

# Effects of mechanical site preparation techniques in forest plantation context on the soil organic carbon stocks and on the priming effect process

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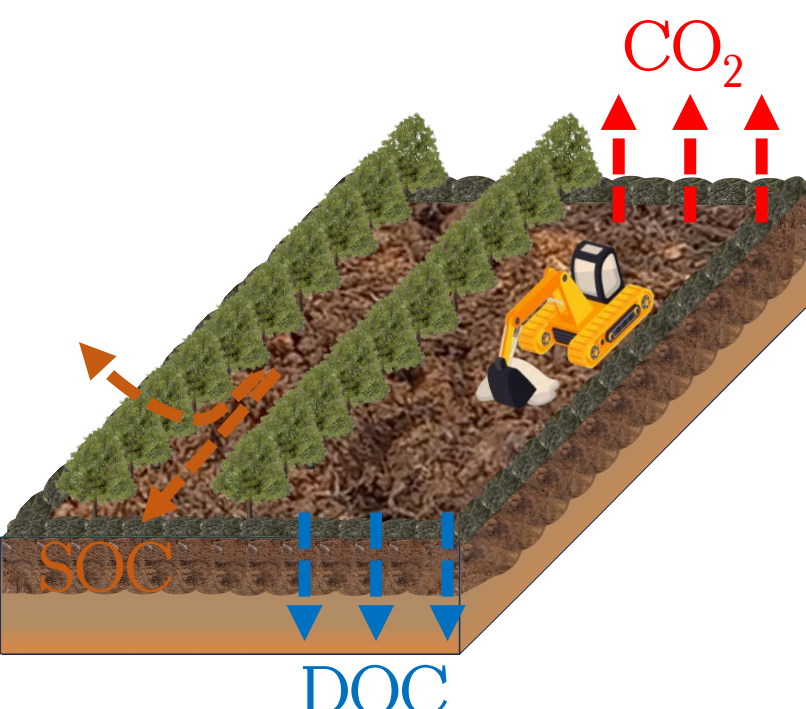
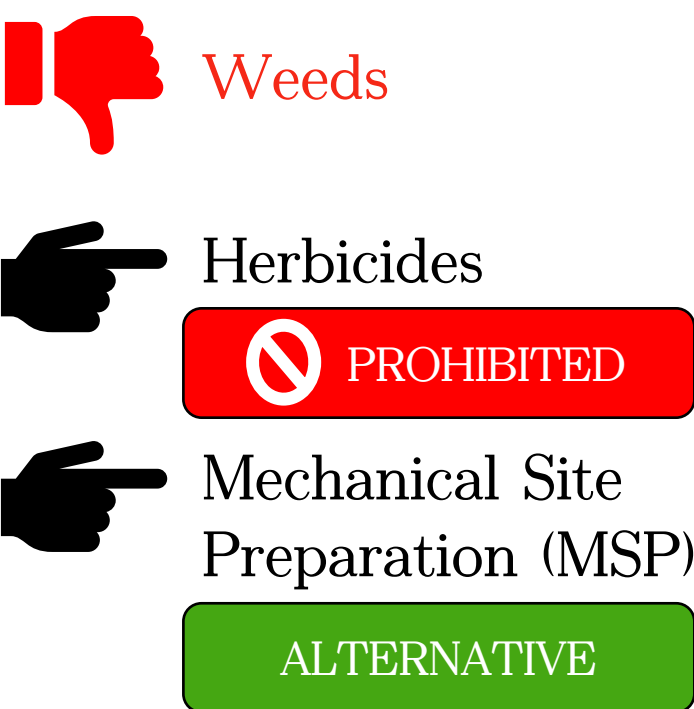
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## CONTEXT

For the forest stand renewal phase, some biotic (e.g. weeds) and abiotic (e.g. compaction, waterlogging etc.) constraints can compromise the establishment and development of young trees. Before 2014, **herbicides were used to control weeds**, but today many pesticides are subject to new regulations (LOI n° 2014-110, Legifrance). **Mechanical Site Preparation (MSP) happens to be an alternative** to herbicides and can be applied to promote the forest plantations establishment (Collet et al., 2014). Nevertheless, **MSP results in soil disturbance** (e.g. structure, density etc.) and **interferes with soil organic carbon** stocks (SOC; Mayer et al., 2020). Alternative MSP techniques are now being proposed to reduce the impact on soil properties and thus preserve the carbon sequestration function of forest soils (Pellerin et al., 2020).



- ! MSP = Soil disturbance**
- Increased mineralization
  - Dissolved organic carbon leaching (DOC)
  - Water and wind erosion
  - Structural impact
  - Mix soil horizons
  - Microclimate modification

## THESIS OBJECTIVES AND WORKING HYPOTHESES

### Objectives :

1. Test different MSP techniques of variable tilled area on SOC destorage
2. Identify a short-term response of SOC stocks to MSP over a textural gradient
3. Measure how the SOC redistribution following MSP influences the SOC mineralization process

### Hypotheses :

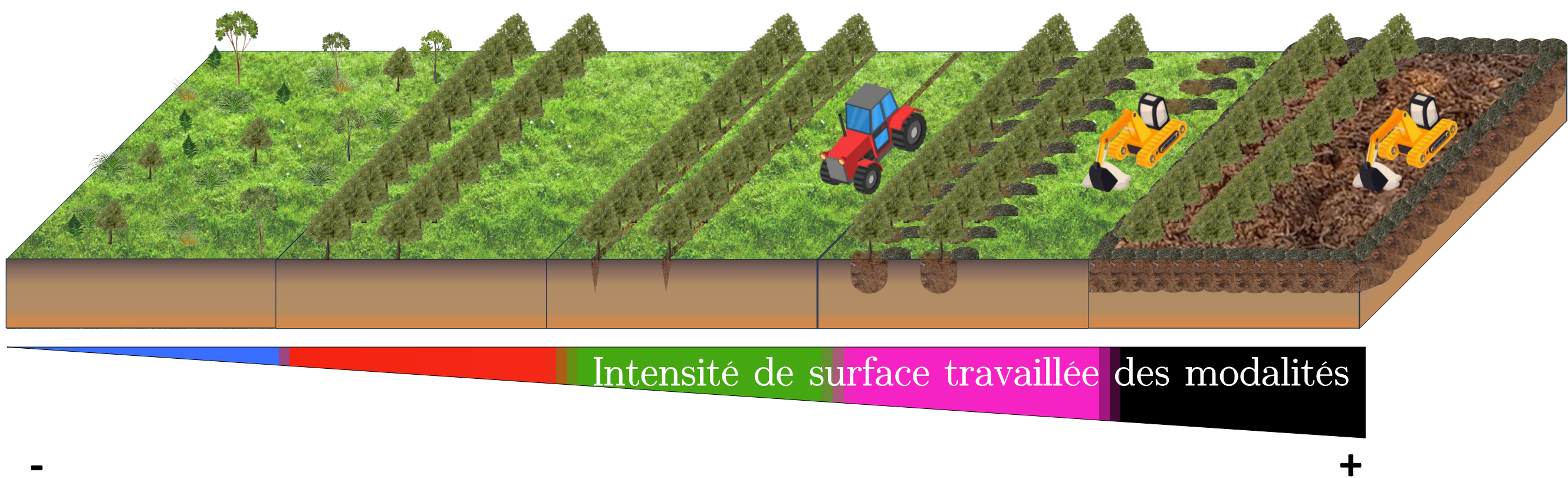
1. MSP localized to a reduced surface area does not significantly impact SOC stocks at the forest stand scale
2. SOC destorage in tilled area is greater in clay-rich soils
3. SOC redistribution following MSP causes overmineralization through the priming effect process

## COMPLEMENTARY APPROACHES

### 1. What is the impact of different MSP techniques on SOC stocks at profil and forest stand level ?

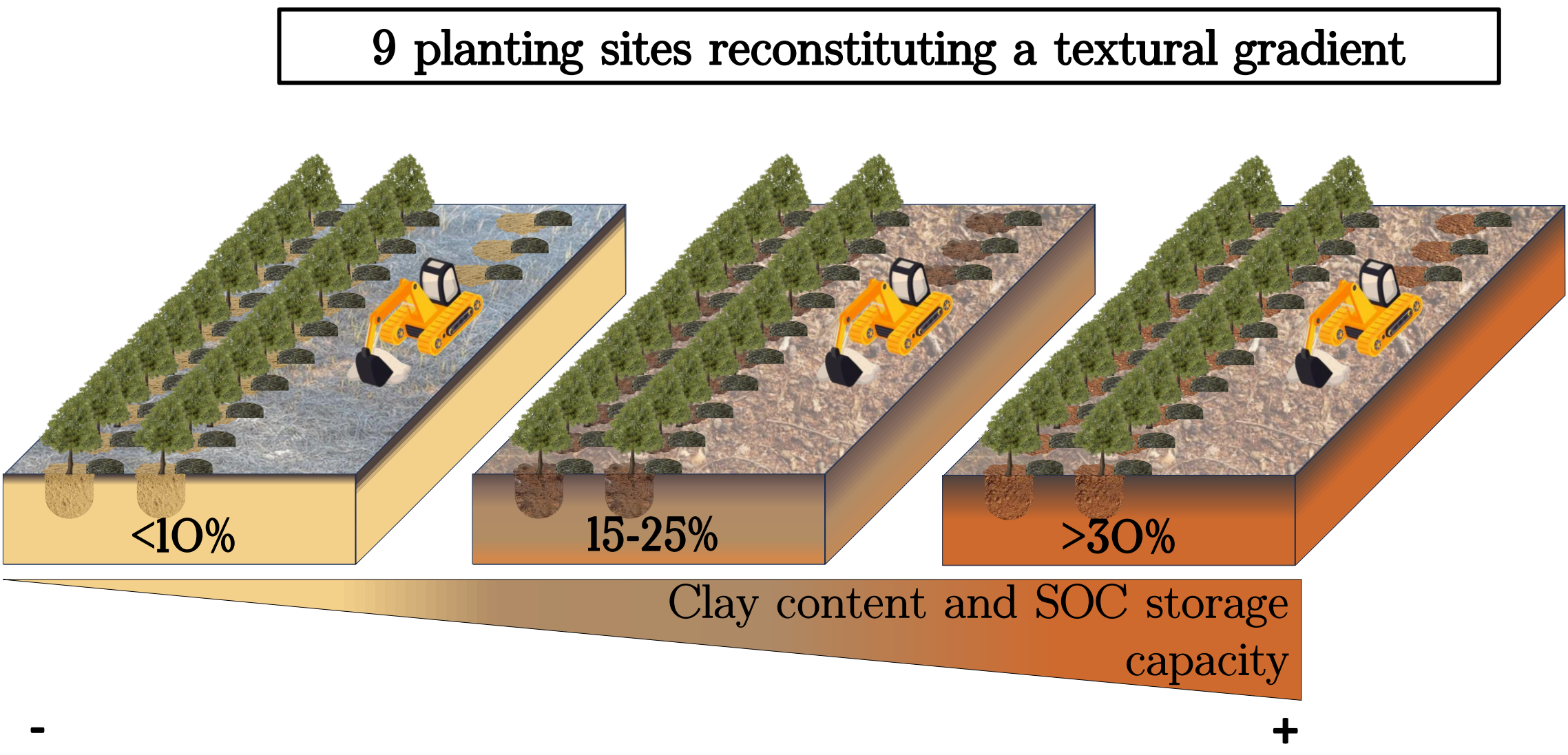


- Legend :
- Parcel 80 demarcation
  - Spontaneous vegetation (SV)
  - Planted control (PC)
  - Trenching subsoiler (TS)
  - Hole multifunction subsoiler (HS)
  - Patch multifunction subsoiler (PS)



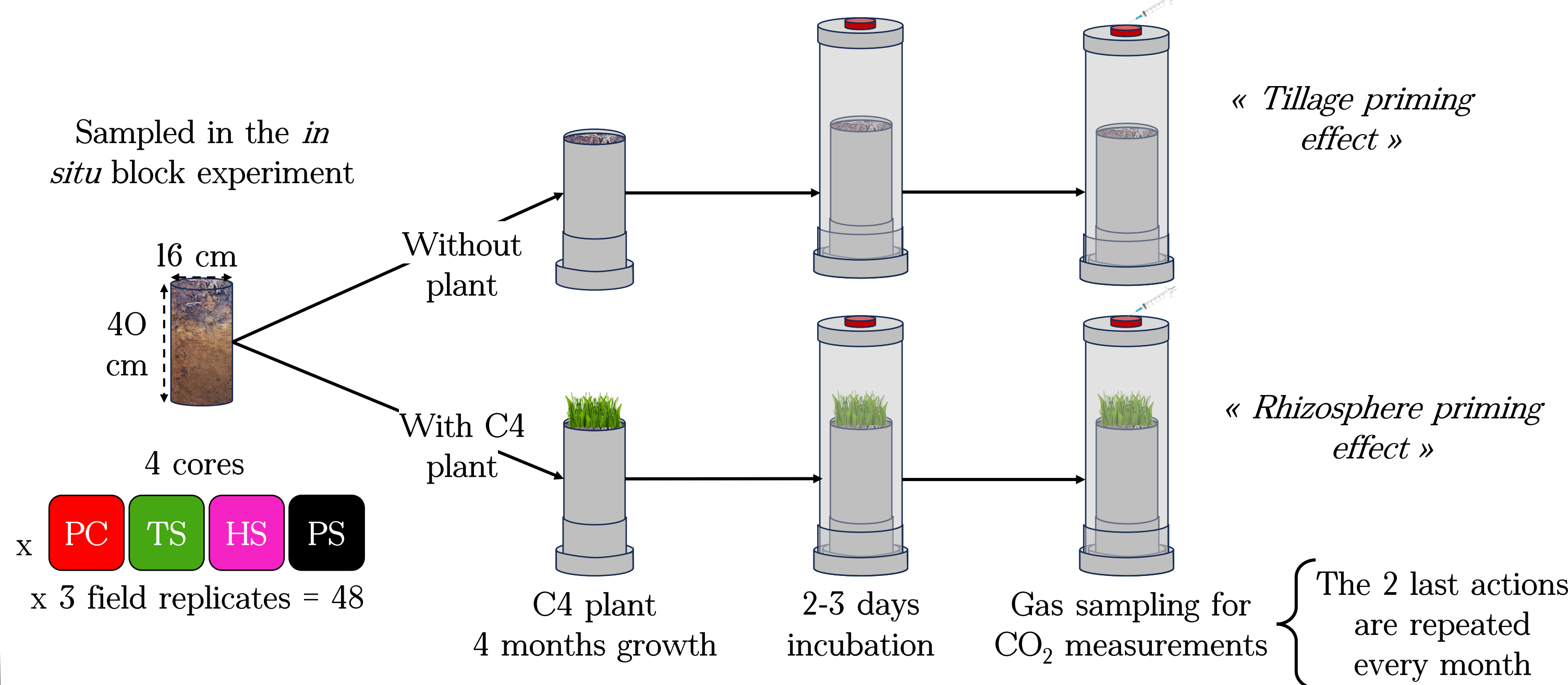
To measure the impact of variable MSP techniques, an ***in situ* block experiment** was establish in Eu State Forest, on loamy soil, over an area of 4.8 hectares, in 2023. This device was positioned taking into account the spatial heterogeneity of the soil previously measured through infrared analysis (Akroume et al., 2016). This allows to test **five MSP modalities of gradual intensity** in terms of tilled surface (**SV**, **PC**, **TS**, **HS** and **PS**). Soil sampling is carried out **over a depth of 60 cm** according to the **mass-based approach** (Toriyama et al., 2011) at initial state before MSP, directly after MSP and 1 year after MSP. The SOC stocks and their spatial redistribution will be compared between each tilled and untilled areas, along the modalities and at the forest stand scale.

### 2. How can we generalize our *in situ* results and verify the impact of MSP on soil variability ?



Today, it is now suggested that the **interaction of SOC with mineral surfaces**, notably the clay fraction, is the **dominant carbon stabilization mechanism** (Lehmann and Kleber, 2015). Similar to the block experiment approach, the **9 selected sites reconstituting a textural gradient** (from **less than 10%** to **more than 30%** clay) will be sampled in the initial state before MSP and directly after MSP. In this approach, **only the soil texture will vary, the MSP technique will be identical** at each site. SOC stocks and their spatial redistribution will be compared between tilled and untilled areas, between each site and also between each soil layers with varying clay content.

### 3. Does the redistribution of SOC in the soil layers by MSP influence the mineralization process, and how ?



The **mixing of soil and the rhizodeposition may induce a « priming effect »** by bringing labile C into contact with stable C. To measure this potential overmineralization we use **48 soil cores** sampled according to **4 modalities** of the *in situ* block experiment (**PC**, **TS**, **HS** and **PS**) and monitored **under controlled conditions in the laboratory**. On 24 cores, a **plant with a C4 photosynthesis type** will be growth to monitor the mineralization process using the plant's natural C4 isotopic signature (Cheng et al., 2005). The mineralization process will also be monitored on the other 24 cores (without plants), which will also serve as controls for the cores with plants. CO2 will be measured at regular intervals and the average age of the carbon will be estimated by <sup>14</sup>C dating.

## EXPECTED RESULTS

1. A significant effect on SOC stocks proportional to MSP intensity
2. A more significant decrease in top soil layer in sites with high clay content
3. A « priming effect » proportional to MSP intensity