
# Greenhouse gas emissions and dynamics of soil nutrients in coffee crops

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GLOBAL SOIL PARTNERSHIP

# Why invest time and resources in the coffee studio?

2.25 billion cups of coffee

~200 billion dollars

25 million small farmers

80% of production


10 million tons

60% Arabica coffee

40% Robusta coffee

+ 60 countries

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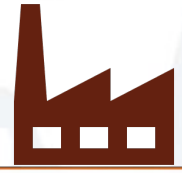
(Samper et al., 2017; Fairtrade Foundation, 2020; OIC, 2021;FAO, 2022)

# Effect of global climate change on coffee production


- Global climate change will reduce by **50%** the world area suitable for growing coffee
- **60%** of coffee species could disappear



- Burning of fossil fuels
- Land-use change

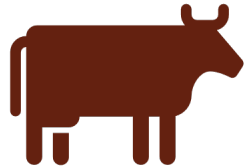
$CO_2$

GWP:1

$N_2O$

- Use of chemical nitrogen fertilizers
- Fertilizer production (Haber-Bosch)

GWP: 298
Lifetime: 114 years



- Enteric fermentation of cattle
- Flooded rice crops

$CH_4$

GWP:25



(Bunn et al., 2015; Davis et al.,2019; IPCC,2007; Tian et al., 2020)

# Objetives

Evaluate greenhouse gas emissions and carbon and nitrogen dynamics in the plant-soil system in three production systems: coffee-mango, coffee-banana and coffee-full sun.

## LEAVES

Micronutrients (Fe, Cu, Zn and Mn), Macronutrients (N, P, Ca, Mg, K). Carbon

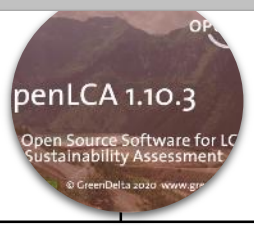
## FOREST FLOOR

Carbon and Nitrogen

## SOIL

pH, soil organic matter, micronutrients (Fe, Cu, Zn and Mn), macronutrients (N, P, Ca, Mg, K), $NO_3^-$ , $NH_4^+$ , carbon, $CO_2$ and $N_2O$ emissions from the soil

## ENVIROMENTAL IMPACT

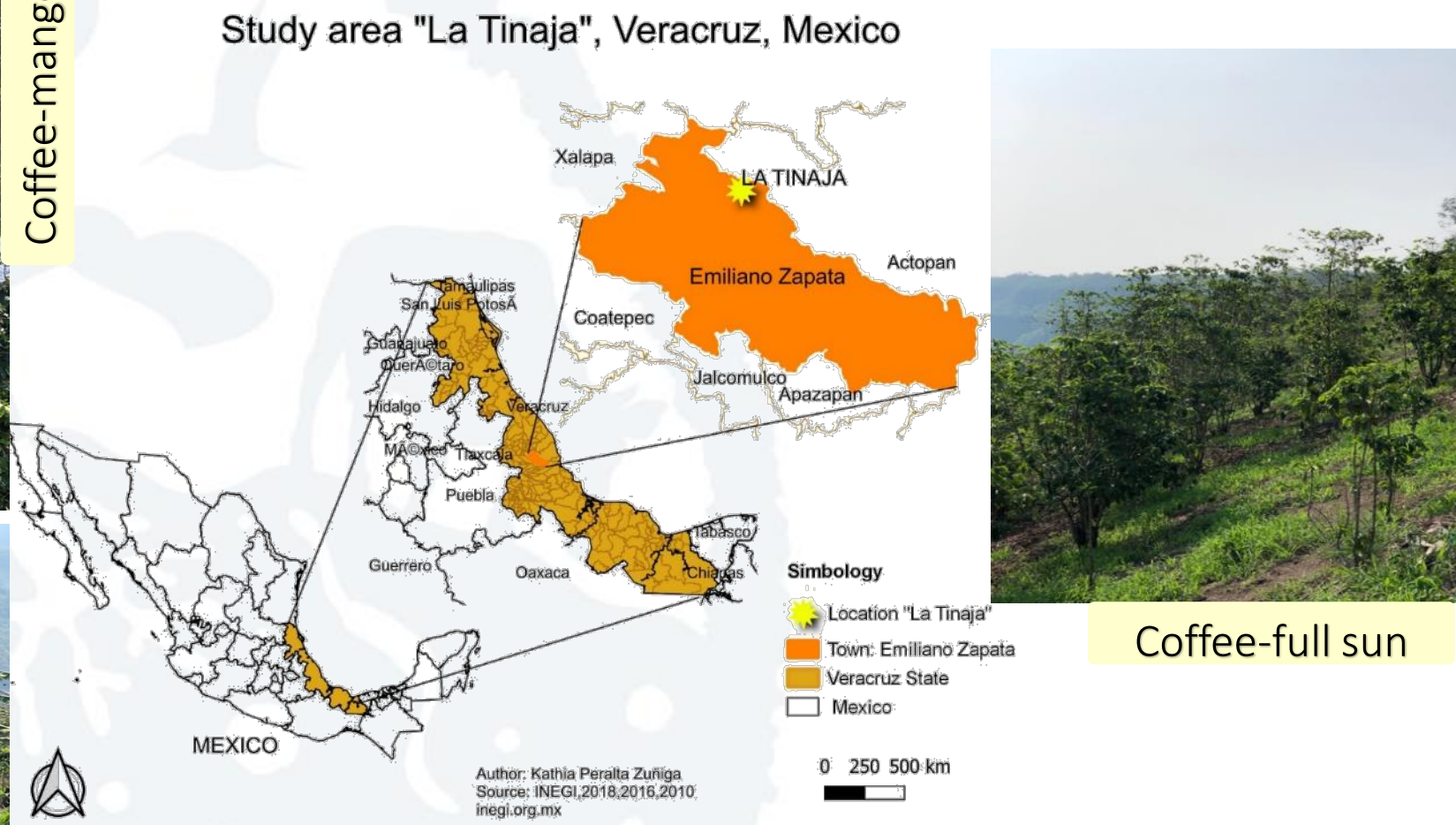



Compilation of information on agronomic management. openLCA 1.10.3 Program.

# Methodology

Coffee-mango

Coffee-banana

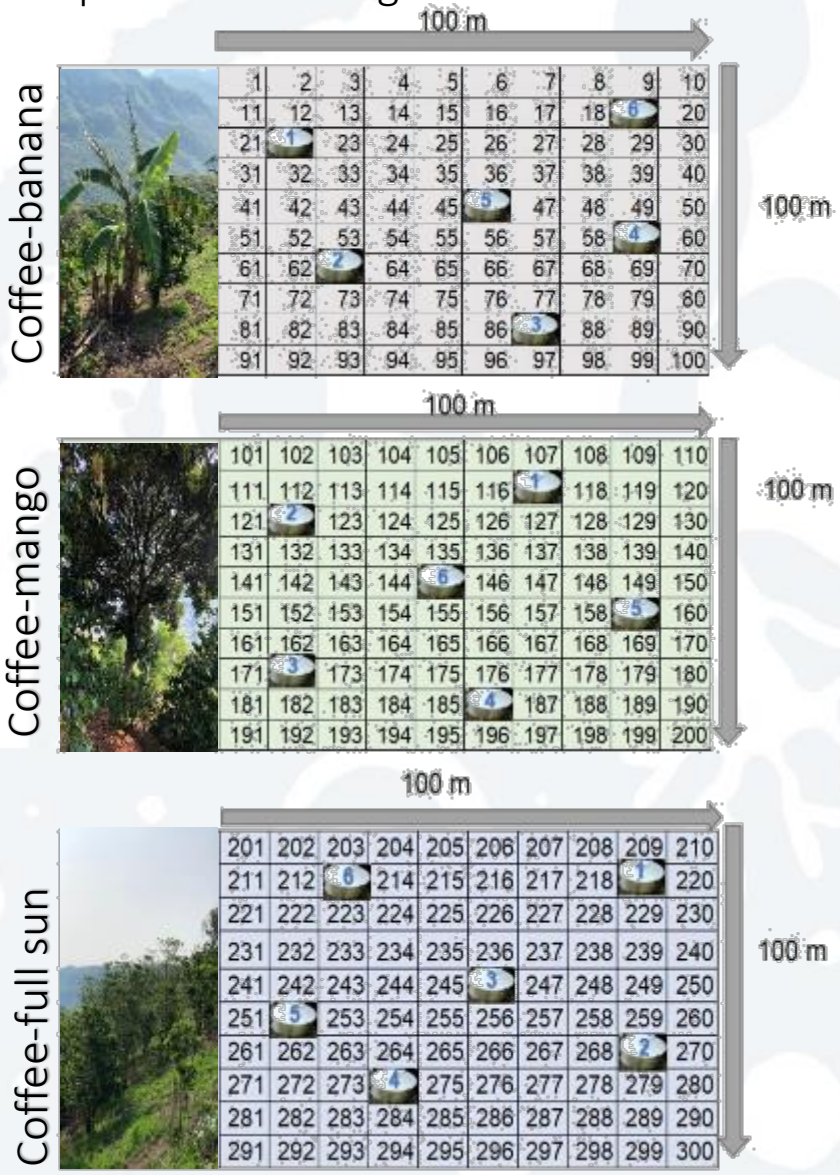


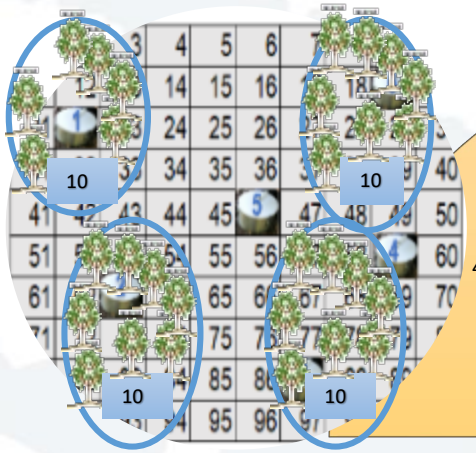



Coffee-full sun

# Methodology

## Experimental design




**Leaf**

40 coffee plants, obtaining four composite samples (80 leaves)

**Litter and Fermentation horizon**

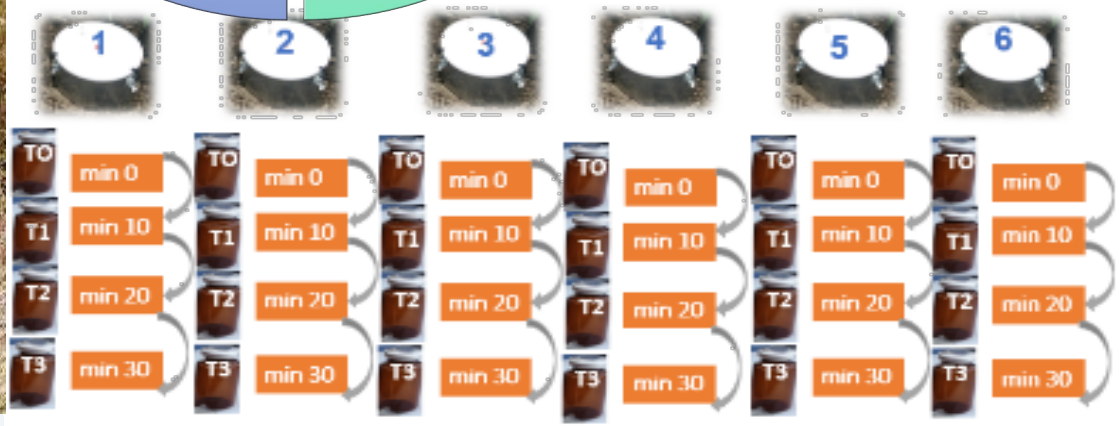
900 $cm^2$ sampling

**Soil**

2.5 cm diameter auger to a depth of 15 cm.

**Soil GHG samples**

Permanent Static Closed Chamber Technique



# Methodology: Life cycle analysis

### 1. Objetive

- Estimate the environmental effects and carbon footprint of agricultural production in three coffee production systems through Life Cycle Assessment
- Functional Unit: 1 kg of cherry coffee
- System Boundaries: Plantation Establishment and Agricultural Management

### 2. Inventory

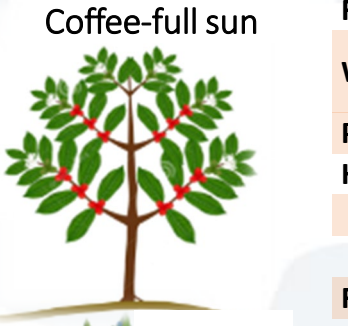
- Compilation of information regarding the agronomic management of production systems.

### 3. Evaluation

- Environmental impacts are classified into categories and inventory information is grouped into those categories.

### 4. Interpretation

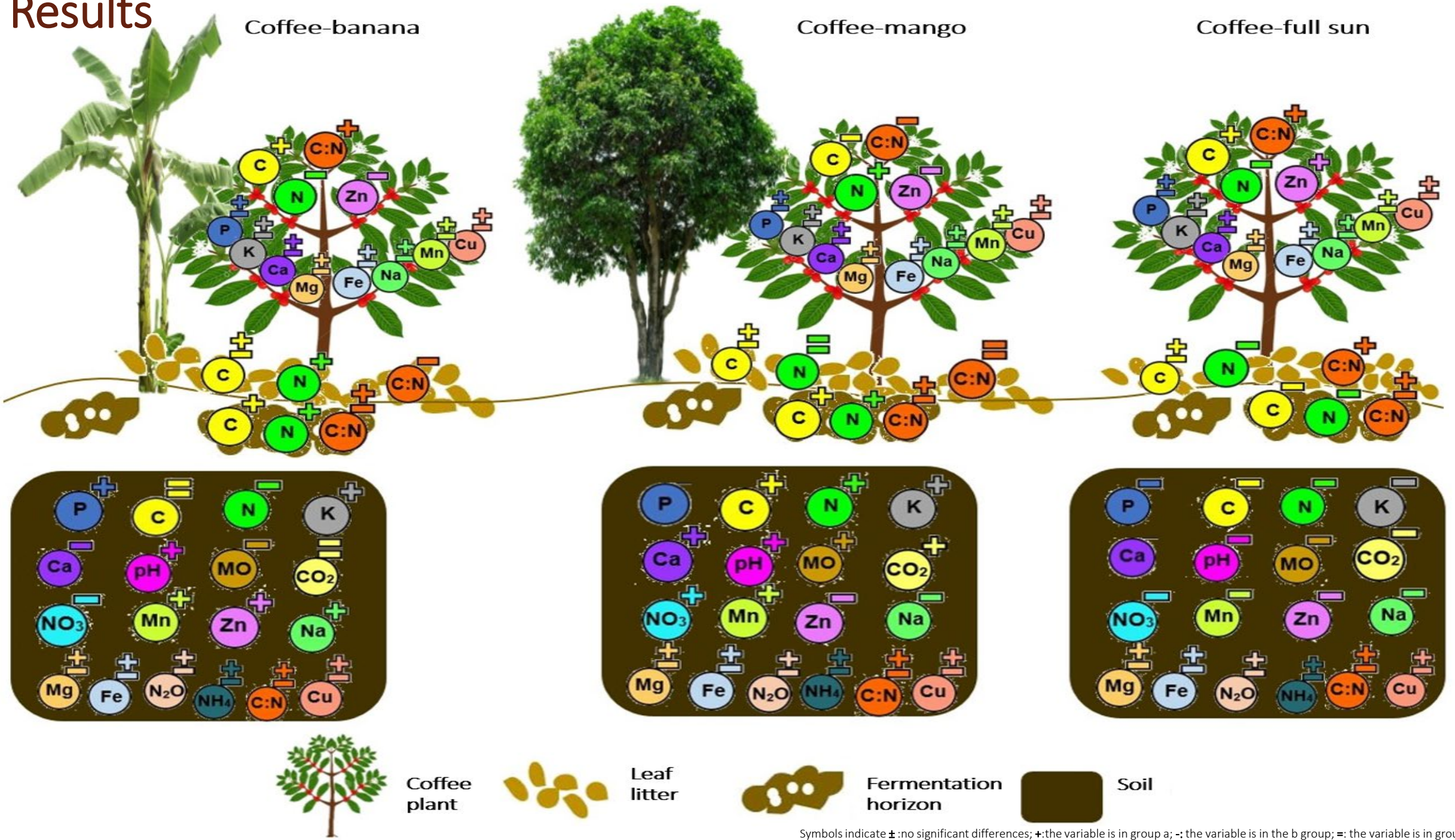
- Generate conclusions and recommendations





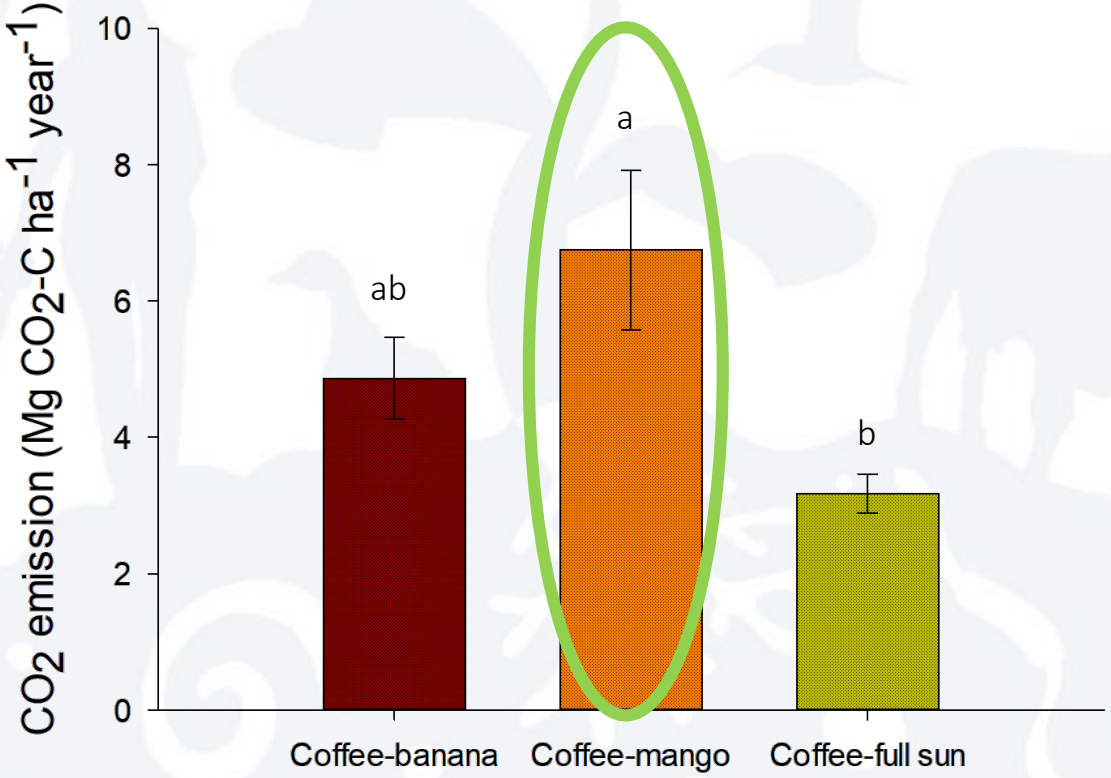

| Agricultural management (Production and harvest, year 4-30) | | | | |
|---|---|---|---|---|
| **Production and Harvest in the coffee-full sun system** | | | | |
| **Fertilization** | NPK 18-12-6 | Fertilizer | kg/ha | 500 |
| **Weed control** | Manual | Weeding | Wage | 1 |
| | Chemistry (takle) | Herbicide | L/ha | 5 |
| **Pest control** | Manual | Alcohol traps | traps/ha | 18 |
| **Harvest** | Court | | Wage | 7 |
| | Horse | | Horse | 2 |
| **Production and Harvest in the coffee-banana system** | | | | |
| **Fertilization** | NPK 18-12-6 | Fertilizer | kg/ha | 400 |
| **Weed control** | Manual | Weeding | Wage | 1 |
| | Chemistry (takle) | Herbicide | L/ha | 5 |
| **Pest control** | Manual | Alcohol traps | traps/ha | 18 |
| **Harvest** | Court | | Wage | 7 |
| | Horse | | Horse | 2 |
| **Cultural work in the banana plant** | | | | |
| **Fertilization** | Urea | Fertilizer | kg/ha | 100 |
| **Weed control** | Tamaron | Insecticide | L/ha | 1 |
| **Production and Harvest in the coffee-mango system** | | | | |
| **Fertilization** | NPK 18-12-6 | Fertilizer | kg/ha | 400 |
| **Weed control** | Manual | Weeding | Wage | 1 |
| | Chemistry (takle) | Herbicide | L/ha | 5 |
| **Pest control** | Manual | Alcohol traps | traps/ha | 18 |
| **Harvest** | Court | | Wage | 7 |
| | Horse | | Horse | 2 |

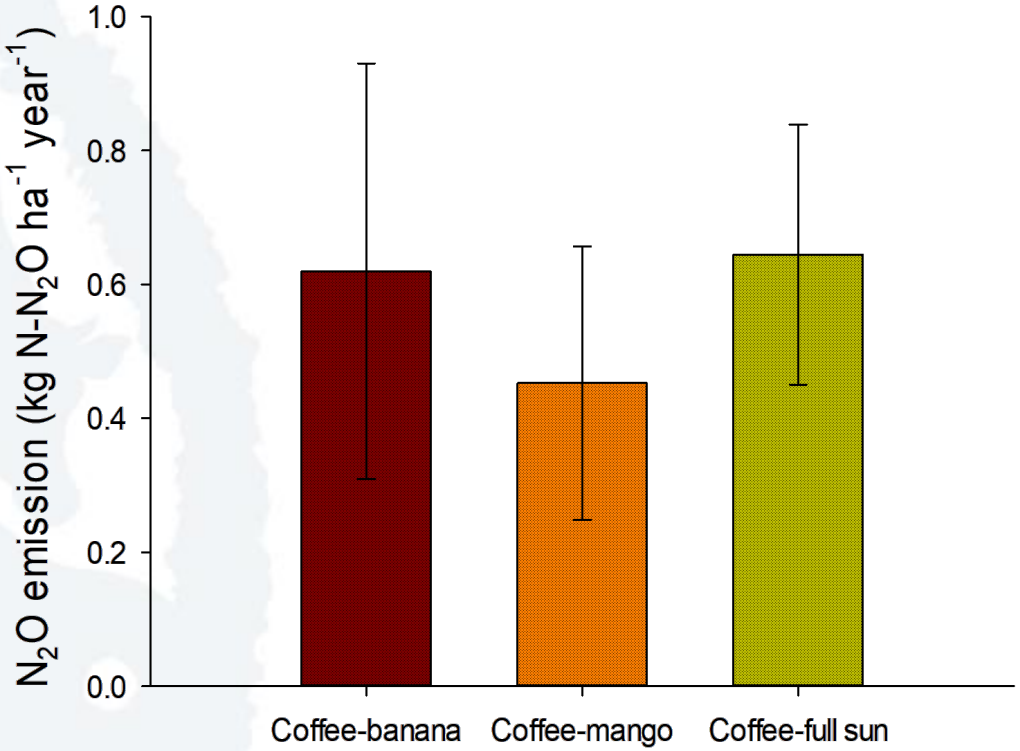
# Results



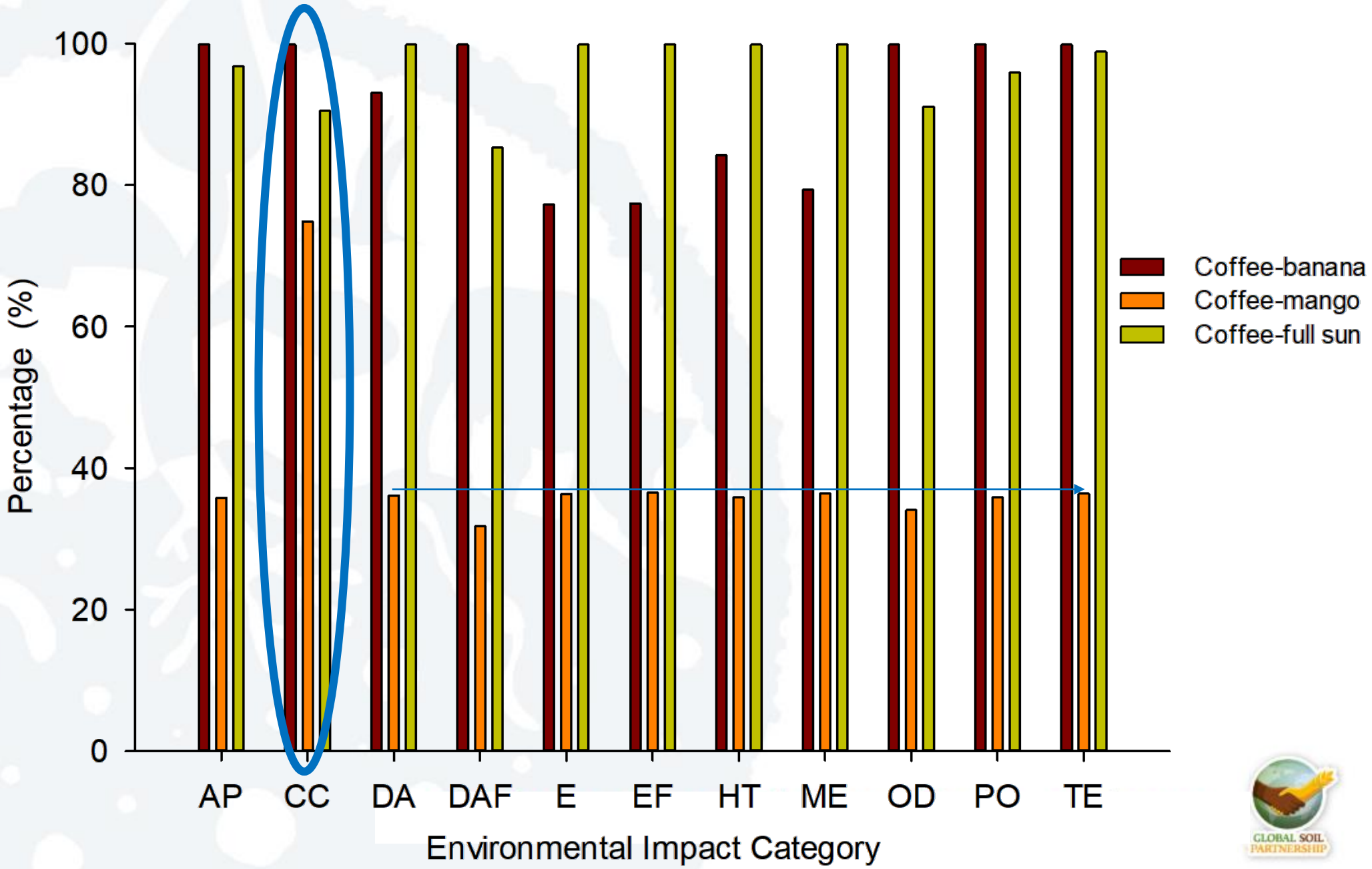

Symbols indicate **±** :no significant differences; **+**:the variable is in group a; **-**: the variable is in the b group; **=**: the variable is in group a and b

# Greenhouse gas emissions ($CO_2$ and $N_2O$)



# Results




AP= Acidification potential
CC= Climate change
DA= Depletion of abiotic resources - elements, ultimate reserves
DAF= Depletion of abiotic resources - fossil fuels
E= Eutrophication
EF= Freshwater aquatic ecotoxicity
HT=Human toxicity;
ME= Marine aquatic ecotoxicity
OD= Ozone layer depletion
PO= Photochemical oxidation
TE=Terrestrial ecotoxicity

# Conclusions

The shade tree species in the coffee production system influences the dynamics and availability of nutrients in the soil as well as $CO_2$ and $N_2O$ emissions from the soil.

The shaded coffee production system of the mango tree has favorable physical-chemical fertility characteristics that would probably make it more resilient to the effects of GCC, in addition to the potential for mitigating atmospheric $CO_2$.

The information generated from this study is relevant from the point of view of monitoring and generating a baseline of $CO_2$ and $N_2O$ emissions in the soils of coffee production agroforestry systems of this study site.

This information represents a start to support producers in their integration into carbon credit, certification and valorization programs in the coffee production chain.


Thank you !
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