



# Precision Mapping of Cadmium in Cocoa & Soil in Dominica & its Mitigation

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Cocoa Research Centre, U.W.I. Trinidad & Tobago





COCOA & CADMIUM: CONCERNS FOR COCOA-PRODUCING COUNTRIES



MANAGING THE ISSUE: A CRC EVIDENCE-BASED SYSTEMATIC APPROACH



STRATEGIC MAPPING- GIS



CADMIUM MITIGATION STRATEGIES



# AGENDA

# COCOA & CADMIUM





# California Proposition 65: What will Change for US Chocolate Lovers and Cocoa Farmers in Latin America?

December 05, 2019



# The Impacts of New EU Cadmium Regulations on the Cocoa Supply Chain

September 19, 2018



## Cadmium in chocolate limits put forward in Codex meeting

By Joe Whitworth on May 24, 2021



California's Proposition 65 is a long-standing... producers in Latin America and chocolate received as much attention as EU regulati



In January 2019, a new European Union (EU) regulation... effect, with a potential for impacting the entire... experts, its effects will be disproportionately fe

## Improving Capacity Building and Knowledge Sharing to support Management of Cadmium Levels in Cocoa in Latin America and the Caribbean

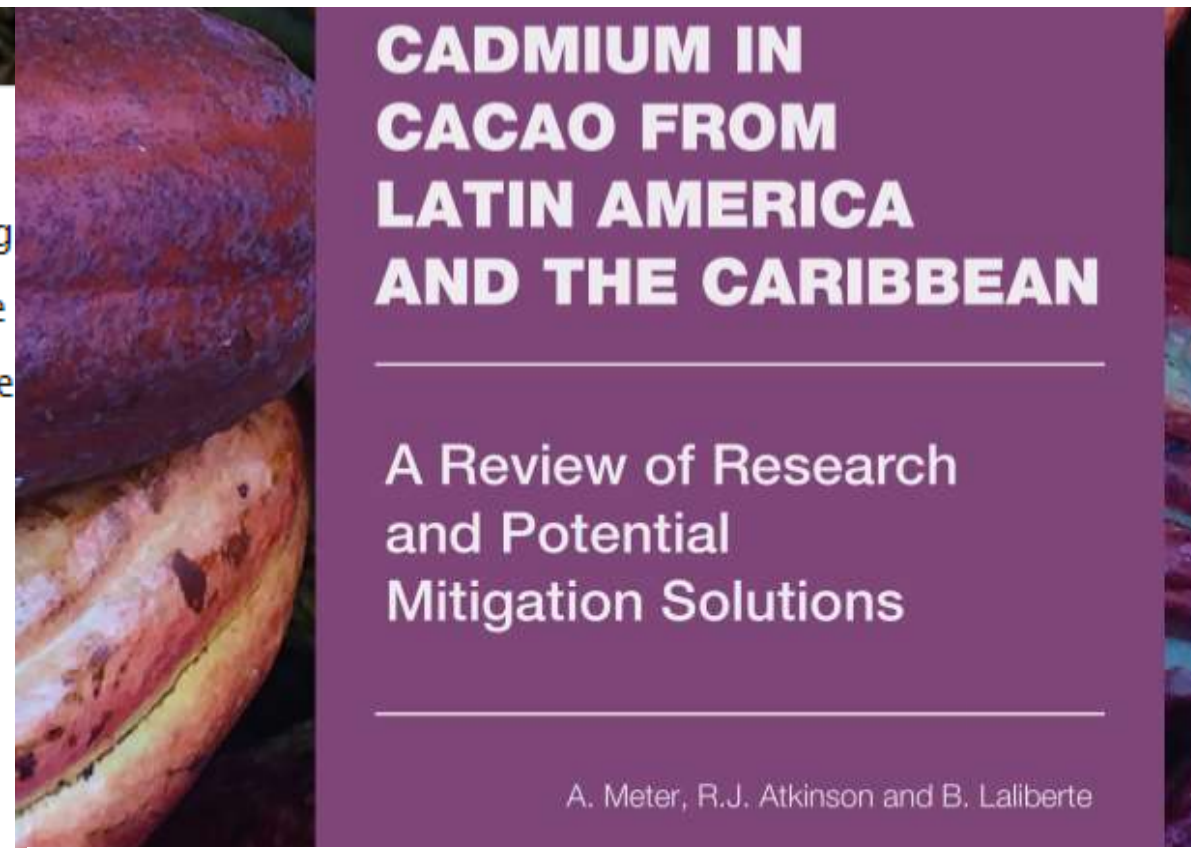
## Cadmium contamination menaces Cocoa exports

By Ntaryike Divine Ramzi in Douala  
Posted on Tuesday, 9 April 2013 11:35

Cocoa farmers across West Africa are worried for their livelihoods after the European Union (EU) announced plans to reject the import of cocoa beans containing certain levels of heavy metals.

The measures are due to take effect in April.

West Africa grows 75 percent of the world's 3.9m tn global supply of cocoa, with the bulk of the beans ending up in Europe.



### CADMIUM IN CACAO FROM LATIN AMERICA AND THE CARIBBEAN

A Review of Research and Potential Mitigation Solutions

A. Meter, R.J. Atkinson and B. Laliberte

## REDUCING CADMIUM LEVELS IN CACAO

October 5, 2020 - Kaine Korzekwa  
Chocolate is almost universally adored. But few know the complicated process of how cacao beans become chocolate. Did you know cacao tree farming is done mostly by small-scale low-income farmers in Latin America, particularly in countries like Ecuador?

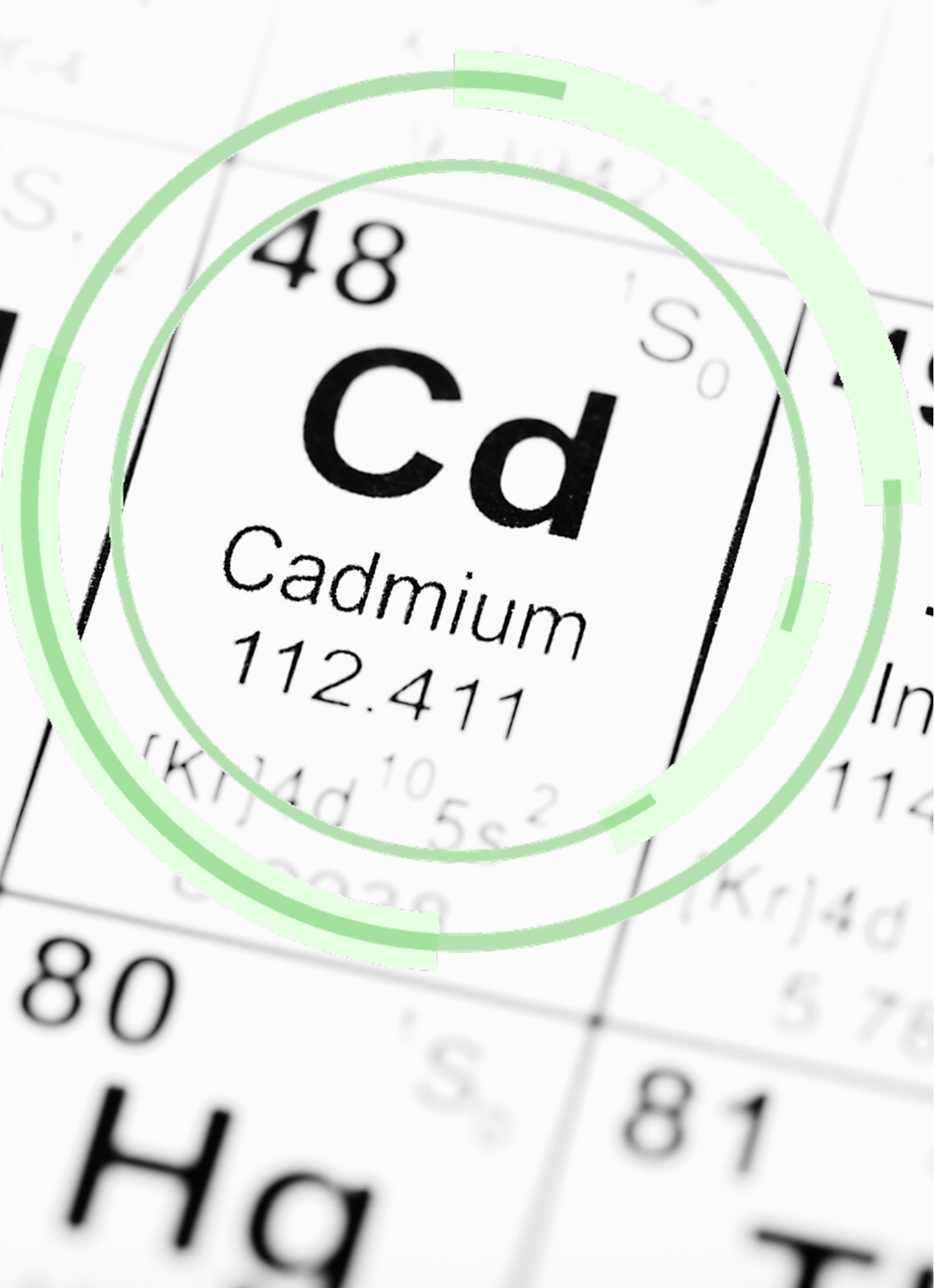
In an additional layer of complexity, soils in these areas are naturally higher in the element cadmium. It's an element that can accumulate in the human body and cause harm. David Argüello and a team of researchers in Ecuador and Belgium set out to find ways to lower how much cadmium from the soil gets into the cacao trees.

"The cadmium issue threatens the livelihood of farmers because their products may not be suitable for trade and some buyers would prefer not to buy polluted cacao beans," Argüello explains. "In order to find an effective mitigation strategy, we have to understand how



# WHY IS CADMIUM CONSIDERED A RISK IN COCOA?





## **WHAT IS CADMIUM?**

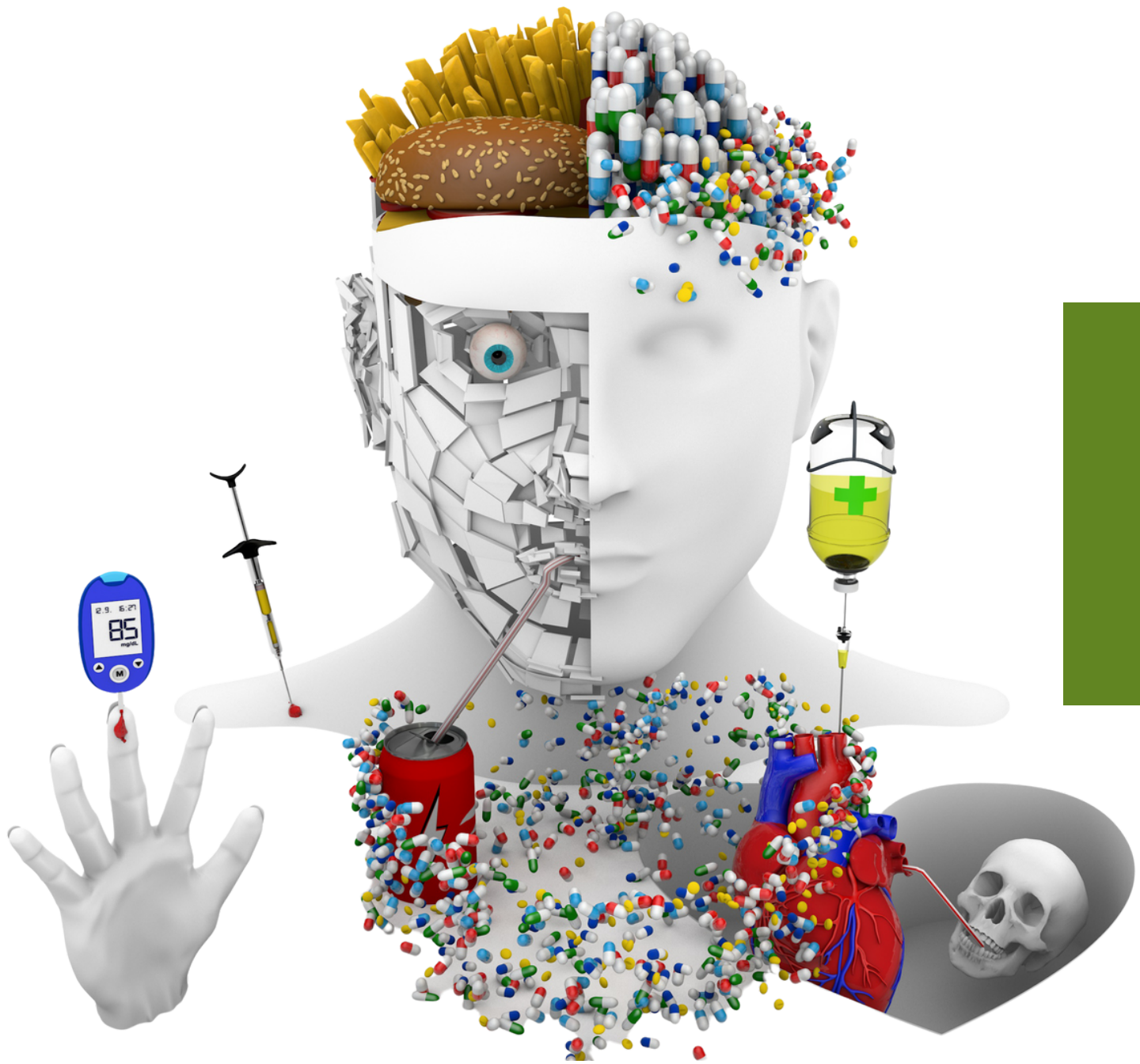
- Metal usually associated with pollution and toxicity.

## **SOME SOURCES:**

- Soils naturally
- Industrial products
  - Fertilizers (Phosphate-based)
  - Ni-Cd batteries
  - Yellow-orange pigmentation in paints
  - Polluted effluent

## **ALSO FOUND IN...**

- Some foods that we consume including cocoa



## Cadmium: Potential Health Risks

### KIDNEY & LIVER

Renal damage and liver disease

### BONES

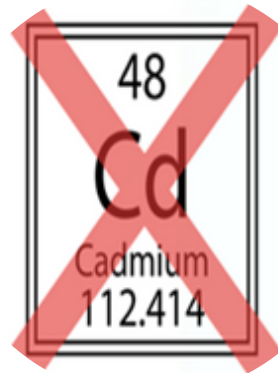
Reduced bone mineral density-  
"brittle bone disease"

### NEUROLOGICAL EFFECTS

Reduced neurobehavioral function-  
learning disability

# Food Safety Limits

## CADMIUM IN COCOA



EU Maximum Limits for Cadmium in Cocoa Products to be applicable from 1st January 2019 (commission Regulation (EU) No 488/2014 amending Regulation (EC) No 1881/2006).

Specific cocoa and chocolate products as listed below - Milk chocolate with <30% total dry cocoa solids	0.10mg/kg as from 1 Jan 2019
Chocolate with <50% total dry cocoa solids; milk chocolate with $\geq$ 30% total dry cocoa solids	0.30mg/kg as from 1 Jan 2019
Chocolate with $\geq$ 50% total dry cocoa solids	0.80mg/kg as from 1 Jan 2019
Cocoa powder sold to the final consumer or as an ingredient in sweetened cocoa powder sold to the final consumer (drinking chocolate)	0.60mg/kg as from 1 Jan 2019

\*For the specific cocoa and chocolate products the definitions set out in points A. 2, 3 and 4 of Annex I to Directive 2000/36/EC of the European Parliament and of the Council of 23 June 2000 relating to cocoa and chocolate products intended for human consumption (OJ L 197, 3.8.2000, p. 19) apply

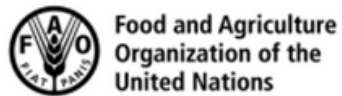
Maximum permissible levels for cadmium in chocolate products set under the Proposition 65 settlement agreement (approved on February 14, 2018)



1 ppm = 1 mg/kg

Cacao percentage in product	Cadmium concentration above which a warning is required (set between 2019 – 2025)	“Drop-down” cadmium concentration above which a warning is required (set from 2025 onward)
< 65%	0.400 ppm	0.320 ppm
$\geq$ 65% – $\leq$ 95%	0.450 ppm	0.400 ppm
> 95%	0.960 ppm	0.800 ppm

### CODEX ALIMENTARIUS COMMISSION



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

Agenda Item 1



CX/CF 21/14/1  
March 2021

JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEX COMMITTEE ON CONTAMINANTS IN FOODS

14<sup>th</sup> Session  
(virtual)  
3-7 and 13 May 2021

#### Cadmium in Cocoa and Chocolate Products

- Agenda Item 5: Maximum level for cadmium in chocolates containing or declaring <30% total cocoa solids on a dry matter basis (at Step 7)
- Agenda Item 6: Maximum levels for cadmium in chocolates containing or declaring  $\geq$ 30% to <50% total cocoa solids on a dry matter basis and cocoa powder (100% total cocoa solids on a dry matter basis) (at Step 4)
- Agenda Item 7: Code of practice for the prevention and reduction of cadmium contamination in cocoa beans (at Step 4)





# Global Distribution

CADMIUM IN COCOA IS MAINLY A PROBLEM IN THE AMERICAS

Example: Latin America, Caribbean

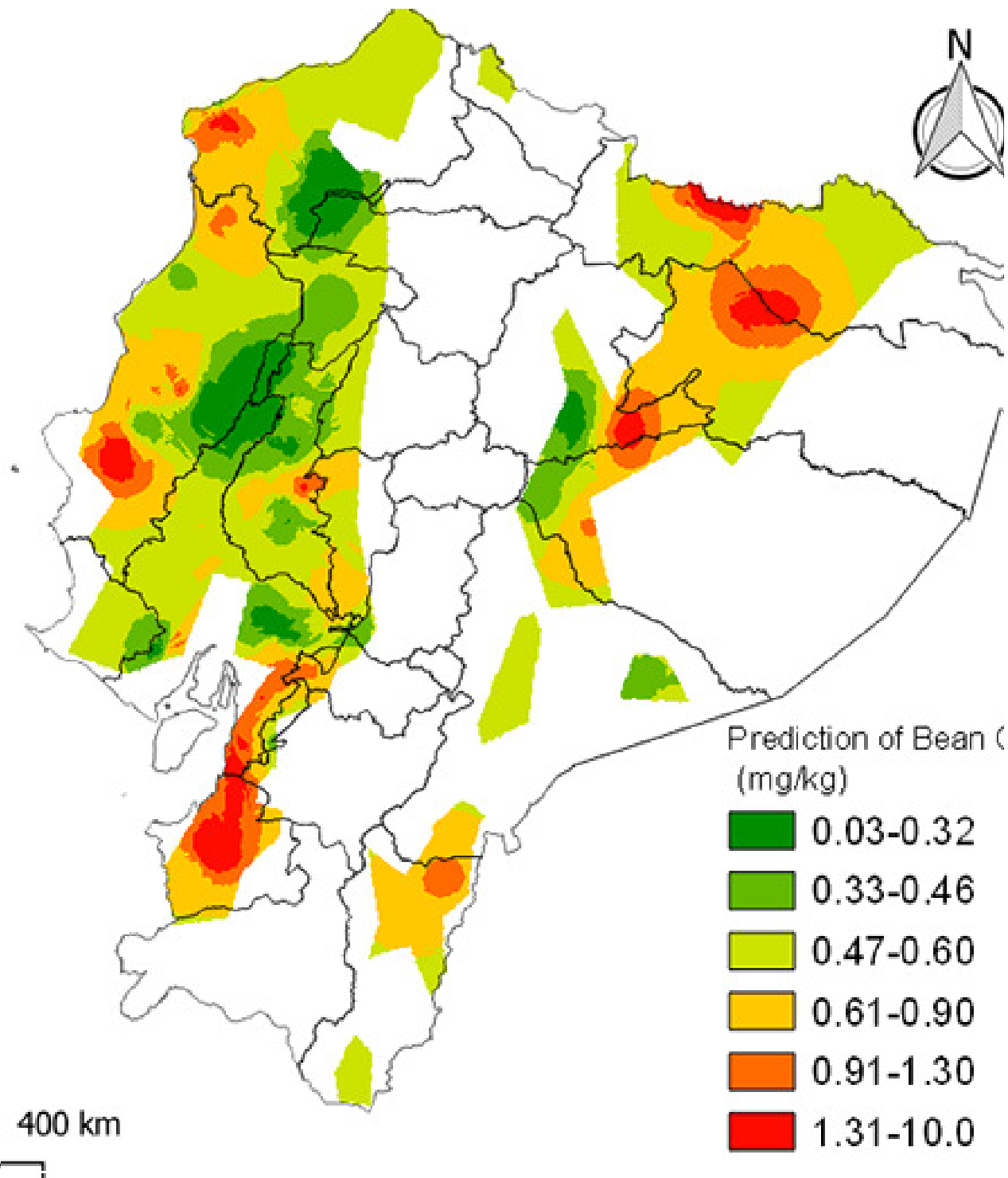
GLOBAL SUPPLY 80% FINE OR FLAVOUR COCOA

May exceed maximum allowable limit for cadmium in some countries

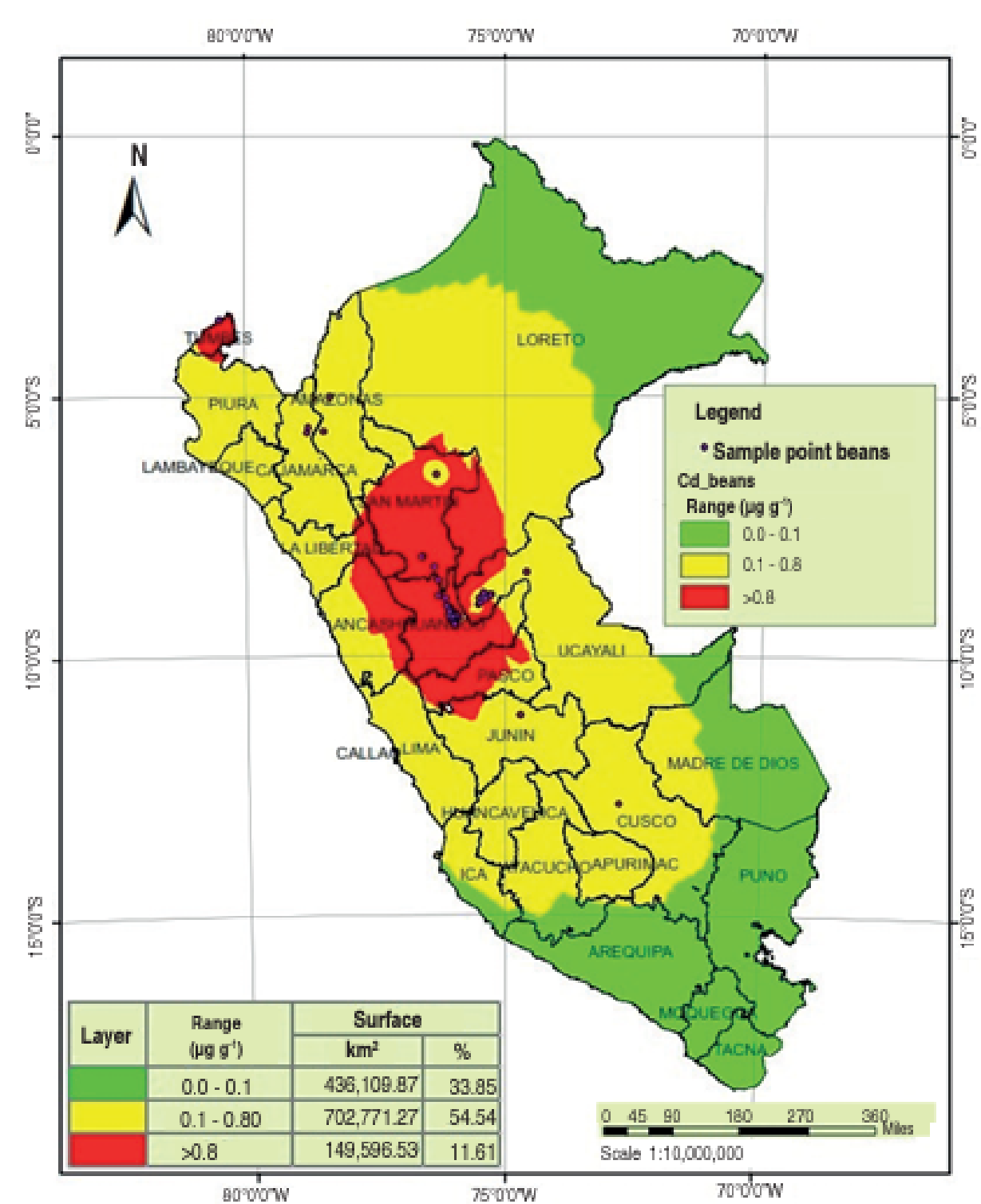
EXPORT BAN

Meeting regulatory limits for cadmium in cocoa beans

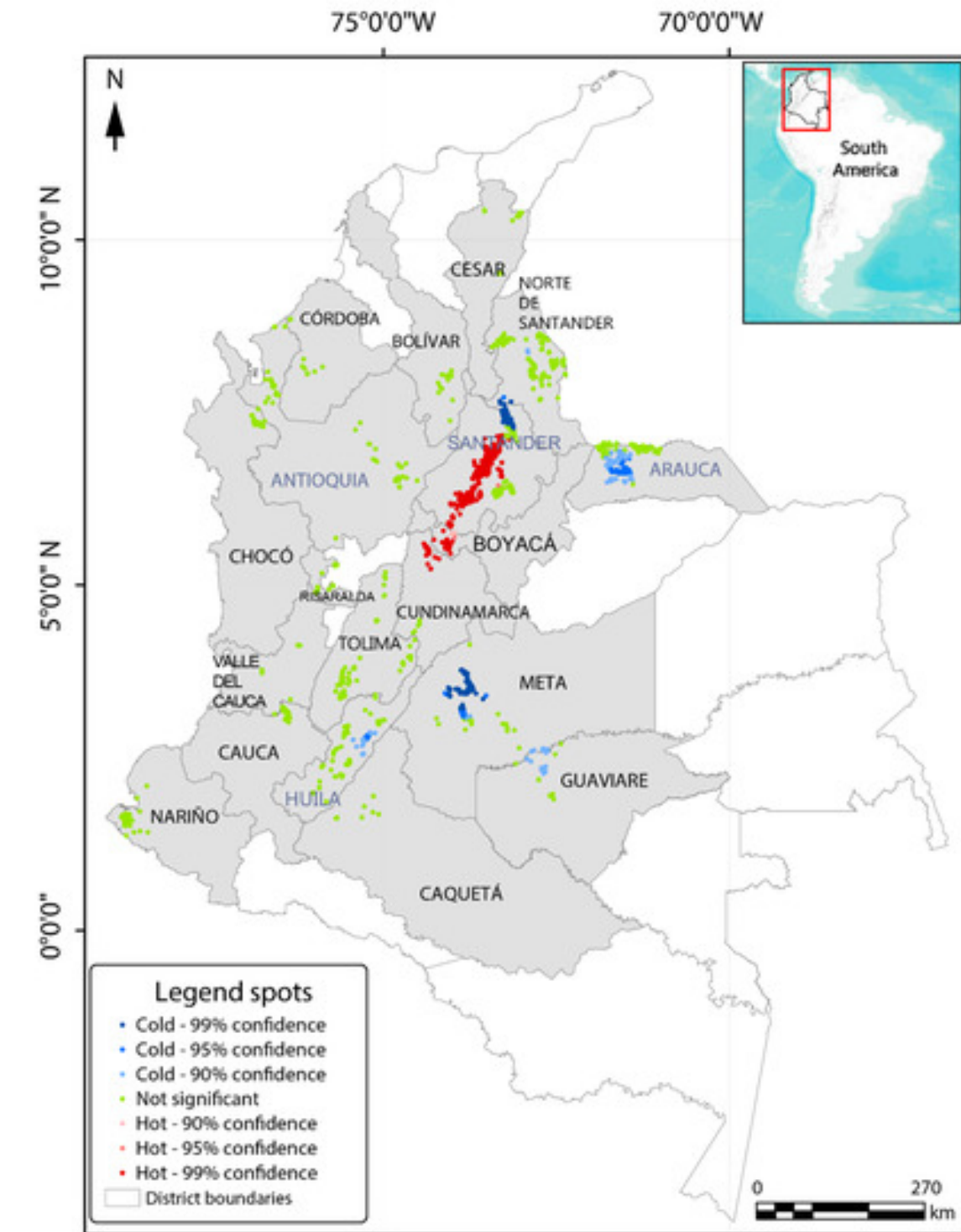
# Latin America: Cd Distribution



Ecuador: Arguello et al., 2019

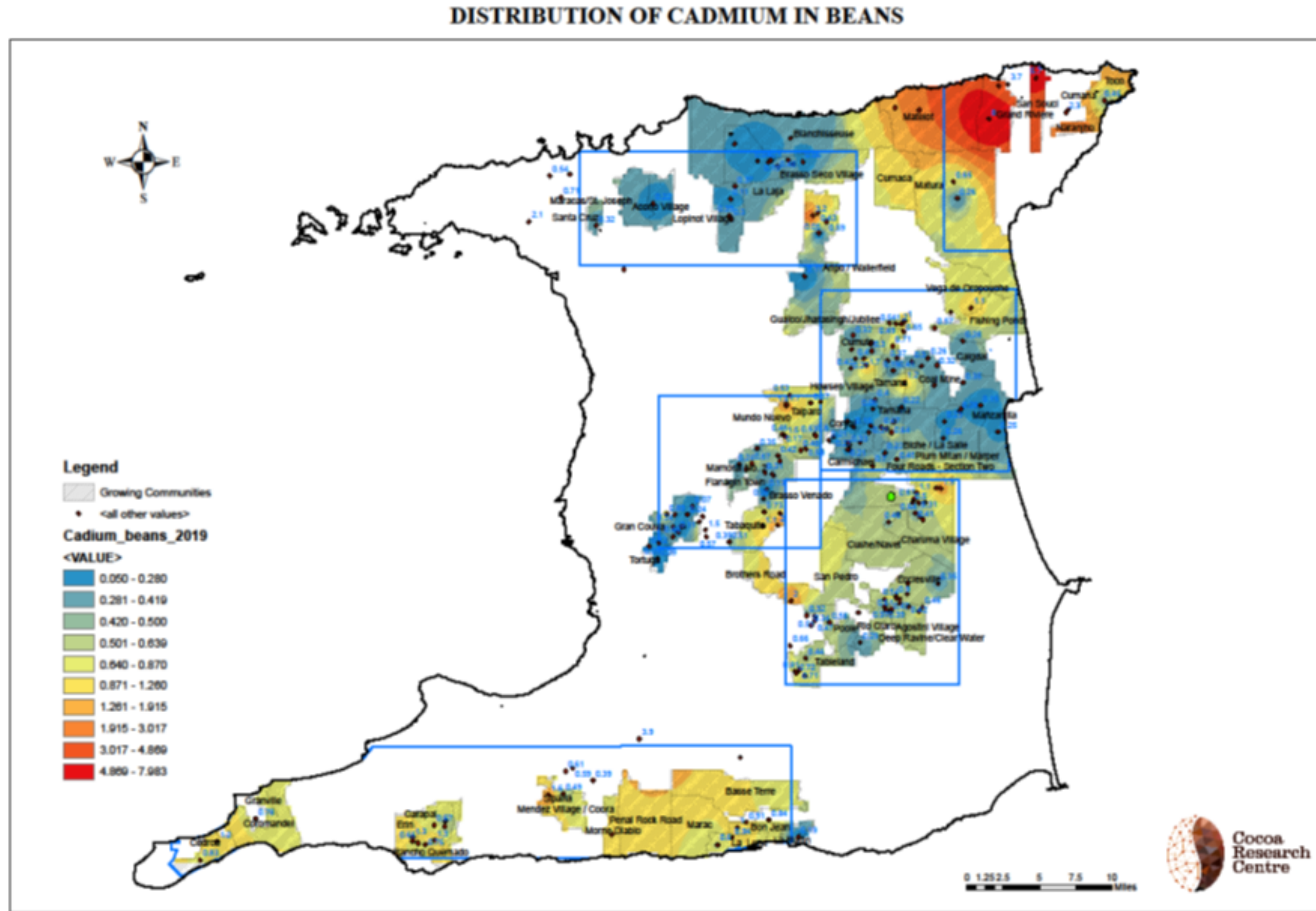


Peru: Florida-Rofner, 2021



Colombia: Bravo et al., 2021

# Caribbean: Cd Distribution



Trinidad

# Central America: Cd Distribution



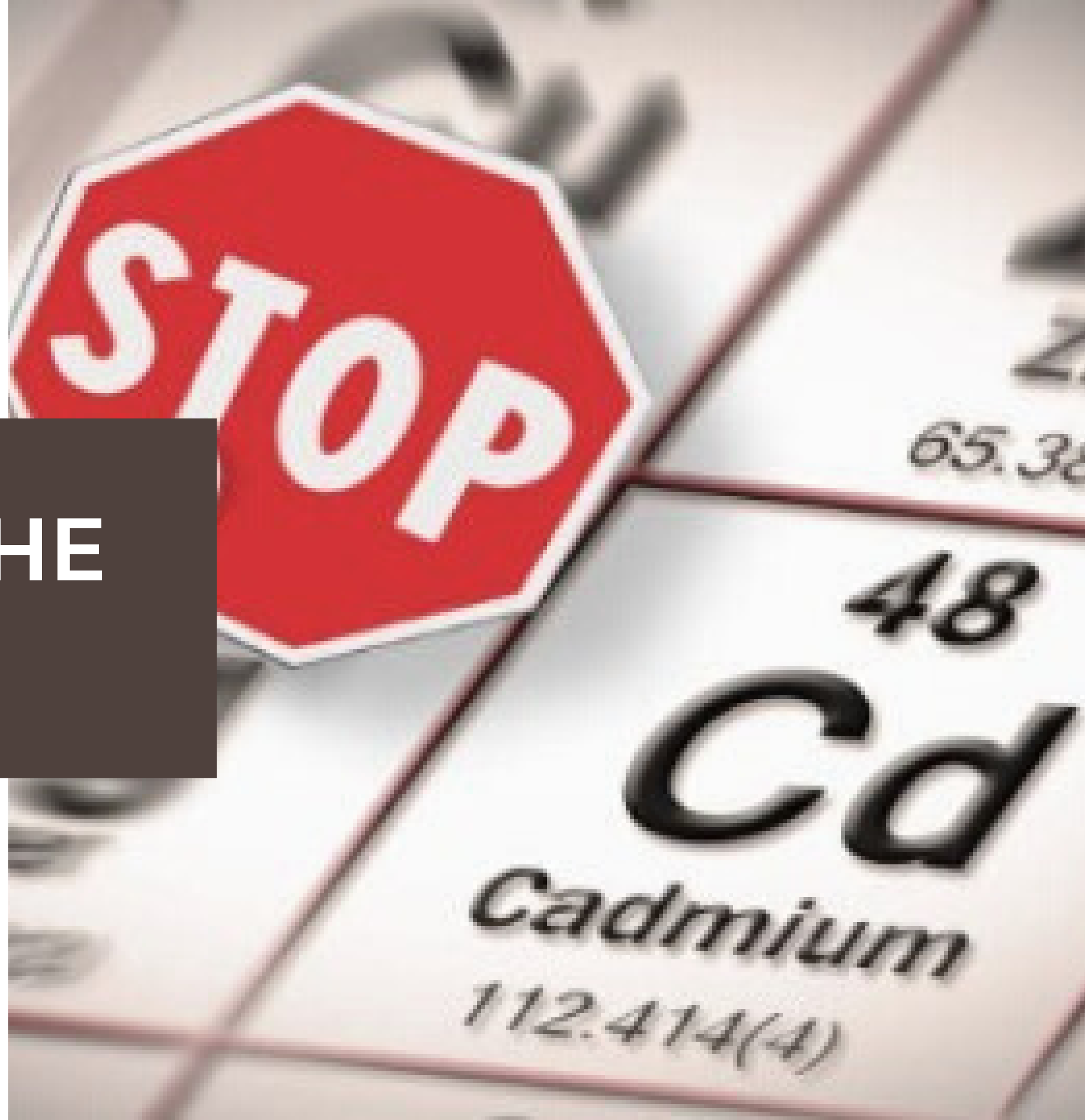
**mocca** | Maximizando Oportunidades  
en Café y Cacao en las Américas



# Precision Mapping of Cadmium in Cocoa & Soil in Dominica & its Mitigation



# MANAGING THE ISSUE





**How does  
cadmium get  
into cocoa?**

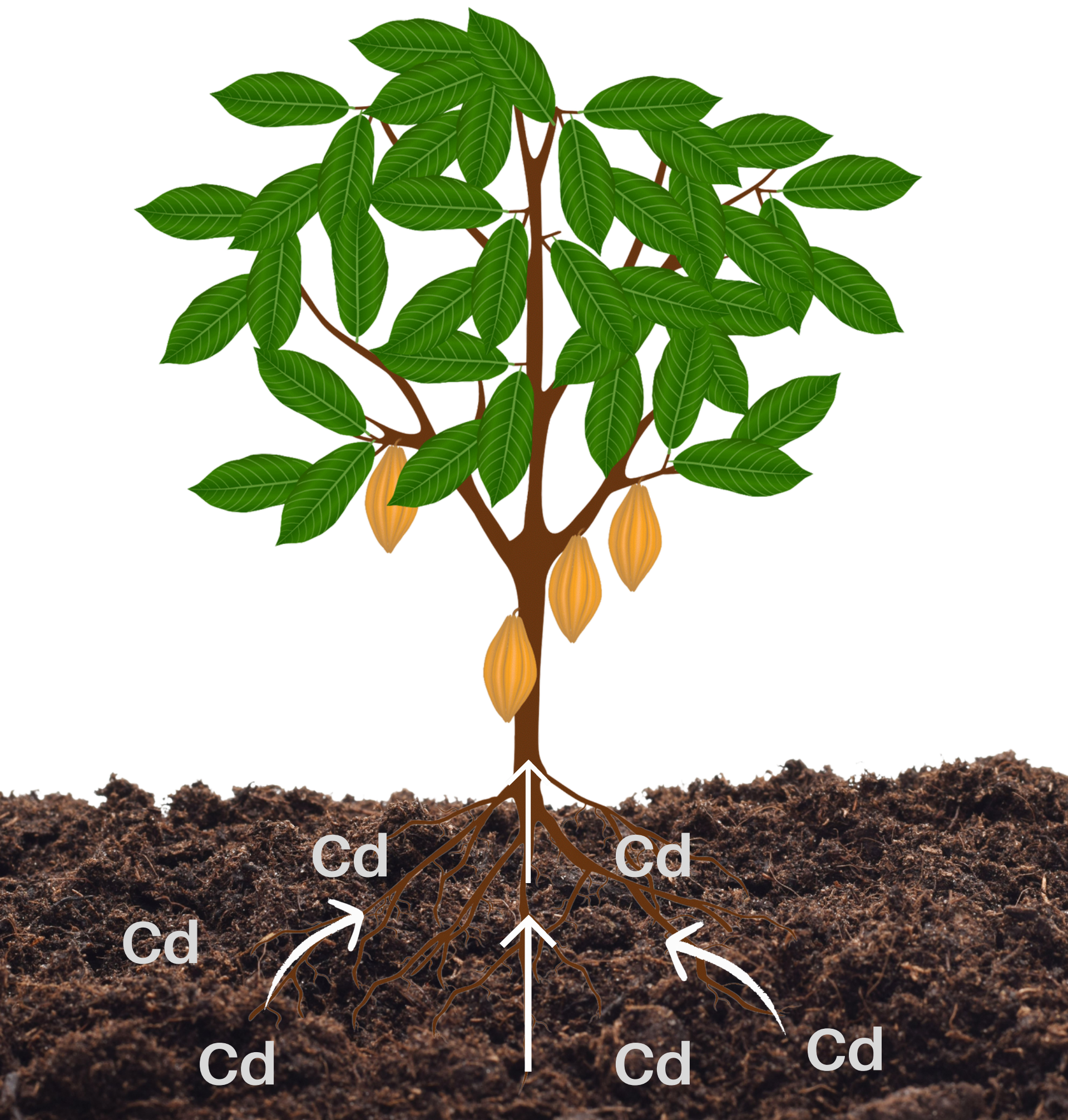




# Pre-harvest Cultivation Phase

CADMIUM ISSUE LOCALIZED  
TO THE FIELD: **SOIL**

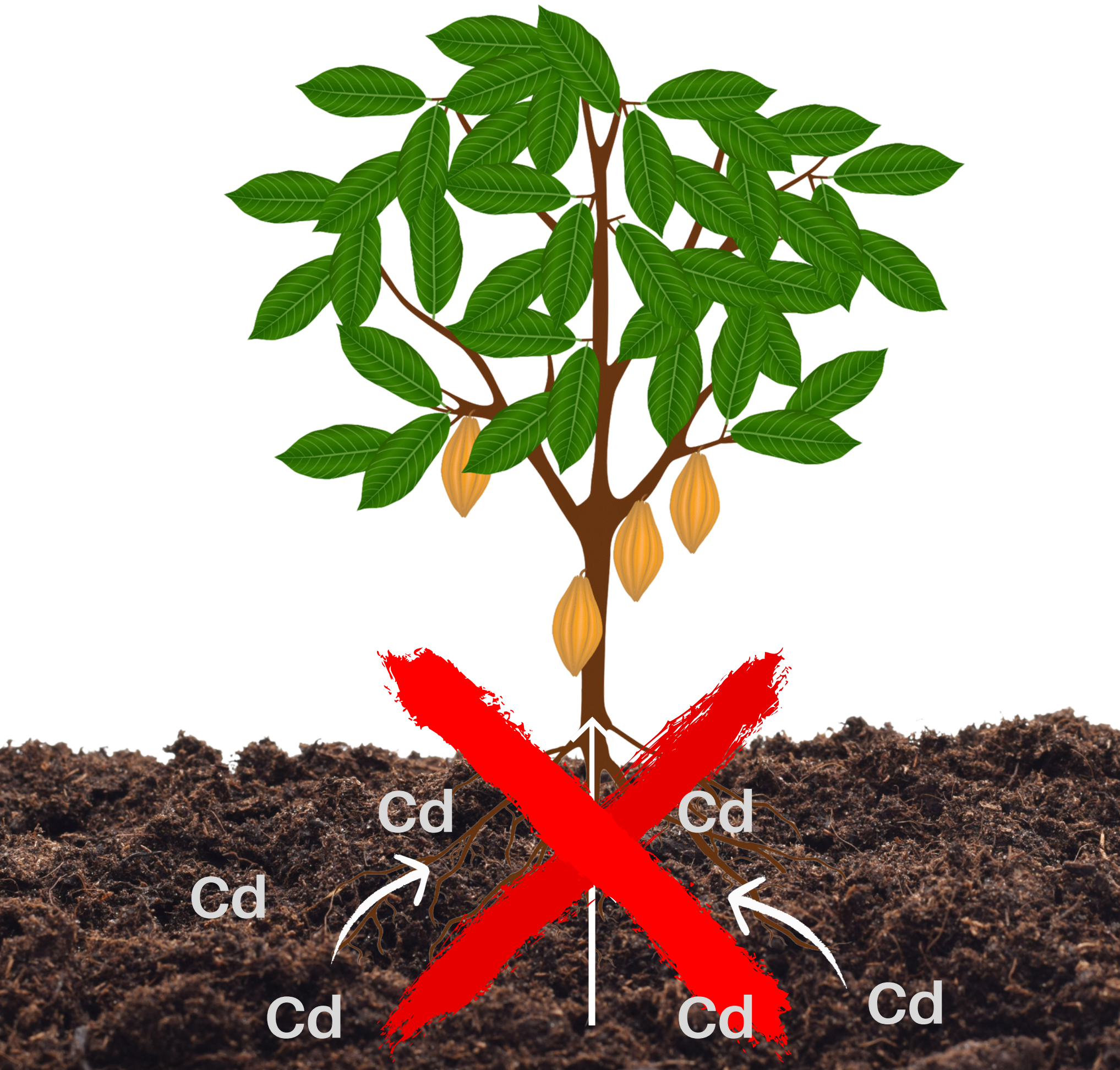




# Accumulation of Cd occurs through:

DIRECT UPTAKE FROM CADMIUM CONTAMINATED SOILS INTO BEANS

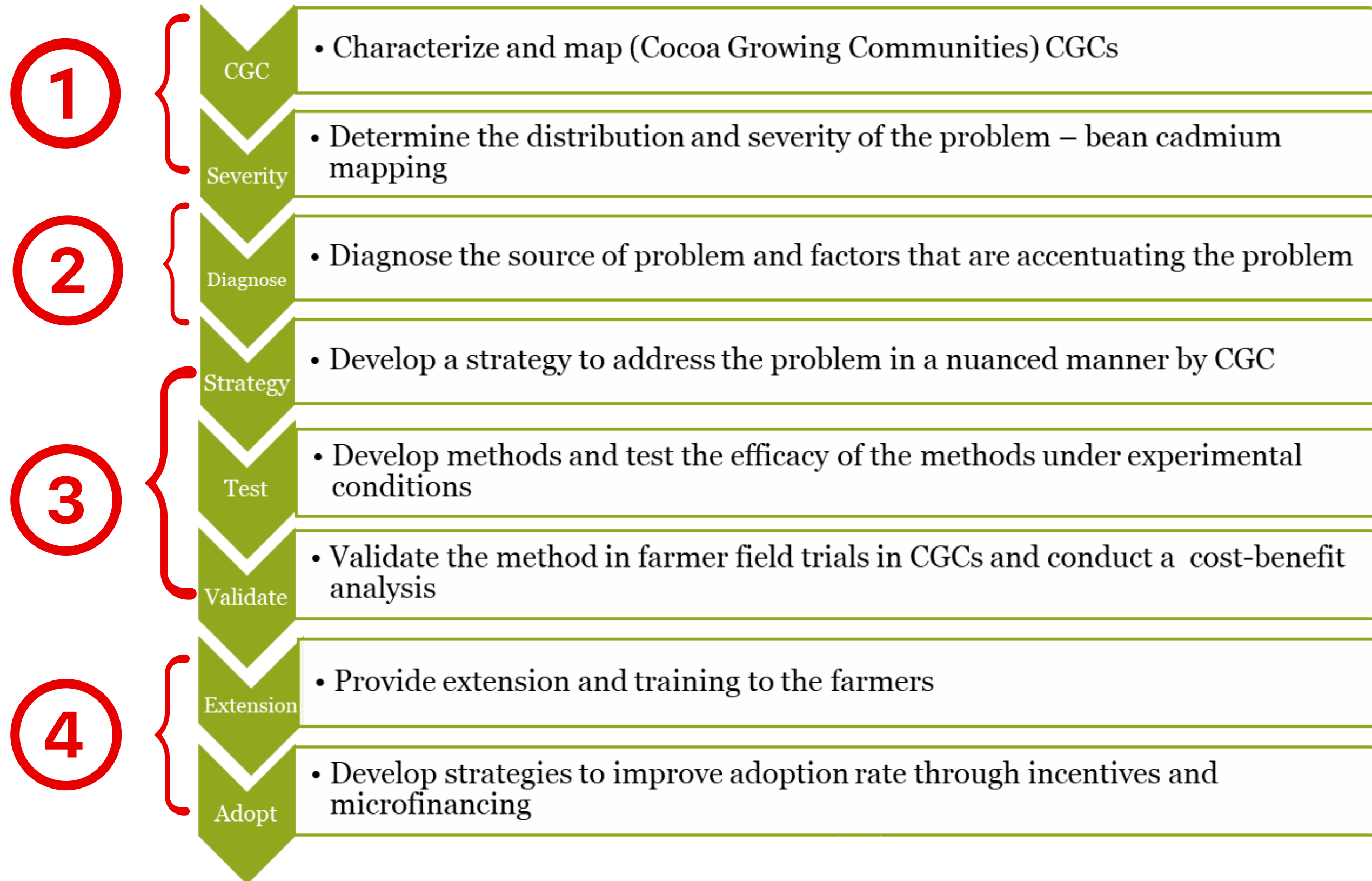




**Reduce cocoa  
bean Cd levels**



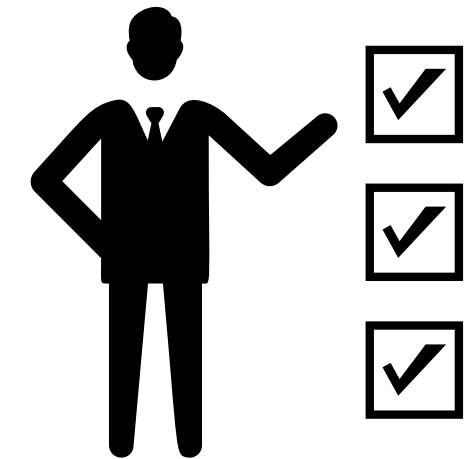
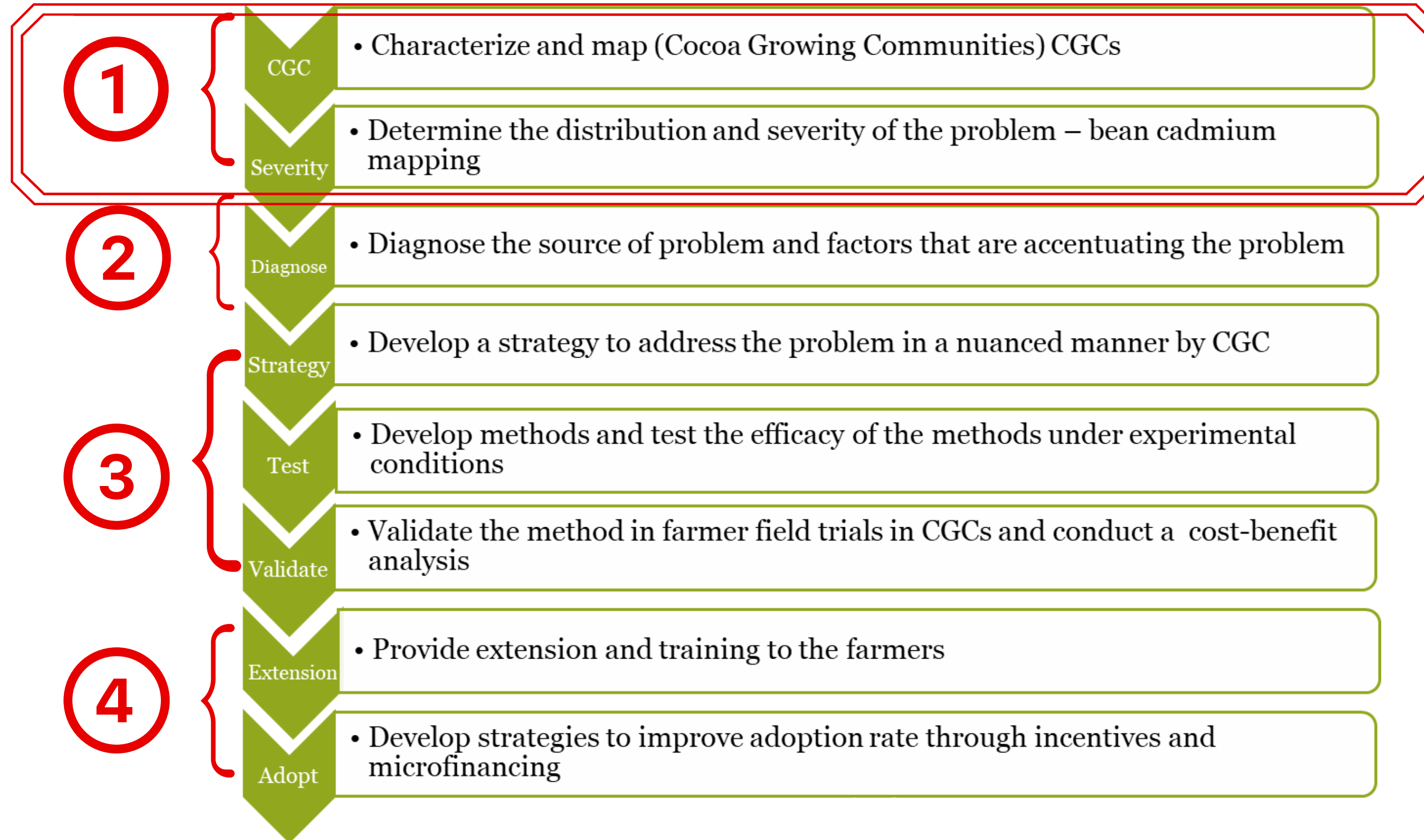
# Evidence-Based Approach: Cd Mitigation Cocoa



# Precision Mapping of Cadmium in Cocoa & Soil in Dominica & its Mitigation



# Evidence-Based Approach: Cd Mitigation Cocoa



# STRATEGIC MAPPING



# Geographic Information System (GIS)

Mr. Marvin Lewis

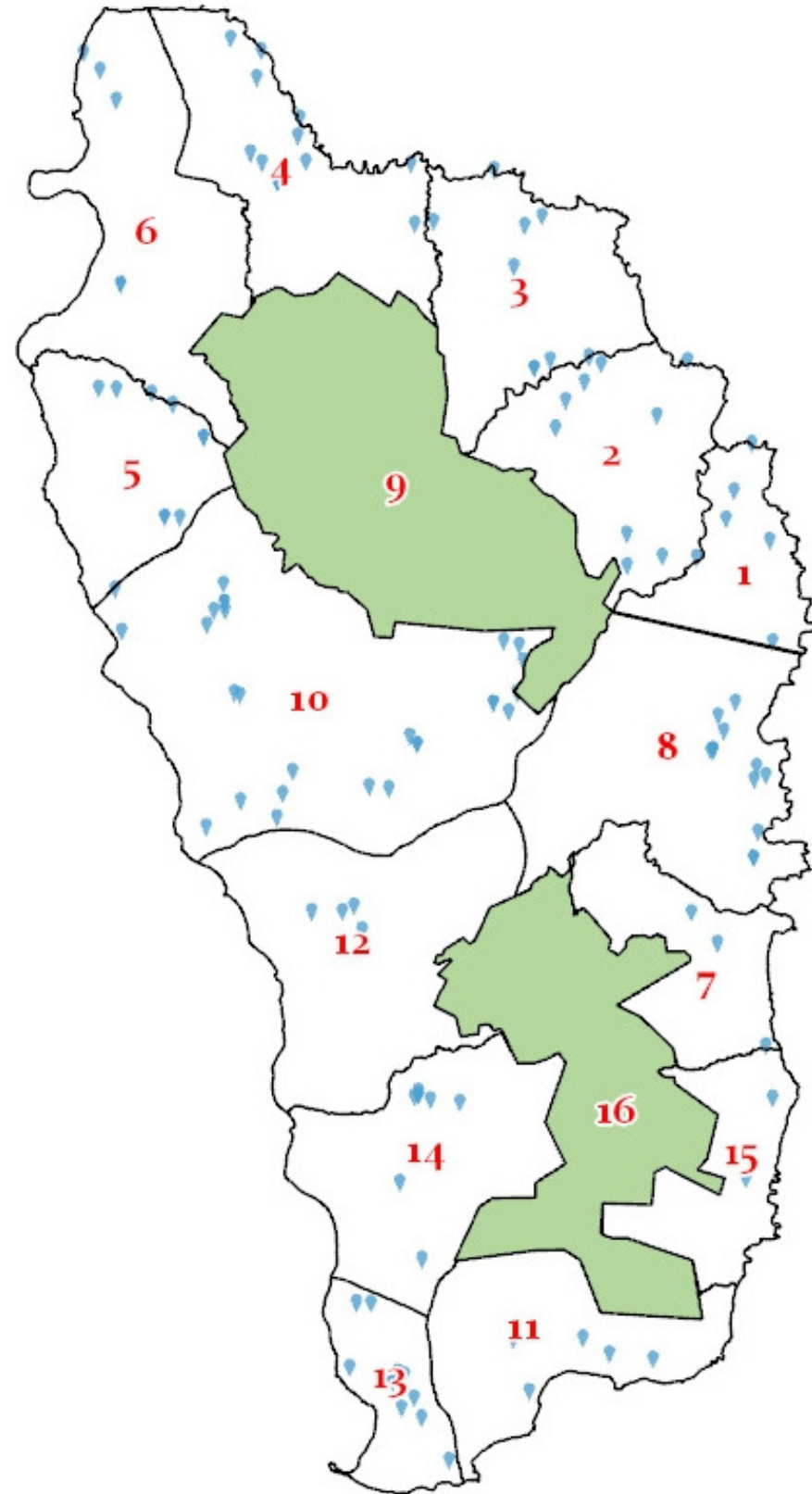


# STRATEGIC MAPPING



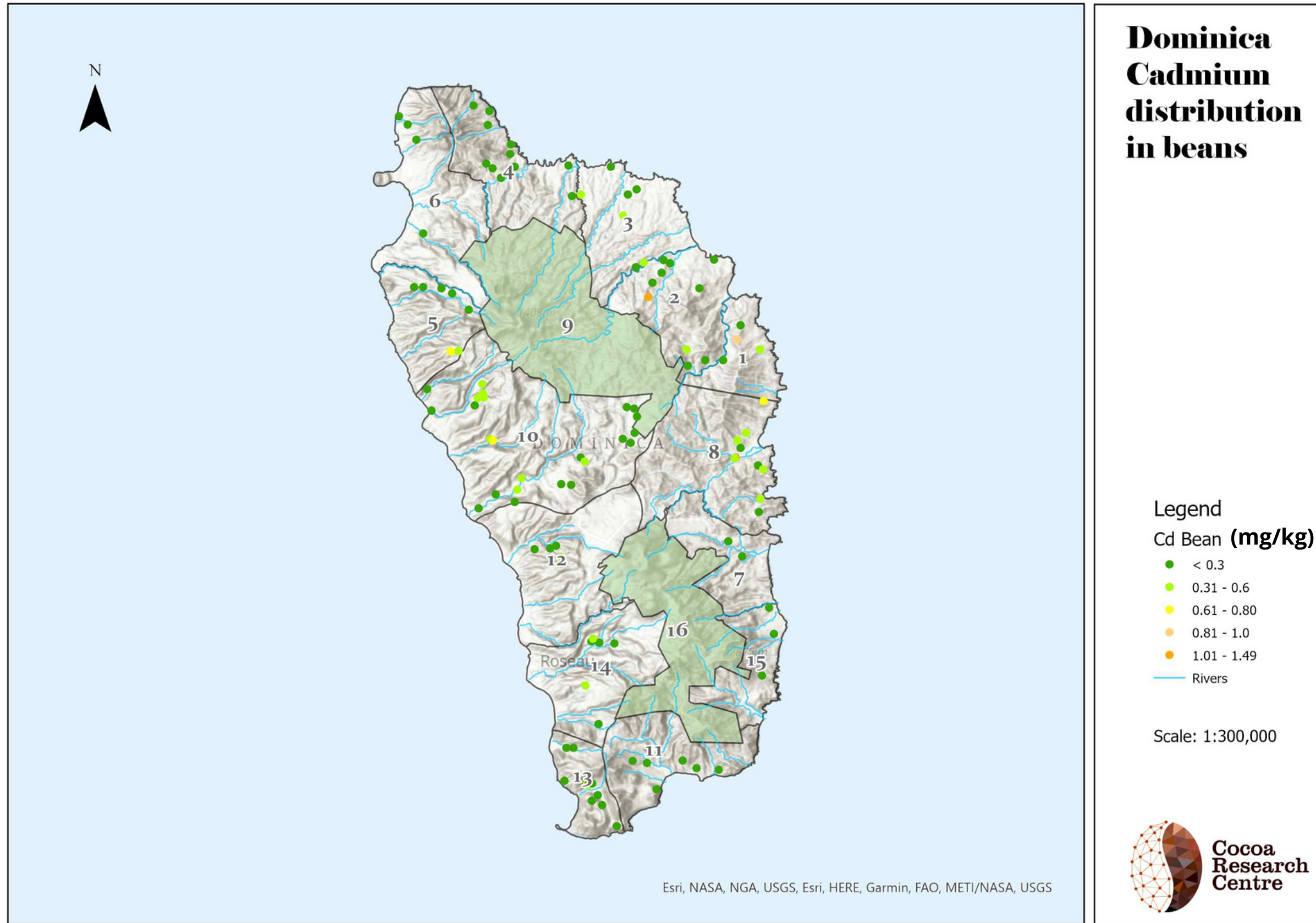
1

# (a) Characterize & Map Cocoa-Growing Communities



Cocoa-growing region	No. of farms sampled
1	5
2	10
3	7
4	11
5	8
6	4
7	2
8	11
9	Nil-protected area
10	24
11	5
12	4
13	13
14	7
15	3
16	Nil-protected area
<b>Total= 114</b>	

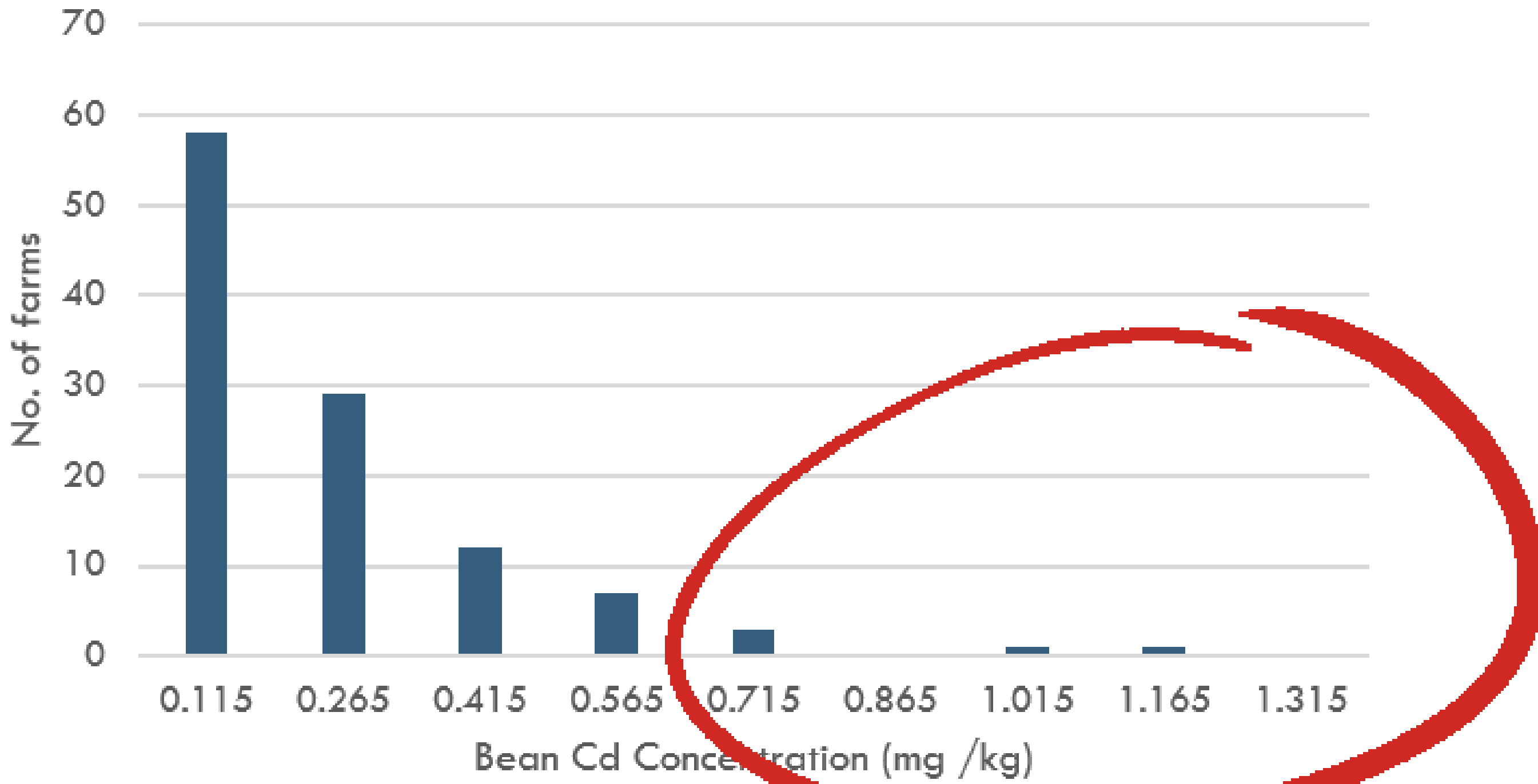
# 1 (b) Determine the Distribution & Severity of the issue (Bean Cd)



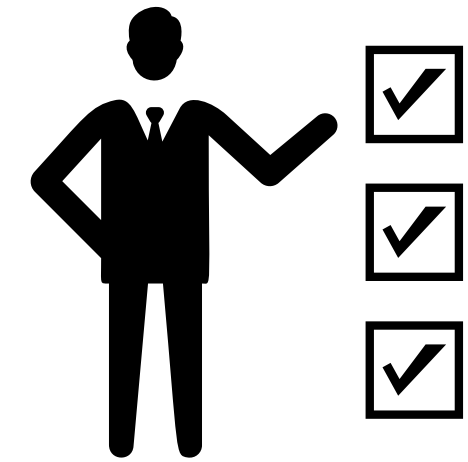
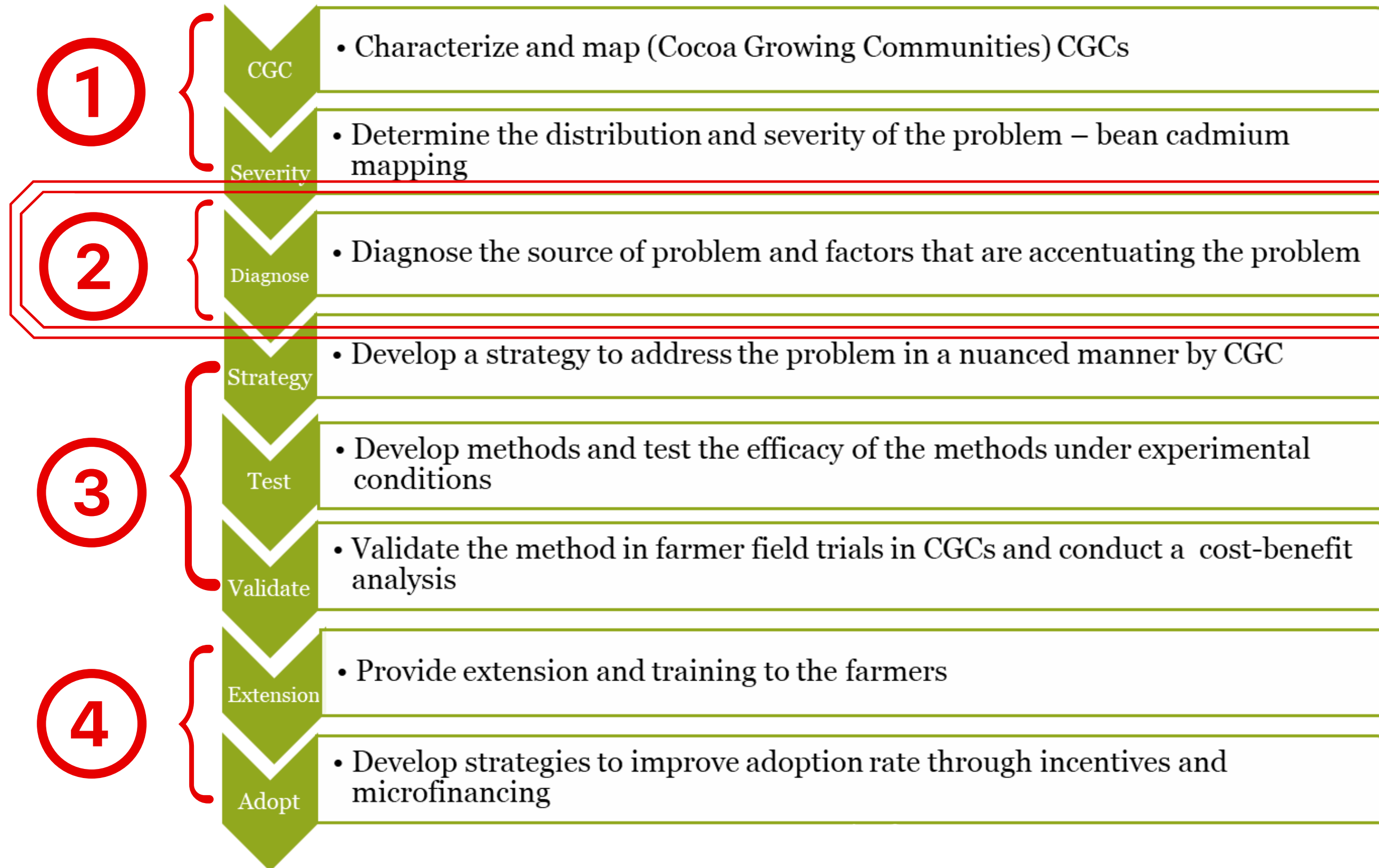
1

**(b) Determine the Distribution & Severity of the issue (Bean Cd)**

Frequency distribution graph of bean Cd

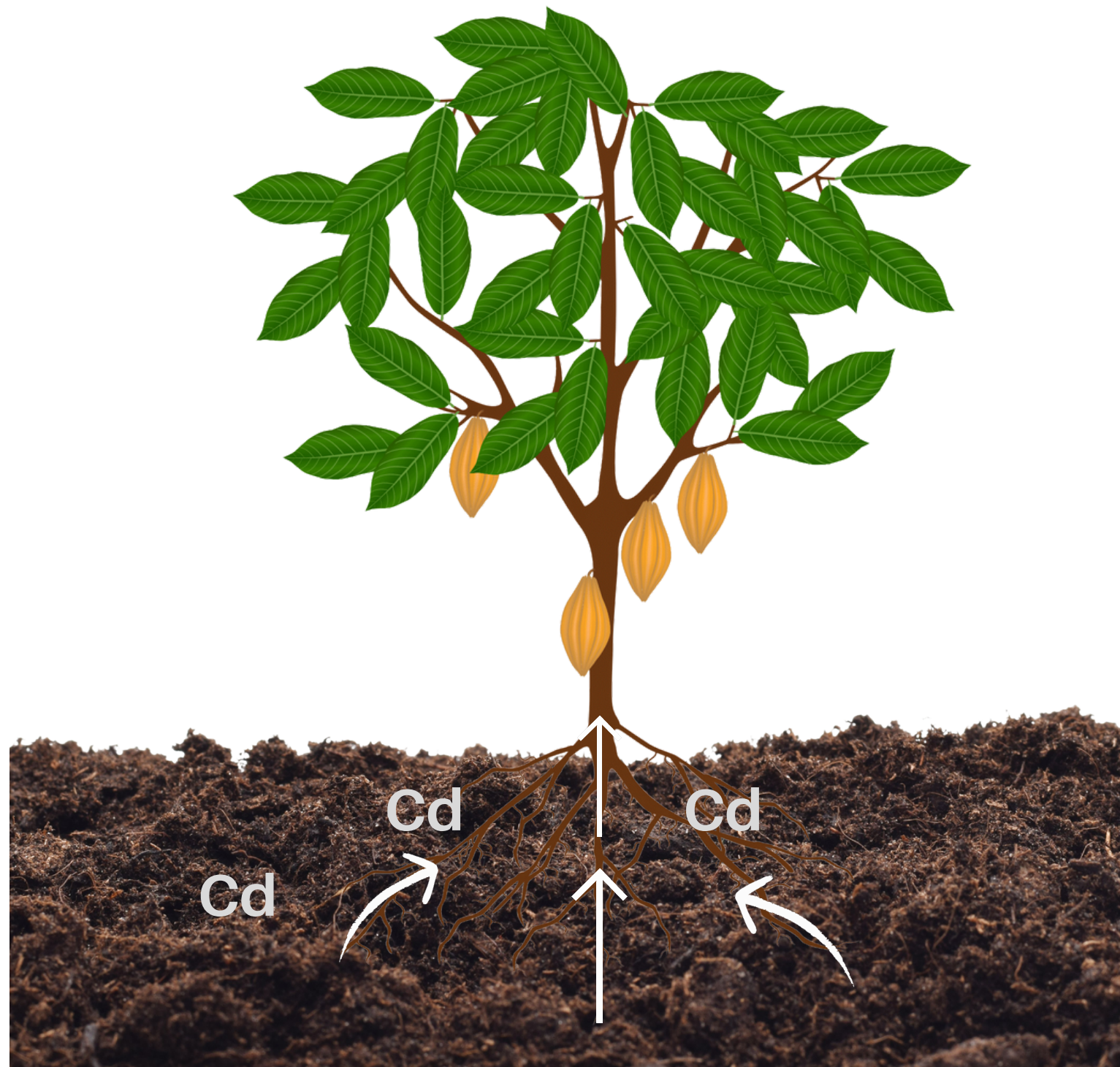
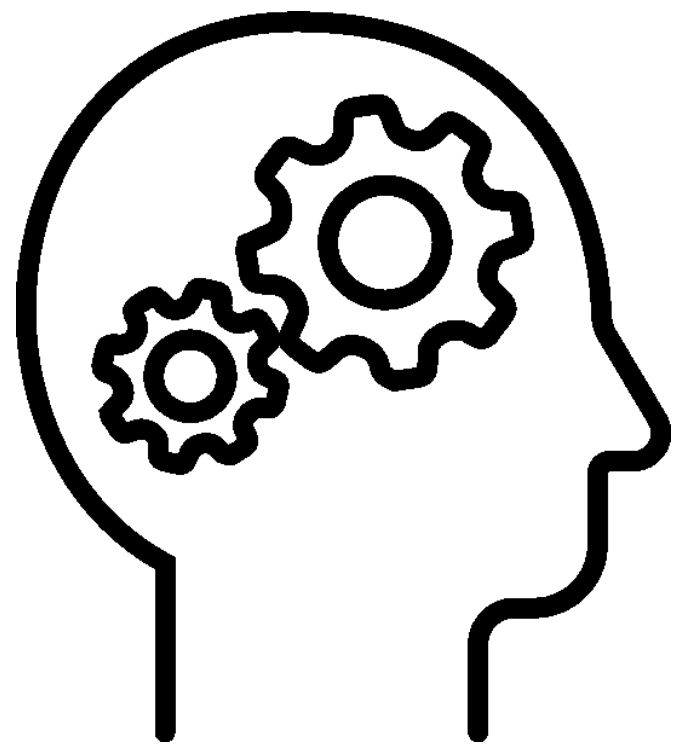


# Evidence-Based Approach: Cd Mitigation Cocoa



2

# Diagnostic study: Factors contributing to Cd uptake



## FACTORS

Soil Cd levels

Sources of Cd

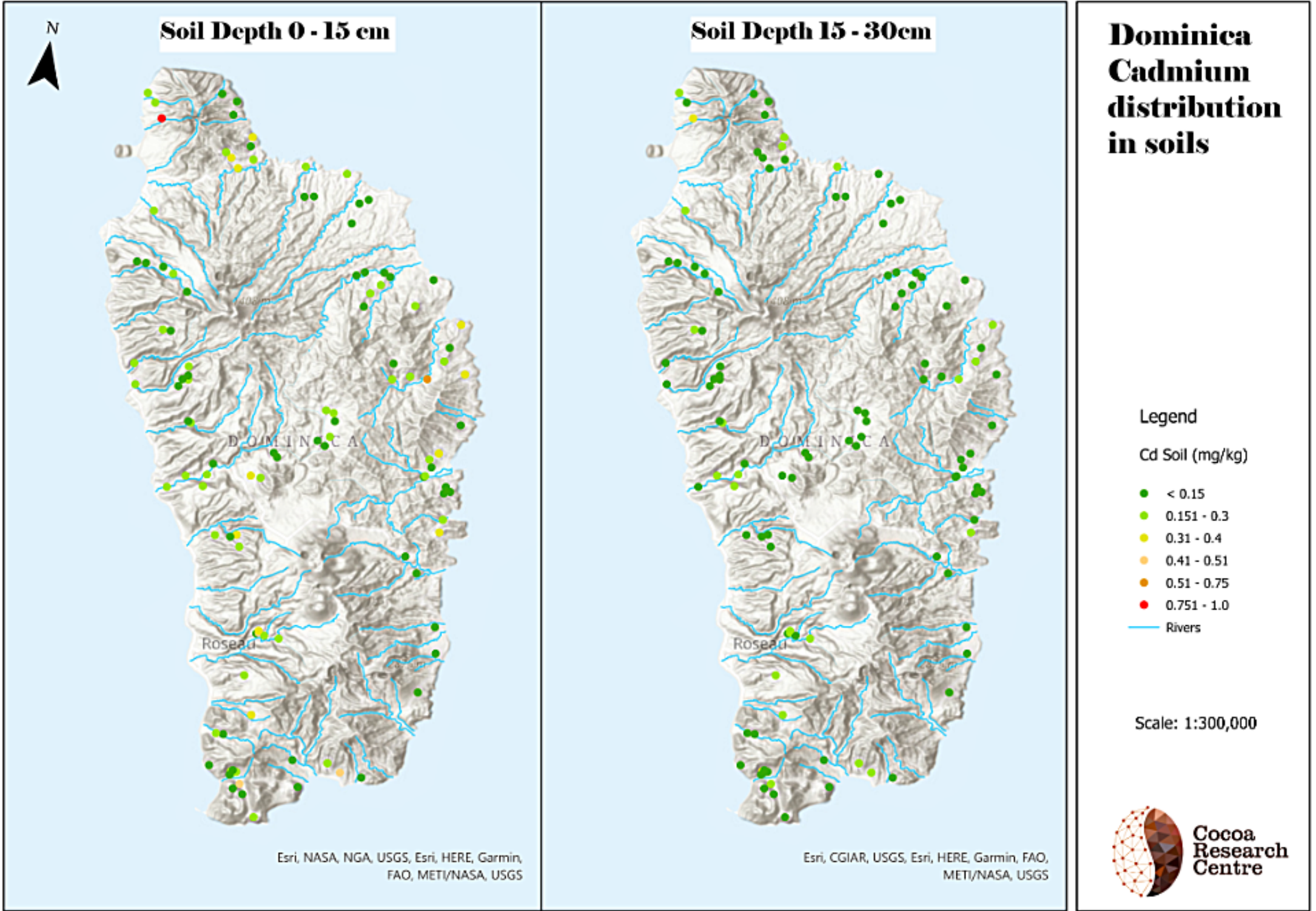
Physicochemical Properties

- pH
- Organic Matter
- Mn, Fe and Zn levels
- Salinity, soil texture... etc.
- Mapping soil physicochemical properties by CGC

Genetic differences

2

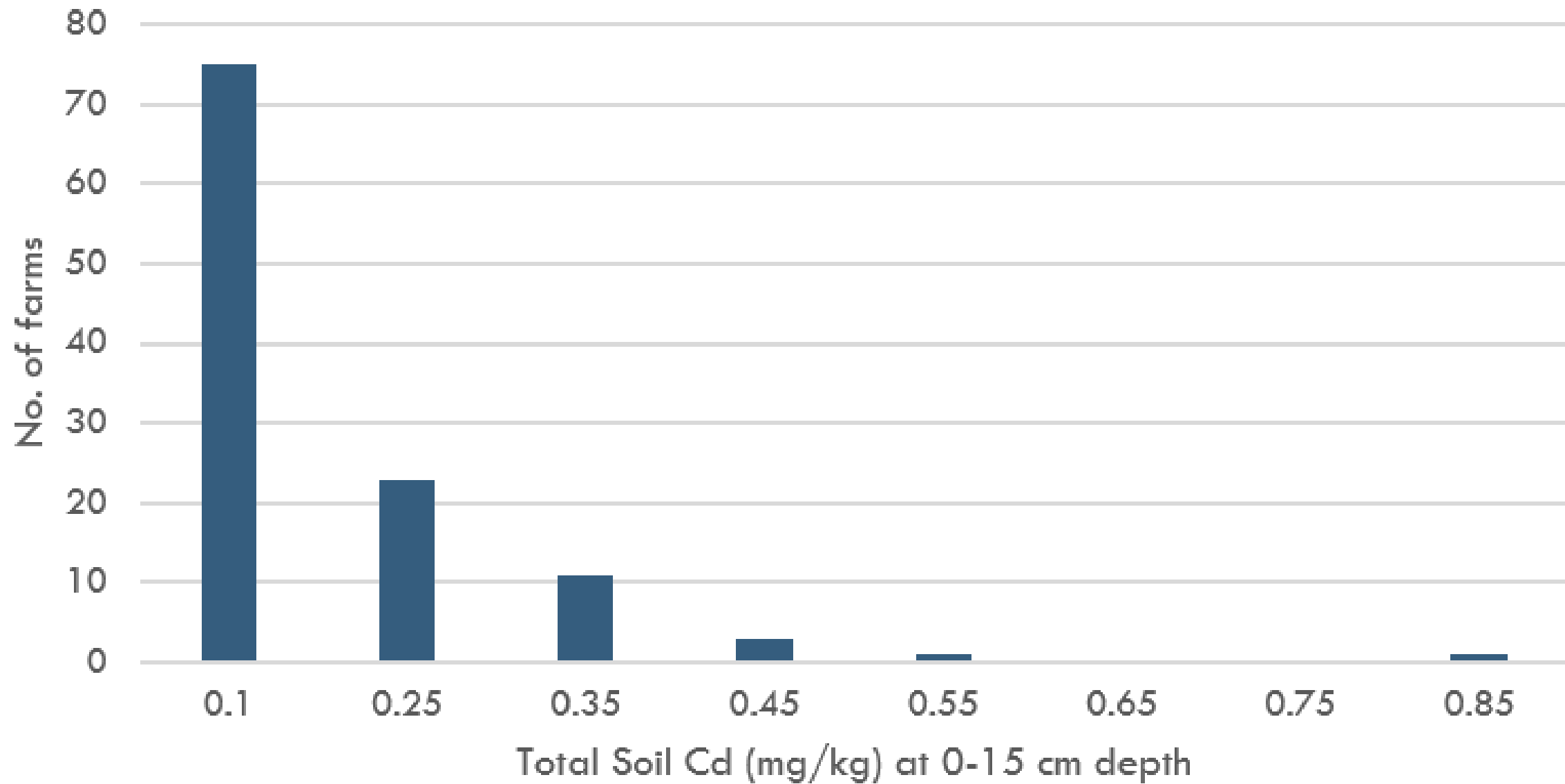
# Diagnostic study: Factors contributing to Cd uptake (Soil Cd)



2

# Diagnostic study: Factors contributing to Cd uptake (Soil Cd)

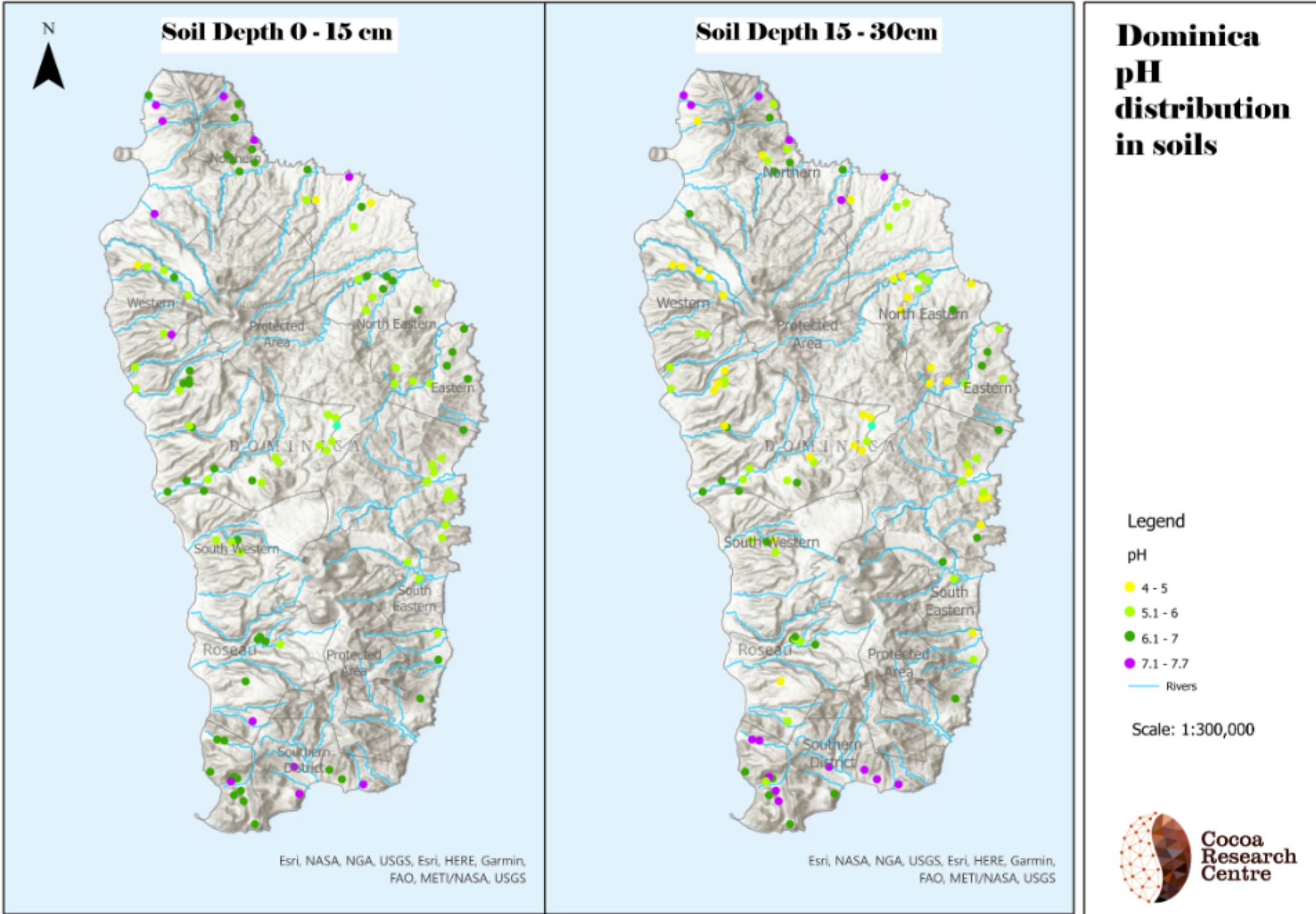
Frequency distribution graph of soil Cd (0-15 cm) depth





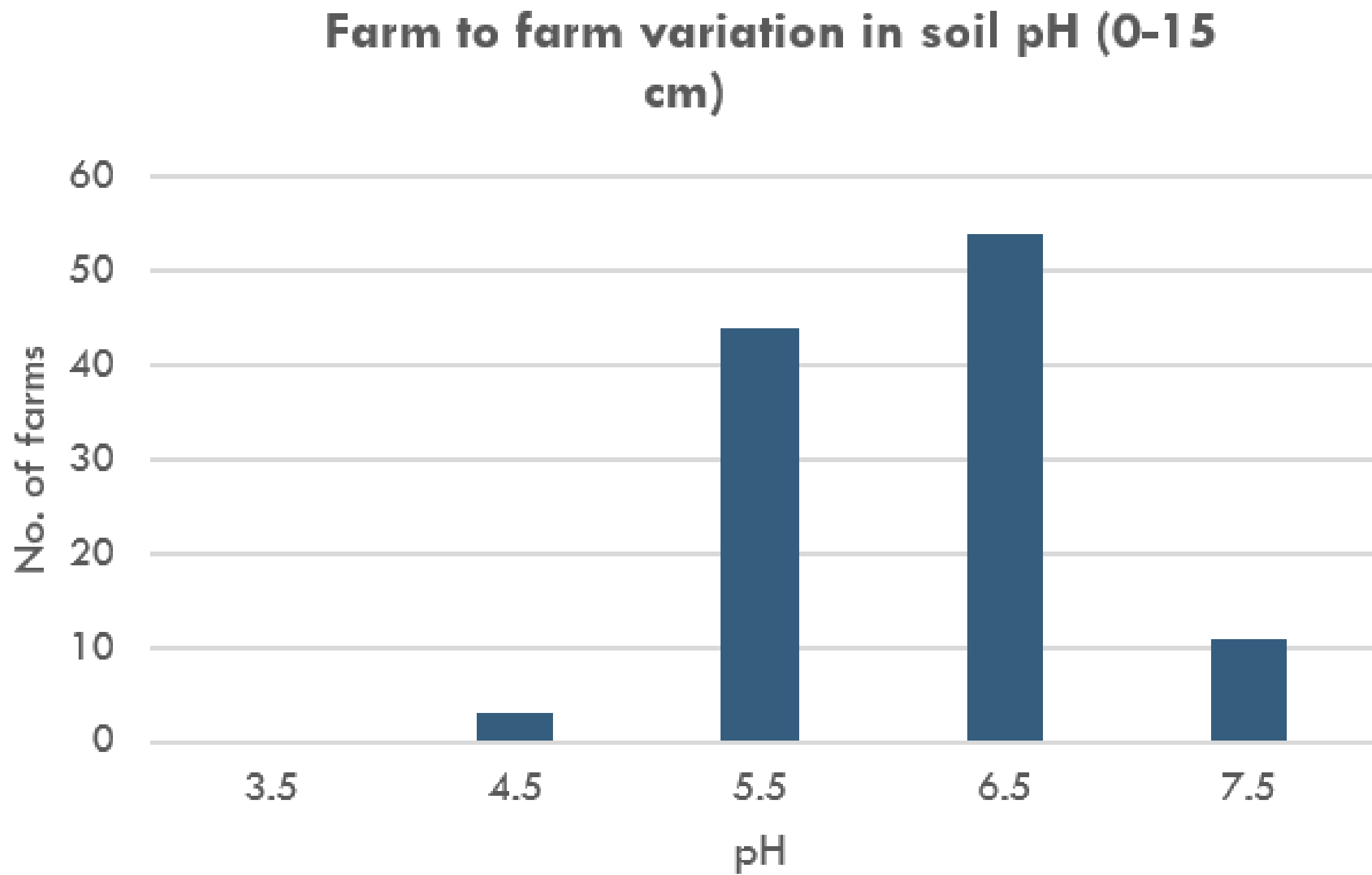
2

# Diagnostic study: Factors contributing to Cd uptake (Soil pH)



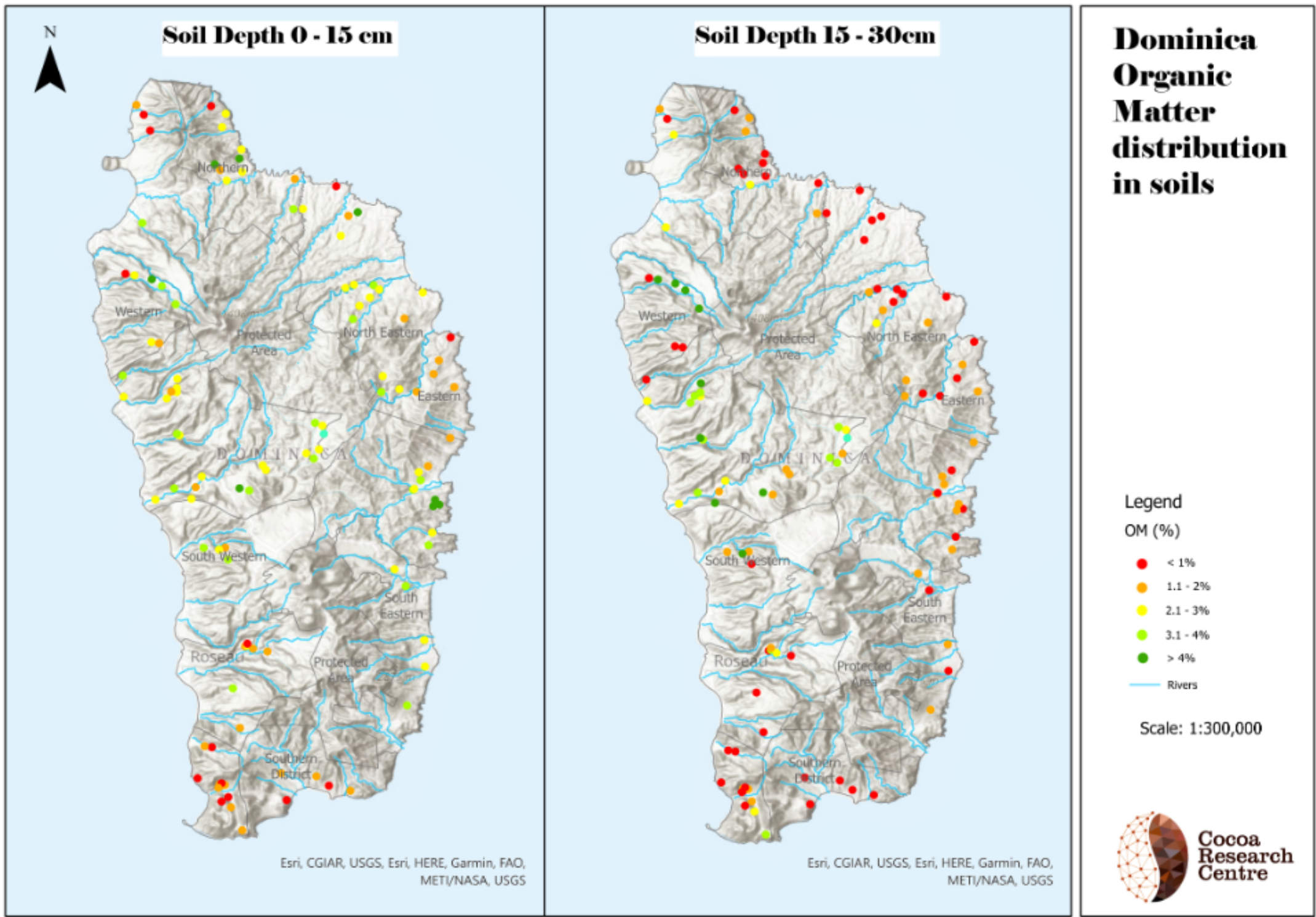
2

# Diagnostic study: Factors contributing to Cd uptake (Soil pH)



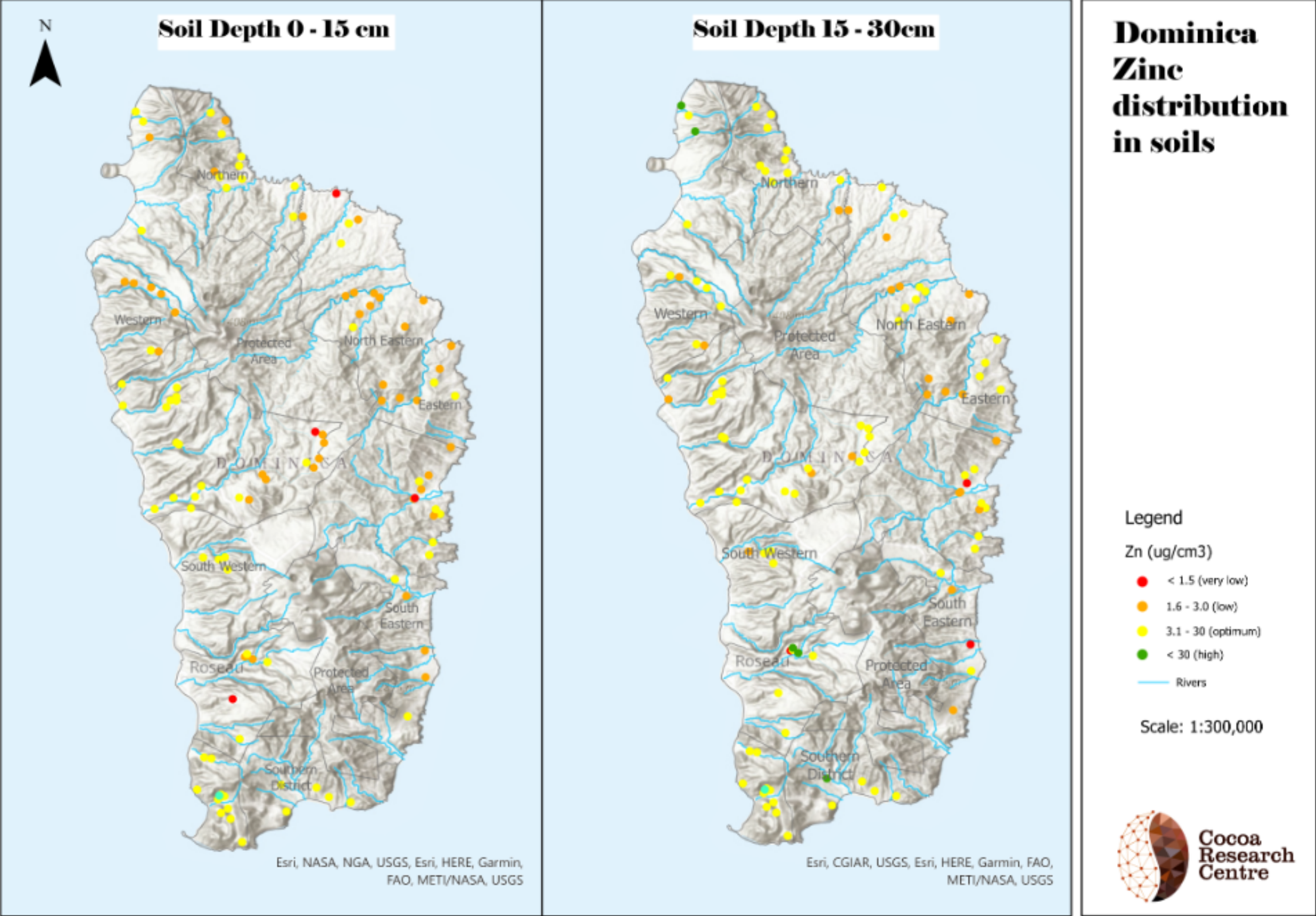
2

# Diagnostic study: Factors contributing to Cd uptake (Soil OM)

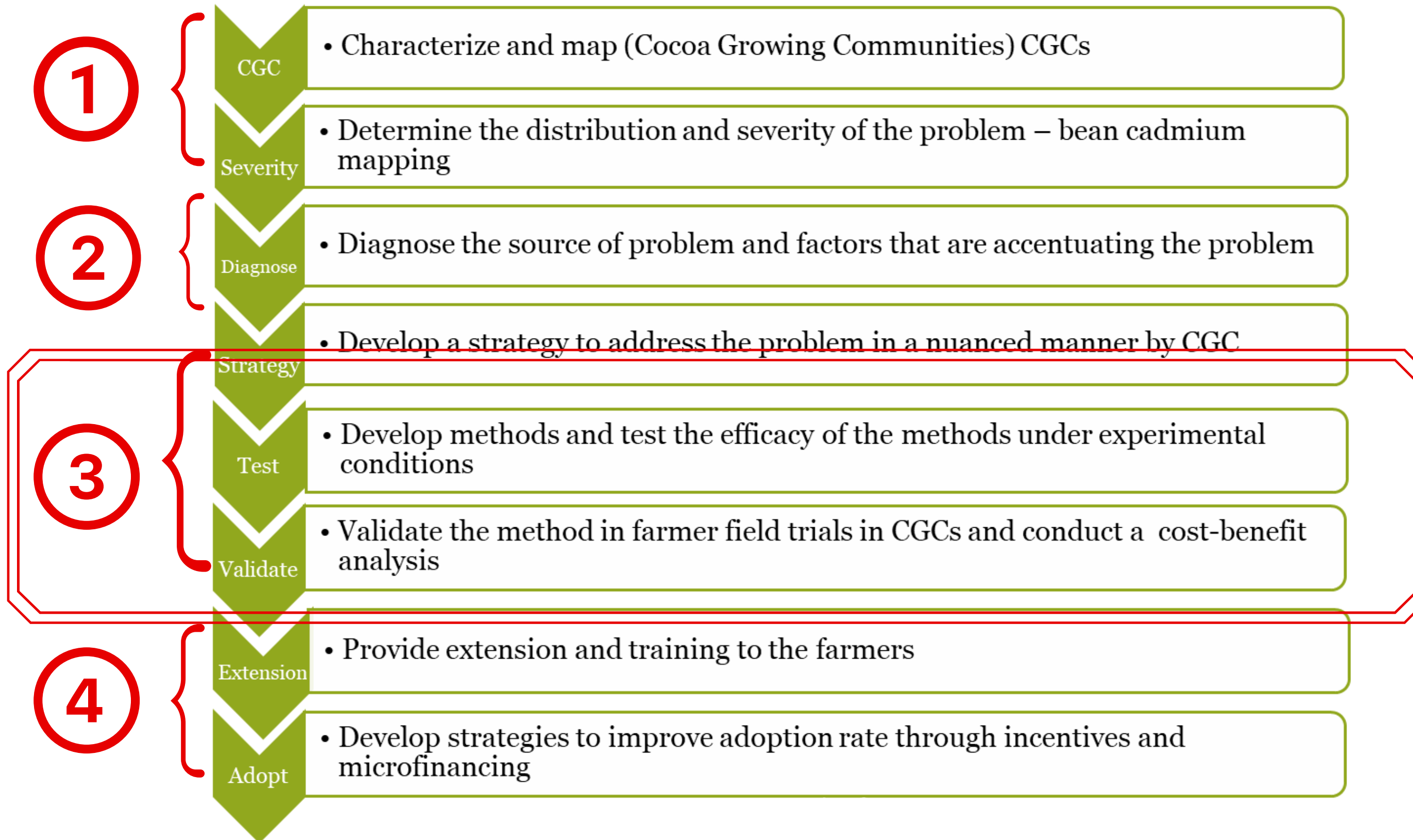


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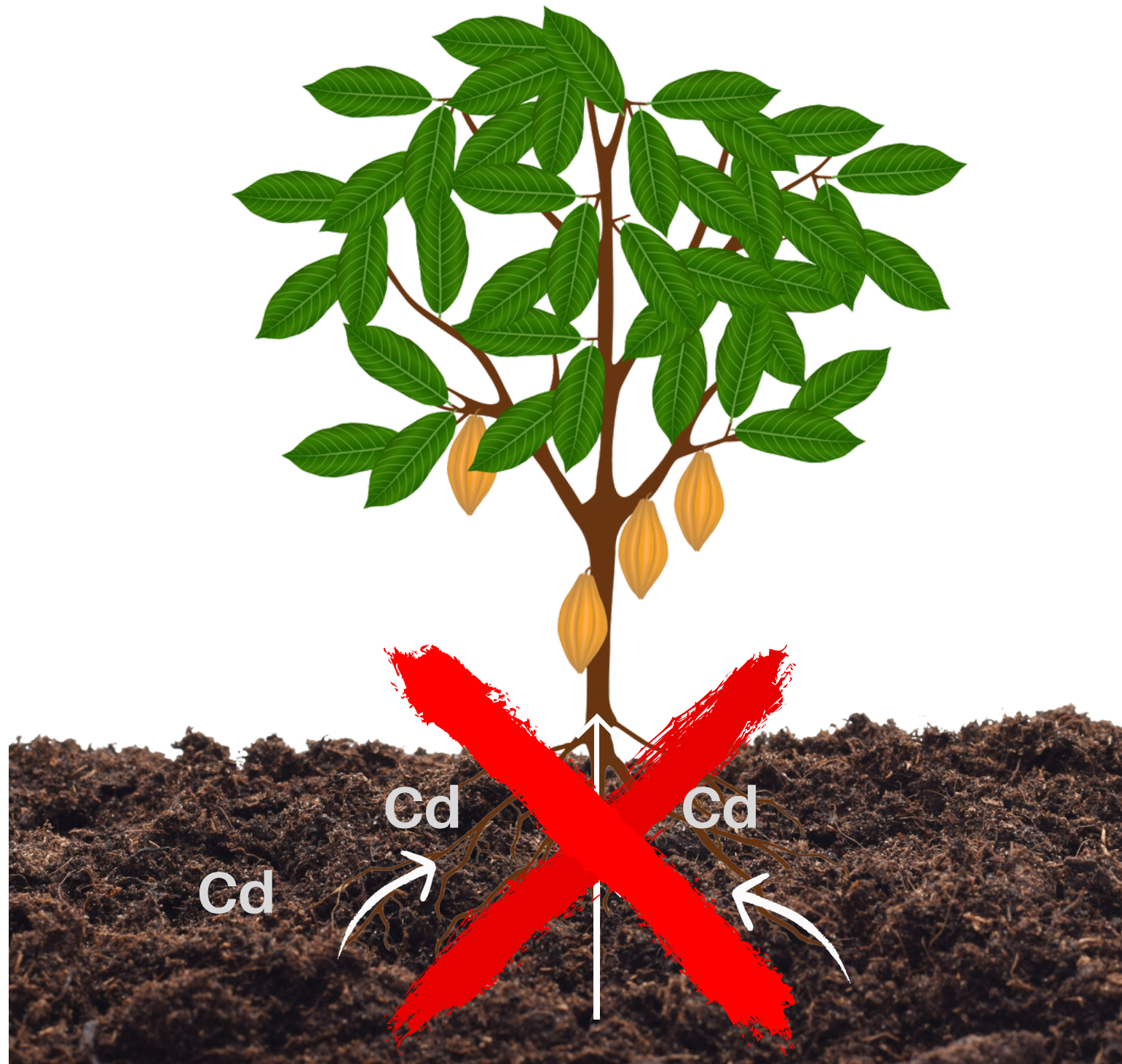
# Diagnostic study: Factors contributing to Cd uptake (Soil Zn)



# Evidence-Based Approach: Cd Mitigation Cocoa



# ③ Development of mitigation strategies to reduce Cd levels



# Minimizing Cd contamination of cocoa-growing soils

## CADMIUM CONCENTRATIONS PHOSPHATE-BASED GRANULAR FERTILIZERS

FERTILIZER	MEAN Cd CONCENTRATION ± SD
<b>(NPK)</b>	
8-16-32	0.53±0.53
9-6-24	BDL
12-12-17 (a)	6.59 ±0.15
12-12-17 (b)	0.99±0.19
12-12-17 (c)	0.89±0.16
12-24-12 (a)	2.70±0.21
12-24-12 (b)	2.97±0.14
12-24-12 (c)	3.94±0.36
13-13-21 (a)	2.50 ±0.11
13-13-21 (b)	1.68±0.09
15-5-20	1.62 ±0.05
15-15-15	1.18 ±0.08
15-30-14	2.08±0.08
16-6-21	2.86±0.26
16-8-24	BDL
20-10-10	1.96±0.25
20-20-20	BDL
21-1-0	4.03 ±0.76
26-13-5	1.59±0.15
<b>(OTHER)</b>	
DAP	1.36 ±0.37
TSP	35.26 ±2.60
MOP Red	BDL
MOP White	BDL

DAP: Diammonium Phosphate

TSP: Triple Super Phosphate

BDL- Below Detection Limit

## FLOODING FROM CONTAMINATED RIVER SOURCES



# Soil Remediation

MITIGATION STRATEGY







# Blending

MITIGATION STRATEGY



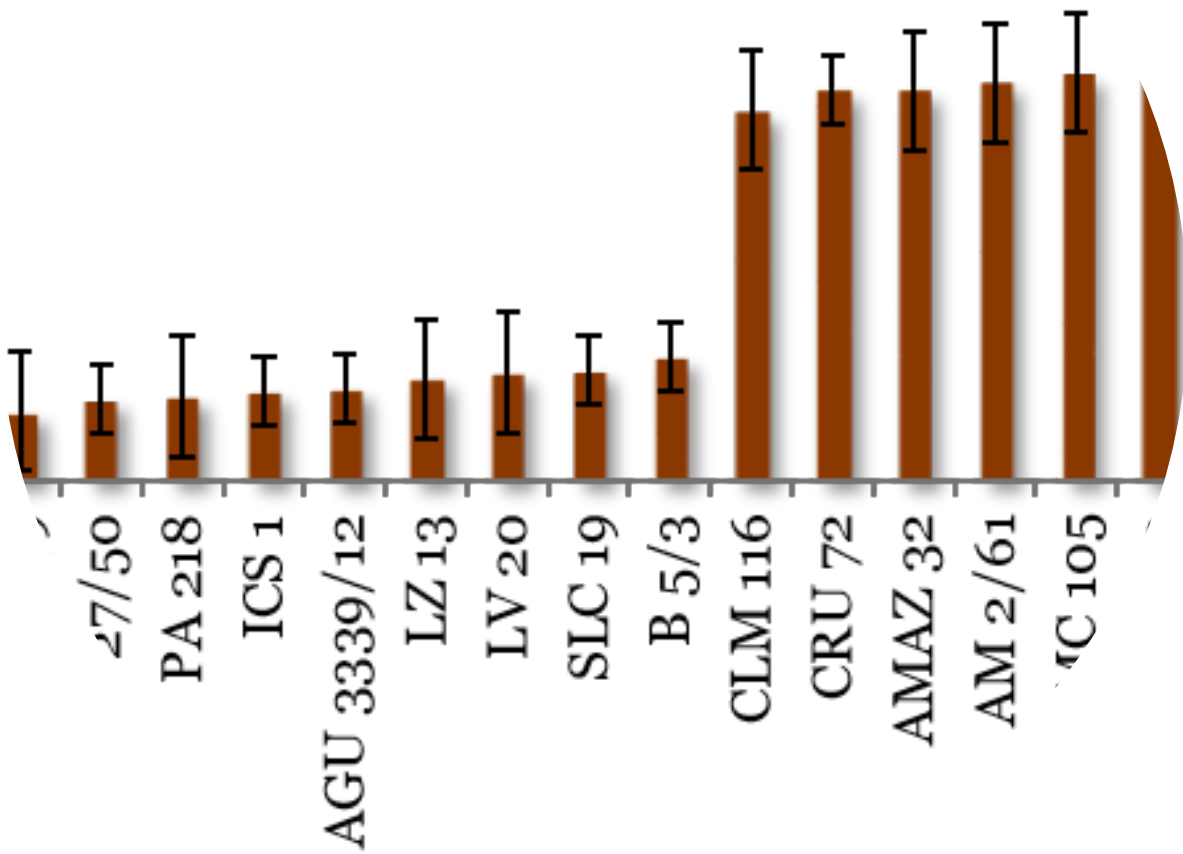


# Genetics

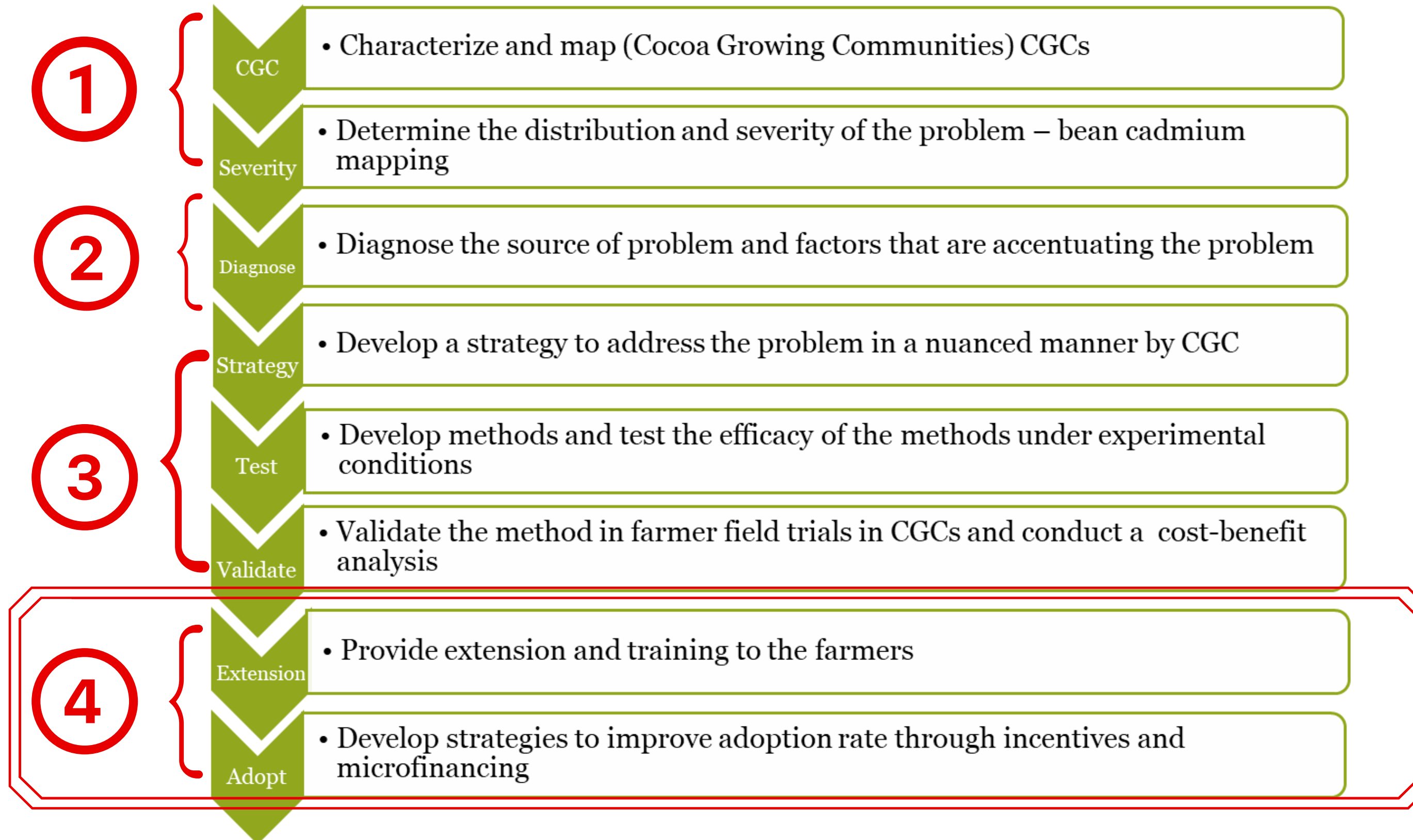
MITIGATION STRATEGY



## Bean Cd



# Evidence-Based Approach: Cd Mitigation Cocoa



# 4. INFORMATION DISSEMINATION AND FARMER TRAINING

## OBJECTIVE

- Support systems in place for farmers
- Extension and training



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# SUMMARY FINDINGS

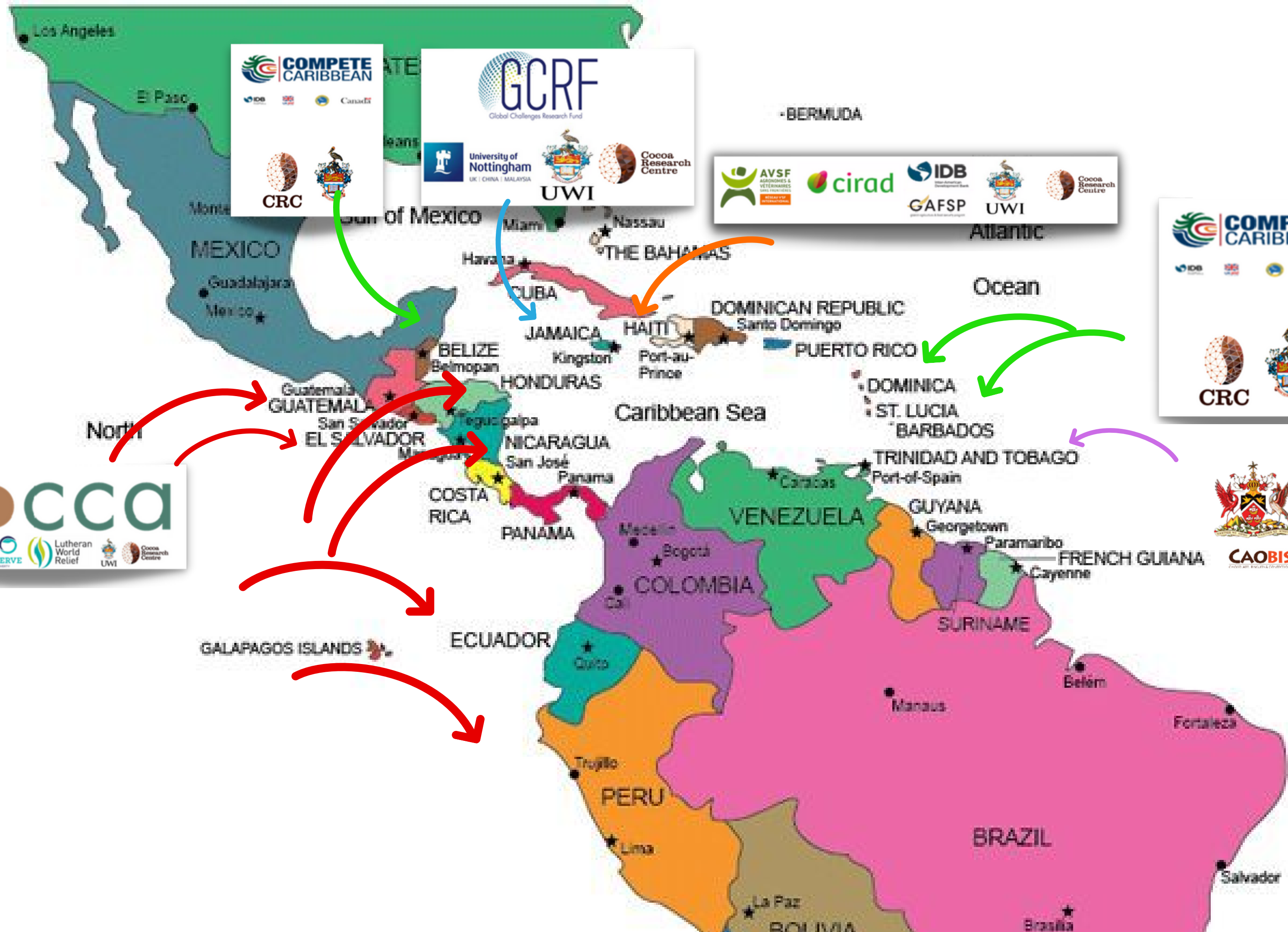
Based on the results from this study, **Dominica does not appear to have a significant cocoa bean Cd issue** as majority of the island has bean Cd levels that are below the limit of concern.

For the very few farms identified, it is possible that this may be due to:

- deficiencies in soil Zn levels
- low pH levels
- low OM

However, these soil factors could be mitigated using soil amelioration strategies.

Short-term solution: blending of cocoa beans



**COMPETE CARIBBEAN**  
 IDB, UWI, Canada  
 CRC

**GCRF**  
 Global Challenges Research Fund  
 University of Nottingham, UWI, Cocoa Research Centre

AVSF, cirad, IDB, GAFSP, UWI, Cocoa Research Centre

**COMPETE CARIBBEAN**  
 IDB, UWI, Canada  
 CRC

**moccoa**  
 USDA, TECHNOSERVE, Lutheran World Relief, UWI, Cocoa Research Centre

UWI, Cocoa Research Centre, CAOBISCO, eca, FCC

**THANK YOU FOR  
YOUR ATTENTION**



