STDF PROJECT PREPARATION GRANT (PPG)

PPG Title	**Mitigation and Remediation of Cadmium Contamination in Cocoa Beans in Latin America & the Caribbean**
Budget requested from STDF	US$ 49,710
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I. BACKGROUND

1. The purpose of the PPG is to undertake a more detailed assessment of research and scientific studies conducted in the Latin America and the Caribbean region on mitigation and remediation of cadmium contamination in cocoa, improve knowledge sharing among the research community on this topic and prepare a project proposal for consideration by donors to step up current national programmes.

2. In 2014, the EU Commission introduced Regulation No. 488/2014, which sets maximum residue levels (MRLs) of cadmium (Cd) in a range of foodstuffs, including a level ranging from 0.1 to 0.8 µg/kg in cocoa and chocolate products. Following the five-year moratorium period, this regulation will come into force in January 2019. This new Regulation, if not adhered to, may have a significant impact on market access for several cocoa producing countries to the European market.

3. The ICCO has been actively involved since 2011 in the process before the introduction of this regulation, reviewing studies related to consumers' health and assessing the potential impact of the introduction of this regulation on cocoa trade, organizing meetings with international experts, the cocoa & chocolate industry, governments of cocoa producing countries and the EU Commission. Cd contamination in cocoa beans appears to be an issue affecting mainly producing countries from the Latin American and the Caribbean region, and to a lesser extent Asia. Analysis on soil, leafs and cocoa beans show that Latin America and the Caribbean may have higher concentration of Cd residues in their products, whereas Africa and most Asian countries do not present high concentrations of Cd.

4. At present, Africa is the main source of cocoa beans for the EU market, representing 89% of their imports. Latin America & the Caribbean's share has been rising in recent years, reaching over 10% in the 2014/2015 cocoa year, while Asia accounts now for only 1% of imports. Although the Latin America & the Caribbean region represents a relatively small percentage of the total cocoa beans imports into the EU, this region is the main origin for fine and flavour cocoa and the main source for organic and Fairtrade cocoa. Recent figures on cocoa trade show an increase in demand of cocoa beans from Latin America & the Caribbean as consumption behaviours are moving to origin-based products with specific flavour and aromas. Furthermore, it was noted that the EU market is for most cocoa producing countries in Latin America & the Caribbean the main market of destination of their cocoa: 22% for Colombia, 25% for Venezuela, 30% for Ecuador, 47% for the Dominican Republic, 62% for Peru and 70% for Trinidad & Tobago. As such, disruption of trade with the EU market will jeopardize the income and livelihood of millions of cocoa farmers in Latin America & the Caribbean, and increase poverty of the rural population.

5. While MRLs of cadmium in cocoa and chocolate products will come into force in the EU market soon, the *Codex Alimentarius* is also considering establishing limits. A working group was set up in 2015 to review the proposal and to make recommendations.

6. It should be noted that the Latin American & Caribbean region is increasingly becoming an important source for cocoa in the world, rising from 12% of global cocoa production in the 2007/2008 season to 17% in the 2014/2015 cocoa year. During this period, cocoa production increased on average by 4.7% per year in the Latin American & Caribbean region, while progressing by only 1.3% in Africa and contracting by 4.8% in Asia. The main cocoa producing countries in the region are Ecuador (with a production of 250,000 tonnes in 2014/2015), Brazil (230,000 tonnes), Peru (85,000 tonnes), the Dominican Republic (82,000 tonnes), Colombia (51,000 tonnes), Mexico (28,000 tonnes) and Venezuela (16,000 tonnes).

II. RESEARCH STUDIES IMPLEMENTED IN LATIN AMERICA AND THE CARIBBEAN.

7. In view of the negative impact that this new EU Regulation may have on cocoa trade and the livelihood of cocoa farmers if not properly adhered to, some cocoa producing countries in Latin America & the Caribbean, in close collaboration with cocoa and chocolate industry associations and international research centres, have started conducting scientific studies to understand the major source of Cd contamination factors and to identify/develop adequate remediation or mitigation measures.

8. A review of the current research studies for Cd remediation in Latin America and the Caribbean showed that only a handful of countries are implementing studies to develop and identify mitigation or remediation practices for Cd. The three main focus areas of these research studies are: identifying and understanding the major sources of Cd contamination factors in cocoa; identifying cocoa varieties/clones which have a low absorption capacity of cadmium; and identifying agricultural practices that reduce the presence of Cd available in the soil for absorption. The countries currently implementing research studies on Cd are: Ecuador, Trinidad & Tobago, Peru and Colombia.

9. Following the general review of current research studies on Cd, the ICCO Secretariat contacted the researchers and government officials in each country responsible for the implantation of these studies, with the view to understand in more detail the specific areas of research, the stage/level in which the research are at present and any knowledge gap or technical problem preventing these studies to be finalized. The following information provides an overview of the importance of the cocoa sector in Ecuador, Peru and Trinidad & Tobago and of the initiatives put in place to remediate and mitigate to possible occurrence of Cd in their national cocoa.

ECUADOR

A) The Ecuadorian cocoa sector

10. Cocoa is the longest-standing traditional export product in the history of Ecuador's economy. Around 100,000 families are involved in cocoa farming, accounting for 4.5% of the country's working population and for 13.5% of the agricultural workforce. Ecuador is the largest producer and exporter of fine and flavour cocoa in the world, with a record production in 2014/2015 of 250,000 tonnes. There is a total of 497,000 hectares of land dedicated to cocoa, of which 75% are destined to fine and flavour cocoa. Cocoa is an important contributor to the economies of these families and also generated important revenue to the Ecuadorian economy as a whole. Cocoa exports represented approximately 0.7% of the national GDP for 2015 and 8% of the agricultural GDP. In terms of total exports, cocoa generated US$ 587 million in 2014, representing 4.4% of total national exports, 7% of the non-oil exports, and 7.5% of agro-industrial exports.

11. Over the past 10 years, Ecuador's cocoa production has almost tripled (2.6-fold increase), rising from 96,481 tonnes in 2003 to 250,000 tonnes in 2014. In total, the government of Ecuador has invested during this period a total of USD 91 million on the cocoa sector, 66 USD millions on farm rehabilitation programmes and an additional USD $25 million on provision of seedling, inputs and technical assistance. The government estimates that during this period, for every dollar invested in this sector, a total of USD 1.50 was generated in exports. During the period from 2012-2015, Ecuador moved from the 7th largest cocoa producing country to 4th. It is expected that Ecuador will have invested a total of 1.5 billion USD by the year 2025, resulting in an expansion to 650,000 hectares of cocoa production.

B) Initiatives conducted on Cadmium in Ecuador

12. From 2008 to 2012, with the support of GIZ, CORPEI and ANECACAO, a project entitled "Monitoring the presence of cadmium in cocoa bean, soil and water, and alternative control measures" was implemented in Ecuador. The results of this study identified areas with levels of Cd residues which are well-above the permissible levels of contamination established by the Ecuadorian Food Safety authorities. Results of the cocoa bean analysis showed that Cd concentration is higher in cocoa shells compared with the nibs, and highlighted that cocoa-shells are discarded following the roasting of the beans.

13. The results of the project formed the basis to formulate a new proposal on "Remediation of Cd contaminated soils in the provinces of Manabí, Santa Elena and El Oro". The main activities of the project, which was officially launched in 2013 but only started to be implemented in 2014, are the evaluations of eight different remediation practices in two different doses. Soil and tissue samples (leafs and cocoa pods) were obtained before and after the application of the remediation practices in three different cocoa plantations in each of the three provinces mentioned above. The results have so far demonstrated a considerable reduction in Cd content in the soil.

14. In view of the results obtained at this stage from this study, and considering that the project is running into its third year of implementation (with only two years of data collected), the need was stressed to expand these research studies to complement the results obtained so far. The overall objectives of these additional studies are to develop and evaluate appropriate techniques to remediate cocoa producing areas with high level of Cd. The specific objective of these studies are: i) evaluate the behaviour of various remediation practices in cocoa producing areas with high levels of Cd in the soil and; ii) to select the best option available to remediate Cd contamination in soils.

15. The following studies are currently under implementation and will complement the results of the first study:

a) ***Identification of local/native plants to absorb Cd in areas with high content of Cd in soil***. The main objective of this study is to identify native plants with high capacity to absorb and accumulate Cd. Once identified, these plants can be used as a bio-remediation practice to reduce Cd levels in soils, therefore reducing the amount of Cd available.

b) ***Determine the Cd absorption capacity by cocoa trees on soils with different physical and chemical characteristics.*** The main objective of this study is to evaluate the Cd absorption capacity of soils with contrasting physical and chemical characteristics in order to refine soil management practices and reduce absorption of heavy metals by the cocoa tree.

c) ***Development of alternative post-harvest practices to reduce Cd content in cocoa beans from highly contaminated cocoa-producing areas.*** The main objective of this study is to evaluate post-harvest practices to reduce Cd levels in cocoa beans without affecting the physical and organoleptic characteristics of the cocoa beans.

d) ***Evaluation of Cd absorption by different commercial planting material/clones used for plant-propagation programmes.*** The main objective of this study is to establish Cd absorption capacity of cocoa clones used in commercial plant-propagation programmes with the view to identify clones with low-absorption capacity.

16. The implementation of these studies will continue until the end of 2017. Once finalized, the most promising results will be used to develop a national training programme, which will be included in the Cocoa Reactivation Programme - MAGAP 2012-2021. Although considerable efforts have been invested in these studies, further financial and technical assistance is required in order to achieve

maximum results and finalize the studies as scheduled. The institutions involved in these studies in Ecuador, namely the Ministry of Agriculture and Livestock (MAGAP), through the Cocoa Reactivation Programme 2012-2021 and the National Institute for Agricultural Research (INIAP) have expressed the need to establish a regional network focused on Cd remediation research, with the view to share experiences and pool-together resources for the benefit of all cocoa producing countries in Latin America and the Caribbean.

TRINIDAD & TOBAGO

A) The cocoa sector of Trinidad & Tobago

17. While the local cocoa industry has contracted to approximately 1,300 farmers operating on approximately 7,000 Ha of land, Trinidad and Tobago intends to increase its annual cocoa output from approximately 800 MT to an estimated 3,000 MT within the next five years. This will increase the volumes available to satisfy a growing demand from existing and new international buyers. Some significant developments have taken place and the Government of the Republic of Trinidad and Tobago (GORTT) is taking steps to promote and develop the national cocoa industry.

18. In December 2013, the GORTT established the Cocoa Development Company of Trinidad and Tobago Limited (CDCTTL) under the Companies Act 1995, with its primary function to facilitate the development of the local cocoa industry in Trinidad and Tobago. The CDCTTL is committed to increasing bean production, adopting more robust Quality Management Systems, supporting aggressive marketing and brand development, including promoting Geographical Indications (GI) and traceability systems among other measures.

19. Within the past three years, there has been a growing interest in value addition into chocolate and other non-food products, as stakeholders seek to diversify income derived from cocoa. Over 100 MT of cocoa beans are utilized locally for this purpose. Along this vein, the GORTT (MFP) has entered into a Memorandum of Understanding with a local based chocolate company, the Trinidad and Tobago Fine Cocoa Company Limited, who will process up to 100 MT of beans into cocoa liquor and couverture for export to UK markets starting in the latter half of 2015. This arrangement will assist in stimulating investment into the sector via the higher revenues derived from value addition to increase bean production and providing secondary products for local chocolatiers to utilize in a range of cocoa-based products.

B) Initiatives conducted on Cadmium in Trinidad & Tobago

20. Studies on cadmium in cocoa in Trinidad and Tobago started in 2006 at the University of the West Indies with support from the Government of the Republic of Trinidad and Tobago and continued through 2012. During this period, an island wide soil survey and an island wide study of bioaccumulation of cadmium in cocoa was carried out, with a view to understand the possible sources of contamination and to understand relationships between soil and cadmium in the cocoa plant. The study also investigated two soil remediation methods to alleviate the problem of bioaccumulation. Subsequently, with support from ECA/CAOBISCO/FCC, three associations representing the European cocoa and chocolate industry, the Cocoa Research Centre of the University of the West Indies started another study (2014-2017) to further investigate methods of mitigation of cadmium in cocoa. Both genetic and soil amelioration strategies were investigated in this study. Furthermore the studies identified suitable methods for measuring total and available cadmium in the soil and cadmium in various parts of the cocoa plant.

Soil and Cocoa Plant Tissue Survey

21. The study identified areas that were contaminated with cadmium and investigated the possible geological and anthropological causes of cadmium contamination. A GIS based map of cadmium levels in the soil was developed and superimposed on geological, soil, terrain, agro-climate maps to further investigate the causes at the macro (country) and micro (local) levels. Screening of fertilizers, river systems, and potential source of contamination along the cocoa value chain were also investigated. Phosphorous based fertilizers as well as flooding were identified as potential sources of contamination in addition to geological factors.

22. A survey of cocoa plant tissue showed that the available cadmium for absorption in the soil was better correlated to cadmium in the leaf, pod, husk and bean rather than total cadmium in the soil. The DTPA and Mellich III based extraction methods were the best suited for measuring available cadmium in the soil. The bioaccumulation was more in the leaves, followed by husk and beans. In the beans it was more in the testa than in the cotyledons.

23. Of the factors investigated, pH, Zn, Fe and organic matter contributed to the availability of cadmium and hence remediation studies were targeted with regards to altering these.

Genetic variability for Cadmium Bioaccumulation

24. A study was conducted to investigate the bioaccumulation of cadmium in 100 accessions of cocoa representing the various genetic groups at the International Cocoa Genebank. A 20-fold variation in bioaccumulation was seen in both leaf and bean cadmium levels. There was also some evidence of differential partitioning into leaf and bean. The results are now being verified in a hydroponics system and the results would be expected by middle of 2017.

25. Based on the results, grafting studies are being planned for early 2017 to investigate the effectiveness of rootstock manipulation as a method of alleviating cadmium bioaccumulation. Studies to understand the genetic mechanism for cadmium bioaccumulation are also being envisaged.

Soil remediation

26. Soil remediation aimed at changing the pH, Zn, Fe or organic matter is being investigated in-vitro, greenhouse and field studies. Preliminary results are promising and work will continue over a period of 18 months. Early results should be available in the middle of 2017. Greenhouse studies were also conducted on the effect of mycorrhizal associations on plant cadmium levels.

Competition studies

27. Using the hydroponic system, competition between Cd bioaccumulation and other minerals will be investigated in the latter half of 2016. These results will provide the basis to both understand the availability of cadmium in various soils as well as methods of mitigating bioaccumulation.

Cultural methods

28. A number of cultural methods are also being investigated under the ECA/CAOBISCO/FCC project to reduce the level of cadmium, including the effect of the age of trees on cadmium levels, the effect of pruning, mineral fertilization and mulch replacement.

29. As part of the ECA/CAOBISCO/FCC project, a handbook is planned to be developed for further testing of technologies developed in other countries. This will include the efficacy of genetic, soil amelioration and cultural and combination strategies on mitigating cadmium in the beans.

Difficulties and gaps

30. Field studies of cadmium are complicated by the effects of genotype, age of trees, geological and local environmental factors as well as anthropological influences such as history of cultural practices. Testing these factors require controlled studies where the influence of other factors can be restrained. Having tested out the factors, system level studies would have to be conducted to validate the efficacy of mitigation methods identified in a more complex environment. Some of the experience gained has allowed circumventing these complications to create technological solutions. Further testing of these measures is critical.

Conclusion

31. The studies in Trinidad and Tobago have mapped cadmium levels in soil and in the cocoa tree to identify potential cadmium affected areas. The results have allowed understanding the factors that contribute to contamination levels and factors that contribute to cadmium bioaccumulation in the cocoa tree. This has allowed designing and testing genetic, soil amelioration and cultural strategies under controlled conditions to reduce cadmium bioaccumulation in cocoa. These technologies are being tested both under greenhouse and field conditions. Early results are promising and can form the basis of management of cadmium bioaccumulation of cocoa in tropical soils. Further studies are required to field test combination strategies under more complex situations to overcome the problem in cadmium in the short term. Further genetic studies are required to further strategies for long-term management of cadmium in cocoa beans.

PERU

A) The Peruvian cocoa sector

32. The Peruvian cocoa sector has been thriving over the last 10 years, with an estimated increase in total exports over the same period calculated at around 600%. In 2015, the total value of cocoa exports in Peru was estimated at around US$ 220 million, which represents an increase of 15% compared to 2014. In term of percentage, USA represents 17% of total exports, followed by Belgium (14%), Colombia (14%), The Netherlands (13%) and Italy (9%). Over the last decades, Peru has become a major origin for the Fine and Flavour cocoa market, being the second largest exporter of this type of cocoa.

33. Cocoa is among the main products promoted by the Alternative-Crop Development Programme. Recent years have witnessed: highly-dynamic growth in terms of area expansion and exports (both volumes and earnings); quality-based promotion campaigns at domestic and international level; technology transfer; a more specialized workforce, thanks to training in crop management, post-harvest management, as well as training of tasters for sensory evaluation; and finally, the manufacture hand-made fine chocolate brands enjoying protected designation of origin, which are gradually finding a sustainable place in a demanding market.

34. Cocoa production plays a major social role in Peru, as cocoa is a key component of international programmes to eradicate illegal crops. The Peru Cocoa Alliance, a public-private initiative supported by the United States Agency for International Development (USAID), seeks to help generate lawful economic opportunities for small farmers who have abandoned illegal coca planting in the San Martín, Huánuco and Ucayali regions. The main challenge is to increase the number of farmers by at least 16,000 by planting 28,000 hectares of new land with fine and flavour cocoa varieties by September 2016. To date, assistance has been provided to over 16,500 families in 999 communities, by planting 20,504 hectares of cocoa in the three regions mentioned above (7,534 ha. in San Martín, 6,642 ha. in Ucayali and 6,327 ha. in Huánuco). A recent visit to the VII Salon del

Cacao y Chocolate del Peru in July 2016 allowed ICCO staff to speak to cocoa farmers previously involved in coca-leaf production to share their experiences.

B) Initiatives conducted on Cadmium in Peru

35. Contamination of cocoa beans with Cadmium and other heavy metals are a major concern for the Peruvian cocoa sector. In view of the review and possible introduction of food-safety regulations, the Peruvian government, through public-private partnerships and in close collaboration with international donor agencies, implemented studies to assess the problem of Cadmium contamination. A summary of some of these studies is presented as follows:

- Following the signature of Contract Nº I – 014-0-COMP II, (2007), the Andean Development Bank (CAF), within the framework of the Competitiveness Project – Programme for Competitiveness, Governance and Social Investment, implemented a study on "Diagnosis and Proposed Parameters for the Standardization of Post-Harvest Practices in Cocoa". The main objective of this study was to relate the post-harvest process with cocoa quality, where physical, chemical and organoleptic studies were implemented on cocoa beans exported to the European market. Within the chemical analysis, Cadmium content was included in the studies made; these studies were implemented with Chocolate Bernain AG (Switzerland), SGS Institute FRESENIUS GMBH (Germany), KVB Schwartauer Werke (Germany) and CertiLab (Peru). The results of these studies indicate that Cadmium content in cocoa beans can range from 0.085 to 1.2 µg/kg, where most of the Cadmium accumulated was found in the cocoa shell, with small amounts founds on the nibs.

- A consultancy implemented by the Instituto de Cultivos Tropical (ICT) and the Sustainable Rural Development Programme of GIZ (at the time, GTZ) in 2008 carried out a study on "Monitoring the Presence of Cadmium in Cocoa Beans, Soil and Water in the San Martin and Amazonas Regions" with the view to identify areas with high levels of Cadmium contamination in different cocoa production systems. The study involved 38 cocoa farms, where 228 soil samples were taken and analysed, showing low levels of Cadmium contamination in the soil. Additionally, a total of 146 cocoa bean samples were analysed, of which 101 samples (69.18%) tested negative on Cadmium contamination, while 45 recorded levels of Cadmiun in the beans. The analysis of the cocoa bean samples was implemented at the lab of ICT in Tarapoto, following international protocols for the testing. These studies showed there are considerable spatial variabilities within the two regions regarding Cadmium content. The results of the study recorded Cadmiun content values between 0.02-0.46 ppm in soil samples. In addition, the study analyzed soil samples taken at 6 different depths in the same cocoa farmers, showing Cadmium contents in all the soil analysis. In San Martin, a total of 104 fresh-bean samples were collected from 28 different cocoa farms. Cadmium residues where found in all samples, ranging from 0.10-2.97 ppm in fresh cocoa bean samples and 0.10-2.29 in fermented cocoa-beans. The study highlighted that samples from fermented cocoa-beans are managed through centralized systems, therefore becoming difficult to identify the source of the cocoa beans with Cadmium levels.

- The Universidad Nacional Agraria de La Selva, (2010), implemented studies to assess Cadmium content for the Cooperativa Agraria Cafetalera Divisoria, located in Tingo Maria – Huanuco. The study evaluated 22 soil samples, which resulted in Cadmium content in the range of 0.38 – 1.52 ppm, while tissue samples assessed resulted in ranges from 0.17 - 0.26 ppm.

- In 2011, TechnoServe, in close collaboration with CITE Cacao, the organization in charge of innovation and technology transfer for the cocoa sector, established a strategic alliance between local and international cooperation agencies. The main objective of this alliance was to establish Cadmium and Lead content in soil and bean samples for the region of San Martin. The study,

entitled “Study on Cadmium and Lead content in Cocoa in the region of San Martin”, identified the presence of Cadmium in cocoa beans at a range of 0.05 – 1.171 ppm.

- The CAI Naranjillo (2011) implemented a preliminary study on Cadmium content in soils and cocoa beans produced and traded by this cooperative. It was established that phosphoric rock had Cadmium concentration of 12.782 ppm, which can be considered a contaminating source. The average Cadmium content for cocoa beans evaluated was 0.736 ppm of Cadmium.

- Preliminary discussion were held with the Consejo Nacional de Ciencia, Tecnologia e Innovacion Tecnica (Concytec) to formulate studies with the view to identify the source of Cadmium contamination and methods to reduce its absorption by cocoa beans.

- In 2012, the Universidad Peruano Cayetano Heredia initiated a study with the view to identify and select microorganisms resistant to Cadmium able to produce psydephores and melanines, which have a proved chelation capacity on heavy metals. The study selected three strains of microorganisms with high resistance levels to Cadmium, which has so far shown to limit Cadmium availability in the soil. The three strains of microorganisms identified can be used as an alternative agricultural practice to limit Cadmium availability in the soil for absorption by the plant.

- Peru’s distinctive geography is divided by the Cordillera Blanca, which contains 70% of the tropical glaciers known in the world and is a major source of water for domestic and agricultural consumption. The water from these glaciers converges along the cities in the river side of the Santa River, the main water affluent on the Pacific Valley. Over the last decades, the effect of global warming has caused a considerable reduction of these glaciers. The melting of these glaciers has led to the exposure of mineral rocks which, in most cases, contain heavy metals. In addition to this phenomenon, the valley covered by the Santa River has seen decades of small/medium size mining activity. Most of these mines, which were set-up illegally, have led to an uncontrolled disposal of heavy metals, particularly Cadmium and Lead, which are being transported through the water along thousands of agricultural areas. Based on this precedence, this project aims to identify native plants with high capacity to bio-remediate heavy metals from the soil. Initial activities are focused on the identification of native plants along the delta of the River Santa. These plants are currently being assessed for the resistance to heavy metals and they absorption capacity. Based on the information provided above, there is an urgent need to develop a national strategy to identify major areas of contamination within cocoa producing regions. This strategy will allow scientists and experts from various institutions in Peru to understand the factors promoting Cadmium absorption (and contamination) in cocoa beans and develop mitigation practices and adequate tools to make better recommendation for the benefit of the whole cocoa-supply chain.

CODEX ALIMENTARIUS – PROJECT TO ESTABLISH MAXIMUM RESIDUE LEVELS OF CADMIUM IN COCOA AND COCOA-BASED PRODUCTS

36. While MRLs of cadmium in cocoa and chocolate products will come into force in the EU market soon, the *Codex Alimentarius* is also considering establishing limits. A working group was set up in 2015 to review the proposal and to make recommendations.

37. During the 6th meeting of the Food Contaminants Committee (March 2012), Members reported on the proposal to evaluate the exposure of Cadmium (Cd) through cocoa and cocoa-based products, to be included in the list of priorities for contaminants and natural toxic substances proposed for evaluation by the *Joint Expert Committee on Food Additives* (JEFCA). The Committee agreed to include the proposal on the list and expressed that relevant data was needed to implement this evaluation.

38. At the request of the Food Contaminant Committee, the issue of evaluating the exposure of Cd on cocoa and cocoa-based products was considered during the 77th meeting of JEFCA (June 2013). The results of JEFCA meeting were examined at the 8th meeting of the Committee (April 2014).

39. At the 8th meeting of the Committee, the delegation of Ecuador presented a proposal for a study to establish new MRLs for Cd in chocolate and cocoa-based products, based on the evaluation of the Working Group on priorities, which also met during this period. The delegation highlighted that even though JEFCA (77th meeting) informed that Cd intake as a result of chocolate and cocoa consumption was not a real health concern, lack of MRLs for Cd in cocoa beans and cocoa-based products, threatens cocoa exports from some Member countries, particularly developing countries, which are the main exporters of cocoa. The Committee decided to initiate a new study to establish MRLs for Cd on chocolate and cocoa-based products. A decision was made at the 37th session of the *Codex Alimentarius* Commission (July 2014) which approved the implementation of the work proposed by the Working Group.

40. At the 9th meeting of the Committee (March 2015), it was agreed to create an electronic Working Group (e-WG), chaired by Ecuador and co-chaired by Brazil and Ghana, with the view to review the proposal on MRLs for Cd in chocolate and cocoa-based products, taking into consideration the observations made during this meeting. The e-WG should clearly establish the products for which MRLs will be established and provide supporting evidence.

41. In view of this situation, all member states of Codex and international observers were invited to examine the conclusions and recommendations and provide observations over the MRLs proposed, for discussion during the 10th meeting of the Committee (April 2016). Discussions at Codex level will continue are still on-going. Members of the e-WG recommended working on the categorization of various types of chocolates and thereafter collecting scientific data on Cd presence in chocolate samples, based on different categories (cocoa content). An issue raised since the beginning of the discussions is a lack standard methods to evaluate Cd content in cocoa and its sub-products. As such, the e-WG requested the Committee to establish standard methods for evaluating Cd presence.

III. RATIONALE

42. The entry into-force of Regulation EC/488/2014 may have severe consequences on cocoa trade and the livelihood of millions of cocoa producers in Latin America and the Caribbean should these countries not comply with food-safety regulations. At present, there are more than one million families in Latin America and the Caribbean who depend directly on cocoa production, in addition to thousands more that depend indirectly involved in the cocoa economy. The EU market is for most cocoa producing countries in Latin America & the Caribbean the main market of destination of their cocoa, accounting for a large share of their exports: 22% for Colombia, 25% for Venezuela, 30% for Ecuador, 47% for the Dominican Republic, 62% for Peru and 70% for Trinidad & Tobago.

43. Compliance with food safety regulations is a priority for countries whose economic development strategies rely on exports of commodities as a main source of foreign exchange; access to these markets is vital to ensure sustainability of their development and social programmes. However, knowledge and technical gaps within their scientific community can sometimes hampers their capacity to respond to new market demands. These knowledge and technical gaps, when not addressed rapidly and effectively, only contribute to an increase in poverty, particularly in rural areas where cocoa farmers are located.

44. As described in the previous section, several cocoa producing countries in Latin America and the Caribbean are implementing research studies to assess the level of Cd contamination in cocoa-producing areas and develop practices to limit Cd contamination in cocoa beans. Despite these efforts, at present there is no coordination or information-exchange among research institutes and food-safety

authorities in the countries affected to share results obtained, develop joint strategies and mitigation/remediation practices for the benefit of all cocoa producing countries in this region. Moreover, the information provided by Ecuador, Trinidad and Tobago and Peru shows that the research areas under evaluation are common in most countries, hence the need to coordination regional actions for the benefit of all cocoa farmers.

45. In view of the information provided above, there is an urgent need to undertake a detailed assessment of research and scientific studies implemented in Latin America and the Caribbean, with the view to understand the level of knowledge and stage of development of practices to mitigate/remediate Cd contamination in cocoa beans. This information will allow research institutes in cocoa producing countries in Latin America and the Caribbean, as well as food-safety authorities, to maximize resources and efforts and establish common areas of collaboration and exchange that can yield results in the short-term and provide scientific arguments to develop a solid regional strategy to mitigate/remediate Cd absorption and ensure market access with products that are innocuous for consumption based on food-safety regulations

IV. OBJECTIVE & IMPLEMENTATION

46. The overall objective of this PPG is to develop a regional project proposal on "Mitigation and Remediation of Cadmium Contamination in Cocoa Beans in Latin America and the Caribbean", focusing on three countries for which presence of Cadmium in cocoa has been identified in some areas: Ecuador, Trinidad and Tobago and Peru. In addition, the situation in the Dominican Republic, Nicaragua and Venezuela will be reviewed for possible inclusion.

47. An international expert with known experience on heavy metals will assess in detail all scientific and research studies developed in Latin America and the Caribbean and by the international community. The information will allow the consultant to establish a detailed status of these studies and will help identify any knowledge/technical gap preventing the development of effective mitigation/remediation practices.

48. The ICCO Secretariat has held consultations with food-safety authorities and representatives from the cocoa sector in Ecuador, Trinidad & Tobago and Peru. These consultations have allowed ICCO to identify experts in each country who have the capacity to act as focal points for this consultancy. These focal point persons will be responsible to assist the consultant and the ICCO Secretariat in the collection of detailed information about research and scientific studies implemented in each country, as well as liaising with local experts who will contribute to this consultancy.

49. Once information about each country is collected, the consultant will collate all information available and make an evaluation of the level of development of mitigation practices to reduce Cd absorption and develop mitigation/remediation practices for cocoa farmers. This information will be described and developed into a framework that will be used to formulate a full project proposal for funding. As countries in Latin America and the Caribbean are each at different stages of development in terms of mitigation practices, the propose framework will allow each country to adapt and formulate activities according to their level of development and need.

50. The work of the consultant will start in January 2017 and will run until the end of June 2017 (6 months). The consultant will begin activities by designing a survey questionnaire which will be used in all participating countries to collect the required information. CABI will be the designated institution in charge of implementing the project. Once the information is collected and assessed, the consultant will start the preparation of the framework for the full project proposal. In April 2017, CABI, in close collaboration with ICCO and the government of Peru, will organize a scientific workshop, where the consultant will share the initial findings. A description of the activities and responsibilities of the project consultant is available in **Appendix 3** at the end of this document. This

meeting will also allow experts from participating countries to share their knowledge and experience in developing remediation/mitigation practices. This exchange of information is expected to enrich the knowledge at regional level and allow countries to identify knowledge and technical gaps in their research. The project framework will then be refined by the consultant based on the findings of this exercise and the comments made by participants. A detailed timetable with specific activities is available in **Table 1**.

51. The total cost of this consultancy amounts to a total of US$ 66,878. The total amount of funds requested for support by the STDF is US$ 49,710. Additionally, the Government of Peru will provide co-financing and in-kind contribution for a total of US$ 17,168. The funds requested to STDF (US$ 49,710) will be used to cover the consultancy fees of CABI, and the regional scientific workshop (travel costs of experts/scientist from the countries participating in this process). The additional funds (US$ 17,168) will be provided by project partners to cover the logistic costs and other expenditures for the organization of the workshop. A detailed budget with a breakdown of each activity is available in **Table 2.**

52. The ICCO Secretariat has held informal discussions with several international partners, including donor agencies, regional development banks and industry associations, to assess the level of support for the implementation of this proposal. All partners agree that urgent actions need to be implemented in cocoa producing countries affected by this regulation in order to ensure market access and ongoing trade with the European market.

53. Following the International Workshop on Cadmium in Cocoa and Chocolate Products workshop organized by the ICCO in May 2012, the European Commission expressed its willingness to finance such a programme. Being the regional block that introduced the MRLs of Cadmium in chocolate products, the European Commission is committed to assist any trade-partner in improving their production systems with the view to ensure the much needed market access and revenue generated from cocoa production and trade. Further consultations with the Commission's Directorate-General for International Cooperation and Development (DG DEVCO) are being conducted to identify the best channel to finance such an initiative at European level.

54. The ICCO Secretariat also contacted industry associations in Europe to inform them about the on-going work to develop a regional proposal for Cadmium remediation. The European cocoa confectionary industry, through a three-party collaboration between CAOBISCO, ECA and the FCC, are currently supporting the implementation of the project entitled “Towards a strategy for the mitigation of cadmium contamination in cocoa”. This project, which is being implemented by the University of the West Indies – Cocoa Research Unit – in Trinidad / Tobago, will yield results that will allow experts from the region to develop mitigation practices to limit Cadmium contamination in cocoa. The findings of this project, which is in its final year of implementation, will be shared among the scientific community in the region. CAOBISCO, through its ECA/CAOBISCO/FCC Joint Cocoa Quality and Productivity working group, has expressed its support toward the formulation and implementation of a regional programme on Cadmium mitigation.

55. Finally, in early July 2016, the ICCO Secretariat met with representatives from the *Corporación Andina de Fomento* (CAF), which is the Andean development bank. Representatives from CAF are currently launching a Latin American Cacao Initiative (ILAC), and ICCO will act as technical and policy advisor, as well as assisting CAF in the formulation of project proposal and regional programmes. Within the framework of this initiative, there is a strong component on market access and quality assurance. The Secretariat of CAF is fully aware of the introduction of the regulation on Cadmium and is committed to contribute to the formulation and implementation of a regional strategy to mitigate Cadmium contamination, once a clear strategy is identified for the region. The actions for such programme can be integrated within the framework of the Latin America Cocoa Initiative.

TABLE 1. WORK PROGRAMME
(JANUARY – JUNE 2017)

Components		January				February				March				April				May				June			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Component 1. Assessment of Information on Cd Remediation/Mitigation																									
Activity 1.1	Formulation of survey forms for the collection of information																								
Activity 1.2	Collection of Information on Cd contamination studies and remediation/mitigation																								
Activity 1.3	Assessment and formulation of framework for regional project proposal																								
Activity 1.4	In-country consultation with stakeholders																								
Component 2. Regional Workshop on Mitigation and Remediation of Cd Contamination in Cocoa Beans																									
Activity 2.1	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)																								

TABLE 2. DETAILED BUDGET

Activity		Inputs required	Unit	Qty	Unit Cost (US$)	Sub Total (US$)	5% Cont	Total Cost (US$)	Source of Funding		
									STDF	Co-funding	External co-financing
Component 1	**Assessment of information available on Cd contamination and remediation/mitigation practices**										
Activity 1.1	Formulation of survey forms for the collection of information	Staff time	days	3	600	1,800	90	1,890	1,890		
Activity 1.2	Collection of Information on Cd contamination studies and remediation/mitigation	Staff time	days	10	600	6,000	300	6,300	6,300		
Activity 1.3	Assessment and formulation of regional project proposal	Staff time for resource person	days	24	600	14,400	720	15,120	15,120		
Activity 1.4	In-country consultation with stakeholders	Travel ICCO Expert	ticket	1	3,000	3,000	150	3,150	3,150		
		DSA ICCO Expert	days	12	227	2,724	136	2,860	2,860		
	Total Component 1					**27,924**	**1,396**	**29,320**	**29,320**	**0**	**0**
Component 2	**Technical Workshop on Cd Contamination and Remediation/Mitigation Practices**										
Travel costs for experts											

Activity		Inputs required	Unit	Qty	Unit Cost (US$)	Sub Total (US$)	5% Cont	Total Cost (US$)	Source of Funding		
									STDF	Co-funding	External co-financing
Activity 2.1	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	Travel Consultant (UK)	ticket	1	1,100	1,100	55	1,155	1,155		
	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	DSA Consultant (UK)	days	7	227	1,589	79	1,668	1,668		
	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	Travel Consultant Latin American	ticket	1	900	900	45	945	945		
	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	DSA Consultant Latin American	days	5	227	1,135	57	1,192	1,192		
	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	Staff time for resource person Consultant (UK)	days	4	600	2,400	120	2,520	2,520		
	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	Travel Experts Trinidad & Tobago	ticket	2	900	1,800	90	1,890	1,890		
	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	DSA Experts Trinidad & Tobago	days	10	227	2,270	114	2,384	2,384		
	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	Travel Experts Ecuador	ticket	2	650	1,300	65	1,365	1,365		
	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	DSA Experts Ecuador	days	10	227	2,270	114	2,384	2,384		

Activity		Inputs required	Unit	Qty	Unit Cost (US$)	Sub Total (US$)	5% Cont	Total Cost (US$)	Source of Funding		
									STDF	Co-funding	External co-financing
	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	Travel experts Peru	ticket	2	300	600	30	630	630		
	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	DSA experts Peru	days	10	227	2,270	114	2,384	2,384		
	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	Travel Expert Venezuela	ticket	1	650	650	33	683	683		
	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	DSA Expert Venezuela	days	5	227	1,135	57	1,192	1,192		
Venue & workshop logistics											
Activity 2.1	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	Venue	lumpsum	1	5,000	5,000	250	5,250		5,250	
	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	Fees for 2 interpreters	days	6	500	3,000	150	3,150		3,150	
	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	Interpretation equipment	days	3	350	1,050	53	1,103		1,103	
Activity 2.1	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	Stationary	lumpsum	1	800	800	40	840		840	
	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	Laptop and audiovisual	lumpsum	1	1,500	1,500	75	1,575		1,575	

Activity		Inputs required	Unit	Qty	Unit Cost (US$)	Sub Total (US$)	5% Cont	Total Cost (US$)	Source of Funding		
									STDF	Co-funding	External co-financing
	Regional workshop on Cd remediation and mitigation practices (Lima, Peru)	Lunch for participants (50 participants)	lumpsum	1	5,000	5,000	250	5,250		5,250	
	Total Component 2					**35,769**	**1,788**	**37,557**	**20,390**	**17,168**	**0**
	TOTAL COST					**63,693**	**3,185**	**66,878**	**49,710**	**17,168**	**0**

Appendixes

Appendix 1: Letters of support from each of the organizations supporting this proposal.

See letters from:

1. Ministry of Agriculture, Ministry of Agriculture, Livestock and Aquaculture of Ecuador
2. Ministry of Agriculture of Peru
3. Instituto de Cultivos Tropicales (ICT) – Peru
4. Centro de Innovación del Cacao – Peru
5. National University of Agriculture of La Selva – Peru
6. Cayetano Heredia Peruvian University - Peru
7. Cocoa Research Centre, University of West Indies – Trinidad and Tobago
8. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
9. Caobisco (European Chocolate, Biscuits and Confectionery association) / Federation of Cocoa Commerce (FCC) / European Cocoa Association (ECA)
10. Alianza Cacao Perú / USAID

1) **Appendix 2:** Curriculum Vitae and record of achievements for any consultants proposed to implement this PPG.

CURRICULUM VITAE

NAME:	Jayne Crozier	**DATE OF BIRTH:**	4 May 1972
PROFESSION:	Coordinator for Trade & Commodities CABI-UK/Plant Pathologist		
NATIONALITY:	British		
COUNTRIES WORKED:	Ghana, Malawi, Ethiopia, Kenya, Costa Rica, Nicaragua, Honduras, Ecuador, Peru, Venezuela, Malaysia and Indonesia		
YEARS' EXPERIENCE:	13		

KEY QUALIFICATIONS:

Over 13 years' experience as a plant pathologist diagnosing disease and implementing management strategies to address food security for tropical crops. This includes 6 years' experience living and working in Latin America implementing and managing projects in the region. Experience of phytosanitary measures for quarantine plant pests as well as investigation of new disease outbreaks and control measures. Experience in lecturing and training in plant health diagnosis and production of extension material. Recent training in pest risk analysis, PRINCE2 Project Management Practitioner qualification, Pesticide Application Certification PA1 and PA6a.

EDUCATION:

Manchester Metropolitan University	2001	PhD, thesis title 'Biological Control of Wood Decay in Tropical Hardwoods'
Manchester Metropolitan University	1995	BSc (Hons), Applied Biological Sciences
Manchester Metropolitan University	1993	HND (Higher National Diploma), Applied Biological Sciences

EMPLOYMENT RECORD:

CABI, UK 2012 to present	**Coordinator for Trade & Commodities CABI-UK/Plant Pathologist** Currently coordinator for Trade and Commodities in CABI-UK which includes responsibilities for business development, project development and implementation within the theme. Specialising primarily in pest management and food safety of cocoa. I also form part of the European support team for the CABI Plantwise initiative. Working with in-country staff to train 'plant doctors' to give better plant disease diagnoses and management recommendations to farmers in Ghana, Ethiopia and Malawi.
Costa Rica, 2006 to 2012	**Team Leader/Plant Pathologist** Secondment for 6 years managing the CABI office in the Centro Agronómico de Investigación y Enseñanza (CATIE), Turrialba, Costa Rica. I managed a team of local staff and students undertaking project work in plant protection. Other responsibilities included the development and implementation of other regional projects, particularly in commodity crops.

CABI, UK, 2003 to 2006	**Molecular Plant Pathologist. Improvement of Coffee Production in Africa.** Control of Coffee Wilt Disease in Eastern and Central Africa where there was a re-emergence of this major coffee disease, caused by *Gibberella xylarioides*. Several molecular techniques to study the epidemiology and variability of this economically important pathogen were used. **Molecular Plant Pathologist. Spread of Bacterial Banana Wilt in Africa**. Previously unrecorded in Uganda, Rwanda and DR Congo, *X. campestris* pv *musasearum* was isolated and identified from banana tissue samples. Inoculation into disease free tissue, re-isolation and identification confirmed Koch's postulates. Rep PCR using BOX and ERIC primers showed that the isolates from Uganda, Rwanda and DRC were identical to those from Ethiopia causing disease in *Musa* and *Ensete* but distinct from isolates causing disease in other hosts. **CABI Identification Service** – identification of yeasts and bacteria using fatty acid analysis, biochemical and molecular methods. Molecular characterisation of *Phytophthora* and *Pythium*. **Global Plant Clinic** – Diagnosis of plant diseases and disorders and offering advice on disease management and control on a wide range of crops.

PROFESSIONAL EXPERIENCE:

Malaysia, Indonesia & Papua New Guinea 2013 – 2016 STDF Multiple trips	**Project Team Member** This project is working to build SPS capacity in Indonesia, Malaysia and Papua New Guinea that will help ensure production and trade of cocoa that meets both food safety and international standards on pesticide residues and other harmful contaminants. Best practices are being promoted throughout the cocoa value chain from production to export to improve the production of high-quality cocoa that complies with international regulations and legislation. Locally adapted training curricula have been developed for each country which includes good agricultural practices, good manufacturing practices and food safety mitigation practices for pesticide residues, heavy metals, PAH and Aflatoxin. CABI staff, working alongside local experts, have begun training 'Master Facilitators' including lead farmers, extension staff, processors and agro-input suppliers who have gone on to train 'Facilitators' who in turn will train their peers in best practices. Project partners include the International Cocoa Organisation (ICCO), the Malaysian Cocoa Board, the Indonesian Coffee and Cocoa Research Institute, PNG Cocoa and Coconut Research Institute and Mars.
Ghana, Ethiopia & Malawi 2012 – ongoing Multiple Donors Multiple trips	**Plantwise European Support Team.** Plantwise is a global programme led by CABI, which works to help farmers lose less of what they grow to plant health problems. Working closely with national agricultural advisory services we establish and support sustainable networks of plant clinics, run by trained plant doctors, where farmers can find practical plant health advice. As part of the European Support team I work with in country CABI staff and national plant protection agencies and other stakeholders in Ghana, Ethiopia and Malawi. Activities include: training 'plant doctors' in diagnosing plant pests and making recommendations to farmers for their management; provide technical backstopping to plant clinic operations; training of stakeholders in the development of extension materials for extension staff and farmers; data management and validation and training on the monitoring and evaluation of plant clinic performance.

Ghana 2015 AfDB, 6 weeks	**Expert Consultant. Supporting Cocoa Farmers: Market Needs Assessment.** Enhancing agro-advisory services though provision of mobile Value Added Services (mVAS) in Ghana. The initial Market Needs Assessment was used to assist in designing and piloting the mVAS to promote cocoa productivity in Ghana in combination with nutrition-sensitive agricultural advice.
Costa Rica and Trinidad & Tobago 2010 & 2014 UNEP & GEF 1 week in CR 2 week in T&T	**Expert Consultant. Preventing the Entry of Moniliophthora roreri (Causal Agent of Frosty Pod Rot of Cocoa) into Trinidad and Tobago.** i) Conducted a training course for a group from the T&T Ministry of Agriculture's phytosanitary unit to strengthen detection and interception of *M. roreri* causal agent of frosty pod rot, so as to prevent, for as long as possible, the introduction into the country. ii) Development of a draft Emergency Action Plan (EAP) to be implemented in the prevention, management and control of the Frosty Pod Rot disease if it should enter T&T. A workshop was also held with stakeholders to identify pertinent members to be included in the response Committee and simulation exercises were carried out to test mechanisms for the EAPs mobilisation.
Peru & Venezuela 2009 - 2012 LNV through ECA/CAOBISCO Multiple trips	**Project Manager. Heavy metal contamination of cocoa and the soils in which it grows.** Recent research has shown that cocoa is one of the foods which can be contaminated with high levels of heavy metals, especially cadmium and lead, which is an increasing concern to the EU. This project reviewed available literature to assess the extent of the problem and the countries affected, reviewed current EU legislation, identified key partner countries and institutes as collaborators. Phase 2 established standard sampling and analysis protocols in line with EU accreditation and soil and cocoa tissue were analysed. Information packs were prepared about cause and extent of contamination, with recommendations made for reduction of contamination and remediation. Findings from the project contributed to data used by producing countries and cocoa industry, through ICCO to lobby the EU to increase permitted levels of Cd in cocoa products in new legislation due to come into force in 2016.
Costa Rica & Ecuador 2006 – 2012 USDA-ARS	**Project Manager. Integrated Pest Management of diseases of cocoa.** The project was part of the 'Alternative Crops Programme' led by USDA-ARS. The fungal diseases frosty pod rot and witches' broom are the major constraints to cocoa production in Latin America. Classical biological control agents were investigated as an alternative to traditional chemical controls: design and implementation of *in vitro* screening methods for control agents, small scale and large scale field trials in Costa Rica and Ecuador; development of biocontrol formulation and application techniques. Investigation into the management of the diseases by means of IPM and rational pesticide use.
Nicaragua 2010 – 2011 The Global Plant Clinic through DIFID 1 month Multiple trips	**Diagnostic consultant. Nicaragua – Public Plant Health Service.** This assignment was to make an assessment of the national plant health laboratory network in Nicaragua, assist in capacity building and make recommendations to improve the diagnostic service for plant diseases and physiological disorders.

LANGUAGES, 1 (POOR) TO 5 (VERY GOOD):

Language	Reading	Speaking	Writing
English	5	5	5
Spanish	4	3	3
French	2	1	1

RECENT PUBLICATIONS:

Buddie, A.G., Crozier, J., Rutherford, M.A., Flood, J. and Bridge, P.D. (2015) Population development within the coffee wilt pathogen Gibberella xylarioides reflects host-related divergence. European Journal of Plant Pathology 142, 291–304. doi:10.1007/s10658-015-0613-z

Crozier J, Arroyo C, Morales H, Melnick RL, Strem MD, Vinyard BT, Collins R, Holmes KA and Bailey BA (2015) The influence of formulation on Trichoderma biological activity and frosty pod rot management in Theobroma cacao. Plant Pathology, 64 (6), 1385-1395 Doi: 10.1111/ppa.12383

Ali S, Melnick R, **Crozier J**, Phillips-Mora W, Strem M, Shao J, Zhang D, Sicher R, Meinhardt L and Bailey B (2014) *Moniliophthora roreri* result in differential *Theobroma cacao* gene expression depending on the clone's level of tolerance. Molecular Plant Pathology 15 (7), 698–710.

Bailey BA, Melnick RL, Strem MD, **Crozier J**, Shao J, Sicher R, Philips-Mora W, Ali SS, Zhang D, Meinhardt L (2014) Differential gene expression by *Moniliophthora roreri* while overcoming cacao tolerance in the field. Molecular Plant Pathology 15 (7), 711–729.

Meinhardt LW, Costa GGL, Thomazella DPT, Teixeira PJPL, Carazzolle MF, Schuster SC, Carlson JE, Guiltinan MJ, Mieczkowski P, Farmer A, Ramaraj T, **Crozier J**, Davis RE, Shao J, Melnick RL, Pereira GAG and Bailey BA (2014) Genome and secretome analysis of the hemibiotrophic fungal pathogen, *Moniliophthora roreri*, which causes frosty pod rot disease of cacao: Mechanisms of the biotrophic and necrotrophic phases. BMC Genomics 15 (1), 164.

Bailey B, **Crozier J**, Sicher RC, Strem MD, Melnick M, Carazzolle MF, Costa G, Pereira G, Zhang D, Maximova S, Guiltinan M and Meinhardt L (2013) Dynamic changes in pod and fungal physiology associated with the shift from biotrophy to necrotrophy during the infection of *Theobroma cacao* by *Moniliophthora roreri*. Physiological and Molecular Plant Pathology 81, 84–96.

Melnick RL, Strem MD, **Crozier J**, Sicher RC and Bailey B (2013) Molecular and metabolic changes of cherelle wilt of cacao and its effect on *Moniliophthora roreri*. Physiological and Molecular Plant Pathology 84, 153–162.

Bailey B, **Crozier J**, Sicher RC, Strem MD, Melnick M, Carazzolle MF, Costa G, Pereira G, Zhang D, Maximova S, Guiltinan M, and Meinhardt L (2012) Dynamic changes in pod and fungal physiology associated with the shift from biotrophy to necrotrophy during the infection of *Theobroma cacao* by *Moniliophthora roreri*. Physiological and Molecular Plant Pathology 81, 84-96.

Bailey BA, Bae H, Melnick R, **Crozier J** (2011) The Endophytic *Trichoderma hamatum* Isolate DIS 219b Enhances Seedling Growth and Delays the Onset of Drought Stress in *Theobroma cacao*. In: Endophytes of Forest Trees: Biology and Applications. Eds: Pirttila AM & Frank AC. Springer USA, Forestry Sciences, Volume 80, Part 2, 157-172.

Krauss U, Hidalgo E, Bateman R, Adonijah V, Arroyo C, Garcia J, **Crozier J**, Brown N, ten Hoopen M & Holmes K (2010) Improving the formulation and timing of application of endophytic biocontrol and chemical agents against frosty pod rot (*Moniliophthora roreri*) in cocoa (*Theobroma cacao*). Biolocial Control 54 (3) 230-240.

Bailey BA, Bae H, Strem MD, **Crozier J**, Thomas SE, Samuels GJ, Vinyard BT, Holmes KA (2008) Antibiosis, mycoparasitism, and colonization success for endophytic *Trichoderma* isolates with biological control potential in *Theobroma cacao*. Biological Control 46 (1) 24-35.

Thomas SE, **Crozier J**, Aime MC, Evans HC, Holmes KA (2008) Molecular characterisation of fungal endophytic morpho-species isolated from pods and stems of *Theobroma gileri*, a close relative of *T. cacao*. Mycological Research 112 (7) 852-860.

Aritua V, Parkinson N, Thwaites R, Heeney JV, Jones DR, Tushemereirwe W, **Crozier J**, Reeder R, Stead DE, Smith J (2007) Characterization of the *Xanthomonas* sp. causing wilt of enset and banana and its proposed reclassification as a strain of *X. vasicola*. Plant Pathology 57 (1) 170-177.

Reeder RH, Opolot O, Muhinyuza JB, Aritua V, **Crozier J** (2007) Presence of banana bacterial wilt (*Xanthomonas campestris* pv. *musacearum*) in Rwanda. Plant Pathology 56, 1038.

Bailey BA, Bae H, Strem MD, Roberts DP, Thomas SE, **Crozier J**, Samuels GJ, Choi IK-Young, Holmes KA (2006) Fungal and plant gene expression during the colonization of cacao seedlings by endophytic isolates of four *Trichoderma* species. Planta 224, 1449-1464.

Crozier J, Thomas SE, Aime MC, Evans HC, Holmes KA (2006) Molecular characterization of fungal endophytic morphospecies isolated from stems and pods of *Theobroma cacao*. Plant Pathology 55, 783-791.

Ndungo V, Eden-Green S, Blomme G, **Crozier J**, Smith J (2006) Presence of banana xanthomonas wilt (*Xanthomonas campestris* pv. *musacearum*) in the Democratic Republic of Congo (DRC). Plant Pathology 55, 294.

Crozier J, Holmes KA, Craig GD, Nayagam SD (1999/2000) In vitro screening for fungal antagonists of wood decay fungi in tropical hardwoods. Material und Organismen 33, 245-260.

Conference publications

Bailey B, Ali S, Melnick R, Guiltinan M, Crozier J, Phillips W, Pereira GAG, Zhang D and Meinhardt L (2015) The biology, genetic diversity, and genomics of *Moniliophthora roreri*, causal agent of cacao frosty pod rot. International Plant and Animal Genome Conference XXIII 2015

Bailey B, Guiltinan M, **Crozier J**, Phillips W, Pereira GAG and Meinhardt L (2013) *Moniliophthora roreri* and *Moniliophthora perniciosa*: Atypical hemibiotrophs causing disease on cacao. International Plant and Animal Genome Conference XXI 2013

Crozier J, Arevalo E, Casanoves F, Diaz F, Zuñiga L (2012) Heavy metal levels of cocoa and cocoa soils in Peru and Venezuela. Proceedings of the 17th International Cocoa Research Conference, 15-20 October 2012, Yaounde, Cameroon. (In press)

Crozier J, Suarez-Capello C, Thomas SE, Krauss U, Bateman R, Bailey B, Holmes KA (2010) Biological control of fungal diseases of *Theobroma cacao* in Ecuador and Costa Rica: A review of field trials and future potential. Poster & paper. Proceedings of the 16th International Cocoa Research Conference, 16-21 November 2009, Bali, Indonesia. ISBN 978-065-959-5, pp 1285-1290.

ten Hoopen MG, **Crozier J**, Buddie A, Flood J, Bramley P, Krauss U (2006) Genetic population structure of *Clonostachys byssicola* and genetic disease resistance in cocoa (*Theobroma cacao* L.) Proceeding of 5th INCOPED Seminar, San José, Costa Rica, 15-17 Oct, 2006 pp 70-75.

CURRICULUM VITAE

Contact Information

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Telephone:	Home:(506) 2557 4305 Movile: (506) 87545086
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Personal information

Date/place of birth:	May 7th 1965, Turrialba, Costa Rica.
Citizenship:	Costa Rica
Profession:	Agronomist, specialized in applied entomology.
Marital status:	Married.
Language:	Spanish (mother tongue) and working level of English.

Education

1984 - 1989	BSc. in Agronomy, University of Costa Rica.
1990 - 1991	Lic. in Agronomy, University of Costa Rica (graduated with honors).
1994 - 1995	Dip. in Applied entomology, University of London, UK
1994 - 1995	MSc. in Applied entomology, Imperial College, University of London, UK
2008 – 2011	PhD. in Ecological Agriculture, Tropical Agriculture Research and Higher Education Center (CATIE), CR.

Other related training courses

1994, AgResearch, New Zealand	"Insect pathology and microbial control of soil dwelling pests"
1994, CATIE, Costa Rica	"Biology and control of white grubs: *Phyllophaga* spp.
1994, CESC, England	"General Study Skills"
1995, CAB International, England	"Biological control of arthropod pests and weeds"
1997, CATIE, Costa Rica	"Ecological management of coffee pests and diseases"
1997, CATIE, Costa Rica	"Experimental design"
1998, CATIE, Costa Rica	"Molecular markers in plants: characteristics and main applications"
1999, CATIE, Costa Rica	"Biological control of agricultural and forestry pests"
1999, CATIE, Costa Rica	"Research methods in biological control"
2003, Costa Rica	"Greenhouse design and construction"
2004, Inbio, Costa Rica	"Culture Collection Training Course"
2005, USDA/UNA, Nicaragua	"Insect Fungal Identification Workshop"
2007, Purdue U./USDA, USA	"Borlaug fellowship for improving research and teaching techniques on pest management"
2011, CABI, Kenya, Africa.	Training of CABI master trainers in "Plantwise and Plant Health Systems" for implementation of regional Plantwise
2013, CABI, Barbados	Workshop on Monitoring and Evaluation of diagnostic and recommendations services within the Plantwise initiative

Work experience

Since March 2012 Coordinator for the initiative CABI-Plantwise (see www.plantwise.org) in Honduras, Nicaragua, and Costa Rica.
Faculty member of CATIE's postgraduate school since year 2000, and lecturer on biocontrol and IPM topics for the MSc. Program on Ecological Agriculture
2010- Jan 2012 Researcher in ecological agriculture at the Tropical Agricultural Research and Higher Education (CATIE).

Invited lecturer to the Sustainable Agriculture MSc. Program at the Army´s Polytechnic School, Ecuador, in 2009-2011.

56. **2007- 2009** Researcher for the project "Innovative technologies for generating a Clean Stock Program for *Dracaena marginata*, bound to the export market to the United States of America" (CATIE, CNP, MAG, COMEX, Purdue University, USDA/APHIS).

57. Coordinator of the microbial control laboratory at CATIE, and cooperating lecturer on biological pest control for CATIE's Ecological Agriculture MSc. program since 1998.

2003-2006 Coordinator and researcher for the Project "Development of mycoinsecticides for whitefly (*Bemisia tabaci*) control in fruit and vegetable crops of Neotropical zones". Project executed in partnership with the Colombian Agricultural Research Corporation (CORPOICA).
2000-2003 Assistant researcher for the Project "Biocontrol of Cocoa Diseases" (CABI).
1999 –2001 Leader *a.i.* of the Plant Protection Unit, and researcher on microbial control of agricultural pests, at CATIE.
1999 Co-leader and researcher on the Project "Design and adaptations of new microbial technologies to control *Phyllophaga* spp. in Tropical America. Project developed in Costa Rica, Mexico and Honduras.
1996 - 1998 *Researcher in the Project "Biological control of soil pests"*. Project funded by DFID through NRI in CATIE, Costa Rica.
1991-1994 Research assistant in microbial control, CATIE, Costa Rica, working on Integrated pest management of soil pests in Central America (NRI-CATIE).
1987-1990 Assistant for the entomology course and entomological museum, at University of Costa Rica.

Publications

Sadof, C., Linkimer, M., Hidalgo, E., Casonoves, F., Gibson, K., & Benjamin, T. (2014). Effects of weed cover composition on insect pest and natural enemy abundance in a field of *Dracaena marginata* in Costa Rica. Environmental Entomology, 43, 320-327.

Hidalgo, E. T. Benjamin, F. Casanoves, and C. Sadof. 2013. Factors influencing the abundance of pests in production fields and rates of interception of *Dracaena marginata* imported from Costa Rica. Journ. Econ. Entomol. 106.

Prado J, Casanoves F, Hidalgo E, Benjamin TJ, Sadof C. 2008. Effects of production practices on the abundance of quarantine pests in *Dracaena marginata* in Costa Rican production fields. Journal of Economic Entomology, 101(6):1779-85

Krauss U., G. ten Hoopen M., Hidalgo E., Martínez A., Stirrup T., Arroyo Cl., García J. and Palacios M.. 2006. The effect of cane molasses amendment on biocontrol of frosty pod rot (*Moniliophthora roreri*) and black pod (*Phytophthora* spp.) of cocoa (*Theobroma* cacao) in Panama . Biological Control, Volume 39, Issue 2, November 2006, Pages 232-239

Fernandez, G., Hidalgo E., Badilla F. 2004. Germinación y reproducción *in vitro* de la bacteria *Paenibacillus* (=*Bacillus*) *lentimorbus*. Manejo Integrado de Plagas. 73, 35-41.

Krauss, U., Hidalgo, E., Arroyo, C. & Piper, S. R, 2004. Interaction between the entomopathogens *Beauveria bassiana, Metarhizium anisopliae* and *Paecilomyces fumosoroseus* and the mycoparasites *Clonostachys* spp., *Trichoderma harzianum* and *Lecanicillium lecanii*. Biocontrol Science and Technology 14, 331-346.

Krauss, U., Hidalgo, E., Arroyo, C. & Piper, S. R. (2004). Interaction between the entomopathogens *Beauveria bassiana, Metarhizium anisopliae* and *Paecilomyces* sp. and the mycoparasites *Clonostachys* spp., *Trichoderma harzianum* and *Verticillium lecanii*. Biocontrol Science and Technology, 14(4) 331-346.

Krauss, U., Martínez, A., Hidalgo, E, ten Hoopen, M. & Arroyo, C. 2002. Two-step liquid/solid state mass production of *Clonostachys rosea*. *Mycological Research* 106, 1449-1454.

Leal, W.S., Oehlschlager, A. C., Zarbin, P.H.G., Hidalgo, E., Shannon, P. J., Murata, Y., Gonzalez, L., Andrade, R., and Ono, Mikio. 2002. Sex pheromone of the scarab beetle *Phyllophaga elenans* and some intriguing minor components. Journal of chemical Ecology, Vol 29(1), p15-25. January 2003

Hidalgo, E., Bateman, R., Krauss, U., ten Hoopen, M. and Martinez, A. 2002. A field investigation into delivery systems for agents to control *Moniliophthora roreri* . European Journal of Plant Pathology, 109, 953-961.

Durán, J., Manuel Carballo., Hidalgo, E., Bustamante, E. 2001. Efecto de fungicidas sobre la germinación y crecimiento de *Beauveria bassiana*. Manejo Integrado de Plagas, 71, 73-78.

Krauss, U. & Hidalgo, E. (1999). Fermentación, formulación y aplicación de biopesticidas. In: Control de Plagas Agrícolas y Forestales con Agentes Microbianos. Manual Teórico-Práctico, CATIE, 18-23 October, 1999.

Carballo, M.; Hidalgo, E. 1999. Reconocimiento de hongos entomopatógenos de importancia en el control de insectos plaga. En: Hidalgo, E. 1999. Control de plagas agrícolas y forestales con agentes microbiológicos. Manual Teórico-Práctico. CATIE, octubre 1999. pp18-34

Hidalgo, E. 1999. Control de plagas agrícolas y forestales con agentes microbiológicos. Manual Teórico-Práctico. 202 pp.

Krauss, U. & Hidalgo, E. (1999). Fermentación, formulación y aplicación de biopesticidas. In: Control de Plagas Agrícolas y

Krauss, U., Martínez, A. & Hidalgo, E. (1999). Pre-tamizado de hongos hiperparásitos de patógenos de plantas. In: Control de Plagas Agrícolas y Forestales con Agentes Microbianos. Manual Teórico-Práctico, CATIE, 18-23 October, 1999.

Hidalgo, E., Moore, D., Le Patourel, G. (1998). The effect of different formulations of *Beauveria bassiana* on *Stophilus zeamais* in stored maize. Journal of Stored Products. Res. Vol. 34, No. 2/3 pp. 171-179.

Contreras T., Carballo, M., Hidalgo, E., Bustamante, E. 1997. Evaluación de trampas de pseudotallo y formulaciones de Beauveria bassiana Bals. en el combate del picudo del plátano (*Cosmopolites sordidus* Germar) en Costa Rica. Manejo Integrado de Plagas 46:44-49.

Shannon, P.J.; Smith, S.M.; Hidalgo, E. 1993. Evaluación en el laboratorio de aislamientos costarricenses y exóticos de *Metarhizium* spp. y *Beauveria* spp. contra larvas de *Phyllophaga spp.* (Coleoptera: Scarabaeidae) en: Diversidad y Manejo de Plagas Subterráneas (M.A. Morón compilador) 1993. Publicación Especial de la Sociedad Mexicana de Entomología e Instituto de Ecología, Xalapa, Veracruz, México. pp. 203-215.

Hidalgo, E.; Carballo, M. 1991. Influencia de las malezas sobre los insectos controladores naturales de *Liriomyza huidobrensis* (Blanchard) (Dip: Agromycidae). Manejo Integrado de Plagas No.20/21. p. 49-54.

Hidalgo, E., Shannon, P. J., Flores, L. 1998 Selección de cepas de *Bacillus popilliae* para el control de especies de *Phyllophaga* (*Coleoptera*: *Melolonthidae*). In: Morón, M.A. & Aragón, A. (eds). Avances en el estudio de la diversidad, importancia y manejo de los coleópteros edafícolas

americanos. Memorias de la V Mesa Redonda sobre Insectos Plaga Edafícolas, 12 al 14 de octubre de 1998, Benemérita Universidad Autónoma de Puebla, Puebla de Zaragoza, Puebla, México. Puebla de Zaragoza, Puebla, México. Sociedad Mexicana de Entomología, A.C. / Benmérita Universidad Autónoma de Puebla. Pp. 165-172

Scientific meetings attended

1992 (Speaker) I Central American entomological and natural pest control congress, Heredia, Costa Rica.
1992 (Speaker) IV international IPM congress. Zamorano, Honduras.
1993 (Speaker) I IV Scientific week, CATIE. Turrialba, Costa Rica.
1994 (Attendant) Brighton crop protection conference, Pests and Diseases. Brighton, England
1995 (Attendant) XIII International Plant Protection Congress. The Hague, Holland
1996 (Speaker) VI International IPM congress. Acapulco, México.
1996 (Speaker) X ATACORI Sugar Cane congress. Guanacaste, Costa Rica.
1996 (Speaker) X National congress of agronomy and natural resources. San José, C.R.
1997 (Speaker) IV Costa Rican entomology congress. San José, C.R.
1998 (Speaker) VII international colloquium on invertebrate pathology and microbial control. And IV international conference on *Bacillus thuringiensis*. Sapporo, Japan.
1998 (Speaker) V Roundtable on soil dwelling pests. Puebla, México.
1999 (Speaker) IV Scientific week, CATIE, Turrialba, Costa Rica.
2006 (Speaker) V Scientific week, CATIE, Costa Rica.
2006 (Speaker) XVI ATACORI Sugar Cane congress. San José, Costa Rica
2006 (Speaker) I FONTAGRO projects follow up workshop for Central America and the Caribbean. Managua, Nicaragua
2007 (Attendant) Annual meeting of the NCERA-193: IPM Strategies for Arthropod Pests and Diseases in Nurseries and Landscapes. Estes Park, Colorado, US.
2007 (Speaker) XXX National congress on biological control and symposium of the International Organization for Biological Control (IOBC), Mérida, Yucatán, México.

2. Proceedings in Scientific meetings

Krauss, U., Hidalgo, E & Arroyo, C. 2004. Compatibility of entomopathogens and mycoparasites. workshop proceedings Semiochemicals and Microbial Antagonists; Their Role in Integrated Pest Management in Latin America, pp. 61-64. Edited by L. Hilje, 22-26 March, 2004, CATIE, Turrialba, Costa Rica.

Bateman, R., Hidalgo, E., García, J., ten Hoopen, G. M., Krauss, U. & Adonijah, V. 2004. Rational pesticide use (RPU) for management of frosty pod rot. Cocoa Endophytes and Frosty Pod Meeting, Pichilingue, Ecuador, 25-30 April 2004.

Bateman R., Hidalgo E., Krauss U., García., ten Hoopen M. & Adonijah V. 2003. Rational fungicide use in cocoa: improving agents and application techniques. 14th International Cocoa Research Conference, Accra, Ghana 12-18 October

Bateman R.,Hidalgo E.,ten Hoopen G.M.,Garcia J. & Krauss U. 2003. Some tactics for managing frosty pod rot in Costa Rica. 4th INCOPED Seminar, Accra, Chana, 19-21 October

Bateman, R., Hidalgo, E. & Krauss, U. (2003). Rational fungicide use in cocoa: improving agents and application techniques. Submitted to the 14th International Cocoa Research Conference to be held in Accra, Ghana, 13-17 Oct. 2003. p37.

Carballo, M.; Hilje, L.; Stansly, P.A.; Arroyo, C.; Hidalgo, E. 2000. Evaluación de *Metarhizium anisopliae* en mezcla con aceite para el control de *Bemisia tabaci*. In IX Taller Latinoamericano y del Caribe sobre Moscas Blancas y Geminivirus. Panamá. Panamá. p. 131.

Hidalgo, E.; Carballo, M.; Bustamnte, E.; Sánchez Garita, V.; Rivas, G. 1999. Potencial del control biológico en el manejo de plagas en sistemas agrícolas sostenibles. Actas de la IV Semana Científica, Programa de Investigación, Turrialba, Costa Rica. 6-9 abril 1999. Resumen p. 78-83.

Carballo, M.; Hilje, L.; Stansly, P.A.; Hidalgo, E. 1999. Mortalidad de ninfas de *Bemisia tabaci* con cepas comerciales y nativas de hongos. In Anais VIII Taller Latinoamericano y del Caribe sobre Moscas Blancas y Geminivirus. Recife, Brasil. p. 135. (También en CD-ROM).

Krauss, U., Martínez, A., Hidalgo, E., Piper, S. & Soberanis, W. (1999). Biological control of moniliasis (*Moniliophthora roreri*) in cocoa. Paper presented at the USDA-CABI-ACRI Collaborative Cocoa Research Meeting, London, 7-8 December, 1999.

Krauss, U., Martínez, A. & Hidalgo, E. (1999). Pre-tamizado de hongos hiperparásitos de patógenos de plantas. In: Control de Plagas Agrícolas y Forestales con Agentes Microbianos. Manual Teórico-Práctico, CATIE, 18-23 October, 1999.

Krauss, U., Soberanis, W., Martínez, A., Hidalgo, E., Harvey, J., Evans, H., Mack, R., Rodríguez, L. & Rodríguez, W. (1999). Biological Control of Cocoa Diseases for the Rehabilitation of Cocoa Small-holdings in Latin America and Organic Chocolate Production. CABI in the Americas

Hidalgo, E. & Flores, L. 1999. Métodos de inoculación para la producción in vivo de *Bacillus popilliae* en larvas de *Phyllophaga menetriesi*. In: Actas IV Semana Científica del CATIE. CATIE, Turrialba, Costa Rica. 6-9 de abril, 1999. Pp. 104-107.

Hidalgo, E., Carballo, M., Bustamante, E., Sánchez, V. & Rivas, G. 1999. Potencial del control biológico en el manejo de plagas en sistemas agrícolas sostenibles. In: Actas IV Semana Científica del CATIE. CATIE, Turrialba, Costa Rica. 6-9 de abril, 1999. Pp. 78-83.

Hidalgo, E., Shannon, P. & Chaves, L. 1999. Collection of *Bacillus popilliae* from the tropical and subtropical americas. In: Actas IV Semana Científica del CATIE. CATIE, Turrialba, Costa Rica. 6-9 de abril, 1999. Pp. 88.

Hidalgo, E., Shannon, P. J., Flores, L. 1998. Selección de cepas de *Bacillus popilliae* para el control de especies de *Phyllophaga* (Coleoptera: Melolonthidae). In: Morón, M.A. & Aragón, A. (eds). Avances en el estudio de la diversidad, importancia y manejo de los coleópteros edafícolas americanos. Memorias de la V Mesa Redonda sobre Insectos Plaga Edafícolas, 12 al 14 de octubre de 1998, Benemérita Universidad Autónoma de Puebla, Puebla de Zaragoza, Puebla, México. Puebla de Zaragoza, Puebla, México. Sociedad Mexicana de Entomología, A.C. / Benmérita Universidad Autónoma de Puebla. Pp. 165-172.

Shannon, P.J., Hidalgo J., E., Flores, L. 1998. Selection of *Bacillus popilliae* isolates in *Phyllophaga* spp. white grubs (Coleoptera: Scarabaeidae). In: Meeting Program and Abstracts. VIIth International Colloquium on Invertebrate Pathology and Microbial Control / IVth International Conference on *Bacillus thuringiensis*. Sapporo, Japan, August 23-28, 1998. [Society for Invertebrate Pathology]. Pp. 47.

Carvajal P., C., Shannon, P.J., Ferreira, P., Hidalgo, E., Bustamante, E. 1998. Interactions of entomopathogenic fungi in *Phyllophaga menetriesi*. In: Meeting Program and Abstracts. VIIth International Colloquium on Invertebrate Pathology and Microbial Control / IVth International Conference on *Bacillus thuringiensis*. Sapporo, Japan, August 23-28, 1998. (Society for Invertebrate Pathology]. Pp. 34

Hidalgo, E., Flores, L. 1998. Evaluación de métodos de producción in vivo de *Bacillus popilliae* con larvas de *Phyllophaga* (Coleoptera: Scarabaeidae). In: Memoria. VII Congreso Internacional de Manejo Integrado de Plagas / VII Taller Latinoamericano y del Caribe de Mosca Blanca y Geminivirus / XXXVIII Reunión Anual de la Sociedad Americana de Fitopatología División Caribe (APS-CD). 26 - 30 de octubre de 1998, Managua, Nicaragua. Nicaragua. Comité Nacional de Manejo Integrado de Plagas. Pp. 120.

Hidalgo, E., Shannon, P.J., Flores, L. 1998. *Bacillus popilliae* from the tropical and sub-tropical Americas. In: Meeting Program and Abstracts. VIIth International Colloquium on Invertebrate Pathology and Microbial Control / IVth International Conference on *Bacillus thuringiensis*. Sapporo, Japan, August 23-28, 1998. [Society for Invertebrate Pathology]. Pp. 42.

Martínez, A., Hidalgo, E., Flores, L. 1998. Evaluación de cepas promisorias de *Metarhyzium anisopliae* y *Beauveria bassiana* para el control de *Phyllophaga* spp a nivel de campo. In: Memoria. VII Congreso Internacional de Manejo Integrado de Plagas / VII Taller Latinoamericano y del Caribe de Mosca Blanca y Geminivirus / XXXVIII Reunión Anual de la Sociedad Americana de Fitopatología División Caribe (APS-CD). 26 - 30 de octubre de 1998, Managua, Nicaragua. Nicaragua. Comité Nacional de Manejo Integrado de Plagas. Pp.118-119.

Carvajal P., C., Shannon, P.J., Ferreira, P., Hidalgo, E., Bustamante, E. 1998. Interactions of entomopathogenic fungi in *Phyllophaga menetriesi*. In: Meeting Program and Abstracts. VIIth International Colloquium on Invertebrate Pathology and Microbial Control / IVth International Conference on *Bacillus thuringiensis*. Sapporo, Japan, August 23-28, 1998. (Society for Invertebrate Pathology]. Pp. 34.

Hidalgo, E., Flores, L. 1998. Evaluación de métodos de producción in vivo de *Bacillus popilliae* con larvas de *Phyllophaga* (Coleoptera: Scarabaeidae). In: Memoria. VII Congreso Internacional de Manejo Integrado de Plagas / VII Taller Latinoamericano y del Caribe de Mosca Blanca y Geminivirus / XXXVIII Reunión Anual de la Sociedad Americana de Fitopatología División Caribe (APS-CD). 26 - 30 de octubre de 1998, Managua, Nicaragua. Nicaragua. Comité Nacional de Manejo Integrado de Plagas. Pp. 120.

Hidalgo, E., Shannon, P.J., Flores, L. 1998. *Bacillus popilliae* from the tropical and sub-tropical Americas. In: Meeting Program and Abstracts. VIIth International Colloquium on Invertebrate Pathology and Microbial Control / IVth International Conference on *Bacillus thuringiensis*. Sapporo, Japan, August 23-28, 1998. [Society for Invertebrate Pathology]. Pp. 42.

Shannon, P.J.; Martinez, A.; Rodriguez, A.; Saenz, C.; Rojas, H.; Flores, L.; Hidalgo, E.. 1997. Desarrollo y adaptación de nuevas técnicas de control biológico para jobotos en América Tropical: Prueba de campo de hongos entomopatógenos contra *Phyllophaga menetriesi* en caña de azúcar.. En Memorias XI congreso ATACORI. Octubre 1997. 23-24 pp.

Hidalgo, E.; Shannon, P.J.; Flores, L. 1997. Avances sobre la selección de cepas de *Bacillus popilliae* para el control *de Phyllophaga* spp. En Resúmenes IV Congreso Costaricense de Entomología. San José, Costa Rica. Nov. 1997. 24p.

Coto, D., Sanchez, V., Gonzalez, R., Gamboa, A., Carballo, M., Shannon, P., Vargas, C., Bustamante, E., Hidalgo, E., Merayo, A., Rivas, G.G. 1997. Inventario agroecológico de plagas y su importancia en el desarrollo sostenible. Actas III Semana Científica del CATIE. CATIE, Turrialba, Costa Rica. 3-5 de febrero, 1997. Pp. 277-280.

Hidalgo, E., Shannon, P.J., Smith, S.M., Arroyo, C. 1997. Metodología para la cría masiva de *Phyllophaga* spp. (Col:Scarabaeidae). Actas III Semana Científica del CATIE. CATIE, Turrialba, Costa Rica. 3-5 de febrero, 1997. Pp. 310-312.

Hidalgo, E.; Flores, L.; Shannon, P.J.;1996. El género *Phyllophaga* (Coleoptera: Scarabaeidae) en Costa Rica y avances en el desarrollo de agentes microbianos para su control. *;In* Congreso Nacional Agronómico y de Recursos Naturales (10., 1996, San José, C.R.). Memoria: Agronomía y Recursos Naturales. Ed. por F. Bertsch; W. Badilla; J. García. San José, C.R., EUNED/EUNA. v.1, p. 101-105.

Hidalgo, E.; Smith, S.M.; Shannon, P.J.;1996. Metodología para la cría masiva de *Phyllophaga spp.* (Col: Scarabaeidae). *In* Congreso Internacional de Manejo Integrado de Plagas (6, 1996, Acapulco, Méx.). Memorias. México. p. 107.

Shannon, P.J.; Hidalgo, E. ; Flores, L.;1996; Selección de aislamientos de *Metarhizium anisopliae y Beauveria* spp. Contra *Phyllophaga spp. (Col: Scarabeidae)* en Costa Rica. *In* Congreso Internacional de Manejo Integrado de Plagas (6, 1996, Acapulco, Méx.). Memorias. México. p. 147.

Shannon, P.J.; Bustamante, M.; Herrera, F.; Lacayo, L.; Morales, R.; Barrios, M.; Flores, L.; Guharay, F.; Hidalgo, E.; Jimenez, C.M.; Sandino, V. 1995. Avances en el control microbiano de insectos en Costa Rica y Nicaragua. In Semana Científica (2, 1995, Turrialba, C.R.). Resúmenes. Turrialba, C.R., CATIE. Programa de Investigación Científica. p. 55-56.

Hidalgo, E. 1995. Evaluación de diferentes formulaciones de *Beauveria bassiana* para el control de *Sitophilus Zeamais* en maíz almacenado. In Semana Científica (2, 1995, Turrialba, C.R.). Resúmenes. Turrialba, C.R., CATIE. Programa de Investigación Científica. Sección II. Poster. p.32-33.

Smith, C.; Hidalgo, E.; Shannon, P. 1994. Muestreo de nematodos entomopatogénicos de Costa Rica y su selección para control biológico de *Phyllophaga* spp (Col: Melolonthidae). *In* Congreso Internacional de Manejo Integrado de Plagas (5., 1994, San José, C.R.). Resúmenes. San José, C.R. p. 101.

Appendix 3: Draft Terms of Reference (ToR) for the Consultant

I. INTRODUCTION

1. In 2014, the EU Commission introduced Regulation No 488/2014, which sets maximum residue levels (MRLs) of cadmium (Cd) in a range of foodstuffs, including a level ranging from 0.1 to 0.8 µg/kg in cocoa and chocolate products. Following a five-year moratorium period, this regulation will come into force in January 2019 and may have a significant impact on market access for several cocoa producing countries to the European market.

2. In response, some countries in Latin America and the Caribbean, as well as the cocoa and chocolate industry and international research centres, have started conducting scientific studies to understand the extent of the problem of cadmium contamination and to identify adequate remediation measures.

3. The three main focus areas of these research studies are: identifying and understanding the major sources of cadmium contamination factors in cocoa; identifying cocoa varieties/clones which have a low absorption capacity of cadmium; and identifying agricultural practices that reduce the presence of cadmium available in the soil for absorption.

4. There is however very little coordination between these studies and while there is a duplication of efforts and resources, there are still significant knowledge gaps. At the current point in time, cocoa producing countries are at different stages of research, and no clear strategy and sufficient funding have yet become available to implement the required activities to mitigate cadmium occurrence in cocoa. Unfortunately, if efforts are not stepped up, this is likely to have a significant impact on the market access of cocoa farmers and therefore on their livelihoods.

5. In view of this situation, the ICCO is proposing to apply for funding for a Project Preparation Grant (PPG) from the Standards and Trade Development Facility (STDF) of the World Trade Organization (WTO). The purpose of the PPG is to enlist the services of an expert who will be responsible for gathering information generated by research studies implemented so far, assess the level/stage which these studies have reached, identify possible knowledge gaps as well as actions subsequently required to assist cocoa producing countries to mitigate cadmium contamination, particularly in relation to farmers in Latin America and the Caribbean, taking into consideration local conditions and situations in individual countries. This information will be used to seek funding from the EU Commission and other possible development partners to implement a regional programme in selected Latin American and Caribbean countries, in coordination with existing local initiatives.

MAIN OBJECTIVE

6. The overall objective of this PPG is to develop a regional project proposal on "Mitigation and Remediation of Cadmium Contamination in Cocoa Beans in Latin America and the Caribbean". An international expert with known experience on heavy metals will assess in detail all scientific and research studies developed in Latin America and the Caribbean. The

information will allow the consultant to establish a detailed status of these studies and will help identify any knowledge/technical gap preventing the development of effective mitigation/remediation practices.

II. METHODOLOGY AND SCOPE OF THE CONSULTANCY

7. The methodology for the PPG will be literature review of existing data, research papers and scientific information on Cadmium contamination and mitigation/remediation practices. The Consultant will collect existing information collected by various institutions (i.e. research centres, universities, NGO's and national food-safety authorities in cocoa producing countries) and building on the expertise of the Consultant hired for this purpose.

8. The ICCO Secretariat has held consultations with food-safety authorities and representatives from the cocoa sector in Ecuador, Trinidad & Tobago and Peru. These consultations have allowed ICCO to identify experts in each country who have the capacity to act as focal points for this consultancy. These focal point persons will be responsible to assist the consultant and the ICCO Secretariat in the collection of detailed information about research and scientific studies implemented in the each country, as well as liaising with local experts who will contribute to this consultancy.

9. In addition to the countries listed above, the ICCO Secretariat contacted other Member countries in region to establish if Cadmium contamination is a problem in their cocoa sector. The information provided shows that other countries in the region have limited knowledge about the extent of the problem. As such, the ICCO Secretariat will assist the consultant in contacting authorities Venezuela, Nicaragua and the Dominican Republic, to assess the level of information available and establish the need to involve them in a larger regional project. The experts and/or representatives from these countries will be invited to attend the technical workshop to present their information and studies, and, if deemed necessary, will be included in the full project proposal.

10. Once information about each country is collected, the Consultant will collate all information available and make an evaluation of the level of development of mitigation practices to reduce Cd absorption and develop mitigation/remediation practices for cocoa farmers. This information will be described and developed into a framework that can be used to formulate a full project proposal for funding. As countries in Latin America and the Caribbean are at different stages of development in terms of mitigation practices, the propose framework will allow each country to adapt and formulate activities according to their level of development and needs.

11. The work of the consultant will start in January 2017 and will run until the end of June 2017 (6 months). The consultant will begin activities by developing a country profile and design of survey which will be used in all participating countries to collect the information. Once the information is collected and assessed, the Consultant will start the preparation of the framework for the full project proposal.

12. In April 2017, the Consultant in close collaboration with ICCO and the government of Peru and other project partners, will organize a scientific workshop in Peru, where the consultant will share the findings. This meeting will also allow experts from participating countries to share

their knowledge and experience in developing remediation/mitigation practices. This exchange of information is expected to enrich the knowledge at regional level and allow countries to identify technical gaps in their research. The project framework will then be refined by the consultant based on the findings of this exercise and the comments made by participants.

Specific Task to be Carried Out

13. The following is a description of the specific tasks and responsibilities to be carried out by the parties involved in the Study:

A. CABI

- Act as the main Consultant for this PPG.

- Identify and appoint an Expert(s) from CABI in charge of implementing the consultancy, as well as the necessary staff members to assist in the process of collection of information.

- Develop a survey form, to be used for the collection of scientific information and research papers related to Cadmium contamination, remediation and mitigation in each of the participating countries.

- Liaise with National Focal Point persons for the collection and assessment of the information.

- Monitor and assist as required the National Focal Point.

- Collate all national and regional information collected by National Focal Point for their integration and analysis.

- Review the information collected and establish the level of scientific development and technical gaps in the formulation of mitigation/remediation practices for Cadmium contamination and propose actions to address these gaps.

- Develop a comprehensive description of current mitigation/remediation practices to reduce Cadmium contamination in cocoa beans, including an analysis of the extension of the problem in the participating countries.

- Assist the ICCO Secretariat in the organization of a regional scientific workshop to disseminate the preliminary results of the consultancy.

- Formulate a detailed proposal for a regional project on Mitigation and Remediation of Cadmium Contamination in Cocoa Beans in Latin America and the Caribbean, including Ecuador, Peru and Trinidad and Tobago and possibly Venezuela, the Dominican Republic and Nicaragua.

- Provide a comprehensive report at the end of the consultancy, including all relevant information collected during the study.

B. NATIONAL FOCAL POINTS

- Assist CABI in the identification of key stakeholders in the cocoa sector in the participating countries and other sources of information and hold consultations for collecting data on Cadmium contamination and the development of remediation/mitigation practices.

- Assist CABI in the collection and compilation of data on Cadmium contamination and remediation/mitigation practices.

- Liaise with the National Focal Points and local experts, as necessary, to ensure that the information collected on Cadmium contamination and mitigation/remediation practices is relevant for this study.

C. ICCO SECRETARIAT

- Act as Supervisory Body (SB) for this PPG. In this capacity, it will supervise and assist the work of the Consultant. It will assess whether the actions undertaken, the expenditures incurred and results achieved by the Consultant are conform to the PPG specifications as agreed.

- Nominate National Focal Points and assist the Consultant in liaising with local experts on the collection of information, as required.

III. EXPECTED OUTPUTS AND DURATION OF THE STUDY

14. The Consultant shall prepare a comprehensive report, including all the information collected during this consultancy. The comprehensive report should include all relevant information collected in the course of the consultancy, including all mitigation/remediation practices submitted by the National Focal Points. The ultimate output of the PPG is a detailed proposal for a regional project proposal on "Mitigation and Remediation of Cadmium Contamination in Cocoa Beans for Latin America and the Caribbean".

15. The International Expert shall prepare a comprehensive report including all the information collected in the course of the Study. The comprehensive report should include all relevant information collected in the course of the Study, as well as all the farming systems and models as submitted by the Local Experts.

IV. WORK PROGRAMME

16. The following table provides a draft work programme for the implementation of the Consultancy. Activities will be reviewed accordingly and the work programme will be revised if necessary.

Activities	Deadlines
Formulate a survey form for the collection of information	2 weeks
Collect information on Cd contamination and mitigation/remediation practices in cocoa producing countries in Latin America and the Caribbean	1 month
Assist the ICCO Secretariat in the preparation of the regional scientific workshop	2 weeks
Formulate the detailed proposal for a regional project on "Mitigation and Remediation of Cadmium Contamination in Cocoa Beans in Latin America and the Caribbean	2 months
Draft and submit report of consultancy to the ICCO Secretariat for approval.	1 month