CODEX ALIMENTARIUS COMMISSION E

Food and Agriculture Organization of the United Nations

World Health Organization

Viale delle Terme di Caracalla, 00153 Rome, Italy - Tel: (+39) 06 57051 - E-mail: codex@fao.org - www.codexalimentarius.org

Agenda Item 7 **CX/CF 20/14/7-Add.1**

July 2020

JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON CONTAMINANTS IN FOODS

14th Session
Utrecht, The Netherlands, 20 – 24 April 2020

PROPOSED DRAFT CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF CADMIUM CONTAMINATION IN COCOA BEANS

Comments[1] at Step 3 submitted by Canada, Chile, Colombia, Costa Rica, European Union, Iraq, Kenya, Syrian Arab Republic, Thailand, Uganda, United States of America, Collagen Casings Trade Association (CCTA), European Cocoa Association (ECA) and International Confectionery Association (ICA)

NOTE: CCCF14 has been postponed to 3 – 7 May 2021. The comments compiled in this document will be made available to the EWG chaired by Peru and co-chaired by Ecuador and Ghana for further consideration and preparation of a revised version of the document for consideration by CCCF14.

Background

1. This document compiles comments received through the Codex Online Commenting System (OCS) in response to CL 2020/20/OCS-CF issued in February 2020. Under the OCS, comments are compiled in the following order: general comments are listed first, followed by comments on specific paragraphs.

Explanatory notes on the appendix

2. The comments submitted through the OCS are, hereby attached as **Annex I** and are presented in table format.

[1] Comments to improve the clarity of the French or Spanish version of the provision but do not change its content are not reflected in the English version.

ANNEX I

COMMENTS ON THE PROPOSED DRAFT CODE OF PRACTICE FOR THE PREVENTION AND REDUCTION OF CADMIUM CONTAMINATION IN COCOA BEANS

GENERAL COMMENTS	MEMBER/OBSERVER
Canada wishes to express its appreciation to the Chair, Peru, and co-chairs Ecuador and Ghana, for their leadership of the electronic Working Group (eWG) tasked to coordinate the proposed draft revision to the Code of practice for the prevention and reduction of cadmium contamination in cocoa beans. Canada supports the development of this Code of practice given that Codex maximum levels (MLs) for certain chocolate products have already been established or are under consideration by CCCF.	**Canada**
Chile welcomes the opportunity to offer its comments on the draft code of practice for the prevention and reduction of cadmium contamination in cocoa beans. Chile reviewed the recommendations in this circular letter and has the following comments to make: Chile agrees with the practices presented in the draft and supports its progress.	**Chile**
It is important to specify clearly and differentiate between pseudo-total Cd and available Cd throughout the document. We suggest reviewing all annotations made, in the body of the text, in relation to microorganisms and their uses, given that the approach offered is incorrect for each of the sections in which they refer to this field. For example, in the sections where they cite the article (Bravo et al., 2019), they do not refer to what the author actually did, and in other sections where there should be a reference to substantiate the source of the assumptions they present, no such reference can be found. We suggest modifying the bibliographic references and the new panel of experts can propose references more in line with current academic thinking in Latin America in this field. It would be advisable not to use either posters or conference papers as references; only published academic articles. Bibliographic annex: Baker, D. E., M. C. Amacher, and R. M. Leach. 1979. "Sewage Sludge as a Source of Cadmium in Soil-Plant-Animal Systems." Environmental Health Perspectives Vol. 28 45-49. Engbersen, Nadine et al. 2019. "Cadmium Accumulation and Allocation in Different Cacao Cultivars." Science of the Total Environment 678: 660-70. https://doi.org/10.1016/i.scitotenv.2019.05.001. Hansen, Henrik K., Anne J. Pedersen, Lisbeth M. Ottosen, and Arne Villumsen. 2001. "Speciation and Mobility of Cadmium in Straw and Wood Combustion Fly Ash." Chemosphere 45(1): 123¬28. Lewis, Caleb, Adrian M. Lennon, Gaius Eudoxie, and Pathmanathan Umaharan. 2018. "Genetic Variation in Bioaccumulation and Partitioning of Cadmium in Theobroma Cacao L." Science of the Total Environment 640-641: 696-703. https://doi.org/10.1016/i.scitotenv.2018.05.365. Wang, Xuebin et al. 2020. "Characteristics of Ash and Slag from Four Biomass-Fired Power Plants: Ash/Slag Ratio, Unburned Carbon, Leaching of Major and Trace Elements." Energy Conversion and Management 214(May):	**Colombia**
We consider that it is essential to adopt a code of practice for the prevention and reduction of cadmium (Cd) contamination in cocoa beans for the Colombian cocoa sector, providing that these practices are achievable by and economically viable for small, medium-sized and large cocoa farmers. It is also essential to ensure the participation of all the institutions that make up the cocoa value chain of this code of practice is to be effectively functional and actually implemented.	
With a view to harmonizing the structure of the document, we recommend either including relevant references that support the data or deleting them. One such example is: the limit for electrical conductivity and soil. Justification: in the body of the document some recommended practices are referenced and others are not. Furthermore, we recommend the inclusion of references to some texts which are not indicated at the end.	**Costa Rica**

GENERAL COMMENTS	MEMBER/OBSERVER
Mixed Competence Member States Vote The EUMS support the development of the code of practice because sufficient information on mitigation measures is available for field production and post-harvest processes. The EUMS would like to suggest the following amendments to the document: - Including in the definitions all products, which are suggested for cadmium immobilisation in the soil such as biochar, vinasse, humus, and cachara. - Adding a chapter on 'avoiding further cadmium contamination of the soil'. Under this chapter it could be advised: o to use by preference organic fertilisers or, in case phosphate fertilisers are used, to use fertilisers with a low cadmium content; o to avoid the application of sewage sludge; o to avoid burial or incineration of household waste, as approximately 10% of garbage is made up of metals, including cadmium. Their burial can contaminate the groundwater, while incineration can contaminate the atmosphere by releasing volatile metals and consequently polluting soils; and o -to take action at the level of national or regional authorities to limit main polluting industrial activities near cocoa plantations, such as non-ferrous mining and smelting, metal using industry, coal combustion and phosphate fertiliser manufactures. - Pruning is only mentioned under 'definitions', but it should also be mentioned in the code of practice. In CX/CF 18/12/16 the following paragraph was included: 'In areas where soil levels of cadmium are high, remove pruned material from the ground as they could contain cadmium which will be released into the top layers of the soil after decay. The practice should be to remove pruned material from the crop field.' This paragraph should be added under the new chapter 'avoiding further cadmium contamination of the soil'. - The strategies for immobilisation of cadmium in the soil could be categorised as 'salts', 'organic matter (humus and sugar cane products)' and adsorbents (zeolite and apatite)'.	**EU**
We agree with the proposed draft of code of practice without any comments.	**Iraq**
Approval	**Syrian Arab Republic**
Thailand would like to express the appreciation to Peru, Ghana and Ecuador for preparing proposed draft COP for the prevention and reduction of cadmium contamination in cocoa. Thailand would like to provide the following comments for consideration. <u>General Comments</u> Thailand consider that the format of this draft COP is different from other existing COP standards. Some recommended practices contain too detail instruction and information. This could lead to limited practices. To be consistent with the existing COP standards, Thailand suggests that the format of this draft should be revised by adding the section of the reference on Code of Practice for Source Directed Measures to Reduce Contamination in Foods with Chemicals (CXC 49-2011), selecting only recommended practices which are practically and supported by scientifically proven data so that the cadmium contamination could be reduced significantly.	**Thailand**
Uganda appreciates the work done,This will help the industry	**Uganda**
The draft COP should acknowledge explicitly that it is in the initial stage of development as many of the mitigation measures have not been tried under long-term field conditions and the COP should identify which particular mitigation approaches are experimental. • The United States supports the progress made in developing the Code of practice, which will be an important contribution to lowering cadmium levels in cocoa beans and supporting international trade in cocoa beans. The United States provided extensive comments and information to the electronic working group to support this work. • The United States recommends further revision of the Code of practice before moving forward in the Step process. The recommended changes include focusing on proven mitigation techniques, clear identification of proposed techniques that are experimental, and removal of Appendix II.	**USA**

GENERAL COMMENTS	MEMBER/OBSERVER
The European Cocoa Association (ECA) would like to thank the chairs and members of the Electronic Working Group on the development of a Draft Code of Practice for the prevention and reduction of cadmium contamination in cocoa beans for their work and have no further comments on the document at this stage.	**ECA**
We, the International Confectionery Association, wish to thank the EWG, chaired by Peru, co-chaired by Ecuador and Ghana, for this proposed draft code of practice. We believe it is important to fully investigate the mitigation possibilities for this issue. This draft provides a starting point for fuller development, to ensure the fullest consideration has been given to take into account the practical possibilities and challenges of mitigation options, including technical input from all stages of production, from the local farming practicalities, geography and geology, the crop implications, crop varieties and factors for successful growth, crop productivity, economy and cost implications, timing factors, and overall commercial feasibility of mitigation options. We look forward to the next stage of discussion on this document. We echo our strong support for global, reasonably achievable standards and guidance measures that are supported by objective science, and global risk assessment, and avoid unnecessary waste in food supply. We wish to thank in advance the committee chairs, the EWG chairs and members of CCCF for taking time to consider our views on this important issue	**ICA**

SPECIFIC COMMENTS	
Section/paragraph	**Member/Observer**
1. INTRODUCTION	
(1) The objective of this proposed draft Code of Practice (COP) is to provide guidance to member states and the cocoa production industry on the prevention and reduction of cadmium (Cd) contamination in cocoa beans during production and postharvest processing: fermentation, drying and storage. Kenya proposes this paragragh to read: The objective of this proposed draft Code of Practice (COP) is to provide guidance to member states and the cocoa production industry on the prevention and reduction of cadmium (Cd) contamination in cocoa beans during production and post harvest processing: fermentation, drying, storage including during any transportation that might be involved.	**Kenya**
(3) Cd is toxic and persistent in soil (estimated half-life for Cd in soils varying between 15 to 1100 years). Cd is absorbed and bioaccumulated by cocoa trees (Theobroma cacao L), which in some cases results in unacceptably high levels in cocoa beans, so measures ~~are required~~ may be needed to prevent Cd presence in the soil and reduce Cd absorption.	**USA**
(5) Greater adsorption of Cd on the surface of soil particles is desirable, considering that this reduces the mobility of this contaminant in the soil profile and, consequently, its environmental impact. The concentration of heavy metals (Cd) in soil solution and, consequently, its bioava ilability and mobility are mainly controlled by adsorption and desorption reactions on the surface of the soil colloids. Soil factors that affect the accumulation and availability of heavy metals include pH, texture, organic material, Fe and manganese (Mn) oxides and hydroxides, Zn, carbonates, ~~salinity~~ chlorinity and cation exchange capacity. Zinc should be included. The problem with saline soils is chloride, not sulfate or Ca ions usually present in the same soils. it is more correct to say “chlorinity” rather than salinity in discussion of Cd uptake in relation to soil properties.	**USA**
(6) Elevated chloride contents in soils tend to enhance chloride complex formation, which decreases the adsorption of Cd on ~~sediment~~soil particles, thereby increasing Cd ~~mobility and, decreasing the concentration of dissolved Cd~~mobility^{+2} and bioavailability.	**Chile**
(6) Elevated chloride contents in soils tend to enhance chloride complex formation, which decreases the adsorption of Cd on sediment, thereby increasing Cd mobility and, decreasing the concentration of dissolved Cd^{+2} and bioavailability. The statement ‘Elevated chloride contents in soils tend to enhance chloride complex formation, which decreases the adsorption of cadmium on sediment, thereby increasing cadmium mobility and, decreasing the concentration of dissolved Cd+2 and bioavailability’ is not correct. The concentration of dissolved Cd+2 is not affected by chloride as demonstrated by Smolders et al. (1998) (1). Elevated chloride in soil increases cadmium bioavailability instead of decreasing it as demonstrated by McLaughlin et al. (1994) (2). Therefore, the following rephrasing is proposed: ‘Elevated chloride contents in soils tend to enhance chloride complex formation, which decreases the adsorption of cadmium on sediment, thereby increasing cadmium mobility and bioavailability’. (1) Smolders E, Lambregts RM, McLaughlin MJ, Tiller KG, 1998. Effect of soil solution chloride on cadmium availability to Swiss chard. J Environ Qual 27: 426–431. (2) McLaughlin MJ, Palmer LT, Tiller KG, Beech TA, Smart MK ,1994. Increased soil salinity causes elevated cadmium concentrations in field-grown potato tubers. J Environ Qual 23:1013–1018.	**EU**
(6) Elevated chloride ~~contents~~ content in soils tend to enhance chloride complex formation, which decreases the adsorption of Cd on sediment, thereby increasing Cd mobility and, decreasing the concentration of dissolved Cd^{+2} and bioavailability.	**USA**
(7) ~~The~~ Over time, the development in our understanding ~~on~~ of how various cropping systems contribute or alleviate cadmium contamination in cocoa beans could be used to develop integrated systems for the management of cadmium levels in cocoa beans. Much of the work is experimental, and has not been tried on long-term field studies.	**USA**

SPECIFIC COMMENTS	
Section/paragraph	**Member/Observer**
(8) The grafting tool as a genetic strategy with low cadmium accumulation varieties is a viable option in various soil types and different Cd levels, but has only been tried experimentally for reducing Cd in cacao trees..	**USA**
(9) ~~It is crucial identifying~~ To mitigate Cd ~~areas~~ levels in ~~a country~~cocoa beans, ~~understanding the source of~~ it is crucial to identify cocoa-growing areas with high Cd ~~in each area~~ and ~~developing~~ develop specific and general strategies to address this problem.	**USA**
2. SCOPE	
(10) The scope of this Code of Practice is to provide guidance on recommended practices to prevent and reduce Cd contamination in cocoa beans before planting or for new plantations and during the production stage through the harvest and post-harvest phase. Kenya proposes the scope to include the transport aspect and therefore to read: The scope of this Code of Practice is to provide guidance on recommended practices to prevent and reduce Cd contamination in cocoa beans before planting or for new plantations and during production stage through the harvest and post harvest phase including during any transportation that might be involved	**Kenya**
(10) The scope of this Code of Practice is to provide guidance on recommended practices to prevent and reduce Cd contamination in cocoa beans before planting or for new plantations and during the production stage through the harvest and post-harvest phase. Do some of the recommendations go towards existing plantations, given cocoa trees can produce beans for up to 25 years?	**USA**
3. DEFINITIONS	
Thailand is of the view that definitions in this COP should be limited as necessary, which is related to the content in the COP. Also, the definitions should be clear and suitable for practicing.	**Thailand**
Terms that are not included in the COP should not be included within the "DEFINITIONS' section and should be deleted, including terms that are only in Appendix 2 (marked for deletion).	**USA**
***~~Cocoa pod~~**: ~~The cocoa fruit pericarp that arises from the ripened ovary wall of a fruit.~~*	**USA**
***~~Episperm or Integument~~**: ~~The protective layer of the seed also called shell when it is dried. The outermost of the two layers that constitute the tegument is called Testa.~~*	**USA**
***~~Harvesting and opening the fruits~~**: ~~Fruits are manually harvested and opened using a sickle, machete or wooden baton.~~*	**USA**
***~~Sea-salt aerosols~~**: ~~They are the most omnipresent natural aerosols over the oceanic region. Aerosols are one of the main decisive components for the radiative forcing of the Earth system. Extensive measurements reveal that processes associated with the bursting of the white-cap and wave breaking primarily generate sea-salt aerosols. In terms of primary marine aerosol, studies have confirmed a significant flux of sub-micrometre sea-spray particles, even down to 10 nm sizes and it is clear that like wind speed, sea surface temperature also affects the physical sea-spray source function. In terms of secondary marine aerosol formation, significant advances identify particle production, at least in coastal zones where iodine oxides are considered the dominant species leading to particle production and contributing to growth can also be isoprene oxidation products and sulphuric acids.~~*	**USA**
***Bioremediation**: ~~It is the~~ The use of living organisms, primarily microorganisms, to degrade environmental contaminants into less toxic forms.*	**USA**
***Phytoremediation**: ~~It is a~~ A type of bioremediation process that uses ~~various types of~~ plants to remove, transfer, stabilize, and/or destroy contaminants in the soil and groundwater.*	**USA**
***~~Air emissions~~**: ~~They are defined as unwanted gaseous or particulate materials released to the atmosphere as a direct result of production, accumulation or consumption activities in the economy.~~*	**USA**
***~~Traceability~~**: ~~is the ability to follow the movement of a food through specified stages of production, processing and distribution using records.~~*	**USA**

SPECIFIC COMMENTS	
Section/paragraph	**Member/Observer**
Bioavailability: Bioavailability of a mineral ~~in nutrition~~ to plants and soil can be defined as its accessibility to normal metabolic and physiological processes~~. In surface and ground water~~, ~~sediment and air, bioavailability of metals (Cd) is a complex function of~~ as influenced by many factors including total concentration and speciation ~~(physical-chemical forms)~~ of metals, ~~mineralogy,~~ pH, redox potential, temperature, total organic content (both particulate and dissolved fractions), and suspended particulate content~~, as well as volume of water, water velocity, and duration of water availability, particularly in arid and semi-arid environments~~. ~~In addition, wind transport and removal from the atmosphere by rainfall (frequency is more important than amount) must be considered. Many of these factors vary seasonally and temporally, and are interrelated.~~	**USA**
~~**Geoavailability**: Geoavailability of an element or chemical compound of a terrestrial material is that portion of its total content that can be released to the surface or near the surface (or biosphere) by mechanical, chemical, or natural biological processes.~~	**USA**
***Adsorption, Absorption and Desorption**: Physical, chemical or exchange adsorption is a concept that refers to the attraction and retention that a body makes on its surface of ions, atoms or molecules that belong to a different body. Absorption is a term that refers to the damping exerted by a body before a radiation that passes through it; to the attraction developed by a solid on a liquid with the intention that its molecules penetrate into its substance; to the ability of a tissue or a cell to receive a material that comes from its outside. Desorption is the process of removing an absorbed or adsorbed substance.* Can this be expressed in terms of adsorption of Cd to soil particles?	**USA**
***Cation Exchange Capacity (CEC)**: It is a measure of the soil's ability to hold positively charged ions. It is a very important soil property influencing soil structure stability, nutrient availability, soil pH and the soil's reaction to fertilizers and other ameliorants (Hazleton and Murphy 2007). The clay mineral and organic matter components of soil have negatively charged sites on their surfaces which adsorb and hold positively charged ions (cations) by electrostatic force. This electrical charge is critical to the supply of nutrients to plants because many nutrients exist as cations (e.g. Mg, K and Ca).* No references should be in the COP.	**USA**
***Cation Exchange Capacity (CEC)**: ~~It is a~~ A measure of the soil's ability to hold positively charged ions. ~~It is a very important soil property influencing soil structure stability, nutrient availability, soil pH and the soil's reaction to fertilizers and other ameliorants (Hazleton and Murphy 2007).~~ The clay mineral and organic matter components of soil have negatively charged sites on their surfaces which adsorb and hold positively charged ions (cations) ~~by electrostatic force. This electrical charge is critical to the supply of nutrients to plants because many nutrients exist~~ such as ~~cations (e.g.~~ Mg, K, ~~K~~ and ~~Ca).~~ Ca cations by electrostatic force.*	**USA**
~~***Redox reaction**: Reactions of oxidation and reduction that occur simultaneously and they are known to be inseparable — as one atom loses an electron, the other gains an electron, hence completing the redox cycle.~~	**USA**
~~***Complexation reaction**: It is a reaction that forms a "complex". In addition, the reaction between a cation and one or more anions is very important in soil systems. Metal complexes are stable species that are less likely to participate in sorption, precipitation, and even redox reactions.~~	**USA**
~~***Drying process**: Drying of cocoa beans either under sunlight or in mechanical/solar dryers (or a combination of both) in order to reduce the moisture content to make them stable for storage.~~	**USA**
***Fermentation**: process designed to degrade the pulp or mucilage and initiate biochemical changes in the cotyledon by enzymes and microorganisms inherent in the environment of the farm.*	**USA**
***Soil Amendments**: ~~They refer to any~~ Any material added to the soil to improve its physical and chemical properties. The ~~applications~~ application of ~~the~~ amendments ~~depend~~ depends on the characteristics of the soils~~. The amendments reported in the studies for the elaboration of this COP were:~~ , and may include compost ~~(refers to humus that is obtained of artificial manner when organic~~ (organic waste is decomposed by organisms and beneficial microorganisms), magnesium carbonate, vinasse (a by-product of the production of alcohol from sugarcane), zeolite (minerals that ~~stand out for their ability to~~ hydrate and dehydrate reversibly, adsorbents); charcoal ~~o~~ or biochar; calcium sulphate, lime, cachaza (by-product of sugar cane), zinc sulphate, dolomite (calcium carbonate and magnesium), vermicompost, sugar cane, palm kernel cake, phosphate rock, and other organic matter.*	**USA**

SPECIFIC COMMENTS	
Section/paragraph	**Member/Observer**
***Soil Amendments**: They refer to any material added to the soil to improve its physical and chemical properties. The applications of the amendments depend on the characteristics of the soils. The amendments reported in the studies for the elaboration of this COP were: compost (refers to humus that is obtained of artificial manner when organic waste is decomposed by organisms and beneficial microorganisms), magnesium carbonate, vinasse (a by-product of the production of alcohol from sugarcane), zeolite (minerals that stand out for their ability to hydrate and dehydrate reversibly, adsorbents); charcoal o biochar; calcium sulphate, lime, cachaza (by-product of sugar cane), zinc sulphate, dolomite (calcium magnesium carbonate ~~and magnesium)~~), vermicompost, sugar cane, palm kernel cake, phosphate rock, organic matter.*	**CCTA**
~~***Validation**: Obtaining evidence that a control measure or combination of control measures, if properly implemented, is capable of controlling the hazard to a specified outcome.~~*	**USA**
***Sampling**: Procedure used to draw or constitute a sample. Empirical or punctual sampling procedures are ~~sampling procedures, which are~~ not ~~statistical-based~~ statistically-based procedures that are used to make a decision on the inspected lot.*	**USA**
~~***Organic agriculture**: It is a holistic production management system which promotes and enhances agroecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, cultural, biological and mechanical methods, as opposed to using synthetic materials, to fulfil any specific function within the system. An organic production system is designed to:~~The text below: a) through h) should also be deleted.*	**USA**
~~***Pruning**: annually removal from shade trees and cocoa plants of branches that are dry, diseased or un-balanced.~~*	**USA**
Shading: Growing cocoa plants with shade trees to reduce the amount of radiation and wind that reaches the ~~crop and protect the crop from winds~~crop. Shading is usually more or less 50% during the first 4 years of plant life after which percentage of shade can be reduced to 25 or 30%.	**USA**
4. RECOMMENDED PRACTICES TO PREVENT AND REDUCE Cd CONTAMINATION IN COCOA BEANS	
4.1 Contamination before sowing – new plantations	
(11) The prevention and reduction of Cd in cocoa should start with a physicochemical analysis of the soil and be an integral part of pre-harvest practices and any prior to the establishment of a new plantation. In this respect, we know that there is no guarantee that Cd will not accumulate in cocoa beans, because there are a number of studies that show that, although there may be low values of Cd in the soil, if the cultivar accumulates it, it will pass it on to the bean. (Argüello et al. 2019; Engbersen et al. 2019; Lewis et al. 2018). We consider it important to specify in the document the parameters for the soil analysis which indicate or lead to the bioavailability of cadmium and are consequently key to its prevention and reduction. We propose: the pH, the organic matter, the cadmium content in the soil, the texture, the cation exchange capacity, the content in iron (Fe) oxides and hydroxides and manganese (Mn) carbonates. Zn content, etc. It is important to find mechanisms that help finance the cost of these analyses if they are to be successful.	**Colombia**
(11) The prevention and reduction of Cd in cocoa should begin with the physical-chemical analysis of the soil and be an integral part of the practices before sowing or establishment of a new plantation. Thailand is of the view that it is difficult and not practical for local farmers to analyze cadmium in soil. Besides, soil analysis on physical and chemical properties, such as pH and essential nutrients, would be more suitable for farmers.	**Thailand**
(11) The prevention and reduction of Cd in cocoa should begin with the physical-chemical analysis of the soil and should be an integral part of the practices before sowing or establishment of a new plantation. • Perhaps should cite Code of Practice Concerning Source Directed Measures to Reduce Contamination of Foods with Chemicals (CXC 49-2001) as a control measure? • Perhaps more information on what this physical-chemical analysis entails (e.g., Cd, nutrients, etc.) would be helpful.	**USA**

SPECIFIC COMMENTS	
Section/paragraph	**Member/Observer**
(12) As prevention, when establishing new plantations, cocoa plantations should be located in areas where Cd content is low, so that agricultural soils should not exceed 1.4 mg/kg of Cd. and the content of Cd in irrigation water should not exceed the value of 0,005 mg /L. • What is the justification for the statement 'As prevention, when establishing new plantations, cocoa plantations should be located in areas where cadmium content is low, so that agricultural soils should not exceed 1.4 mg/kg of cadmium'? The survey of Argüello et al. (2019) (3) is not cited but this is probably the largest published survey of cadmium in cacao in terms of number of trees collected (n=560). This nationwide survey allows to estimate the soil cadmium concentrations, which correspond to specific concentrations of cadmium in cocoa beans. The data which originate from this survey (Table 1 in the Annex to the EU comments) show that, for example, for ensuring that the mean cadmium concentrations in cocoa beans do not significantly exceed 1 mg Cd/kg, the soil cadmium should not exceed 0.4 mg Cd/kg if the soil pH=5.0. If the soil pH =7, the cadmium concentrations in the soil should not exceed 1.0 mg Cd/kg. On the basis of these data the proposed maximum concentration of 1.4 mg/kg cadmium in the soil is too high. (3) Argüello D, Chavez E, Lauryssen F, Vanderschueren R, Smolders E, et al., 2019. Soil properties and agronomic factors affecting cadmium concentrations in cacao beans: A nationwide survey in Ecuador. Sci Total Environ 649:120–127. doi: 10.1016/j.scitotenv.2018.08.292. • As prevention, when establishing new plantations, cocoa plantations should be located in areas where Cd content is low, so that agricultural soils should not exceed 1.4 mg/kg of Cd and the content of Cd in irrigation water should not exceed the value of 0.005 mg/L.	**EU**
(12) As prevention, when establishing new plantations, cocoa plantations should be located in areas where Cd content is low, so that agricultural soils should not exceed 1.4 mg/kg of Cd. and the content of Cd in irrigation water should not exceed the value of 0,005 mg /L. Thailand is of the view that the ML for cadmium in agricultural soil and irrigation water be able to establish where supported by sufficient scientific information to confirm the reduction of cadmium contamination in cocoa. Moreover, the levels should be practical for worldwide.	**Thailand**
(12) As prevention, when establishing new plantations, cocoa plantations should be located in areas where Cd content is low, so that agricultural soils should not exceed 1.4 mg/kg of Cd. and the content of Cd in irrigation water should not exceed the value of 0,005 mg /L. • There is no basis for using a maximum of 1.4 mg Cd/kg as the guidance for selection of land for cocoa farms. If the soil is strongly acidic, cocoa grown on such soils will accumulate excessive Cd. The soil Cd guidance should be connected with soil pH which is more important than soil Cd concentration per se. If there is no specific information supporting this level in relation to cocoa production/cocoa growing areas, this statement can be qualified, such as: "No specific recommendation on Cd levels in cocoa growing áreas has been identified, but 1.4 mg/kg has been identified as an upper level for Cd in soil for growth of other crops." • Is there any information on how this level, which appears to be based on acceptable levels for drinking wáter, relates to observed levels in cocoa growing áreas? If there is nothing specific supporting the designation of 0.005 mg/L for cocoa growing regions, a revisión like the following might be appropriate: "There is not sufficient information to identify an appropriate irrigation wáter Cd level, but wáter levels can be monitored to determine if they are a potential source of Cd, e.g.,higher than background levels due to point source contamination."	**USA**
(13) Use a design of mixed plantations (agroforestry) with several varieties of cocoa and with different types of shade adapted to each ecological environment, instead of a monoculture of cocoa without shade. It is important to be aware of the cadmium content in the leaves of other plants introduced into an Agroforestry System. It is also important to evaluate cadmium in materials of cocoa used for budding, as they are directly in contact with the soil and the effect of the pods (clones) on the capacity of assimilation. According to the experience of some Colombian CNCH companies, it is recommended to plant only self-compatible clones by separate blocks to facilitate their management. We do not recommend planting designs.	**Colombia**

SPECIFIC COMMENTS	
Section/paragraph	**Member/Observer**
(13) Use a design of mixed plantations (agroforestry) with several varieties of cocoa and with different types of shade adapted to each ecological environment, instead of a monoculture of cocoa without shade. What is the scientific evidence for the recommendation to 'Use a design of mixed plantations (agroforestry) with several varieties of cocoa and with different types of shade, adapted to each ecological environment, instead of a monoculture' and what is the mechanism of lower cadmium uptake in agroforestry? Studies by Gramlich et al. (2017) (4) and Argüello et al. (2019) (3) have systematically or statistically compared agroforestry with monoculture and found no statistically significant difference in cadmium uptake in cacao beans. (3) Argüello D, Chavez E, Lauryssen F, Vanderschueren R, Smolders E, et al., 2019. Soil properties and agronomic factors affecting cadmium concentrations in cacao beans: A nationwide survey in Ecuador. Sci Total Environ 649:120–127. doi: 10.1016/j.scitotenv.2018.08.292. (4) Gramlich A, Tandy S, Andres C, Chincheros Paniagua J, Armengot L, et al., 2017. Cadmium uptake by cocoa trees in agroforestry and monoculture systems under conventional and organic management. Sci Total Environ 580:677–686. doi: 10.1016/j.scitotenv.2016.12.014.	**EU**
(13) Use a design of mixed plantations (agroforestry) with several varieties of cocoa and with different types of shade adapted to each ecological environment, instead of a monoculture of cocoa without shade. Although there are known benefits to agroforestry, data on the impact of agroforestry (vs. monoculture) on cadmium levels in cocoa is rather preliminary. Some acknowledgement of this is needed.	**USA**
(14) The most commonly used species are musaceae (bananas, moles and cambures) for temporary shadows and legumes such as the pore or bucare (Erythrina sp.) and guabas (Ingas) for permanent shadows. It is advisable to sow short trees, and use citrus and/or fruit trees for the borders of the cocoa plantation lots. It is recommended to use timber species for their permanent shade such as Colombian mahogany (cariniana pyriformis) because it adapts well to different elevations.	**Colombia**
(14) The most commonly used species are musaceae (bananas, moles and cambures) for temporary shadows and legumes such as the pore or bucare (Erythrina sp.) and guabas (Ingas) for permanent shadows. In other cocoa plantations, other shading species are being used that provide greater economic benefits such as timber species (laurel, cedar, cenizaro or rain tree and terminalia) and / or fruit trees (citrus, avocado, sapote, breadfruit, date palm etc.). Thailand is of the view that it is required sufficient scientific information to ensure that shade trees can reduce cadmium contamination in cocoa.	**Thailand**
(14) The most commonly used species are musaceae (bananas, moles and cambures) for temporary ~~shadows~~ shade and legumes such as the pore or bucare (Erythrina sp.) and guabas (Ingas) for permanent ~~shadows~~shade. ~~In other cocoa plantations, other~~ Other shading species ~~are being used~~ that provide greater economic benefits ~~such as~~ include timber species (laurel, cedar, cenizaro or rain tree and terminalia) and / or fruit trees (citrus, avocado, sapote, breadfruit, date palm etc.).	**USA**
(15) Install plantations in areas far from roads or take measures to reduce the exposure of the cacao plantations to gases emitted by the combustion of vehicles because they may contain Cd (they should be spaced 200 meters from the cacao plantation). Likewise, they should be located in areas separated from dumps in cities or mining areas and flooded soils because they could be a source of Cd.	**Colombia**
(15) Install plantations in areas far from roads or take measures to reduce the exposure of the cacao plantations to gases emitted by the combustion of vehicles because they may contain Cd (should be spaced 200 meters apart from the cacao plantation). Likewise, they should be located in areas separated from dumps in cities or mining areas. Kenya proposes this paragraph to include more possible sources of cadmium as appears in Introduction section second paragraph. Therefore the proposal is for this paragraph to read: Install plantations in areas far from roads or take measures to reduce the exposure of the cacao plantations to gases emitted by the combustion of vehicles because they may contain Cd (should be spaced 200 meters apart from the cacao plantation). Likewise, they should be located in areas in areas separated from dumps in cities , mining areas, smelting areas, industrial wastes, sewage and household waste water.	**Kenya**

SPECIFIC COMMENTS	
Section/paragraph	**Member/Observer**
(15) Install plantations in areas far from roads or take measures to reduce the exposure of the cacao plantations to gases emitted by the combustion of vehicles because they may contain Cd (should be spaced 200 meters apart from the cacao plantation). Likewise, they should be located in areas separated from dumps in cities or mining areas. Thailand is of the view that "the planting location should be spaced 200 meters apart from roads" is too specific and lead to limitation for practice. Moreover, it is required scientific information to prove the reduction of cadmium contamination in cocoa.	**Thailand**
(15) Install plantations in areas far from roads or take measures to reduce the exposure of the cacao plantations to gases emitted by the combustion of vehicles because they may contain Cd ~~(should be spaced 200 meters apart from the cacao plantation)~~. Likewise, they should be located in areas separated from dumps in cities or mining areas. Roadways are a very minor source of Cd, so specifying a 200 m buffer zone may not help reduce cadmium.	**USA**
(16) ~~Avoid flooded soils because they could be a source of Cd.~~	**Colombia**
(16) Avoid flooded soils ~~because they could be a~~ if the water sources are an increased source of Cd. Flooded soils might have higher Cd risk only if soils with higher Cd or industrial sources of Cd are discharged to the streams which cause the flooding. In most cases, flooding will be a trivial aspect of Cd in cocoa.	**USA**
(17) In new plantations, the use of cover crops of perennial legumes should be considered. Cover crops improve soil organic matter and they can protect soil from erosion and reduce the loss of nutrients, improving soil productivity through greater availability of essential nutrients and reducing the bioavailability of metals.	**Colombia**
4.2 From the production to the harvesting phase	
4.2 From ~~the~~ production to the harvesting phase	**USA**
(18) Knowledge of the sources and the distribution of Cd in the soil is important. The key factor for success in this section is the joint participation of different intergovernmental and research institutions and unions to pool results. It is known that sewage sludges, fly ash and flag have high concentrations of cadmium (Baker, Amacher, and Leach 1979; Hansen et al. 2001; Wang et al. 2020; Zhang, Wang, and Wang 2017), which implies that in this specific case they constitute a source of contamination instead of providing an alternative to immobilize cadmium. In general, it should be noted that any organic or inorganic amendment applied to the crop should previously be submitted to cadmium analysis, because depending on its source it may contain levels of this element and become a source for the entry of cadmium into the crop.	**Colombia**
(18) Knowledge of the sources and the distribution of Cd in the soil is important. Kenya proposes this section to include a paragraph that touches on fertilizers used in cocoa plantations. The proposal to read: The fertilizers applied during production should meet the specified criteria in relation to cadmium levels.	**Kenya**
(18) Knowledge of the sources and the distribution of Cd in the soil is important. Are there specific recommendations based on having this knowledge?	**USA**
(19) Data suggest that there is a positive correlation between higher levels of Cd in soil (as measured by soil tests) and elevated levels of Cd in plant tissues and cocoa beans.	**Colombia**
(19) Soil analyses have shown a positive correlation between the highest levels of Cd in the soil and in the tissues of the plants and cocoa beans It is essential to correlate the content of cadmium in the soil and leaves with the physical and chemical characteristics of the soil as mentioned in the paragraph on the prevention and reduction of Cd and the climatic condition at the time the sample is taken. This means that the appropriate analytical methodology and mechanisms to finance the cost of these analyses should be defined and standardized.	**Colombia**

SPECIFIC COMMENTS	
Section/paragraph	**Member/Observer**
(20) Soil characterization analysis laboratories for cocoa plantations should be conducted by laboratories that are accredited with the worldwide recognized ISO/IEC 17025:2018 standard; using validated methods which include the use of certified reference materials, standards and associated uncertainties. In addition, it is very important to carry out soil analyses with internationally recognized methods (e.g. endorsed by Codex Alimentarius). As regards the ISO 17025 standard, it should be noted that the latest valid version dates from 2017, as there was no update for 2018. Website: https://www.iso.org/obp/ui/#iso:std:iso-iec:17025:ed-3:v2:es	**Colombia**
(20) Soil characterization analysis laboratories for cocoa plantations should be conducted by laboratories that are accredited with the worldwide recognized ISO/IEC 17025:2018 standard; using validated methods which include the use of certified reference materials, standards and associated uncertainties. In addition, it is very important to carry out soil analyses using internationally recognized methods (e.g. endorsed by Codex Alimentarius). Costa Rica considers it very important to carry out soil analyses with internationally recognized methods (e.g. endorsed by Codex Alimentarius). Consequently, it would like to propose having more extensive information on recognized methods for carrying out soil analysis, protocols for taking soil samples and handling samples until they reach the laboratory. The soil sampling protocol should consider obtaining a representative sample because Cd content could be variable in the same production area (finca or chacra, Spanish-language names for cocoa farms) of cocoa.	**Costa Rica**
(20) Soil characterization analysis laboratories for cocoa plantations should be conducted by laboratories that are accredited with the worldwide recognized ISO/IEC 17025:2018 standard; using validated methods which include the use of certified reference materials, standards and associated uncertainties. In addition, it is very important to carry out soil analyses with internationally recognized methods (e.g. endorsed by Codex A limentarius). Kenya notes that the recent version of this standard is 2017. Therefore the standard should read as: ISO/IEC 17025:2017	**Kenya**
(20) Soil characterization analysis laboratories for cocoa plantations should be conducted by laboratories that are accredited with the worldwide recognized ISO/IEC 17025:2018 standard; using validated methods which include the use of certified reference materials, standards and associated uncertainties. In addition, it is very important to carry out soil analyses with internationally recognized methods (e.g. endorsed by Codex Alimentarius). Thailand is of the view that "the soil analysis should be conducted by laboratories that are accredited with the recognized ISO/IEC 17025:2018" leads to limitation for practice and not appropriate for local farmers.	**Thailand**
(20) Soil characterization analysis laboratories for cocoa plantations should be conducted by laboratories that are accredited with the worldwide recognized ISO/IEC 17025:2018 standard; using validated methods which include the use of certified reference materials, standards and associated uncertainties. ~~*In addition, it is very important to carry out soil analyses with internationally recognized methods (e.g. endorsed by Codex Alimentarius).*~~ • Would CCMAS/CAC endorse methods for soil análisis? They would typically focus on methods for análisis of food. • Does this soil analysis include just Cd, or also nutrient analysis as well? This should be stated. If nutrients, it is important to state here that "soils well supplied with nutrients are less likely to bioaccumulate Cd."	**USA**
(21) The soil sampling protocol should consider obtaining a representative sample because Cd content could be variable in the same production area (finca or chacra, Spanish-language names for cocoa farms) of cocoa. It is very important to note that not only is the representativity of the sample important, but that the sampling protocol should be based on or take account of international standards for taking samples in soils specifically contaminated with metals	**Colombia**
(21) The soil sampling protocol should consider obtaining ~~*a*~~ *samples representative* ~~*sample*~~ *of each farm, because Cd content could be variable in the same production* ~~*area (finca o chacra, Spanish names for cocoa farms) of cocoa*~~*area.*	**USA**

SPECIFIC COMMENTS	
Section/paragraph	**Member/Observer**
(22) The determination of soil and irrigation water salinity (Cd chloride salts) is vital since the absorption of Cd by plants increases with chloride. Therefore, it is important to determine the electrical conductivity of soil and water which should be less than 2mS/cm. Is there any bibliographical reference to support this claim?	**Colombia**
(22) The determination of soil and irrigation water salinity (Cd chloride salts) is vital since the absorption of Cd by plants increases with chloride. Therefore, it is important to determine the electrical conductivity of soil and water which should be less than 2mS/cm. ~~The determination~~ In areas where cocoa beans have relatively higher levels of Cd, it is important to determine soil and irrigation water salinity (Cd chloride salts) ~~is vital~~ since the absorption of Cd by plants increases with chloride. Therefore, it is important to determine the electrical conductivity of soil and water which should be less than 2mS/cm. Added, as it seems that these measures would not be needed if there are no concerns regarding Cd levels in cocoa beans	**USA**
4.2.1 Strategies to immobilize cadmium in the soil	
(23) ~~Zinc has a positive effect in reducing Cd content of the cocoa beans.~~ The application of zinc sulphate is carried out with the balanced fertilization that is ~~carried out~~ conducted annually ~~to~~ at the cocoa plantation, according to the requirements of the crop and the ~~soil (characterization analysis)~~soil. However, with the addition of zinc sulphate, soil acidification occurs, requiring addition of limestone.	**USA**
(24) When there is a deficiency of Zn in the soil, soil Zn levels should be increased. Cd competes with Zn, and Cd is more likely to enter the plant and accumulate in cocoa beans when Zn soil concentration is low. Costa Rica would like to propose having more extensive information on critical levels to determine a deficiency of Zn for cultivating cocoa. Justification: Extend the recommendation by specifying critical levels of extractable Zn for cocoa taking as a reference various methods of sample analysis, for example: DTPA, Olsen Modified with the aim of making the strategy more applicable. Liming is an agronomic management practice that reduces Cd uptake by cocoa trees cultivated on highly acidic soils, and its addition also might improve the nutrition and production of cocoa trees.	**Costa Rica**
(24) When there is a deficiency of Zn in the soil, soil Zn levels should be increased. Cd competes with Zn, and Cd is more likely to enter the plant and accumulate in cocoa beans when Zn soil concentration is low. This paragraph should be the first in this section.	**USA**
(25) Liming is an agronomic management practice that reduces Cd uptake by cocoa trees cultivated on highly acidic soils, and its addition also might improve the nutrition and production of cocoa trees. It is important to know the contents of Cd in these lines as they come from mines and are highly variable. In Colombia, it is been shown that there are limes with contents of cadmium of up to 300 ppm, with the effect that the same brand could have high and low percentages, and, on the basis of the above, everything depends on the origin of the raw materials used.	**Colombia**
(26) The most effective method to decrease the bioavailability of Cd developed so far is by liming the soil when its pH is below 5.5. It has been shown that increasing the pH by 1 unit reduces Cd in the cocoa bean by 1/10. If the pH is higher than 5.5, how should it be managed?	**Colombia**

SPECIFIC COMMENTS	
Section/paragraph	**Member/Observer**
(26) The most effective methods developed to date to decrease Cd bioavailability is through liming the soil when soil pH is below 5,5. It has been shown that increasing the pH by 1 unit reduces Cd in the cocoa bean by 1/10. The statement 'It has been shown that increasing the pH by 1 unit reduces cadmium in the cocoa beans by 1/10' can be interpreted as 'reduces by 10%' or 'reduces by factor 10'. The latter cannot be correct, as not even the solubility is affected by such pH change. It would be beneficial to include in the appendix the data, which support the statements in this document.	**EU**
(26) The most effective methods developed to date to decrease Cd bioavailability is through liming the soil when soil pH is below 5,5~~. It has been shown that increasing the pH by 1 unit reduces Cd in the cocoa bean by 1/10~~. How well established is the 1 unit: 1/10 relationship? If this is not well established (e.g., based on one study in one área), this sentence can be omitted.	**USA**
(27) Apply liming levels in low doses (3 t/ha/year) and preferably dolomite [CaMg (CO3)2] to gradually increase pH and incorporate Ca and Mg that are essential for the growth of cocoa and can precipitate Cd decreasing its bioavailability. Over liming should be avoided.	**Colombia**
(28) A greater amount of soil organic matter causes a lower absorption of Cd. The use of organic fertilizers such as treated manure from stabled livestock, compost, etc. increases the organic matter content of the soil and improves its microbiological activity. The application of 3 to 4 % of organic matter in cocoa plantations decreases cadmium in cocoa beans.	**Colombia**
(28) A greater amount of soil organic matter causes a lower absorption of Cd. The use of organic fertilizers such as treated manure from stabled livestock, compost, etc. increases the organic matter content of the soil and improves its microbiological activity. The application of 3 to 4% of organic matter in cocoa plantations decreases cadmium in cocoa beans. The proposed wording is confusing and therefore we propose the following amendment: Levels of 3 to 4% of organic matter in cocoa plantations decreases cadmium in cocoa beans. Justification: Clarity in wording to achieve a proper understanding of the information.	**Costa Rica**
(28) A greater amount of soil organic matter causes a lower absorption of Cd. The use of organic fertilizers such as treated manure from stabled livestock, compost, etc. increases the organic matter content of the soil and improves its microbiological activity. The application of 3 to 4 % of organic matter in cocoa plantations decreases cadmium in cocoa beans. For the recommendation 'The application of 3 to 4 % of organic matter in cocoa plantations decreases cadmium in cocoa beans' it should be specified to what the 3 to 4% refers, e.g. to 3 to 4% organic matter by weight of the top 5 cm of soil? It might be more clear to state the mass of organic matter which should be applied per area.	**EU**
(28) A greater amount of soil organic matter causes a lower absorption of Cd. The use of organic fertilizers such as treated manure from stabled livestock, compost, etc. increases the organic matter content of the soil and improves its microbiological activity. ~~The application of 3 to 4 % of organic matter in cocoa plantations decreases cadmium in cocoa beans.~~ How well studied is this estimate of 3-4%? If it is based on a handful of field studies, this should be stated explicitly. Otherwise, it should be deleted.	**USA**
(28) A greater amount of soil organic matter causes a lower absorption of ~~Cd~~Cd and may help decrease cadmium in cocoa beans, based on experimental studies. The use of organic fertilizers such as treated manure from stabled livestock, compost, etc. increases the organic matter content of the soil and improves its microbiological activity. The application of 3 to 4 % of organic matter in cocoa plantations decreases cadmium in cocoa beans. Possible alternate wording and could delete last sentence.	
(29) The use of phosphate fertilizers and sedimentary phosphoric rock should be carried out after chemical analysis because they usually have Cd as an impurity. Nonetheless, for successful cocoa production it is vital to add phosphate fertilizers because tropical soils have very limited native phosphorus content. However, the absolute concentration of Cd in phosphate fertilizer should be considered. Producers and governments should control the use of phosphate fertilizers.	**Colombia**

SPECIFIC COMMENTS	
Section/paragraph	**Member/Observer**
(29) The use of phosphate fertilizers and sedimentary phosphoric rock should be carried out after chemical analysis because they usually have Cd as an impurity. Nonetheless, for successful cocoa production it is vital to add phosphate fertilizers because tropical soils have very limited native phosphorus content. However, the absolute concentration of Cd in phosphate fertilizer should be considered. Producers and governments should control the use of phosphate fertilizers. We recommend providing more extensive information indicating the undesired levels of contents of Cd in the inputs. Justification: More extended recommendations clearly specifying the undesired levels of Cd in the inputs would make the recommended strategy more applicable, as there would be criteria for taking decisions on the use or otherwise of certain agricultural inputs.	**Costa Rica**
(29) The use of phosphate fertilizers and sedimentary phosphoric rock should be carried out after chemical analysis because they usually have Cd as an impurity. Nonetheless, for successful cocoa production it is vital to add phosphate fertilizers because tropical soils have very limited native phosphorus content. However, the absolute concentration of Cd in phosphate fertilizer be considered. Producers and governments should control the use of phosphate fertilizers. Paragraph 29 states that it is vital to add phosphate fertilisers because tropical soils have a limited native phosphorous content. However also by using organic fertilisers the phosphorous content of the soil can be improved, while these fertilisers typically contain less cadmium and they show a high phosphorous bioavailability.	**EU**
(29) The use of phosphate fertilizers and sedimentary phosphoric rock should be carried out after chemical analysis because they usually have Cd as an impurity. Nonetheless, for successful cocoa production it is vital to add phosphate fertilizers because tropical soils have very limited native phosphorus content. However, the absolute concentration of Cd in phosphate fertilizer be considered. Producers and governments should control the use of phosphate fertilizers. • What is the absolute concentration? For example, is this based on a phosphate ratio? • The setting of levels by national authorities is controversial, and may best be left to the producer. Proposed revision: ~~*The use of phosphate*~~ *Phosphate fertilizers and sedimentary phosphoric rock* ~~*should be carried out after chemical analysis because they usually*~~ *may contain*~~*have*~~ *Cd as an impurity, and thus the concentration of Cd in phosphate fertilizers should be considered. Nonetheless, for successful cocoa production it is vital to add phosphate fertilizers because tropical soils have very limited native phosphorus content. However*~~*, the absolute concentration of Cd in phosphate fertilizer be considered. Producers and governments*~~ *producers should control the* ~~*use*~~ *amount of Cd in phosphate* ~~*fertilizers*~~*fertilizers they use or comply with any national limits.*	**USA**
(30) In general, the formula for the doses of nitrogen, phosphorus and potassium (NPK) in fertilizers to be applied to cocoa crop vary according to the age of the plant and the characteristics of the soil. Verify the heavy metal analysis prior of application to ensure that Cd content is low. Soils well supplied with nutrients are less likely to bioaccumulate Cd. Perhaps this should be mentioned prior to paragraph 20, that begins "Soil characterization analysis laboratories..."?	**USA**
(31) The application of amendments (magnesium carbonate (MgCO3), vinasse, zeolite, humus, charcoal, calcium sulphate (CaSO4), cachaza and zinc sulphate (ZnSO4), depending on the characteristics of the soils, can help decrease Cd concentrations in cocoa beans.	**Colombia**
(31) The application of amendments (magnesium carbonate ($MgCO_3$), vinasse, zeolite, humus, charcoal, calcium sulfate ($CaSO_4$), cachaza and zinc sulfate ($ZnSO_4$), depending on the characteristics of the soils, can help decrease Cd concentrations in cocoa beans. Paragraph 31 mentions under soil amendments MgCO3 and CaSO4, which should rather be mentioned under paragraphs 25, 26 and 27, which deal with liming/ salts. ZnSO4 should be dealt with under paragraph 24 on Zn supplementation of the soil via the addition of salts to the soil.	**EU**
(31) The application of soil amendments (magnesium carbonate ($MgCO_3$), vinasse, zeolite, humus, charcoal, calcium sulfate ($CaSO_4$), cachaza and zinc sulfate ($ZnSO_4$), which vary depending on the characteristics of the soils, can help decrease Cd concentrations in cocoa beans.	**USA**
(32) ~~*The application of vinasse, as a liquid fertilizer*~~ *Vinasse is a source of K that promotes the installation of fungi that form mycorrhizas in the roots of the cacao tree, increasing the efficiency of P nutrition and immobilizing Cd.*	**USA**

SPECIFIC COMMENTS	
Section/paragraph	**Member/Observer**
(33) Lime and sugarcane cake can reduce the flow of Cd in the soil profile. Zeolite is another option in soils with high sand content and apatite in clay-textured soils. Apatite is "rock phosphate", and all rock phosphate contains Cd. So use of apatite to reduce Cd in cocoa is incorrect, and would be very expensive compared to use of dolomitic limestone to raise pH and reduce soil Cd phytoavailability.	**USA**
(34) The application of biochar has been shown to reduce the bioavailability of Cd in cocoa beans. The reduction rates are comparable to liming and have an additive influence on liming. However, biochar or activated carbon is an expensive soil amendment and may not be cost effective for farmers who grow cocoa.	**Colombia**
(34) Biochar has shown to reduce the bioavailability of Cd in cocoa beans. The reduction rates are comparable to liming and have an additive influence on liming. However, biochar ~~or activated carbon~~ is an expensive soil amendment and may not be cost effective for farmers who grow cocoa. Why not recommend compost, manure etc. as alternatives?	**USA**
(34) Biochar has been shown to reduce the bioavailability of Cd in cocoa beans. The reduction rates are comparable to liming and have an additive influence on liming. However, biochar or activated carbon is an expensive soil amendment and may not be cost effective for farmers who grow cocoa.	**CCTA**
(35) Biochar, compost and their combinations have significant effects on soil physicochemical features, metals (Cd) availability and enzyme activities in heavy-metal-polluted soil.	**Colombia**
(35) ~~Biochar, compost and their combination have significant effects on soil physicochemical features, metals (Cd) availability and enzyme activities in heavy metal polluted soil.~~ What is the advice for mitigation?	**USA**
(36) Genotypes identified with low bioaccumulation of Cd have the potential to be used as rootstocks in the production of propagation material to reduce the absorption of Cd from soil; however, additional field studies are needed.	**Colombia**
(36) The genotypes identified with low bioaccumulation of Cd have the potential to be used as rootstocks in the production of propagation material to reduce the absorption of Cd from soil; however, additional field studies are needed. Paragraph 36 on genotypes does not belong under the section of strategies to immobilise cadmium in the soil. This could be included in the chapter on actions, which can be taken when creating new plantations. In order to gain more knowledge on the uptake of cadmium by different varieties of cocoa trees, a recommendation could be added to encouraged to carry out further studies to identify such varieties. Furthermore, when planting new plantations, it should be recommended to plant varieties of cocoa trees, which are less prone to cadmium uptake. More information on specific varieties is included in the background document. However, as the background document will not be included in the final code of practice, more information of on cadmium uptake by different varieties of cocoa trees should be included in the code of practice.	**EU**
(36) The genotypes identified with low bioaccumulation of Cd have the potential to be used as rootstocks ~~in the production of propagation material~~ to reduce the absorption of Cd from soil; however, additional field studies are needed. For grafting (?)	**USA**
(37) The Streptomyces sp. strain has bioremediation activity as it reduces Cd uptake in cocoa plants.	**Colombia**
(37) The Streptomyces sp. strain has bioremediation activity as it reduces Cd uptake in cocoa plants If this has been demonstrated on an experimental basis, this should be stated.	**USA**
(38) Legumes co-inoculated with plant growth promoting Cd-resistant bacteria could be useful in phytoremediation of Cd-contaminated soil and biofertilization.	**Colombia**
(38) The legumes coinoculated with plant growth promoting bacteria Cd resistant could be useful in phytoremediation of Cd-contaminated soil and biofertilization. Paragraph 38 should be further clarified, in order to explain with which types of bacteria plants should be inoculated and how this is expected to result in bioremediation and bio fertilisation. A separate chapter on reducing the cadmium uptake via the use of bacteria could be added.	**EU**

SPECIFIC COMMENTS	
Section/paragraph	**Member/Observer**
(38) The legumes coinoculated with plant growth promoting bacteria Cd resistant could be useful in phytoremediation of Cd-contaminated soil and biofertilization. • Perhaps consider deleting this bullet and the one above as they are unclear and experimental. • Again, if only performed on an experimental basis, this should be stated.	**USA**
4.3 Post-harvest phase	
(39) An experimental study demonstrated that the draining of the mucilage for 12 hours significantly reduced the content of Cd in cocoa beans of the clonal hybrid (cultivar) CCN-51. The quantity of mucilage removed from the cocoa beans did not affect the physical or organoleptic quality of the cocoa at the time of the evaluation.	**Colombia**
(39) An experimental study demonstrated that the draining of the pulp or mucilage for 12 hours significantly reduced the content of Cd in cocoa ~~beans~~beans in one variety, without ~~of~~ affecting the ~~clonal hybrid (cultivar) CCN-51. The quantity of mucilage removed from the cocoa beans did not affect the~~ physical or organoleptic quality of the cocoa at the time of the evaluation. What is the normal draining time? It is not clear what change is being recommended. If this is a longer time than normal, you could potentially say, consider draining pulp longer than normal on a trial basis.	**USA**
(40) After fermentation, cocoa beans should be dried on clean solid surfaces to avoid contamination by soil.	**Colombia**
(41) Make sure that cocoa beans are not contaminated with smoke, or with gases coming from dryers or vehicles.	**Colombia**
(41) Make sure that cocoa beans are not contaminated with smoke, or with gases coming from dryers or vehicles. Is there a recommended practice or change in practice?	**USA**
(42) The process of fermentation of cocoa beans should be the most important practice that any export organization should carry out to reduce the levels of Cd of their cocoa beans.	**Colombia**
(42) The process of fermentation of cocoa beans should be the most important practice that any export organization should carry out to reduce the levels of Cd of their cocoa beans. Paragraphs 42, 44 and 45 deal with the fermentation step, so they should be merged.	**EU**
~~*(42) The process of fermentation of cocoa beans should be the most important practice that any export organization should carry out to reduce the levels of Cd of their cocoa beans.*~~ We suggest that this be deleted. It is addressed elsewhere and it is difficult to know if this is the most important practice, given that many mitigation methods, including this one, are in the experimental phase.	**USA**
(43) During storage, contamination of cocoa beans due to spills of fuels, exhaust gases or fumes should be prevented.	**Colombia**
(44) The longer the fermentation process (80%), the less Cd in cocoa beans. Cd in beans can be reduced if the pH is sufficiently acidified during fermentation.	**Colombia**
(44) The longer the fermentation process (80 %), the less Cd in cocoa beans. Cd beans can be reduced if pH is sufficiently acidified during fermentation. A reference could be added to a very recent publication by Vanderschueren et al. (2020) (5) that confirms the statement that the cadmium concentrations decrease as the fermentation proceeds. (5) Vanderschueren R, Mesmaeker V De, Mounicou S, Marie-Pierre I, Doelsch E, et al., 2020. The impact of fermentation on the distribution of cadmium in cacao beans. Food Res Int 127:108743 . doi: 10.1016/j.foodres.2019.108743.	**EU**

SPECIFIC COMMENTS	
Section/paragraph	**Member/Observer**
(44) The longer the fermentation process (80 %), the less Cd in cocoa beans. Cd beans can be reduced if pH is sufficiently acidified during fermentation. Thailand would like to seek the clarification that the meaning of 80% fermentation process. It is needed reliable scientific information to prove that the fermentation process at 80% can reduce the contamination of cadmium in cocoa.	**Thailand**
(44) ~~The longer the fermentation process (80 %), the less~~ Cd in cocoa ~~beans. Cd~~ beans <u>also</u> can be reduced if pH is sufficiently acidified during fermentation. • This should be moved up, and made the second item under "Post-harvest phase", so that the fermentation bullets are at the beginning of this section. • It should be made clear that this has only been demonstrated on an experimental basis, and further study is needed on the effect of longer fermentation on the flavour profile of the cocoa bean. How is this done? If there is no specific information, it can be removed.	**USA**
(45) The strain of Saccharomyces cerevisiae is one of the strains that intervenes in cocoa fermentation, so increasing its population in such processes could improve the absorption of Cd and the safety of cocoa. There are some bibliographical references which mention this but there is no consensus nor definitive studies on the levels of removal of cadmium by specific strain or strains of that yeast or their influence as a method of beginning the fermentation process. More studies are required before one is recommended as a practice.	**Colombia**
(45) The strain of Saccharomyces cerevisiae is one of the strains that intervenes in cocoa fermentation, so increasing its population in such processes could improve the absorption of Cd and the safety of cocoa. On indicating that the strain of Saccharomyces cerevisiae is one of the strains that intervenes in cocoa fermentation. We recommend a clarification as to whether the absorption of Cd is by the bacterium. Justification: It is important to offer clarity because the wrong criteria could be created.	**Costa Rica**
(45) The strain of Saccharomyces cerevisiae is one of the strains that intervenes in cocoa fermentation, so increasing its population in such process could improve the absorption of Cd and the safety of cocoa. BACKGROUND INFORMATION Table 1. The relationship between soil cadmium concentration, soil pH and the bean cadmium concentration. The predicted bean cadmium is based on the regression model in (Argüello et al. 2019). The values in bold show the soil cadmium beyond which the bean cadmium is significantly above 1.0 mg Cd/kg. Soil Cd (mg Cd/kg) pH (in CaCl2) Predicted Cd in cacao bean mg Cd/kg 95% confidence mean interval 0.4 5.0 1.02 0.92 1.13 0.6 5.0 1.49 1.33 1.68 0.8 5.0 1.96 1.71 2.23 1.0 5.0 2.41 2.09 2.79 1.2 5.0 2.86 2.45 3.34 1.4 5.0 3.30 2.80 3.89 0.4 7.0 0.40 0.36 0.44 0.6 7.0 0.58 0.53 0.64 0.8 7.0 0.76 0.69 0.84 1.0 7.0 0.93 0.84 1.04 1.2 7.0 1.11 0.99 1.24 1.4 7.0 1.28 1.13 1.44	**EU**

SPECIFIC COMMENTS	
Section/paragraph	**Member/Observer**
(45) The strain of Saccharomyces cerevisiae is one of the strains that intervenes in cocoa fermentation, so increasing its population in such process could improve the absorption of Cd and the safety of cocoa. • If this is only done on an experimental basis, then perhaps the latter part of the sentence should be reworded as, “so increasing the population during fermentation has the potential to improve Cd absorption”. Where is the Cd being absorbed? By the yeast or the pulp? Hopefully no the bean. • This should be moved up and made the third item under "Post-harvest phase", so that fermentation bullets are at the beginning of the section.	**USA**