# Soil management impacts on soil structural properties in ten European long-term experiments

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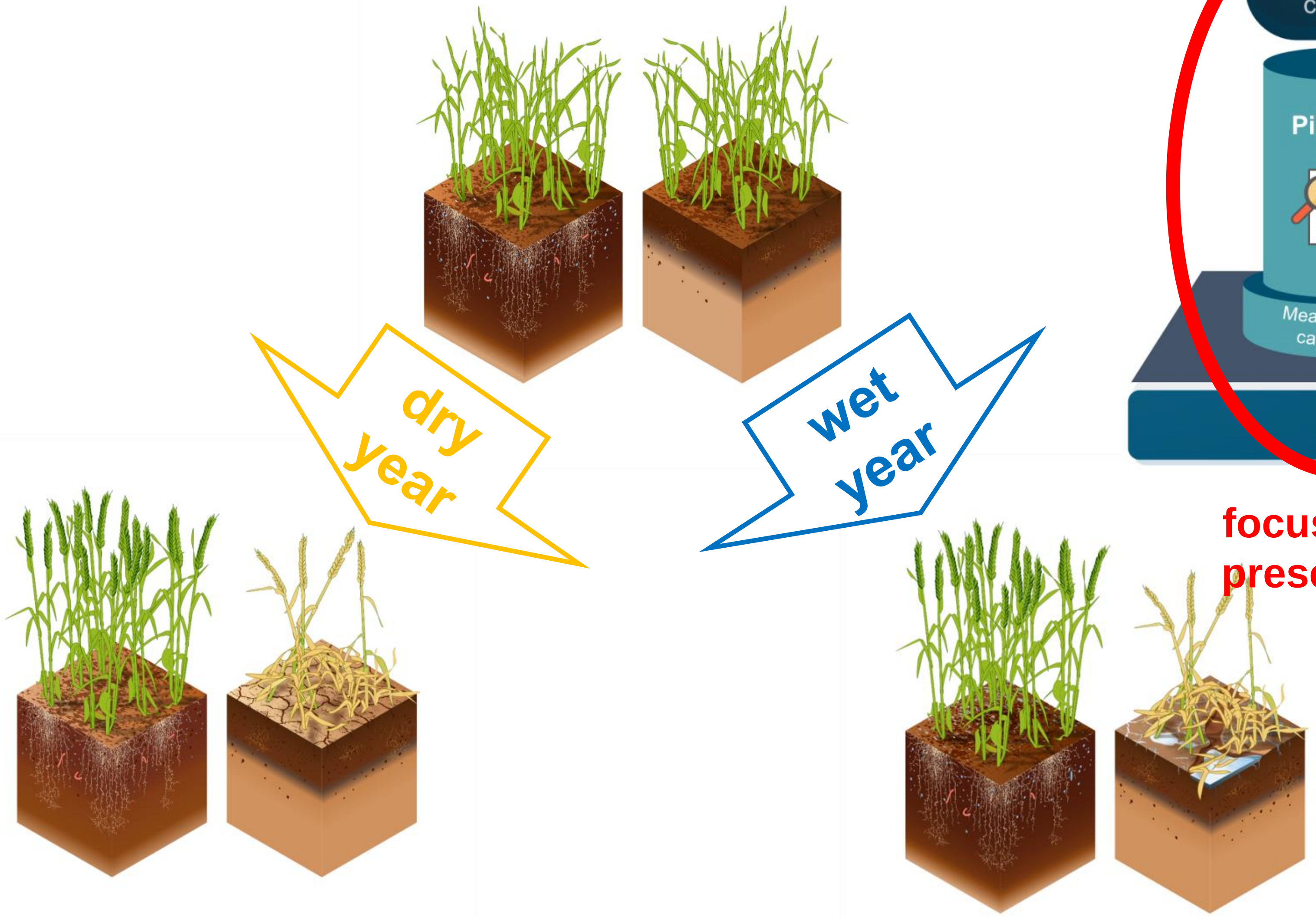
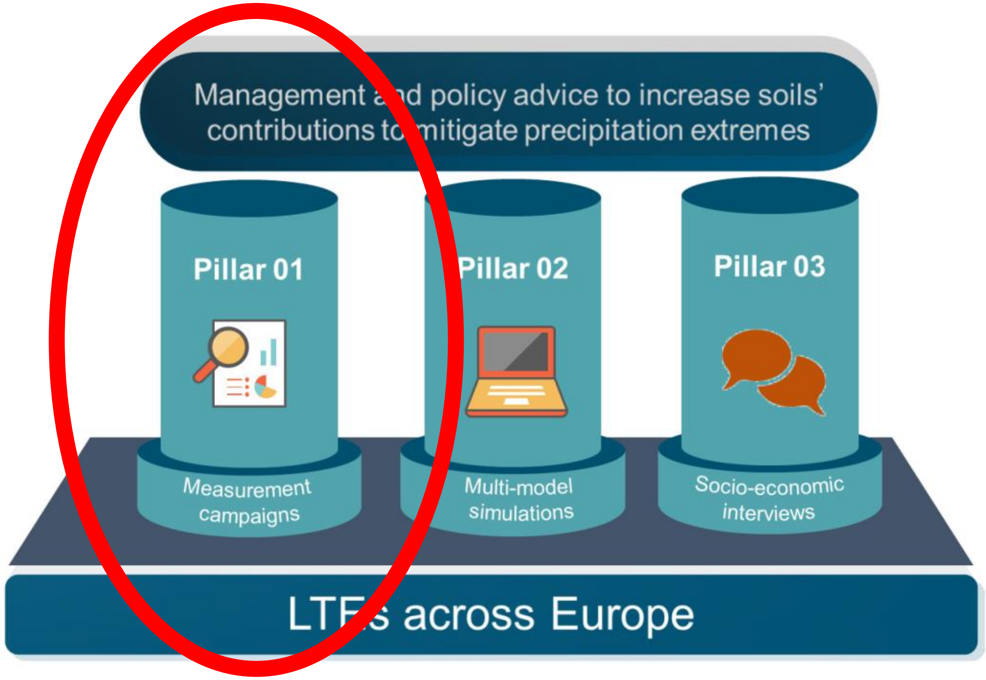
# SoilX: Soil management to mitigate climate change-related precipitation eXtremes

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# Aim and Hypotheses

**Aim:** Quantification of management effects on climate-change adaptation related soil physical properties in European LTEs

**Hypotheses:**

- Higher C input, higher soil cover and lower tillage intensity enhances soil structure directly and indirectly (via soil biota and soil oragnic matter)
- The enhanced soil structure contributes to climate resilience of cropping systems by increasing soil hydraulic conductivity, aggregate stability and soil water retention.

# Sampling in ten long-term experiments (LTE)


Map from Metzger (2018), doi.org/10.7488/ds/2416

| | Experiment | Institution | Factors | Treat. | Blocks |
|---|---|---|---|---|---|
| 1 | Säby | SLU | tillage, rotation | 3 | 3 |
| 2 | CENTS | AU | tillage, org. inputs | 4 | 4 |
| 3 | BOPACT | ILVO | tillage, org. inputs | 4 | 4 |
| 4 | Čáslav | CZU | organic inputs | 2 | 4 |
| 5 | Lukavec | CZU | organic inputs | 2 | 4 |
| 6 | Hollabrunn | BOKU | tillage | 2 | 3 |
| 7 | FAST I | AGS | tillage, org. inputs | 4 | 4 |
| 8 | ZOFE | AGS | organic inputs | 2 | 4 |
| 9 | P24A | AGS | organic inputs | 2 | 4 |
| 10 | ROT | INIA | tillage, rotation | 4 | 4 |

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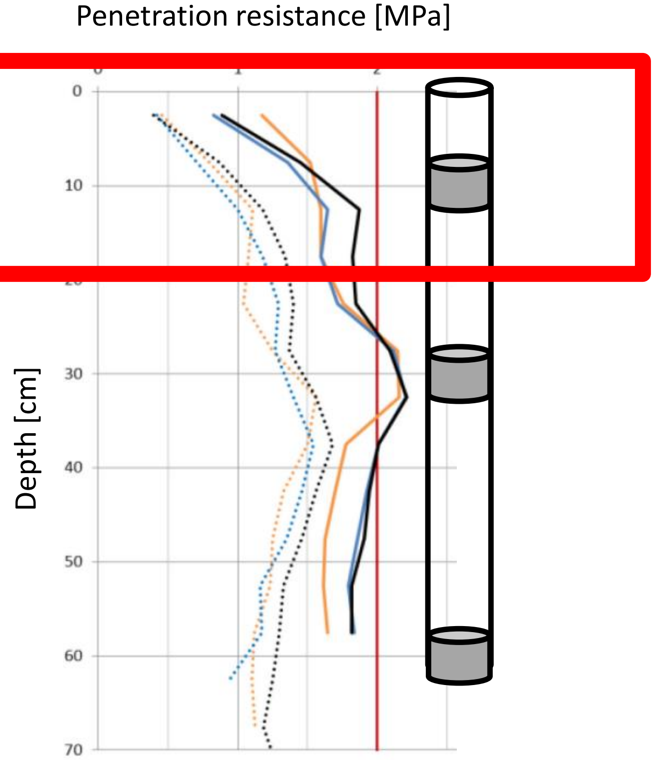


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~~111~~ 63 plots x ~~3~~ 1 depths

=

**~~333~~ 63 observations**



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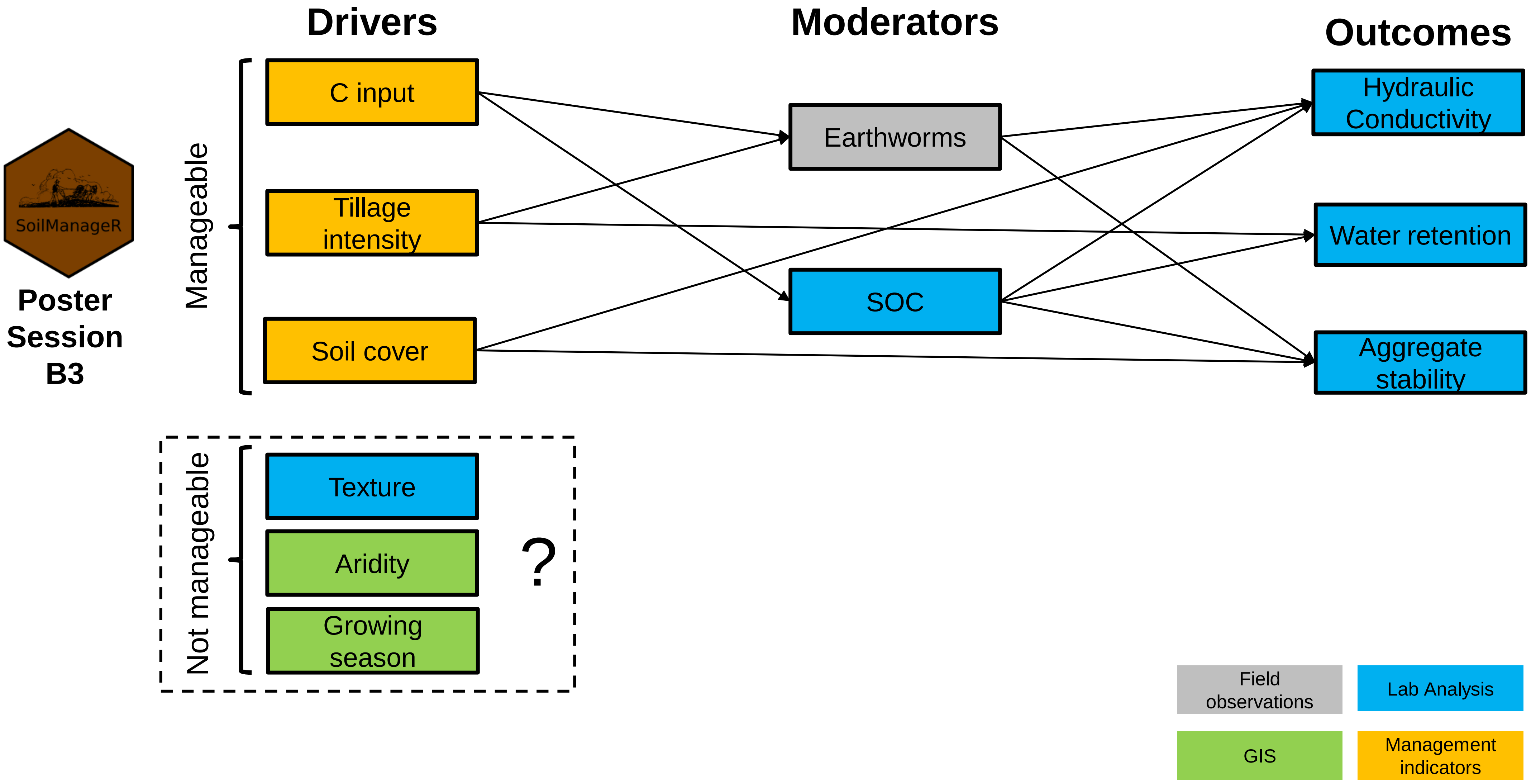
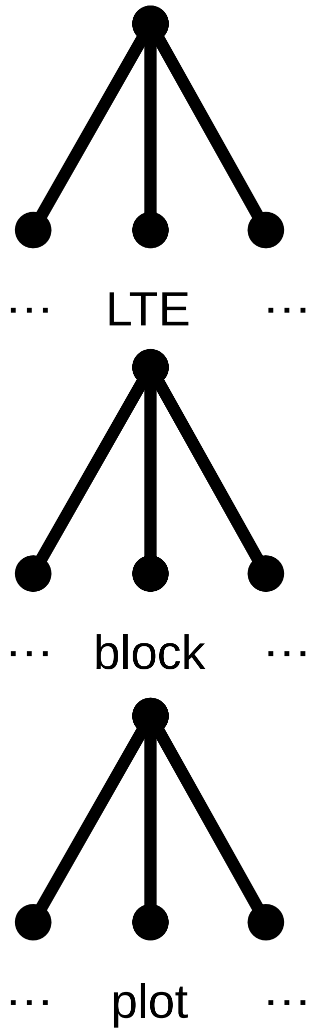
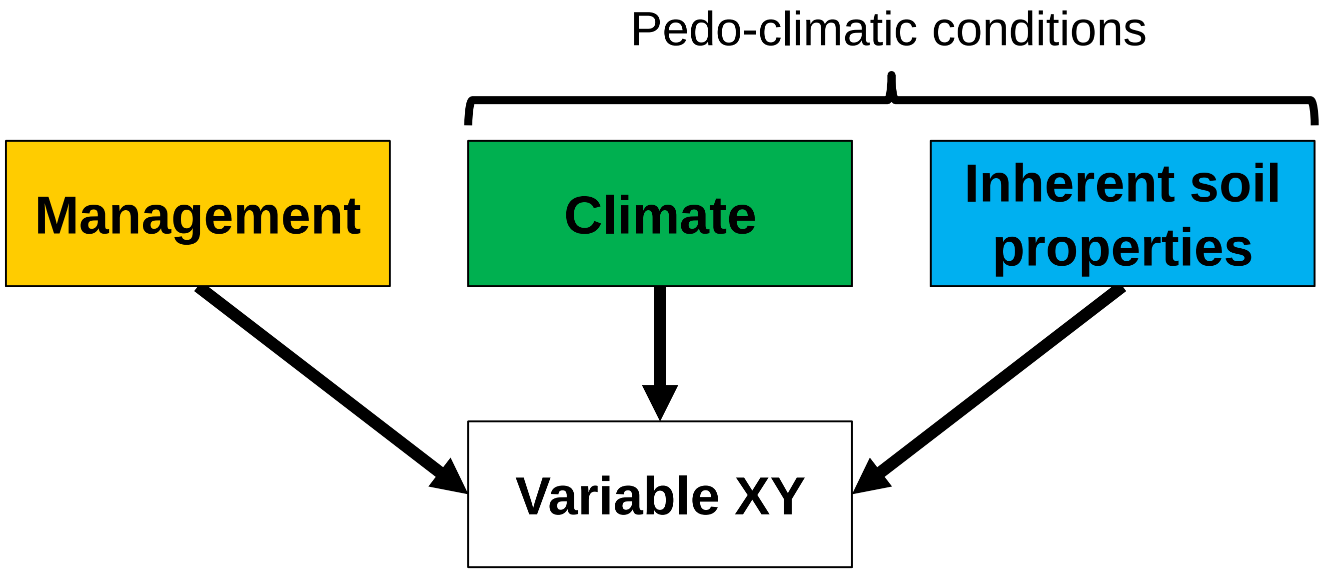
# Variables under investigation



# Linear mixed-effect model to disentangle effects

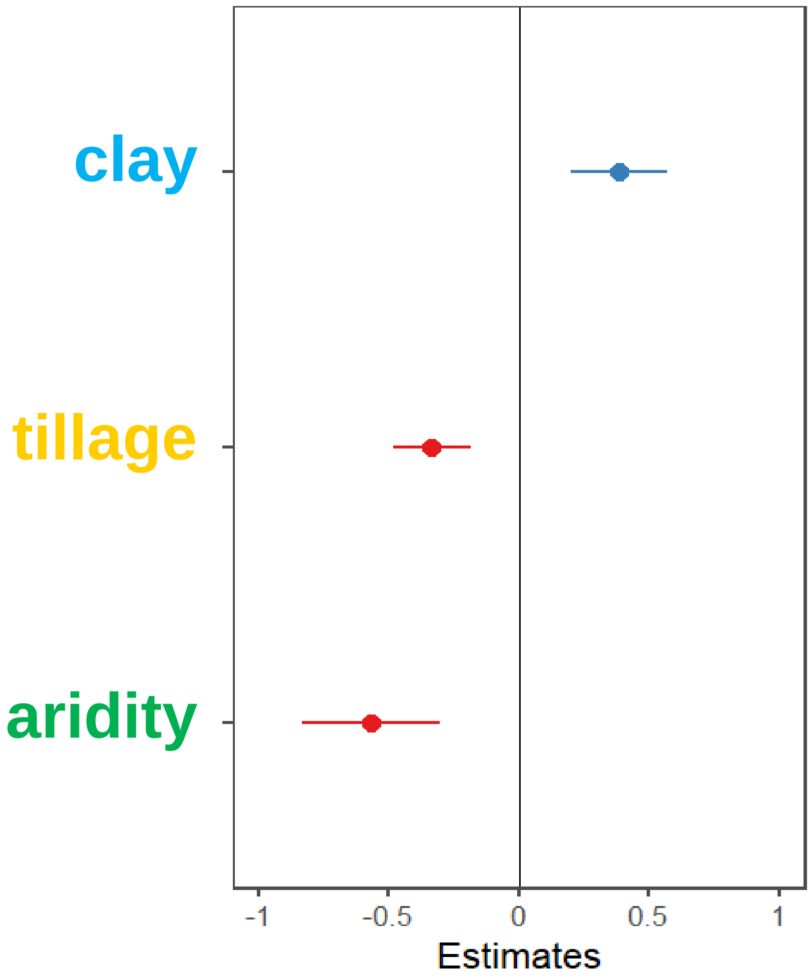



nlme::lme (**Variable XY** ~
**Var1** * **Var2** * **Var3** +
**Var5** * **Var4** +
**Var6**,
random = ~ 1 | **LTE / block**)

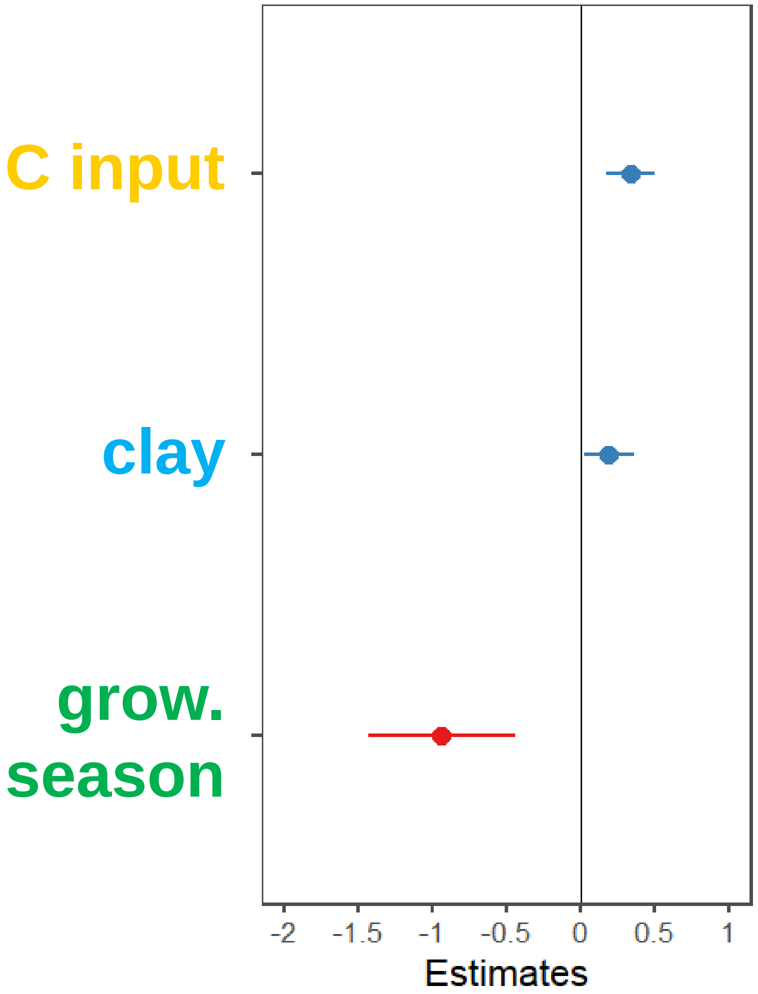
# Determinants of earthworm abundance and SOC

Number of earthworms




(6 of 10 LTEs)

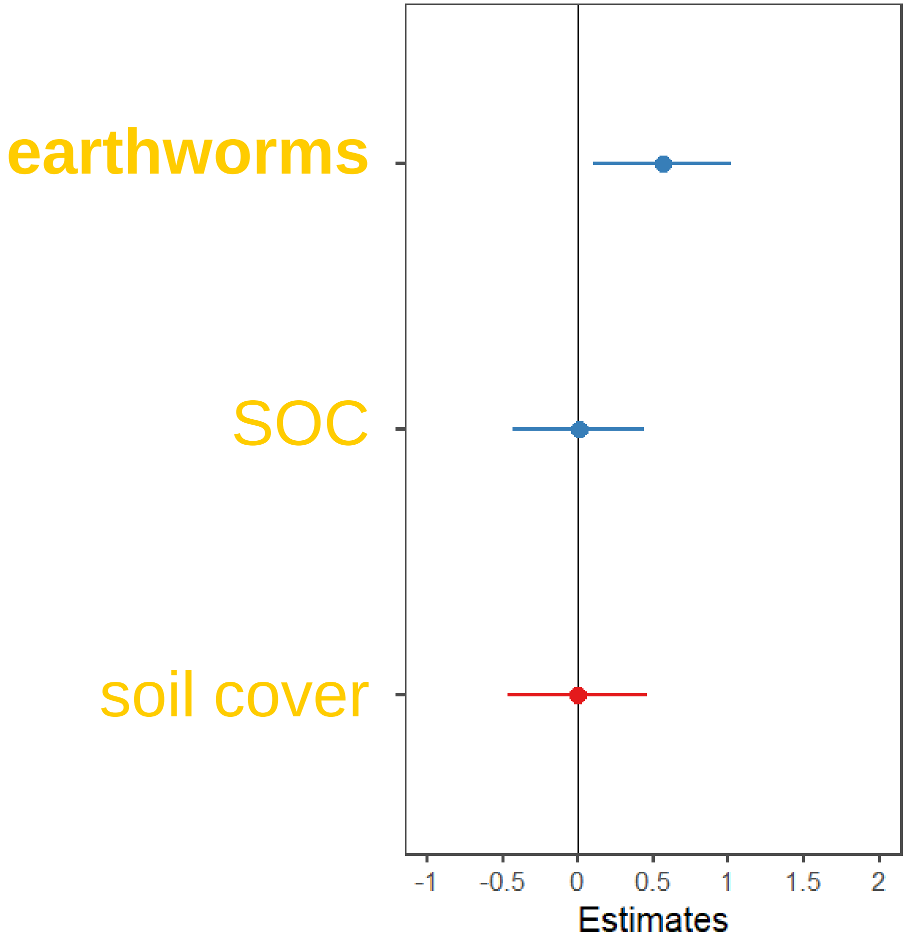
Soil organic carbon content




(7 of 10 LTEs)

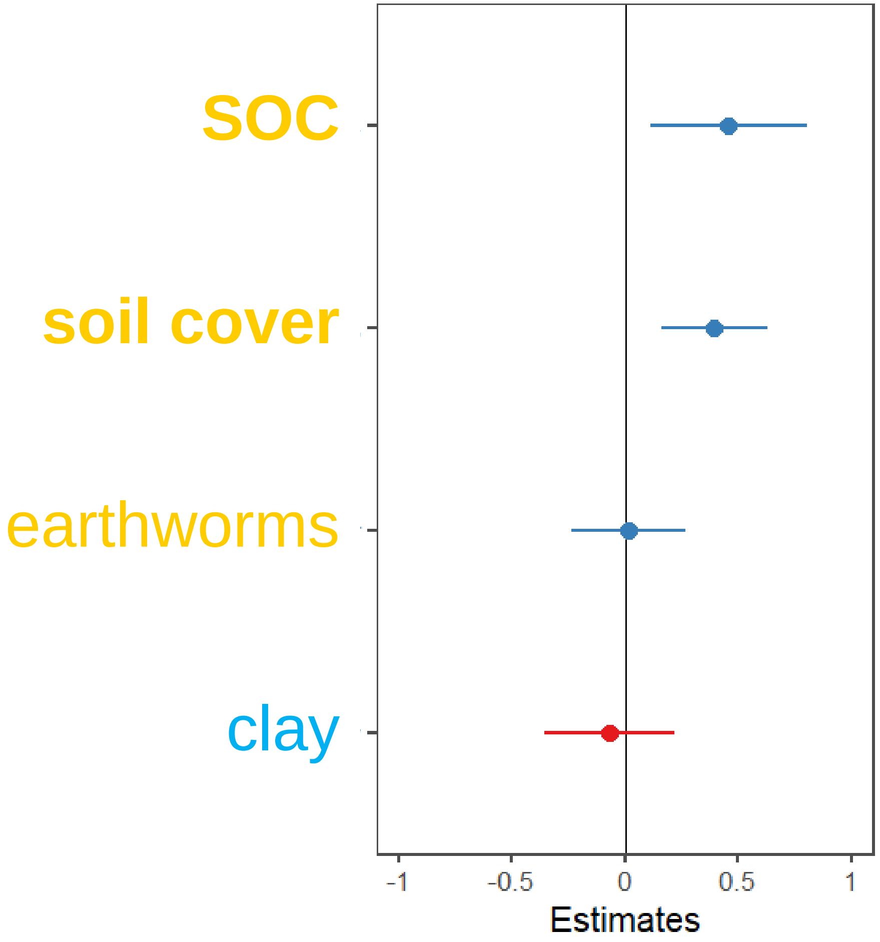
# Determinants of $K_{sat}$ and Aggregate Stability

Saturated hydr. conductivity




(6 of 10 LTEs)

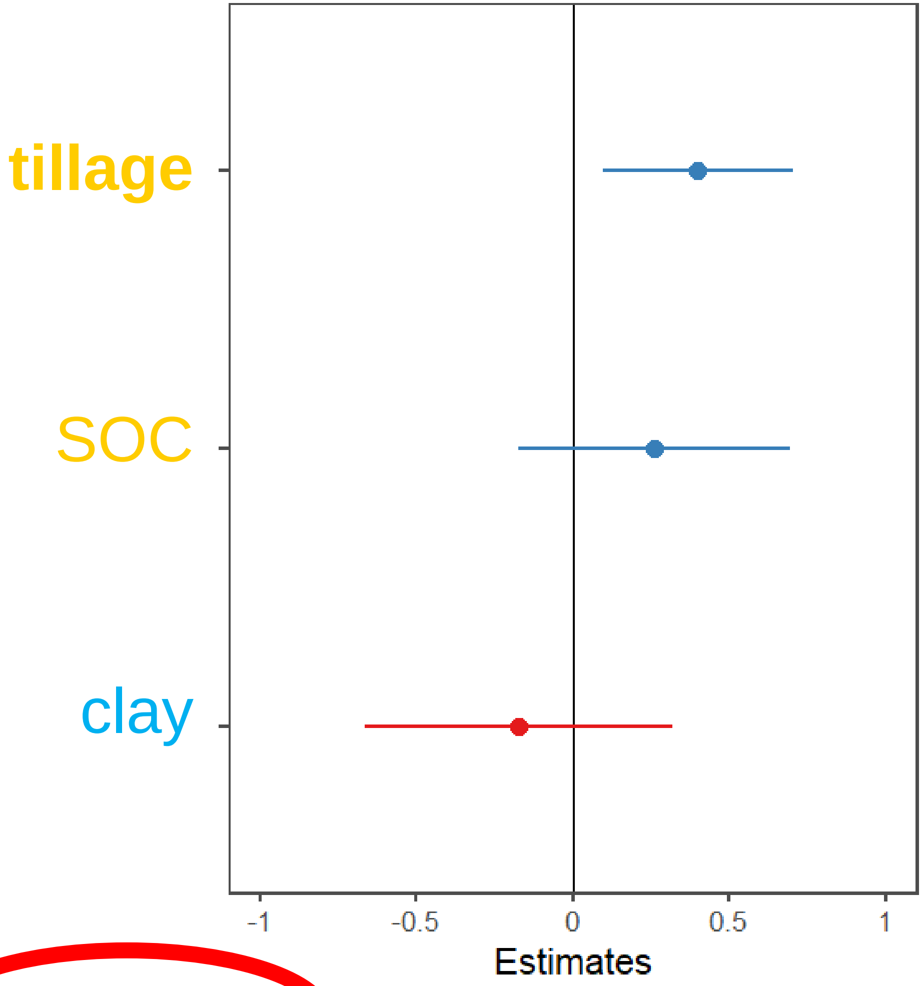
Water stable aggregate index

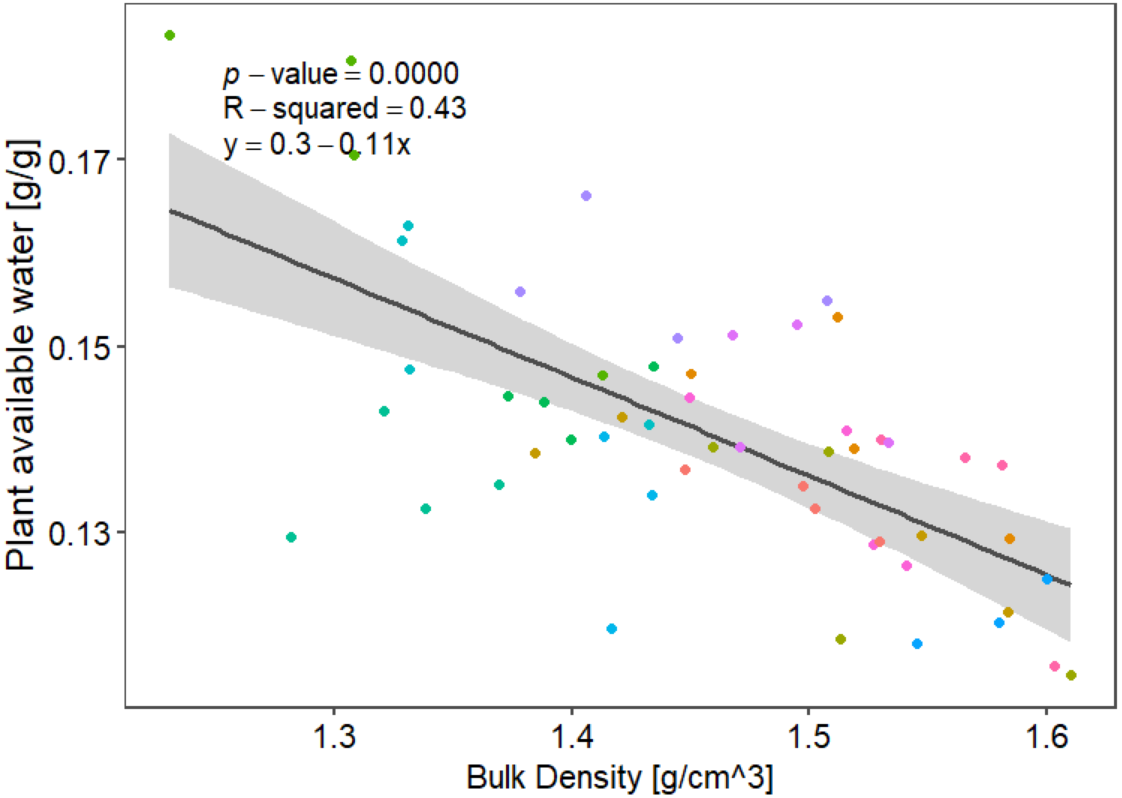



(7 of 10 LTEs)

# Determinants of plant available water

plant available water (gravimetric)




(**4** of 10 LTEs)

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# Preliminary conclusions

**Summary:**

- Earthworms abundance was driven by tillage intensity, clay content and aridity
- SOC was driven by C input and C mineralisation
- Hydraulic conductivity increased with earthworm abundance
- Aggregate stabilty increased with SOC and soil cover
- Plant available water in the topsoil increased with tillage intensity (or bulk density)

**Conclusions:**

- Reduced tillage intensity, higher C input and higher soil cover was correlated with soil physical properties relevant in a wet context.
- Less dense soil stored more plant available water.

# Further investigations within SoilX

**Within WP2:**

- More data:
  - Collate data from all ten LTEs
  - Investigation of subsoil data
  - Investigation of more variables (mechanical properties)
- Statistical analysis:
  - Rigorous model selection
  - Use of causal inference or structural equation modeling

**Other WPs:**

- Feed data into modeling (WP3)

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# Reflections on further research directions

- Extend the approach:
  - More pedo-climatic contexts
  - More diverse management (LTEs, farmers fields)
  - More dependant variables (e.g. productivity, other soil quality indicators)
  - Derive benchmarks for management intensities to minimize trade-offs
- Digitalize, harmonize and valorize existing management information (LTEs, monitoring schemes, FMIS,…)
- Quantify water fluxes and not only hydrological properties under different management
- New LTEs to test innovative strategies for increased climate resilience
- Further development of mechanistic models to predict management effects under future climate

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**any many more…**