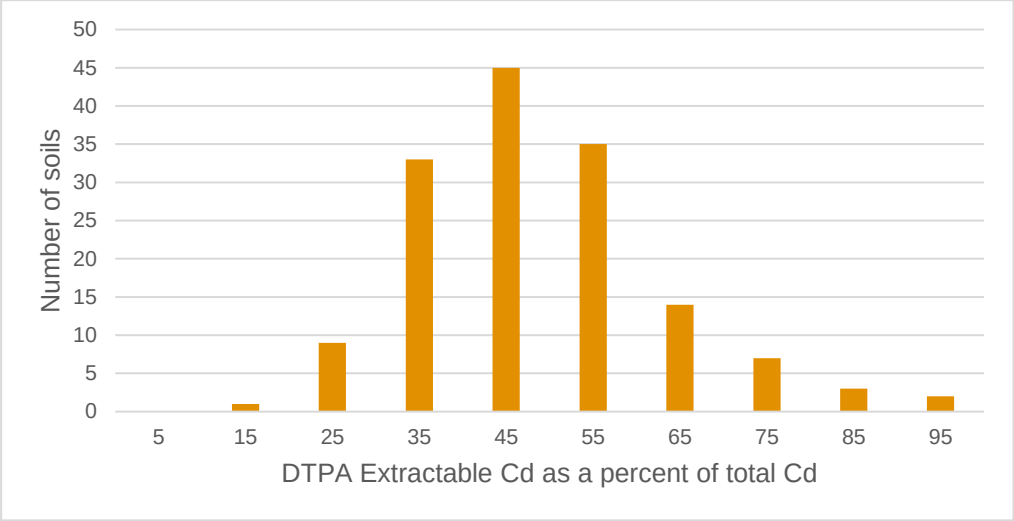


We reanalyzed the data from the genebank study. The results showed large and significant differences in the leaf :bean ratio. Eighty two percent of the cocoa accessions studied had a leaf to bean ratio between 1.5 to 3.5, with a mode of 2. The results shows selecting an appropriate along with an appropriate scion can result in significant reduction in bean Cd.



Milestone-4: Understanding soil physical and chemical properties that influence availability of cadmium to the cocoa tree

150 soil samples collected from 6 agro-ecologies and 44 cocoa communities (total of 150 soils) were analysed for total and available cadmium. The proportion of available cadmium to total cadmium varied widely as seen below.



Eighty five percent of the soil samples in Trinidad had a 35-65% of the total cadmium in the soil that was available. The mode for available cadmium as a percentage of total cadmium was 45 percent.

Milestone 7: Development of other cultural practices to reduce cadmium mitigation – micronutrient applications, tree pruning effects.

Greenhouse Experiment: The effect of application of Zn and Mn in cadmium deficient and sufficient soils were tested in a greenhouse experiment and reported for 6 months. During the study period samples were collected and study extended to 12 months to determine how long the effectiveness of the applications will last. The last sample (12 month) collected is awaiting cadmium analysis. The effectiveness of the applications decreased after 8 months for all treatments except for Zn spray.

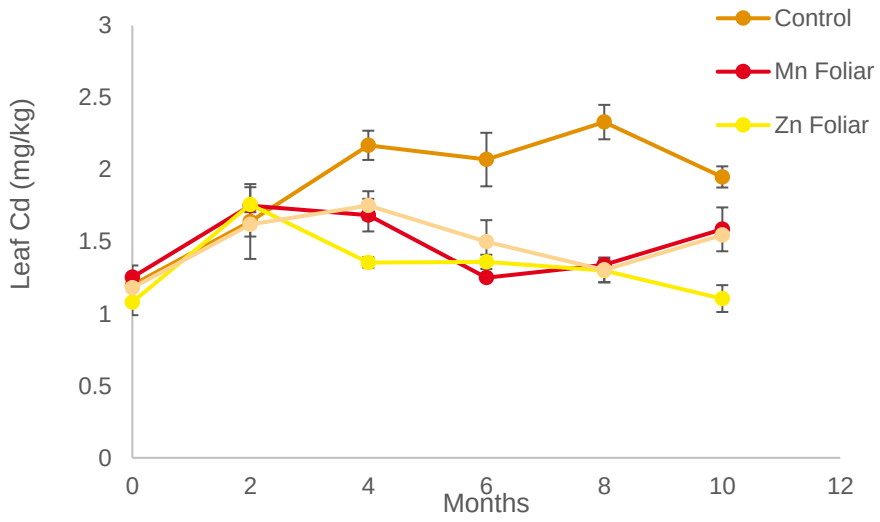


Fig 1: Comparison of micronutrient foliar applications on Cd leaf concentration of cocoa plants in a greenhouse study

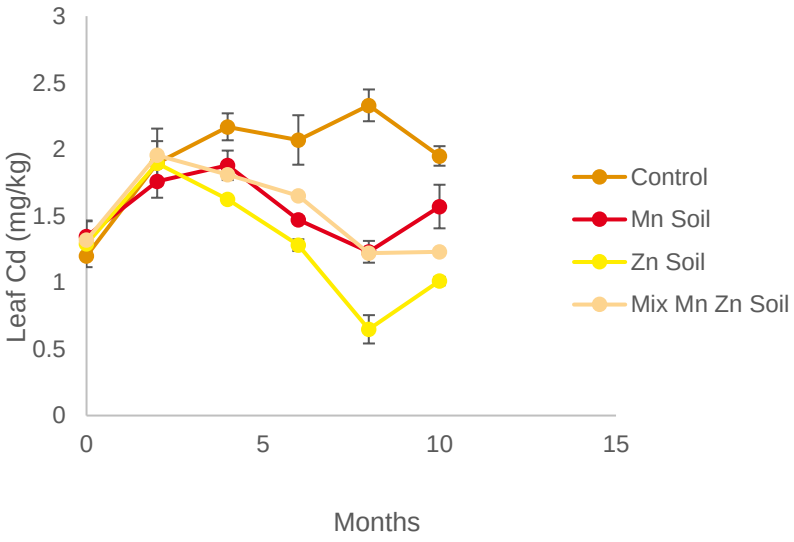


Fig 2: Comparison of micronutrient soil applications on Cd leaf concentration of cocoa plants in a greenhouse study

Field Experiment: To understand the effect of Zn and Mn applications in cadmium deficient soils, based on the recommendation at the last JRF meeting we have now established a field experiment. We have not collected samples as yet for analysis.

Milestone – 8: Understanding the effect of postharvest manipulation on reducing cadmium levels.

Experiment-1
We had shown previously in controlled experiments that the fermentation process results in (a) reduction in the total cadmium level in the cocoa bean (b) increases the level of cadmium in the shell in relation to the nib. We tested the reduction by fermenting 20 varieties and correlating the fermented bean cadmium against the unfermented bean cadmium, in the previous report. To further strengthen the association, we repeated the study in the current crop year. The data analysis is still on going.

Experiment-2
To understand the effect of fermentation on cadmium levels in farmer fermentation systems we sampled the fermenting beans in 6 farms from each of the agro-ecological regions and collected samples over two cycles of fermentation at 0. 2. 4. 6. 8 days. The samples have been processed but the analytical results are still not available.

Transfer of the project results

The data collected over the project period has been used to develop two documents that is useful for wider dissemination

1. A decision tree for cadmium mitigation based on diagnostic analysis of genotype, soil and cultural practices (awaiting the last set of data for finalization) Will be presented at the JRF meeting.
2. A nuanced evidence based approach for cadmium mitigation. This has been developed and is being used to support other countries in LAC. (Completed)

- Communication and transfer of applications to the user group
Developing cadmium maps and mitigation practices in 4 countries in Latin America as part of MOCCA project (completed), a data analysis to support the diagnostic study is underway; Developing cadmium maps and mitigation in Jamaica (GCRF), Haiti (AVSF), Dominica (Compete Caribbean) on going. These offer opportunities to test the evidence-based approach developed under this project in 7 countries in Latin America and the Caribbean.
A video clip is being prepared.

Challenges

- The COVID-19 lockdown during May to August delayed all laboratory work, although field sampling of established experiments continued.
- The lockdown period resulted in a number of grafted plants dying and hence the stock-scion experiment is being repeated.

Next Steps

- Laboratory work and data analysis is to be completed. The field experiment on Zn, Mn application and stock-scion relationship in greenhouse are the only outstanding experiments.

Submissions and Publications

- No new publications emanated during the reporting period. One paper is under revision after review

Ramtahal, G, Umaharan, P, et al. "Mitigation of cadmium uptake in cocoa: efficacy of soil application methods of lime and biochar". Plant and Soil (Under revision).

- Others are being written up

Contributed to the following review:

Vanderschuerena R, Argüelloab D, Blommaertc H, Montalvo D, Barrazadi F, Maurice L. Schreck E, Schulin R, **Lewis C,** Vazquez JL, **Umaharan P**, Chavez E, Sarret G, Smolders, E (2021). Mitigating the level of cadmium in cacao products: Reviewing the transfer of cadmium from soil to chocolate bar. Science of the Total Environment 781 (146779) doi:10.1016/j.scitotenv.2021.146779

Spatially explicit recommendations for optimal levels of shade-tree cover for sustainable cocoa production - Shade-tree Project

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Research Institute
University of Queensland (UQ) and ETH Zürich
Dr. Wilma Hart, Dr. Simon Hart (UQ)
Prof. Jan Wegner, Mr Alexander Becke (ETH Zürich)

Framework
Project starting date: 01.10.2020 (JRF agreement signed 18.03.2021)
Planned date of completion: 30.09.2023
Expected date of completion: 30.09.2023
Reporting Period: 01.04.2020 to 31.10.2021

Background
Efforts to implement cocoa agroforestry to improve production, sustainability, conservation, and climate goals are currently hampered by: 1) limited information on current levels of shade-tree cover and carbon stocks, 2) the need to make recommendations for shade tree cover across large geographic regions but accounting for locally-varying growing conditions, and 3) the lack of a tool to monitor progress on agroforestry initiatives and commitments. This project is designed to assist the industry to overcome these challenges.

The specific aims of this project are to:

1. Develop methods to determine current shade-tree cover and carbon stocks in cocoa farms using artificial intelligence.
2. Develop spatially explicit recommendations for optimal shade-tree cover.
3. Estimate the carbon-sequestration potential of cocoa agroforestry across Ghana and the Ivory Coast.

Milestones and Progress
During the past six months we aimed to reach the following milestones:

1. pilot project to test and adjust the field sampling protocols (May 2021)
2. ground-truth campaign in 330 farms across Ghana (October 2021)
3. pre-processing of satellite images (September 2021).

The pilot project has been completed. The field campaign to collect ground truth data is on schedule to reach ~330 farms by the end of November 2021. As of October 30th, 251 farms have been assessed across 12 administrative districts. Pre-processing of satellite images has been completed.

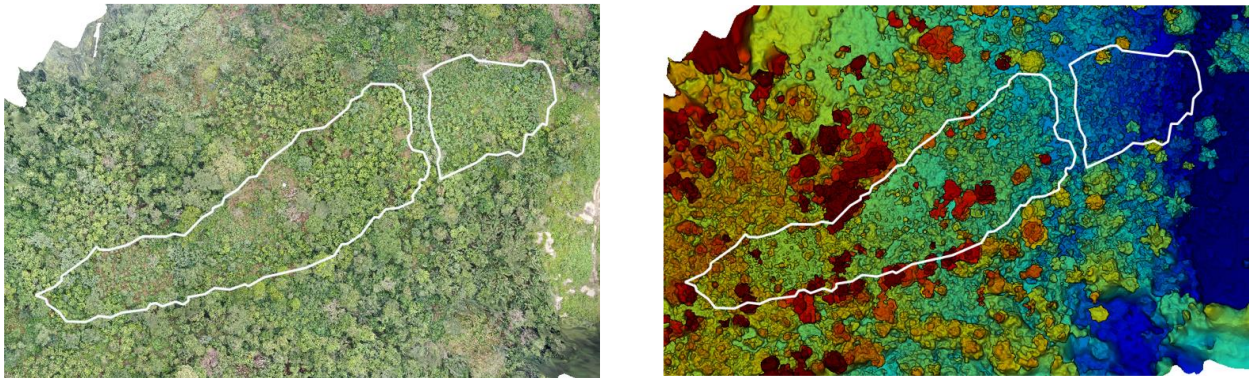

Fig.1 Orthomosaic (left) and digital surface model (right) derived from images captured with a drone at 80m height. White lines delineate the boundaries of two cocoa farms. Shade trees in the digital surface model (right) appear as orange/red colours. The resolution of the images is 2.5 cm/pixel.

Transfer of the project results

As described in our project proposal, development of applications and transfers of project results are scheduled to occur during later project phases.

Challenges

We have encountered the following challenges:

1. Lack of reliable internet in remote locations in the field prevented drone images being uploaded daily. To overcome this issue field teams saved images to hard drives, and data was subsequently uploaded at the end of each week using a slow but stable internet connection at the KNUST University in Kumasi. This procedure led to some data quality issues because it was not possible to check images at the end of each day. However, the team was informed every week about potential sources of poorer quality data and used this feedback to improve the protocol in subsequent weeks.

2. Delays were caused by temporary unavailability of field staff, and tiring field teams. To overcome these issues, we recruited and trained three additional team members so that two teams could alternate in the field.

3. Quality control of the data obtained from farmers' interviews indicate that some farmers substantially overestimate their cocoa yields. To reduce the impact of this issue we have been recording both the overall yield and the yield harvested in a specific plot and so will be able to cross check these values in more detail.

4. Progress on the collection of industry data was slower than anticipated because, Dr. Wilma Hart has been on maternity leave since July 2021. Nevertheless, Dr Hart has continued to lead the project during this period. This has been assisted by a grant specifically to support women in research during their parental leave. Efforts to collect industry data will be intensified over the next reporting period.

Next Steps

Over the next reporting period we will finish the data collection in Ghana (Milestone 4). We will continue to process all the data collected in the field and start with the development of the deep learning methods applied to the data from Ghana (Milestone 6 by March 2022). We will intensify our efforts to obtain data from industry partners until March 2022 (Milestone 5).

Submissions and Publications

As we are in the early stages of this project, no manuscripts resulting from this work were submitted for publication during the reporting period.

Understanding the genetic basis of resistance to Vascular Streak Dieback (VSD) in cacao and developing highthroughput DNA tools to permit Marker Assisted Selection

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Members of Managerial Team: Martin Gilmour (Barry Callebaut), Michelle End (CRA), Bob Eagle
Coordinating Secretariat: Robin Dand (FCC)

Research Institute
University of Sydney
Prof. David Guest
Prof. Robert Park
MA Gurpreet Singh

Framework
Reporting Period: April 2021 – October 2021

Background
The basidiomycete Ceratobasidium Theobromae was identified as the causal organism of a devastating disease of cacao named Vascular-streak Dieback (VSD) in Papua New Guinea in the 1960s. VSD now causes substantial losses in seedlings and kills branches in mature cacao trees throughout south east Asia and parts of Melanesia. The aim of this project is to understand the genetic basis of resistance among cacao trees that are naturally resistant to VSD. Markers conferring resistance to VSD will be identified and tested for their potential use in Marker-assisted selection.

Milestones and Progress
No update

Next steps
No update