

# Ureolytic bacteria that induce carbonate precipitation from cocoa farms in Santander, Colombia: cadmium distribution, isolation and application of rhizobacteria

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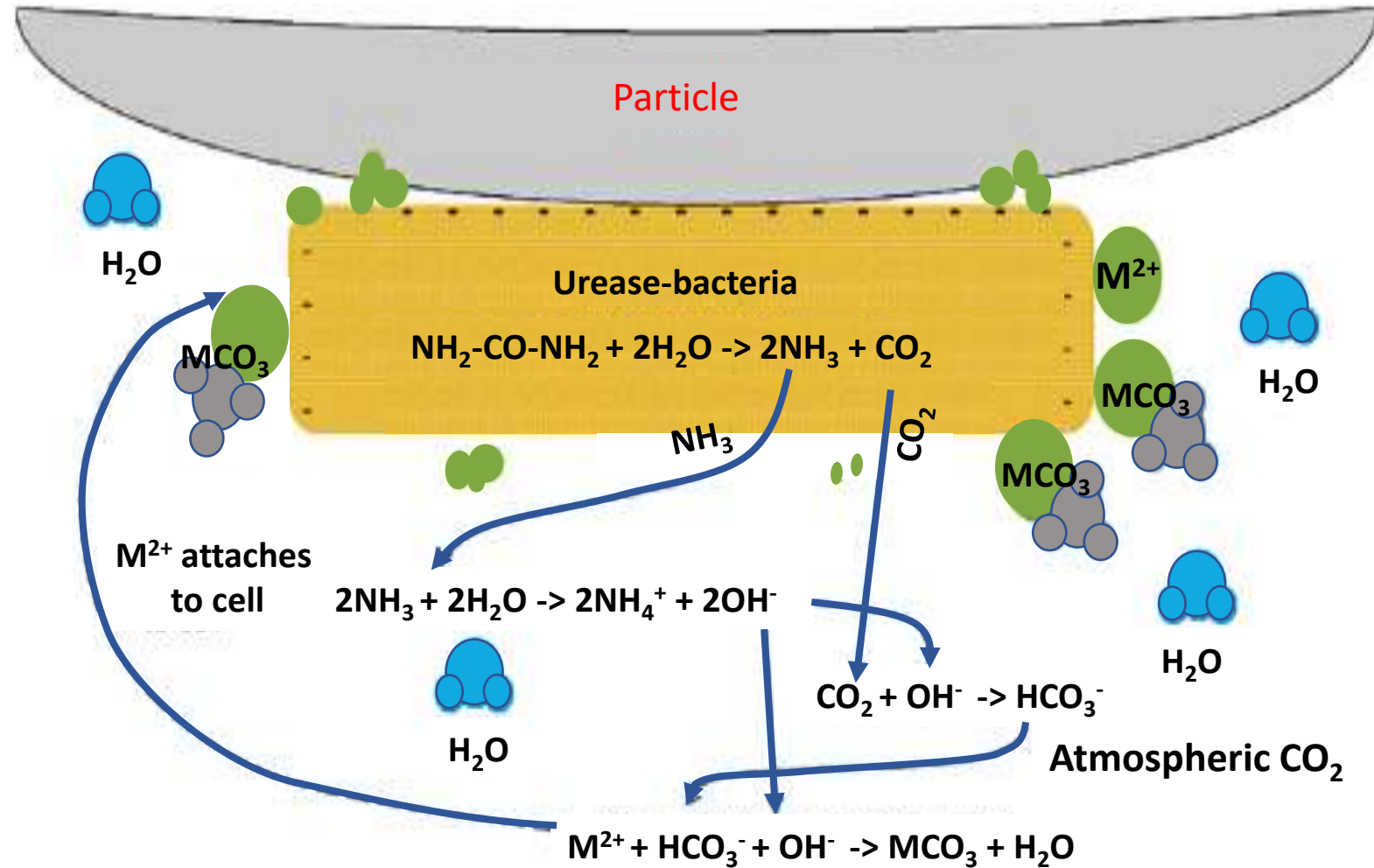
**Carlos A. Adarme-Durán<sup>1</sup>, Elianna Castillo<sup>2</sup>, Pedro F.B. Brandão<sup>2</sup>**  
**[cadarme@unal.edu.co](mailto:cadarme@unal.edu.co)**

<sup>1</sup>Universidad Nacional de Colombia - Bogotá – Instituto de Biotecnología – Colombia

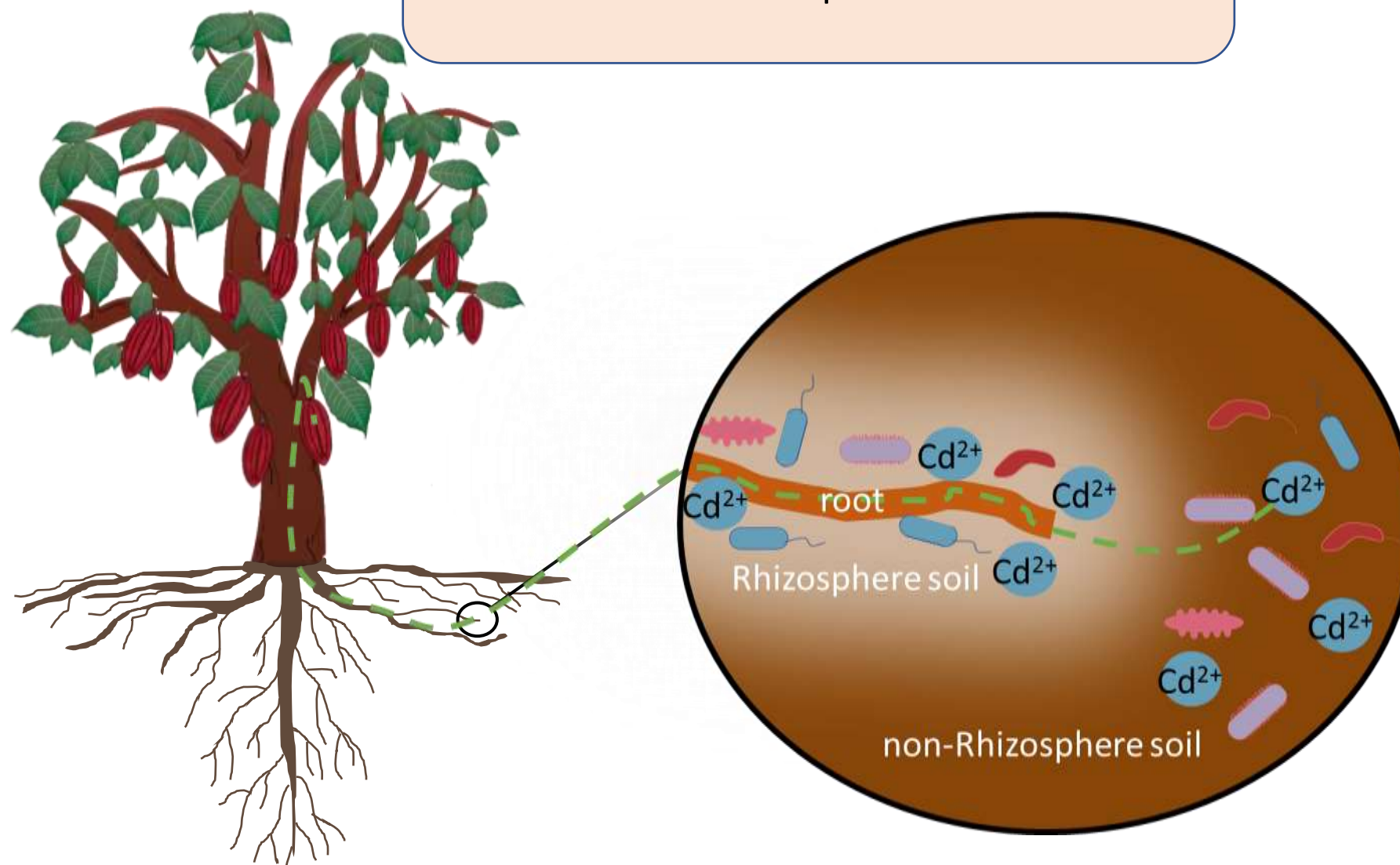
<sup>2</sup>Universidad Nacional de Colombia – Bogotá – Facultad de Ciencias - Departamento de Química - Colombia.



# Microbially Induced Carbonate Precipitation MICP by ureolytic bacteria

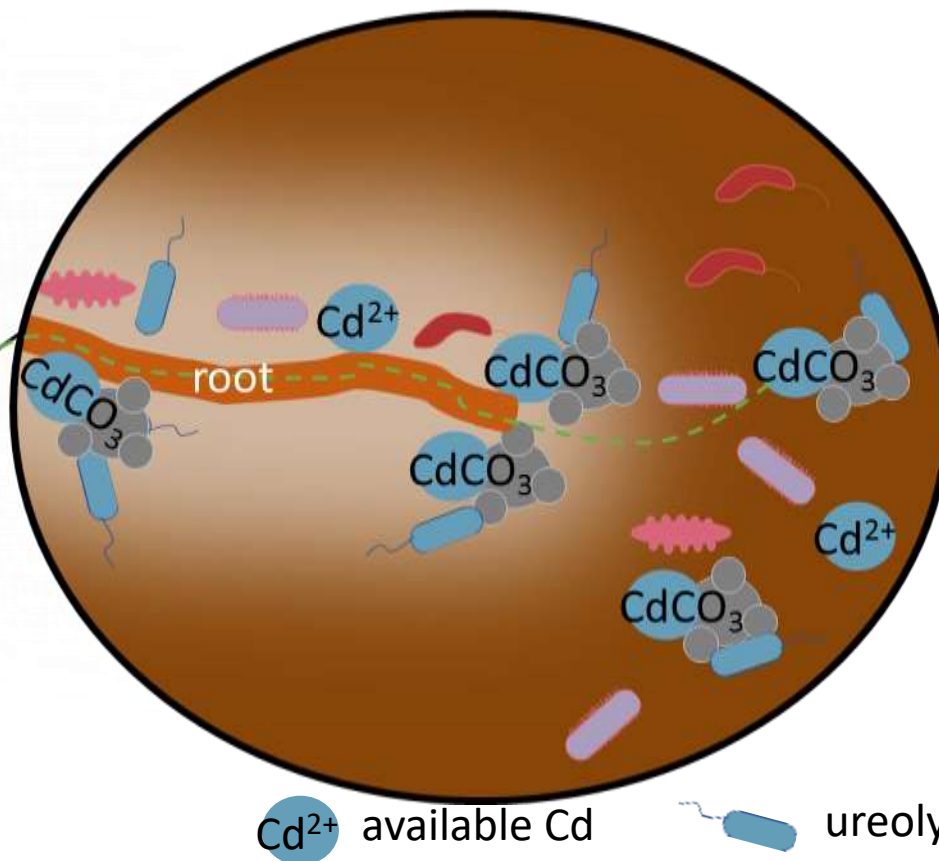
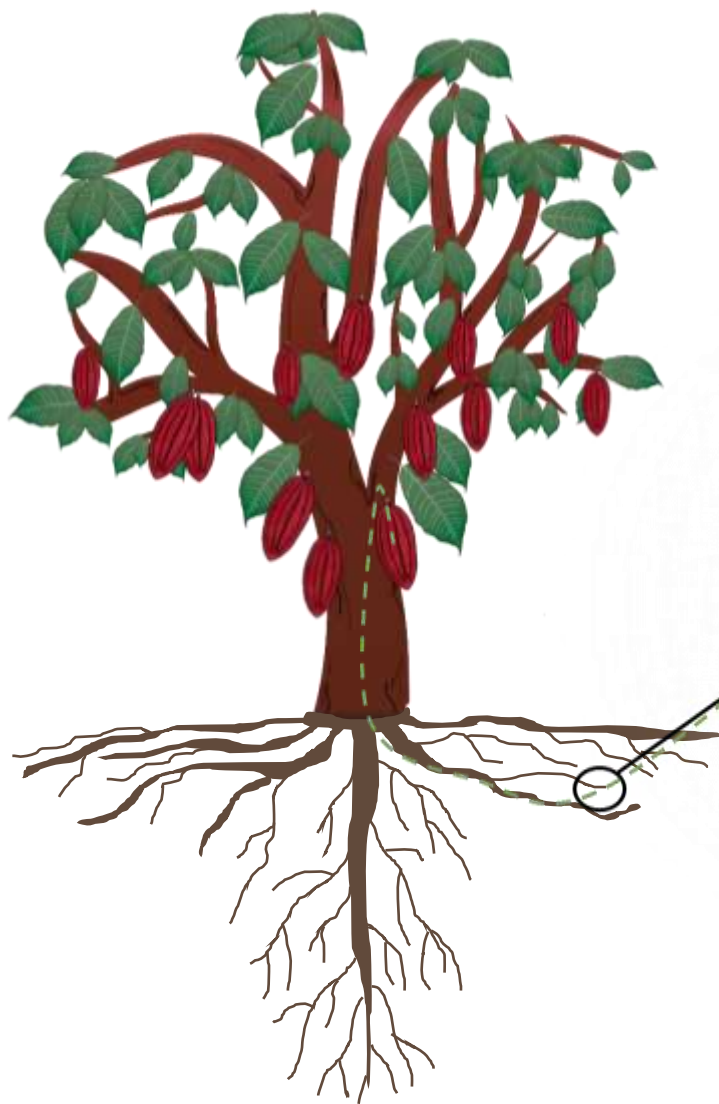


Field soil Cd distribution:  
Rhizosphere and  
non-Rhizosphere soils



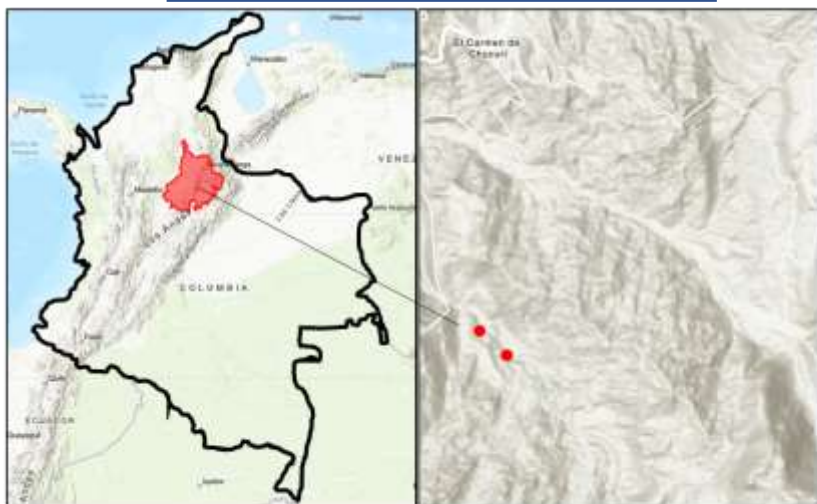
Strategy for mitigation of Cd uptake  
in *Theobroma cacao* L.

MICP by ureolytic rhizobacteria  
to reduce Cd availability

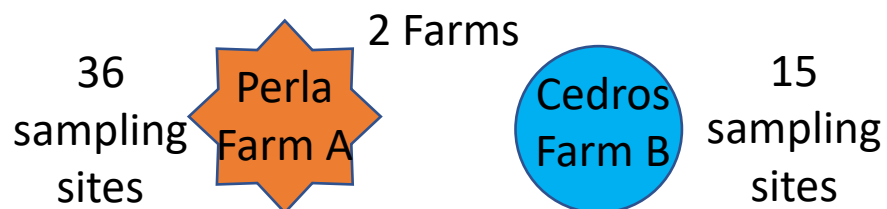




Study area



Colombia-Santander El Carmen de Chucurí Farms

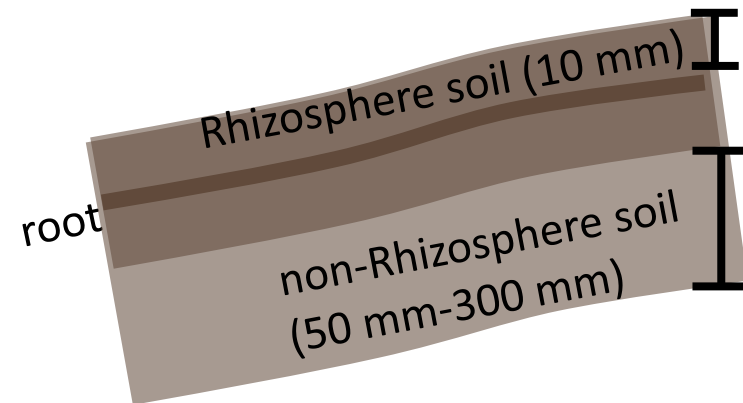
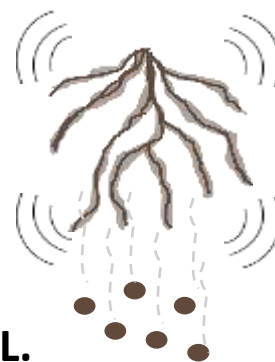


1% of planted trees for each farm  
 Total: 51 points, 102 soil samples  
 (51 rhizosphere, 51 non-rhizosphere)

Sampling of rhizosphere and non-rhizosphere soil



*Theobroma cacao* L.

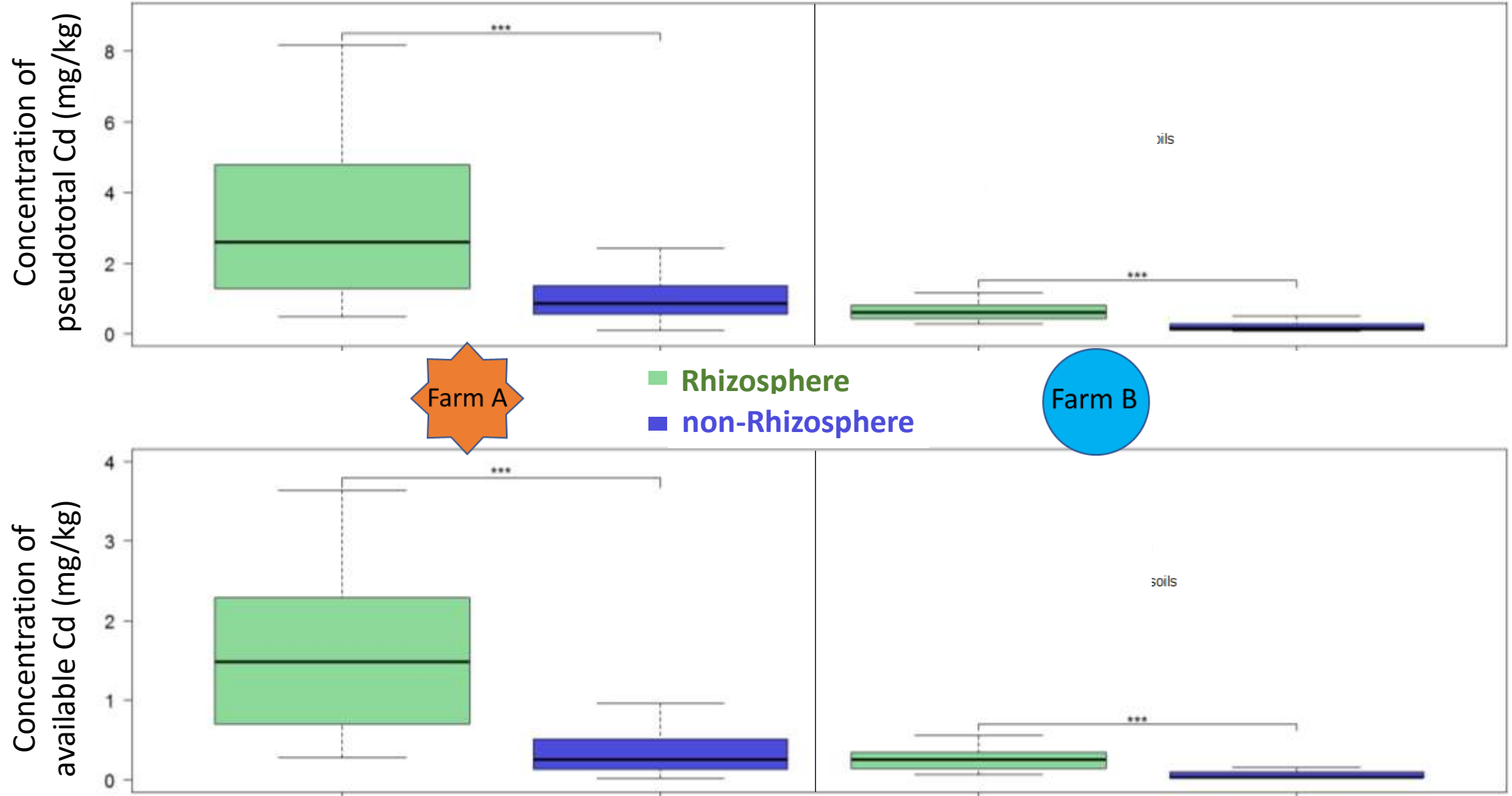


Laboratory analysis

Variable	Method	Determination	Unit
pseudototal Cd - soil	Aqua regia	Flame and Graphite Furnace Atomic Absorption Spectrometry (FAAS and GFAAS)	mg/kg
Available Cd - soil	DTPA		
Bean Cd	HNO <sub>3</sub> -H <sub>2</sub> O <sub>2</sub>		
Urease activity	Ammonia production - Berthelot	Colorimetric	mg NH <sub>4</sub> <sup>+</sup> /kg*2h
Isolation bacterias	Modified Christensen medium	-	-

# BOXPLOT FOR PSEUDOTOTAL AND AVAILABLE Cd

p-value: <0,001: \*\*\*; Outliers are not shown.



RESULTS

# DISTRIBUTION MAP FOR CONCENTRATION OF AVAILABLE Cd

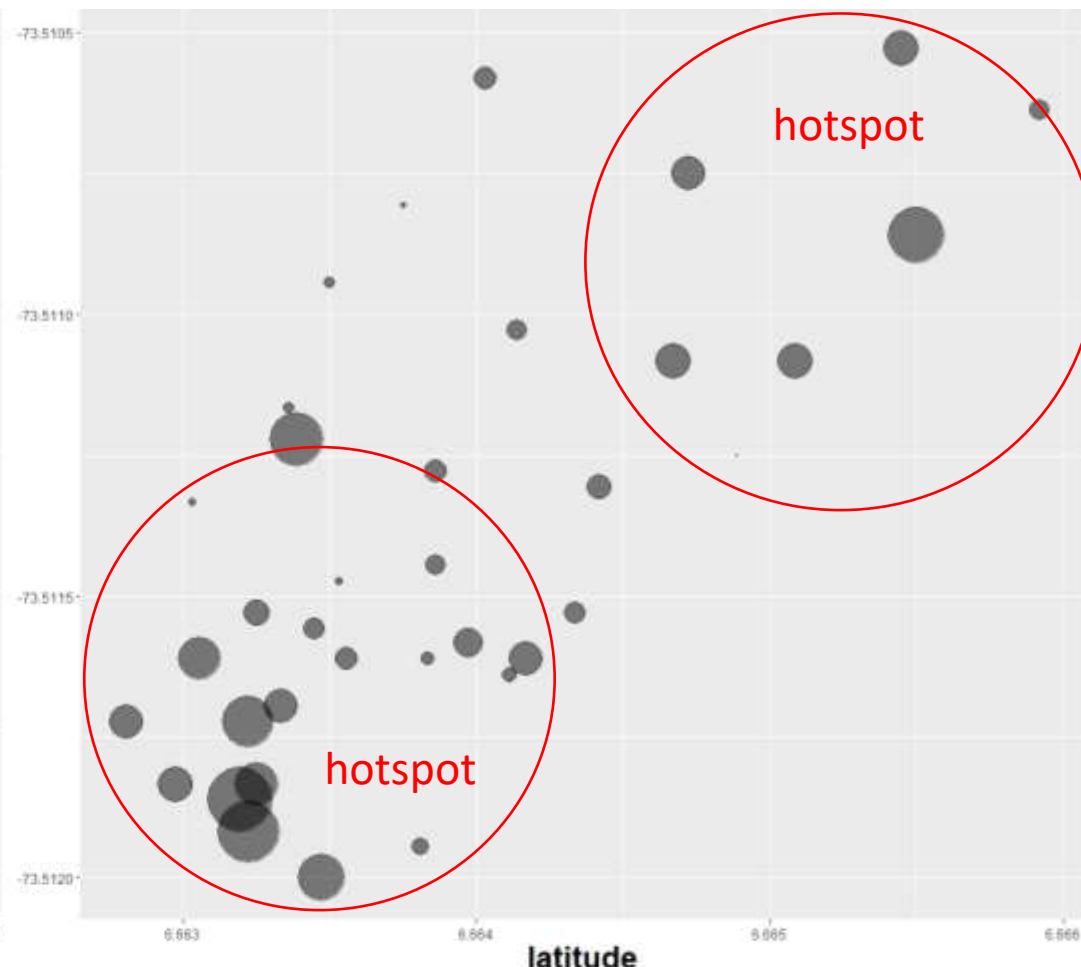
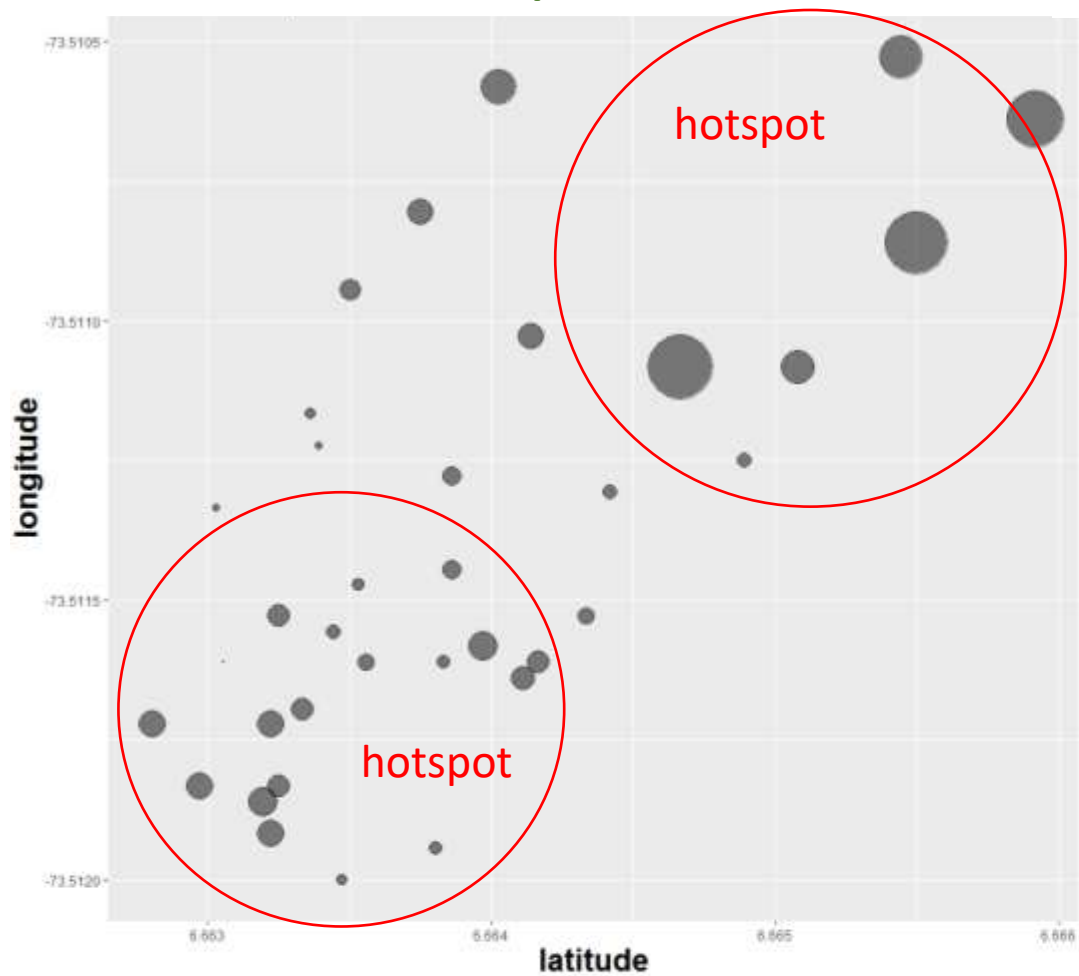
Farm A

Soils



Rhizosphere

non-Rhizosphere



Concentration of available Cd (mg/kg)

● 3	● 6	● 9	● 12
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Concentration of available Cd (mg/kg)

● 0.5	● 1.0	● 1.5
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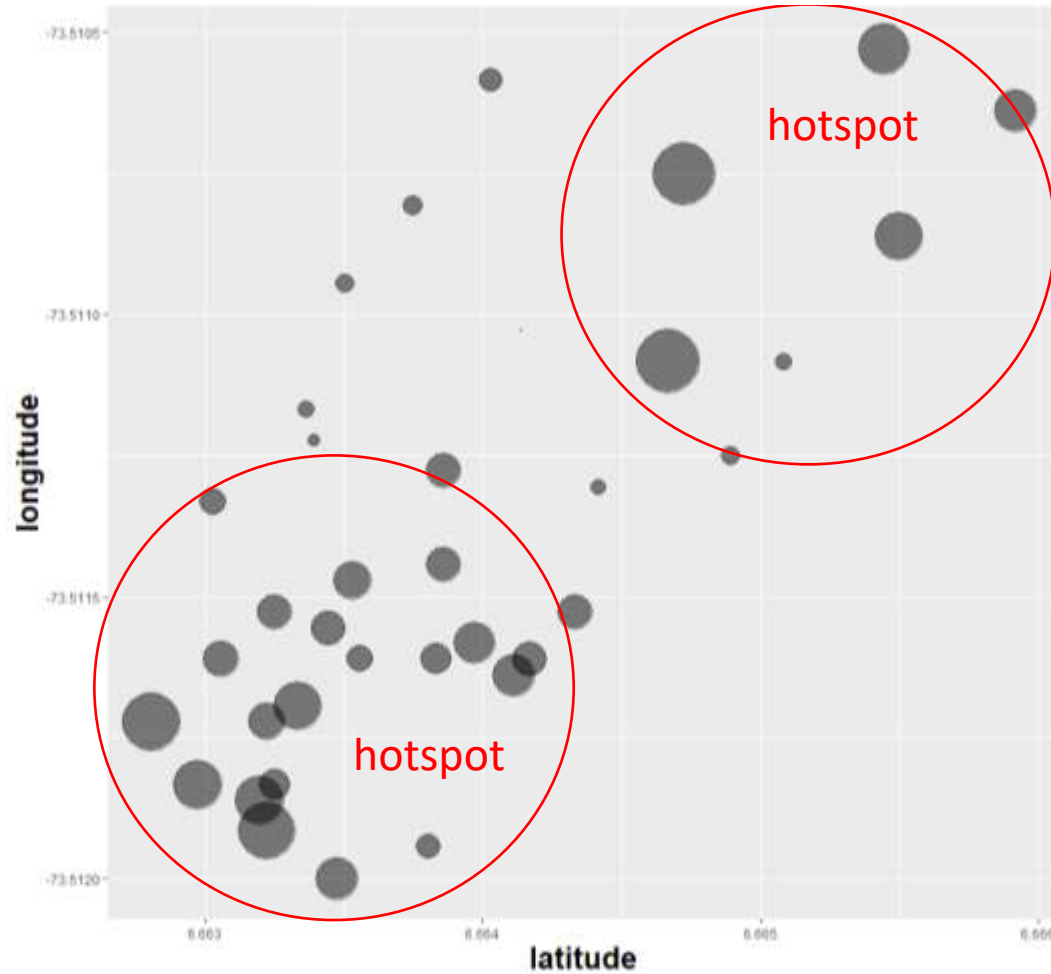
# DISTRIBUTION MAP FOR Cd CONCENTRATION IN CACAO BEANS

Farm A

Beans



Bean Cd



Similar pattern to both rhizosphere and non-rhizosphere soils

Concentration of available Cd vs concentration of Bean Cd.

Soil type	Pearson correlation coefficient
Rhizosphere	0,58***
non-Rhizosphere	0,40*

p-value: <0,05: \*; <0,01:\*\* <0,001: \*\*\*

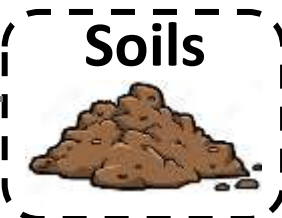
Concentration of Bean Cd (mg/kg)





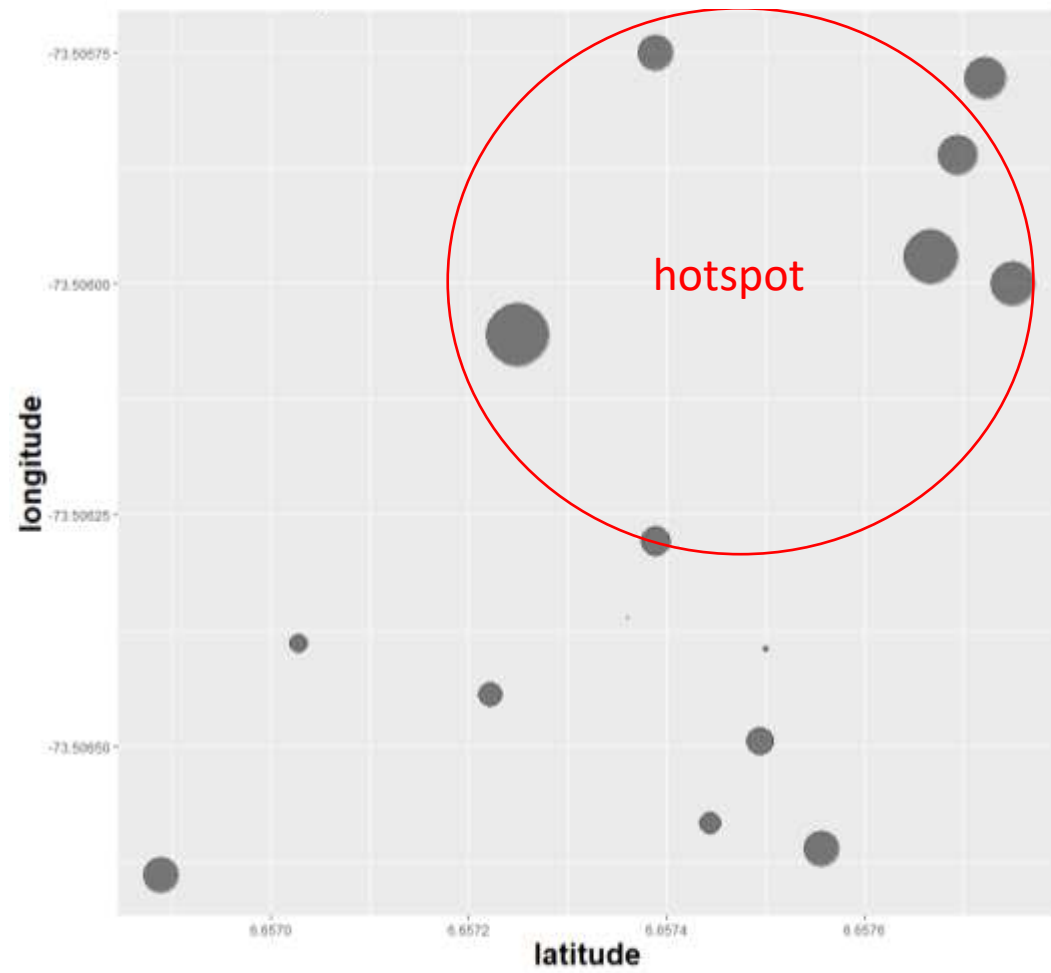
# DISTRIBUTION MAP FOR CONCENTRATION OF AVAILABLE Cd

Farm B



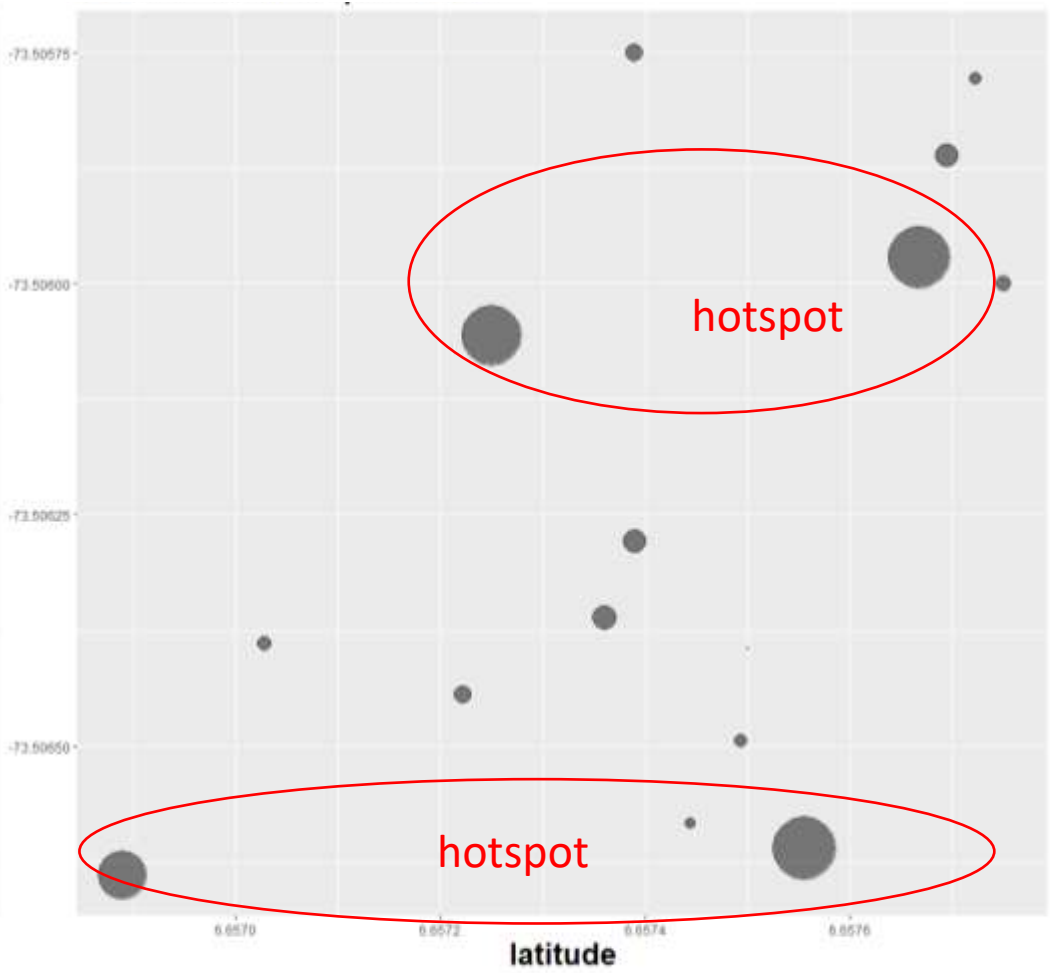
Rhizosphere soils

non-Rhizosphere soils



Concentration of available Cd (mg/kg)

● 0.2	● 0.4	● 0.6
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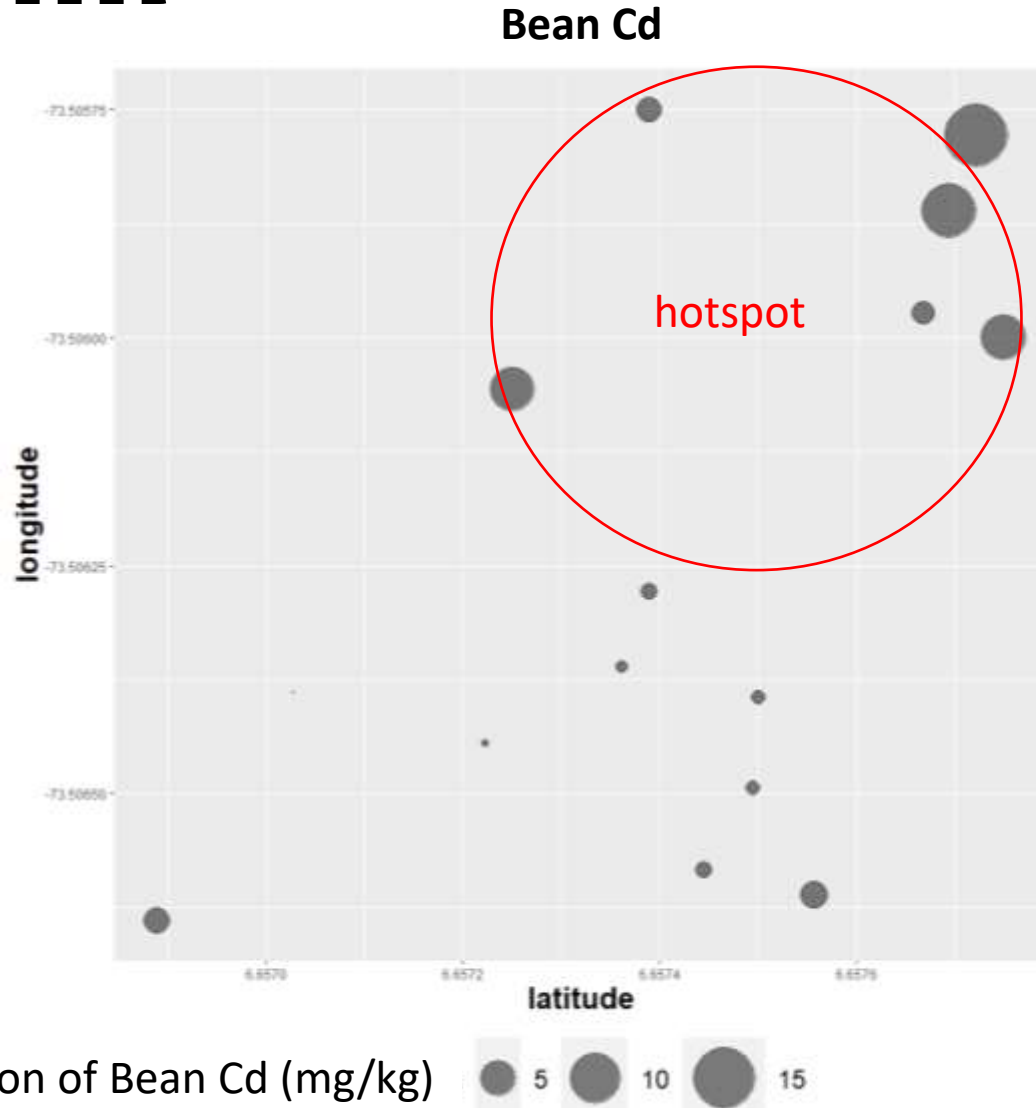
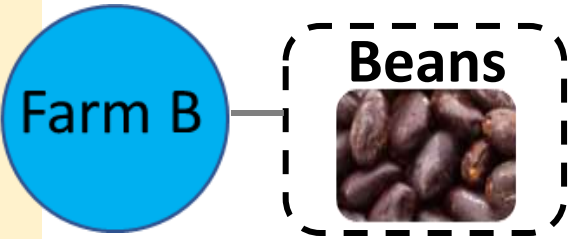


Concentration of available Cd (mg/kg)

● 0.10	● 0.15	● 0.20
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RESULTS

# DISTRIBUTION MAP FOR Cd CONCENTRATION IN CACAO BEANS



Similar pattern to Rhizosphere soils

Concentration of available Cd vs concentration of Bean Cd.

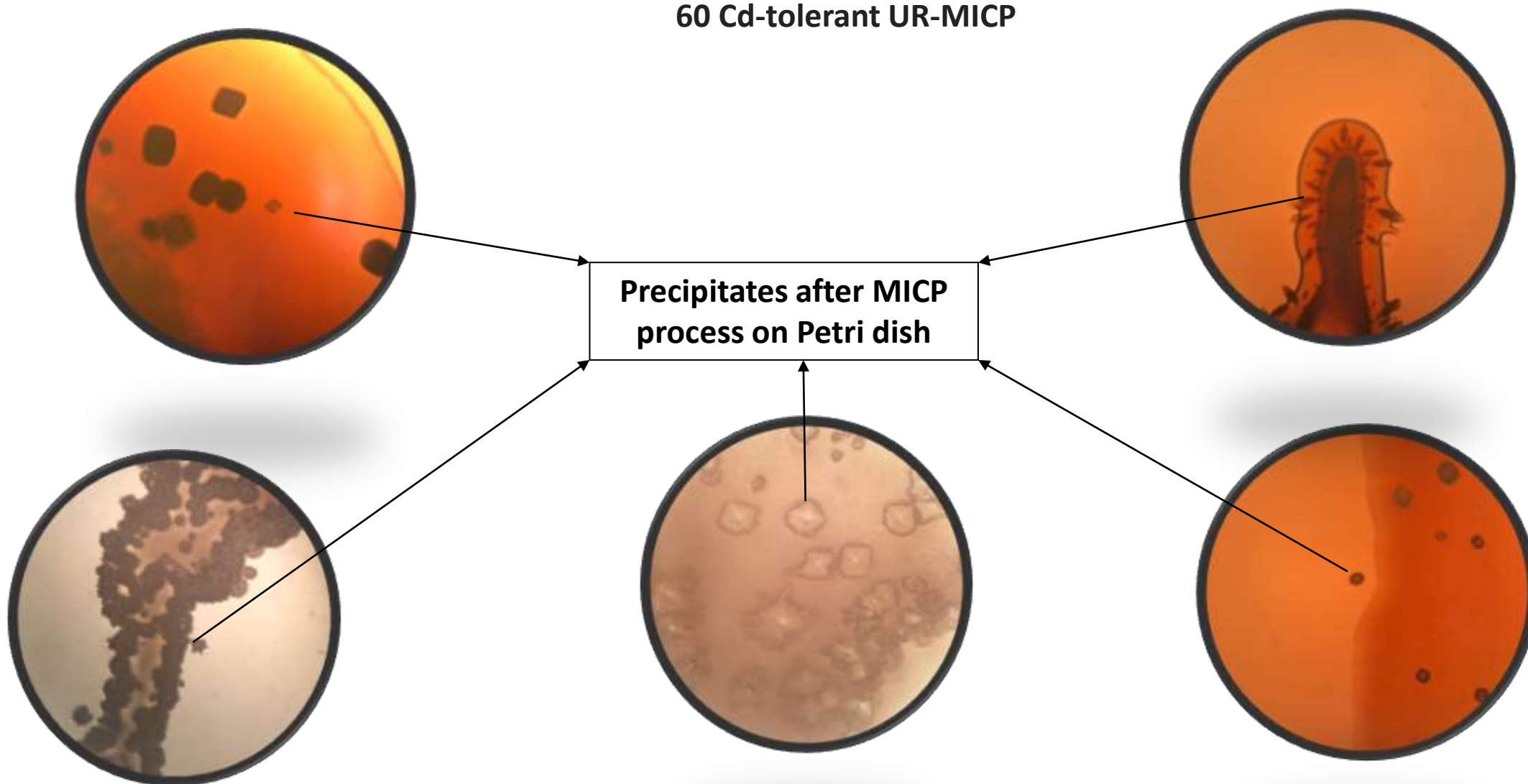
Soil type	Pearson correlation coefficient
Rhizosphere	0,52*
non-Rhizosphere	-0,16

p-value: <0,05: \*; <0,01\*\* <0,001: \*\*\*

RESULTS

# ISOLATION OF UREOLYTIC RHIZOBACTERIAS

60 Cd-tolerant UR-MICP



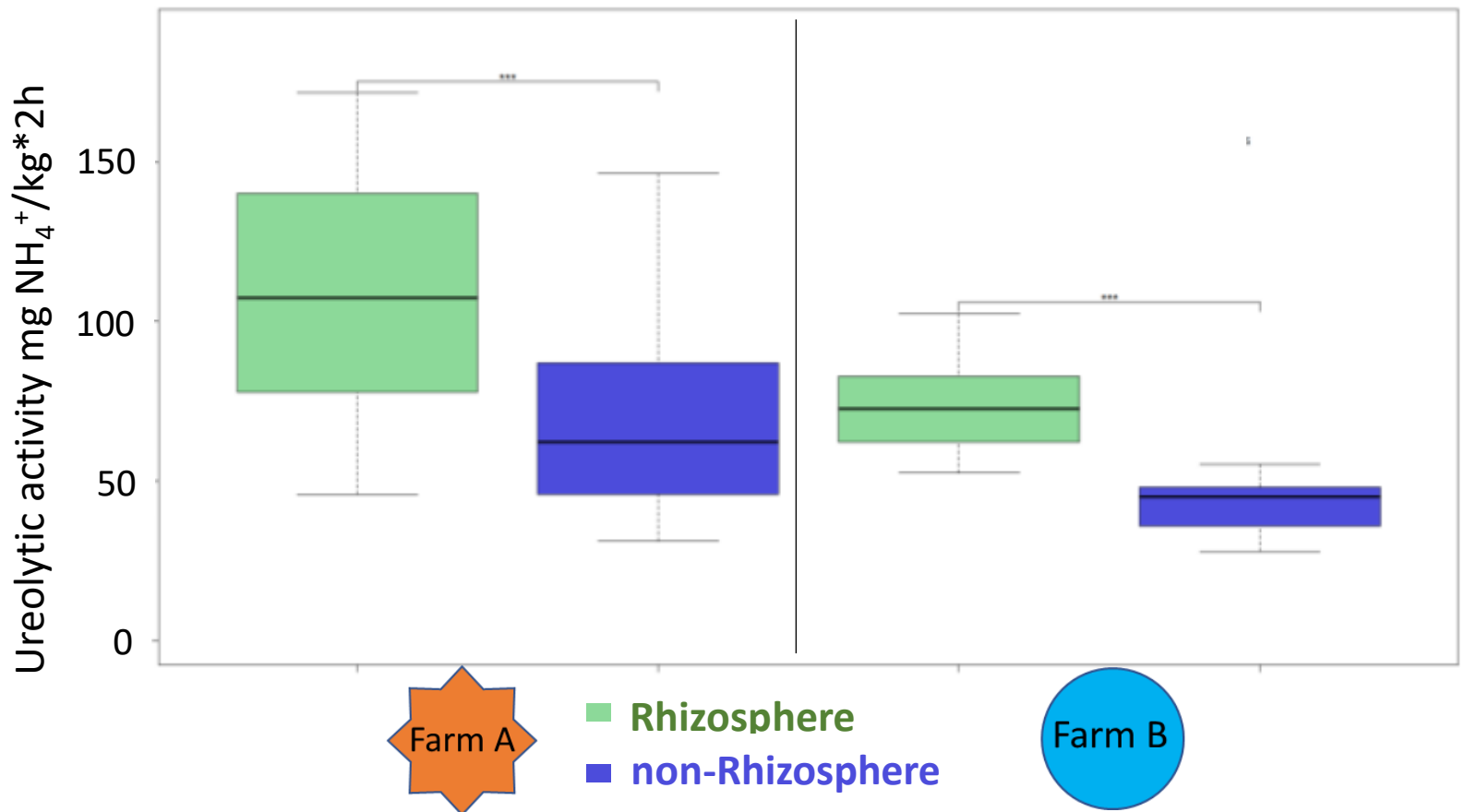
Medium supplemented with urea,  $\text{Cd}^{2+}$ ,  $\text{Ca}^{2+}$   
Microscopic photographic images



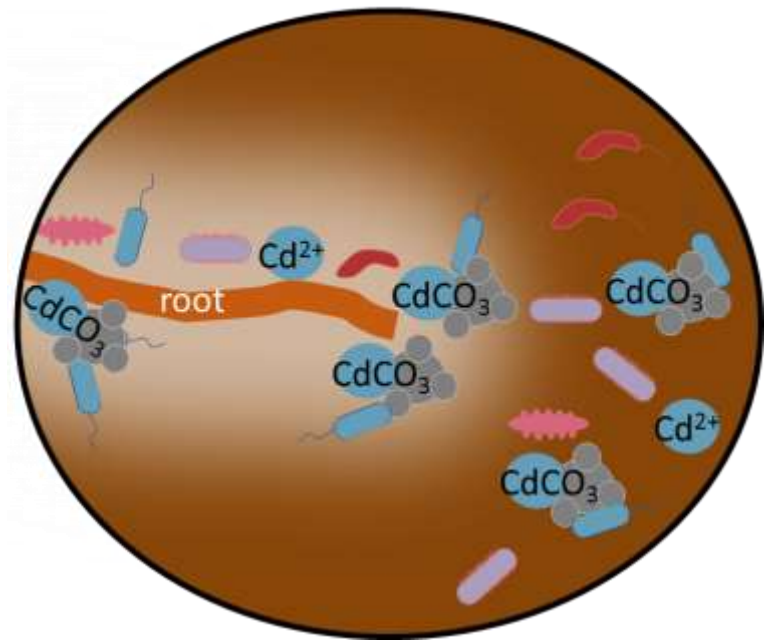
# POTENTIAL APPLICATION OF MICP IN CACAO-GROWING SOILS

### Boxplot of ureolytic activity

p-value: <0,001: \*\*\*



### Possible enhance MICP process on the rhizosphere



RESULTS

# Conclusion - Recommendations



Rhizosphere and non-rhizosphere soils have different Cd content and both types of soil should be included in the sampling design.



Studied cacao farms have hotspots and their location helps farmers to decide where to plant/renovate and identify possible areas with high concentration of Cd in cacao beans to classify its harvest.



Ureolytic activity of rhizosphere soils indicates its potential for MICP application as an alternative for bioremediation of Cd.



This investigation contributes to the development of a mitigation strategy to reduce Cd content in cacao beans that will allow farmers and cacao exporters to negotiate better deals.







El conocimiento  
es de todos

Minciencias



COLCIENCIAS

BECAS  
BICENTENARIO 2019

PROGRAMA DE

EXCELENCIA DOCTORAL  
DEL BICENTENARIO



El ambiente  
es de todos

Minambiente

Contrato de acceso a recursos genéticos



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Grupo de Estudios para la  
Remediación y Mitigación  
de Impactos Negativos al  
A m b i e n t e



ASOCAPAYARI

Miguel Ángel Beltrán, Carlos Mario Marín, Miguel Marín  
Alcaldía de El Carmen de Chucurí, Santander - Colombia

RGE-152-17 -Contrato de acceso a recursos genéticos No. 121 -otrosí No. 17 -Permiso de recolecta Res. 1982

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Código de Proyecto: 48335

Convocatoria para el apoyo a proyectos de investigación y creación artística de la sede Bogotá – 2019

Código del proyecto: 48328

# THANKS

[cadarme@unal.edu.co](mailto:cadarme@unal.edu.co)



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