



# **CLIMate change adaptation through SOil and crop MAnagement - synthesis & ways forward -**

presented by Sarah Garré (ILVO)



**EJP SOIL**  
European Joint Programme

EJP SOIL has received  
funding from the European  
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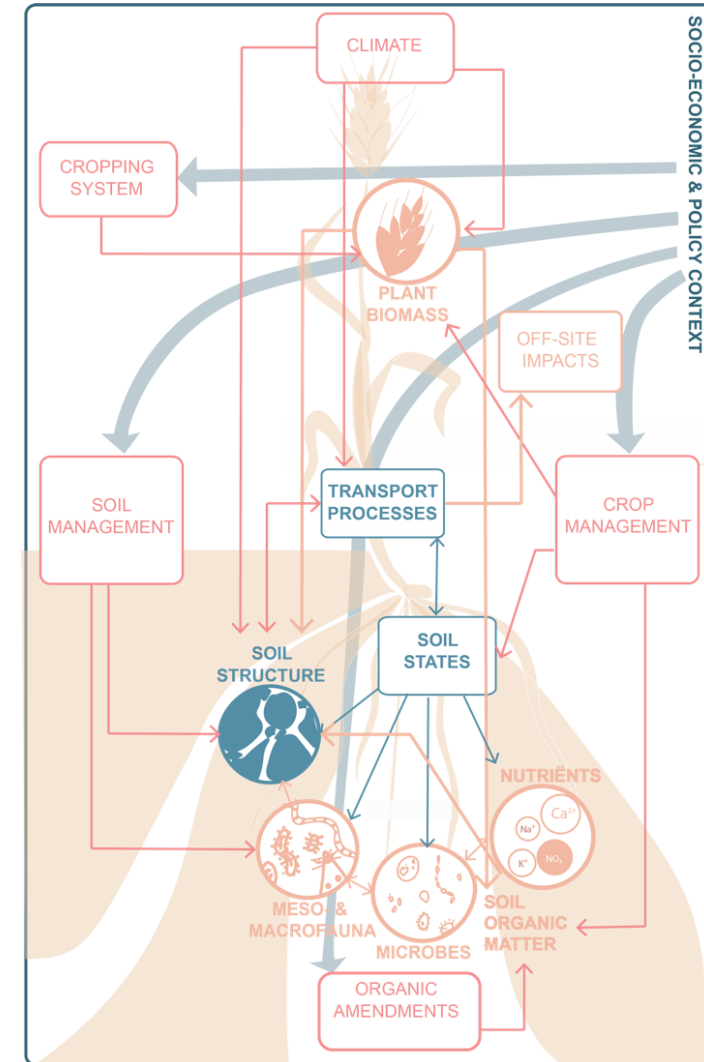
# CLIMASOMA Context – soil, its role in climate change adaptation



Flanders, May 2022  
*Middelkerke*



Flanders, Jan 2021  
*Halle*



# What is the effect of these agricultural practices on soil parameters?

## Practices:

- zero or reduced tillage
- cover crops

## Soil parameters:

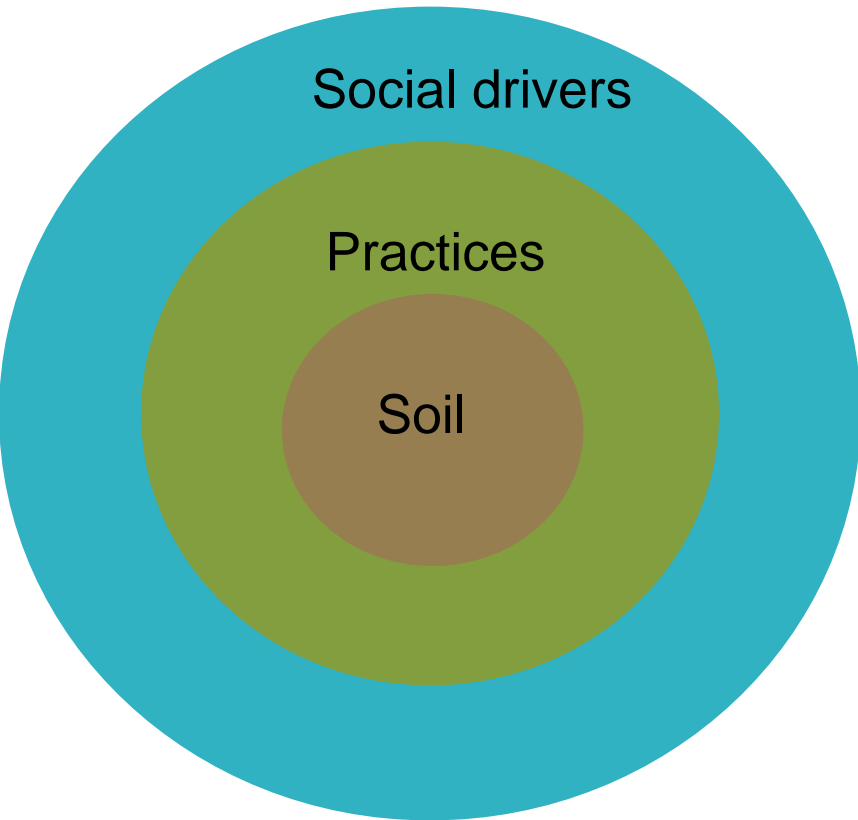
- plant available water
- run-off



Go to [www.menti.com](https://www.menti.com) and insert 4009 2805



# Context



CLIMASOMA aims at **synthesising** existing evidence based on scientific literature for Europe.

Focus on the effect of **agricultural practices** (drivers) on **soil parameters** (variables) taking into account **existing policy** and **farmer perception**.

→ towards a **climate-resilient** agriculture

# REVIEW OF META-ANALYSES

Guillaume Blanchy, Gilberto Bragato, Claudia Di Bene, Nicholas Jarvis, Mats Larsbo, Katharina Meurer, Sarah Garré

*Original research article submitted to SOIL in April 2022*



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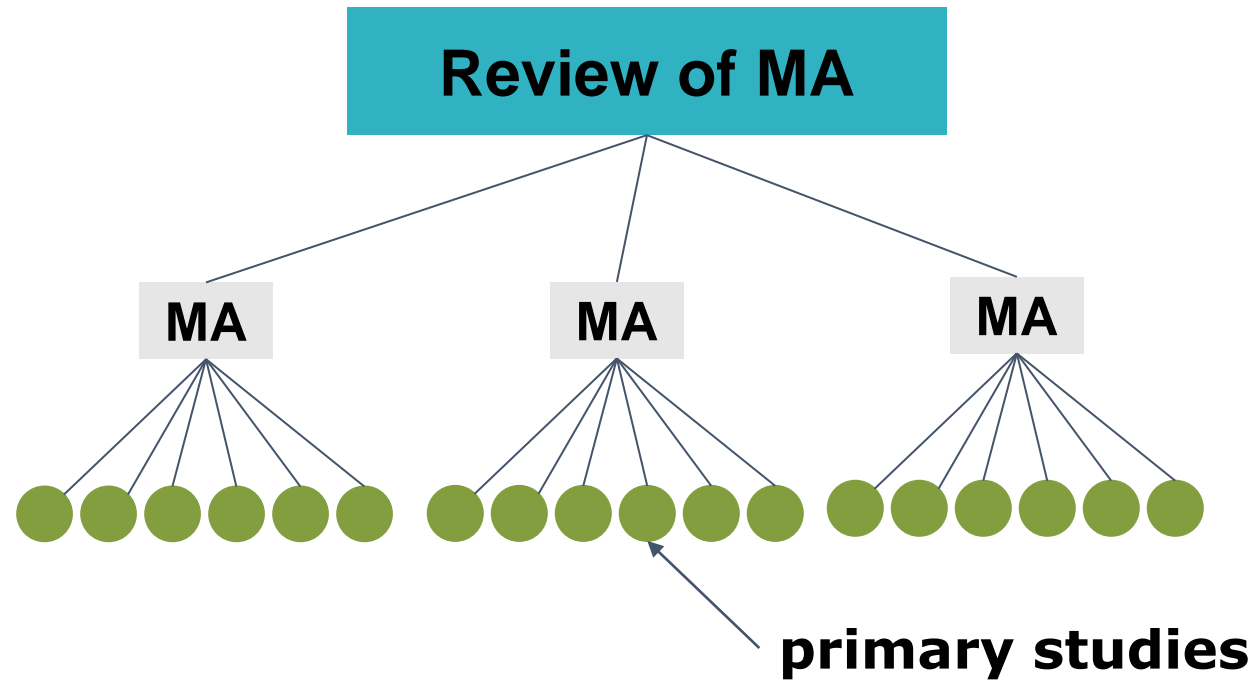
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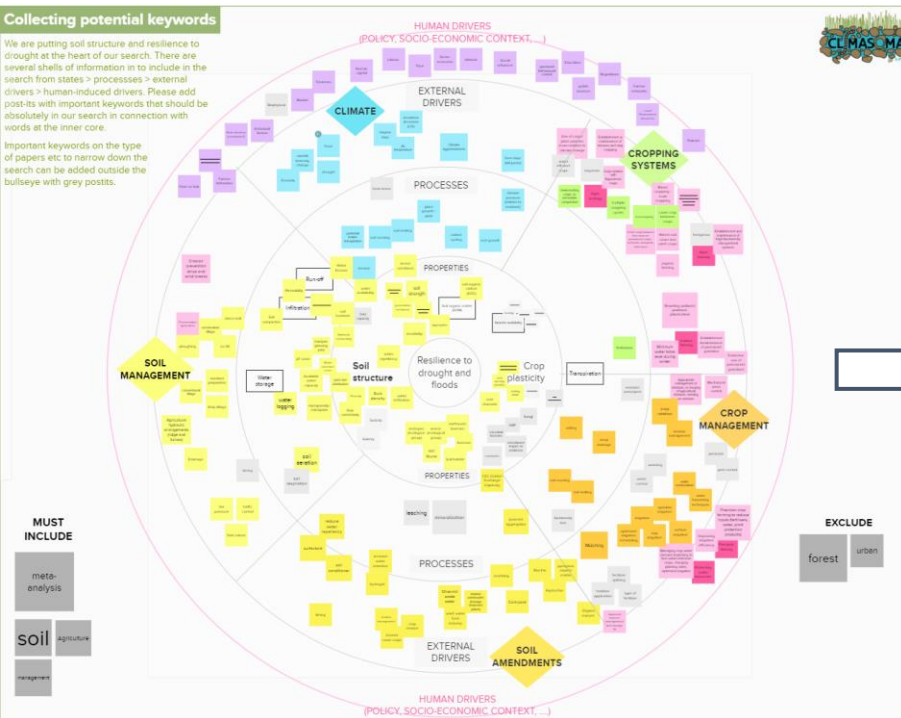
# Review of meta-analysis

Meta-analysis (MA)

= paper which reviews scientific finding from other papers in a quantitative way



# List of keywords

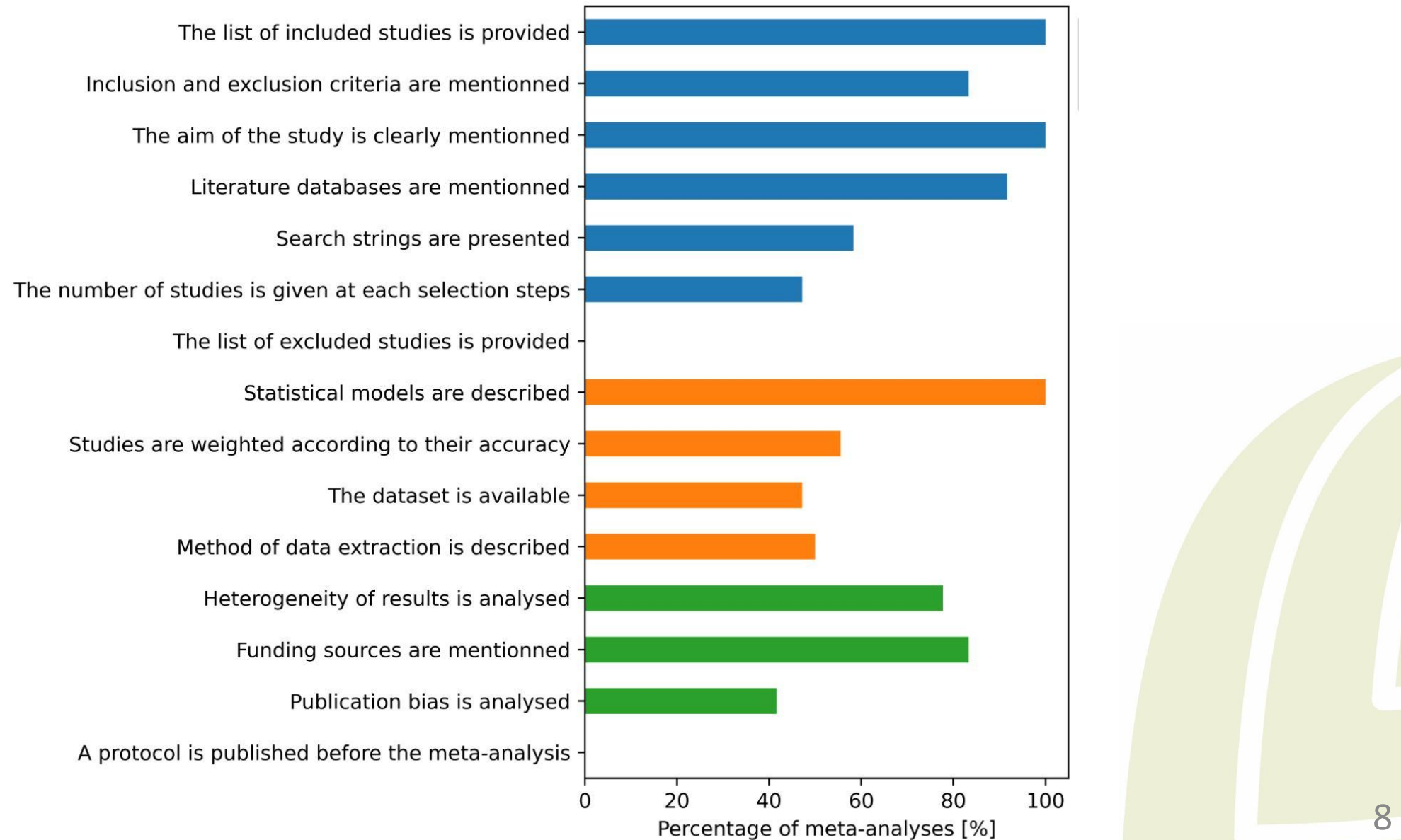


soil AND meta-analysis NOT forest NOT urban AND

(management or tillage or cropping or crops or crop or (cover and crops) or (catch and crop) or residue or residues or fertilizer or manure or amendment or liming or compost or traffic or biochar or irrigation or intercropping or agroforestry) AND

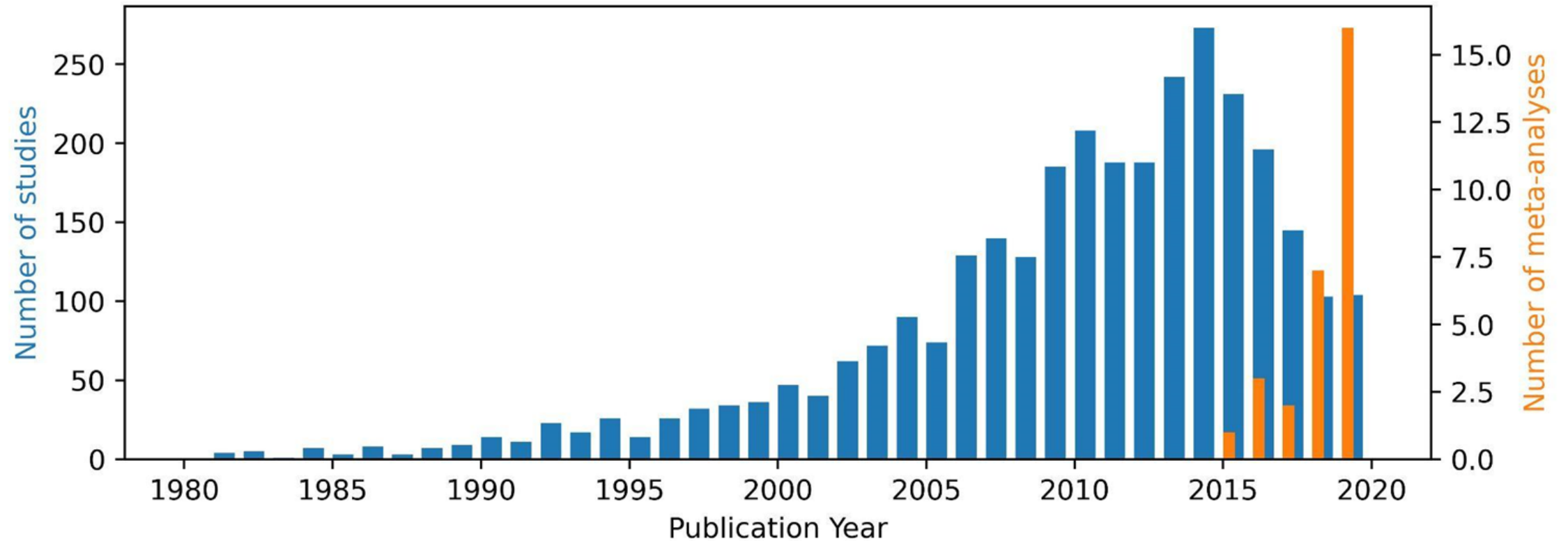
hydraulic conductivity OR  
 water retention OR  
 available water OR  
 runoff OR  
 infiltration OR  
 bulk density OR  
macroporosity OR  
 penetration resistance OR  
 soil strength OR  
 aggregate stability OR  
 aggregation OR  
 transpiration OR  
 (water and consumption) OR  
 yield OR  
 organic matter OR  
 organic carbon OR  
 (microbial OR faunal OR earthworm) AND (biomass OR activity)  
 root AND (depth or biomass or growth)

# Quality criteria

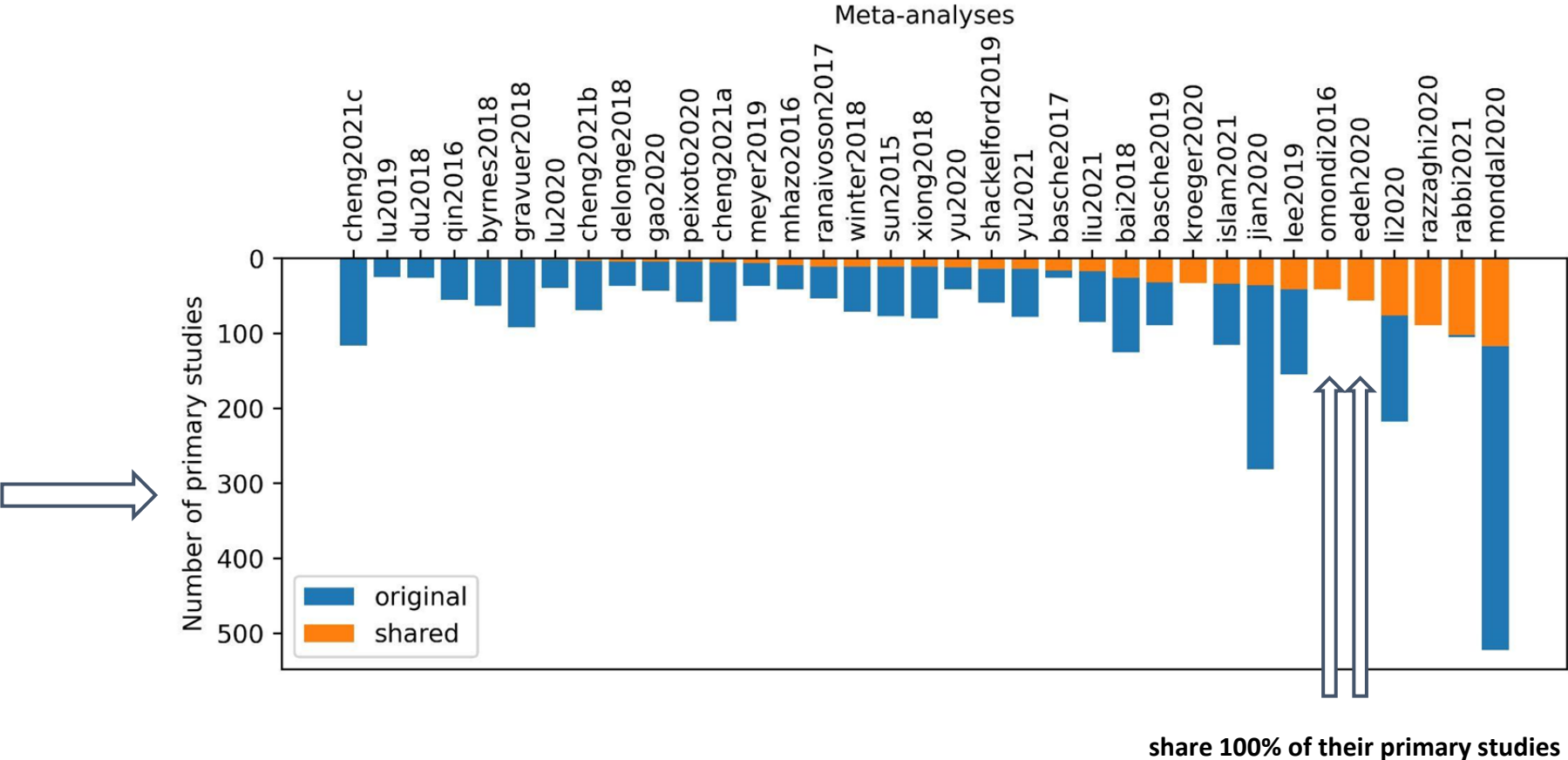
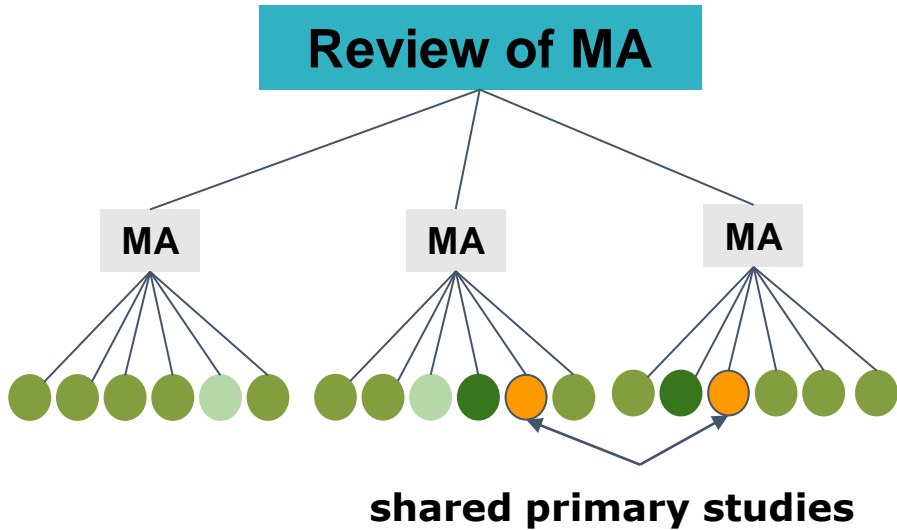




# Selected meta-analysis

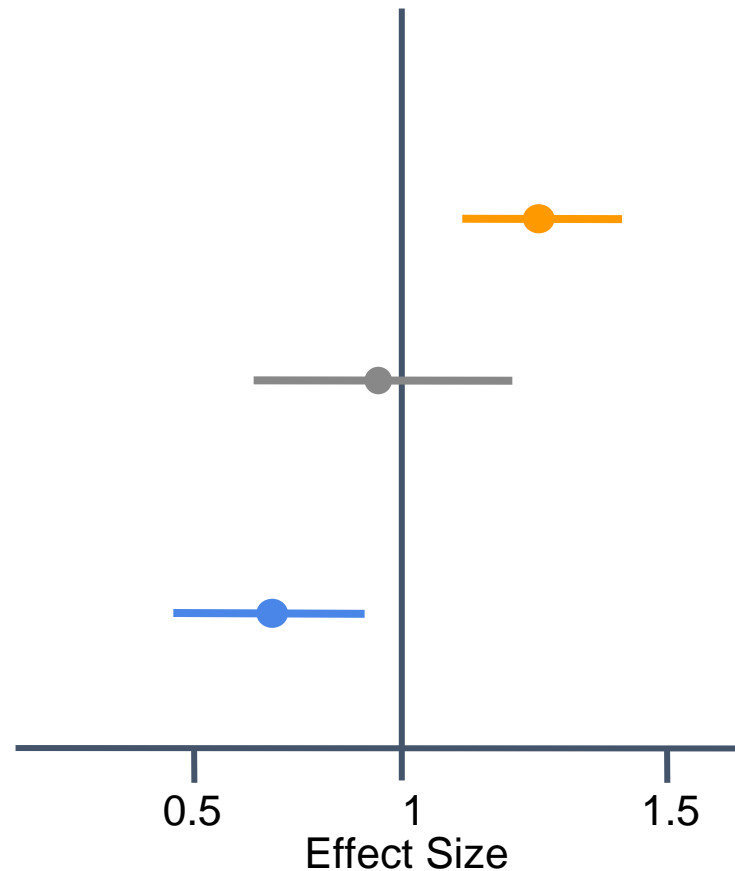


# Redundancy analysis

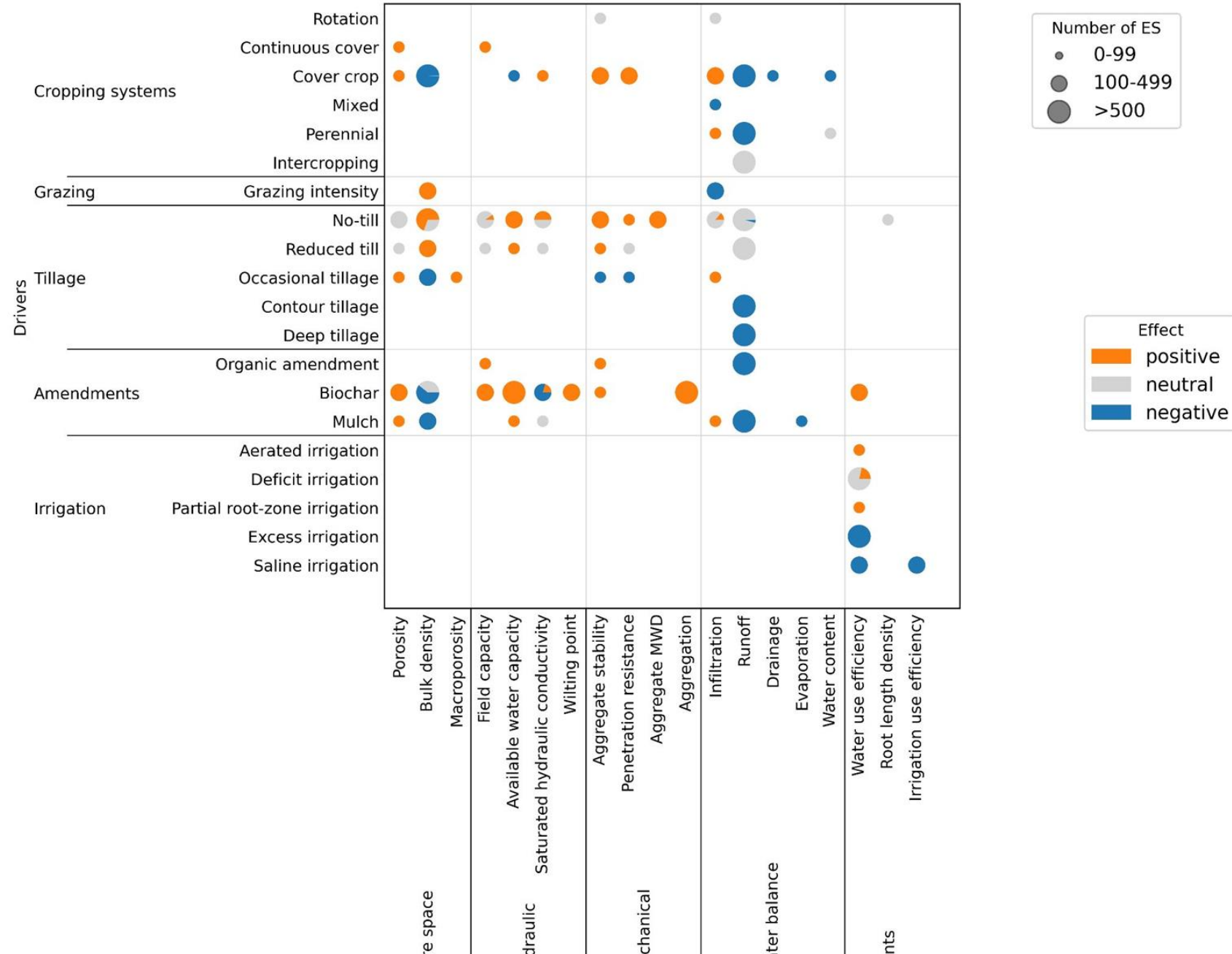


# Extracting effect sizes from meta-analysis

Meta-analysis compute the ratio between two effects = the effect size (ES)

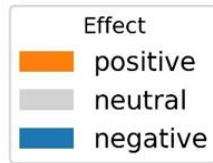
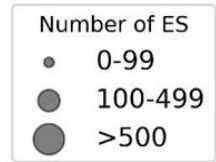
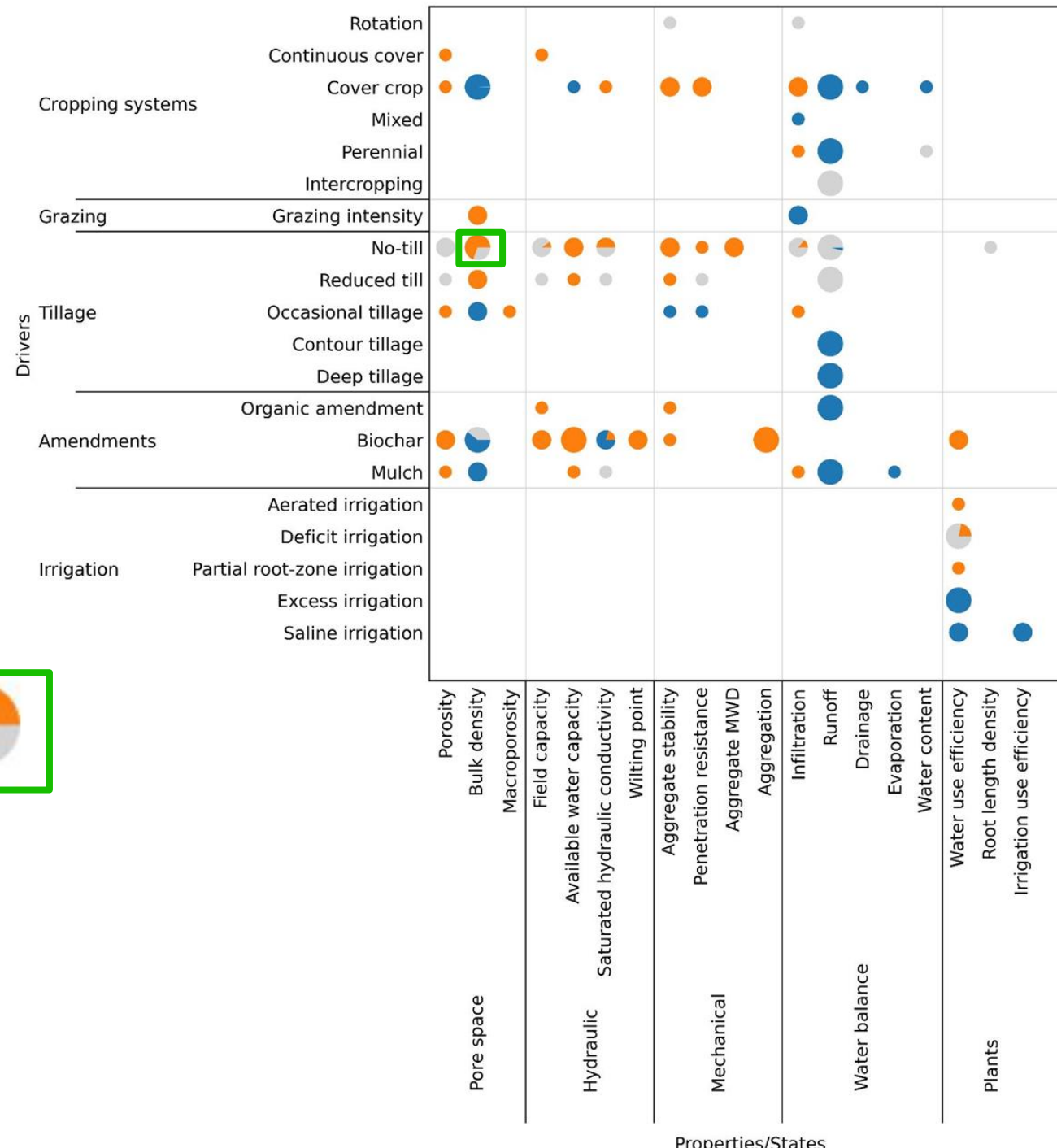


# Average effect sizes for each pair of driver and variable



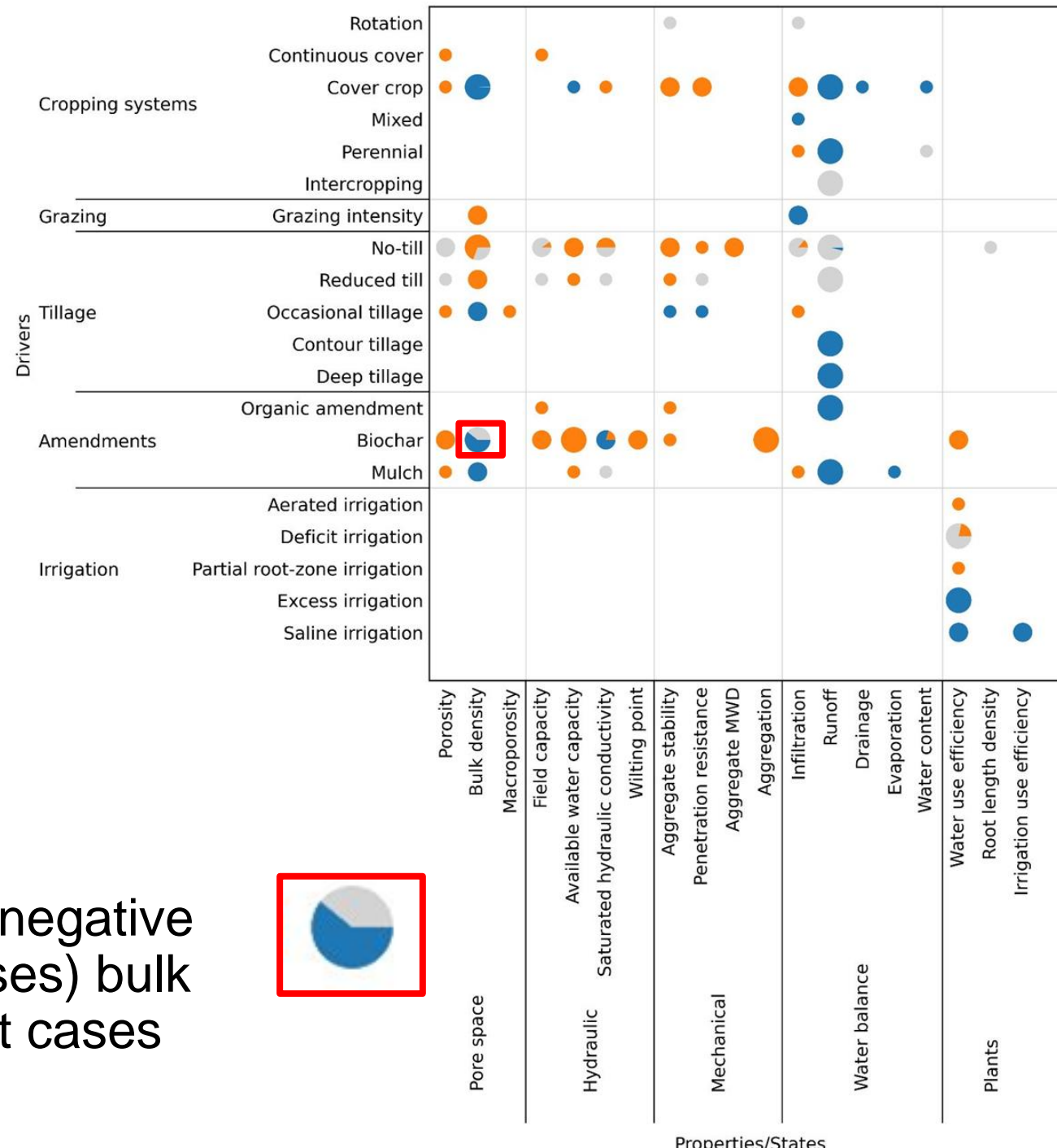
no dots  
= no MA available





No-till has a positive effect (increase) bulk density in most cases



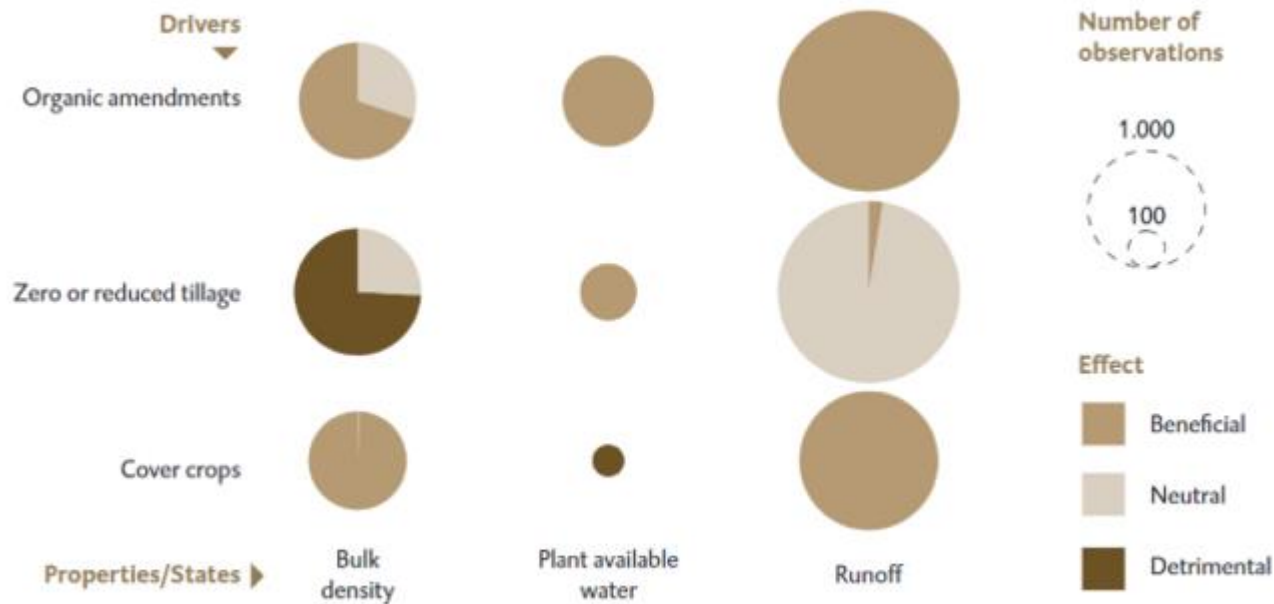


Biochar has a negative effect (decreases) bulk density in most cases



# 3 clear tendencies in the data

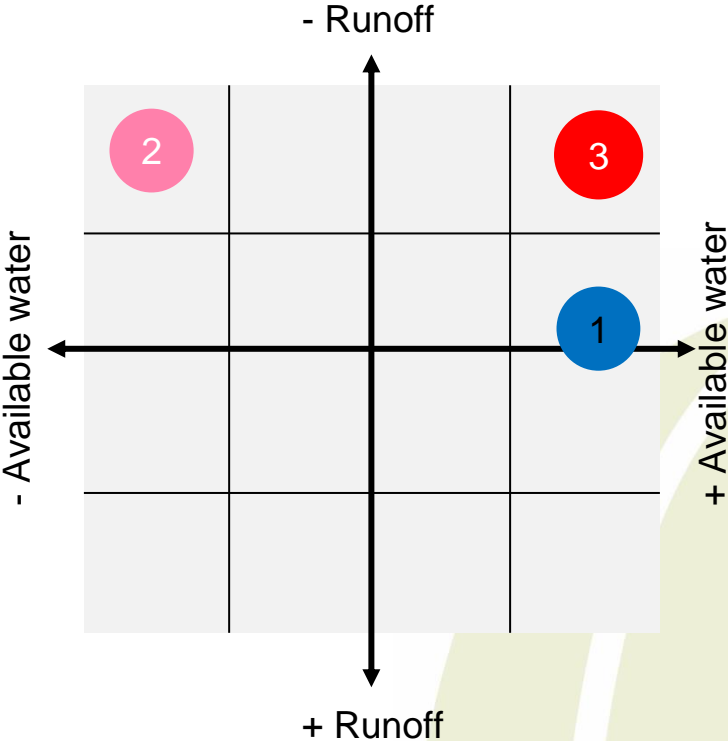
Figure 1: Scientific evidence for three (combinations of) practices



These relationships are often specific to local soil type & climate.

YOU ! ☺

Literature





# QUANTITATIVE ANALYSIS OF NEAR-SATURATION HYDRAULIC CONDUCTIVITY OF SOILS

Johannes Koestel, Lucas Albrecht, Guillaume Blanchy

*Original research article in preparation for submission in May 2022*

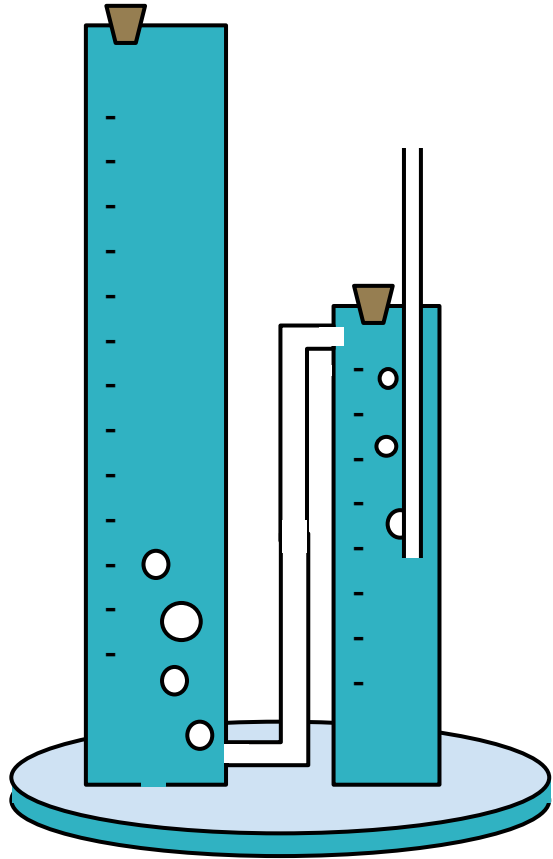


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# How management practices influence soil hydraulic conductivity?



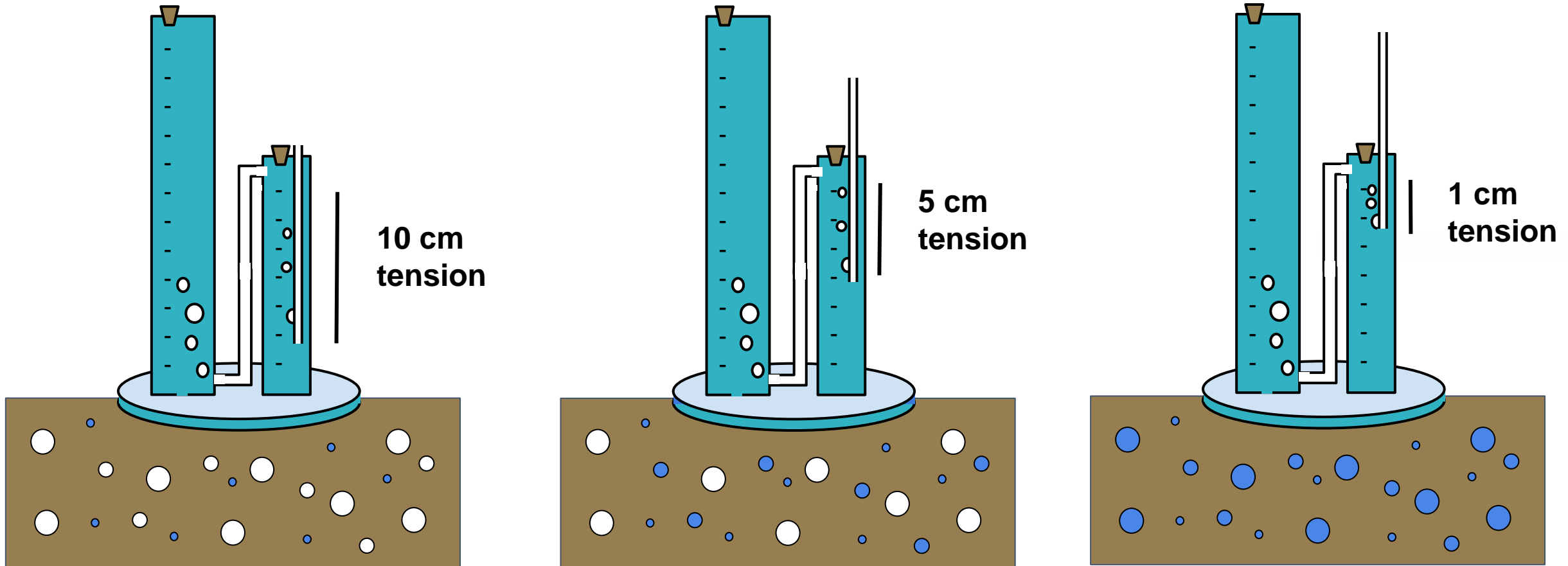
## **Agronomic importance:**

- speed of water infiltration
- information on pore network and soil structure

## **Why near-saturation and not at saturation?**

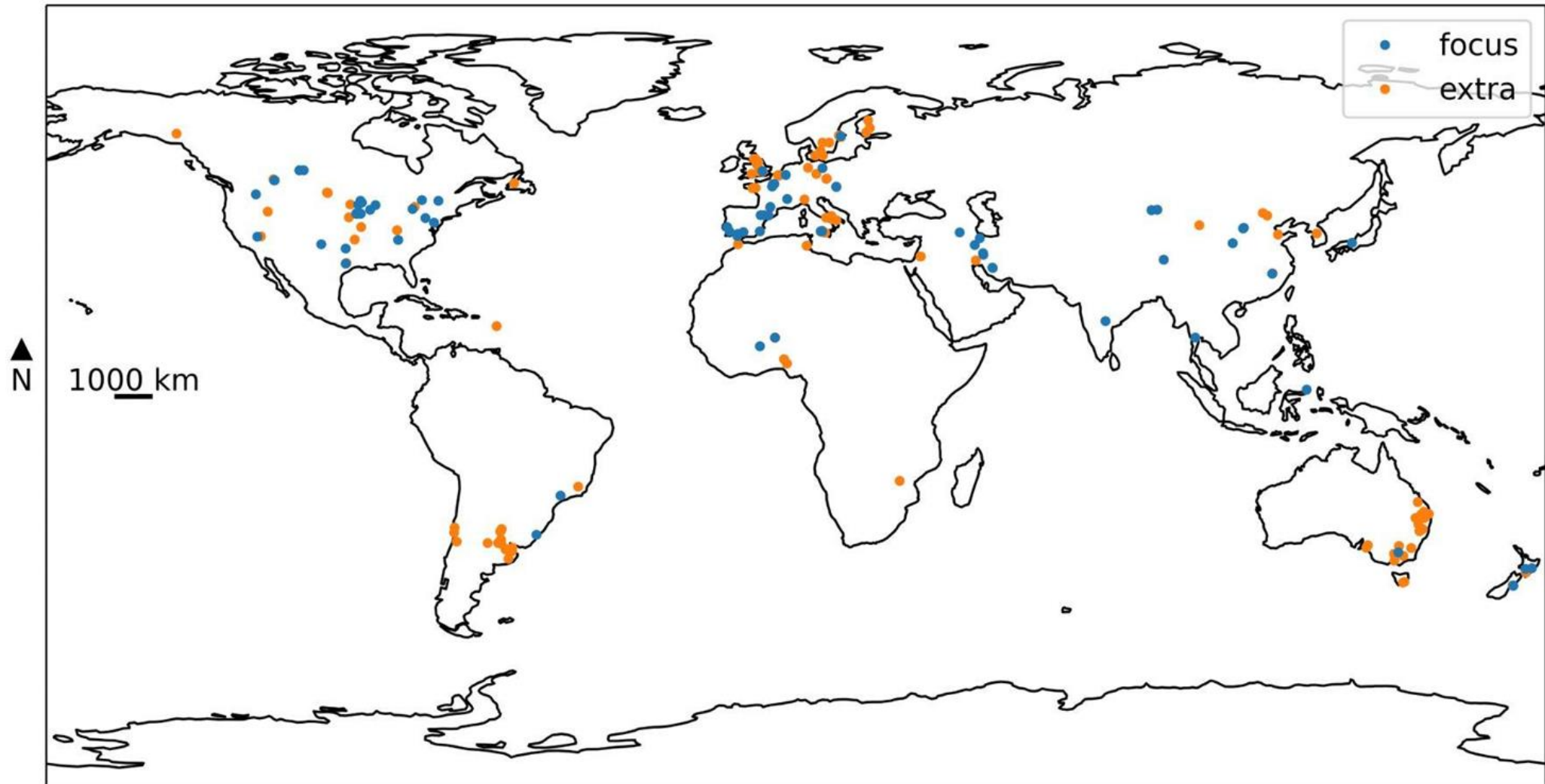
- saturated hydraulic conductivity is influenced by preferential flow
- near-saturated hydraulic conductivity is more representative of soil structure

# Tension-disk infiltrometer



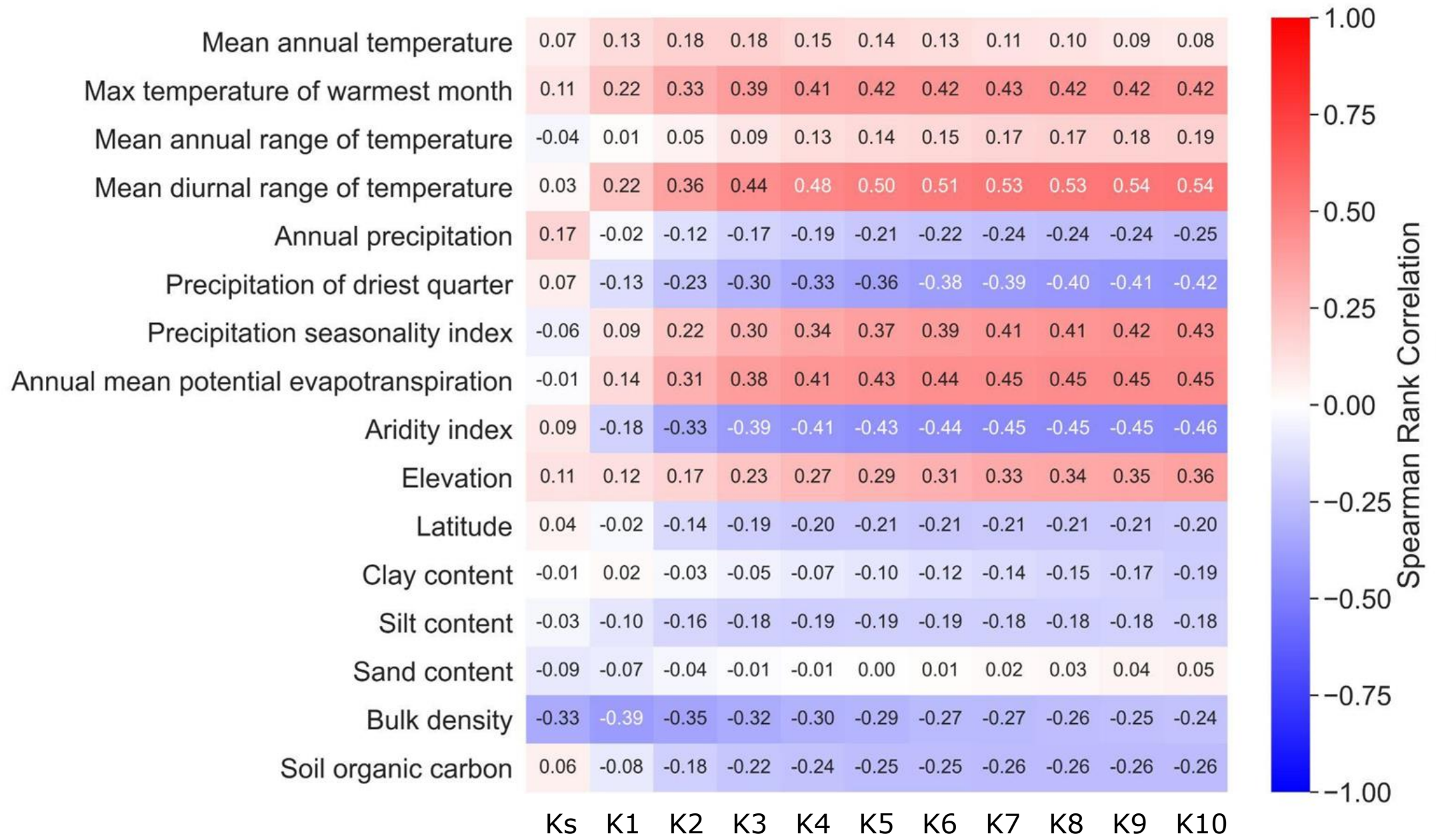
For each tension, the speed of infiltration (= hydraulic conductivity  $K$ ) is measured

# Open-source database of tension-disk infiltrometer (OTIM-DB)



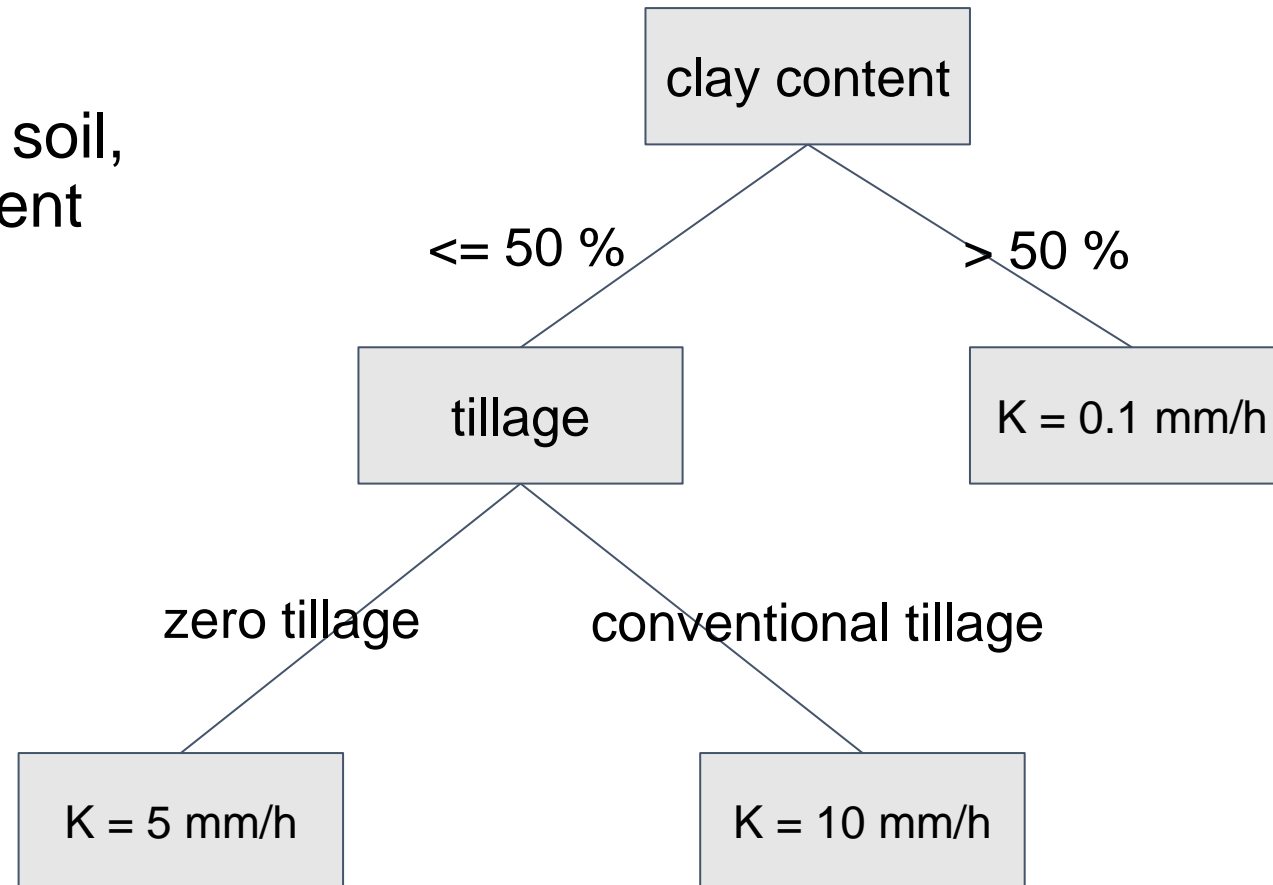


# OTIM-DB: Correlation



# Machine learning

Prediction of hydraulic conductivity (K) based soil, climate and management parameters



Example of decision tree

# Key messages

- Relationships between agricultural practices and soil parameters from literature have been summarized
- Some driver/variable pairs are not studied/summarized -> knowledge gaps
- Pedo-climatic results need large database

# Farmer perceptions

Sinead O'Keeffe, Jan Verhagen, Jan Hassink



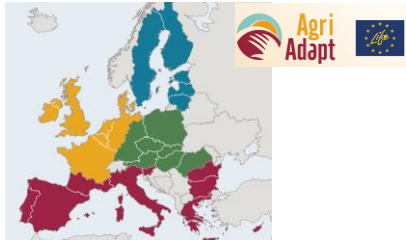
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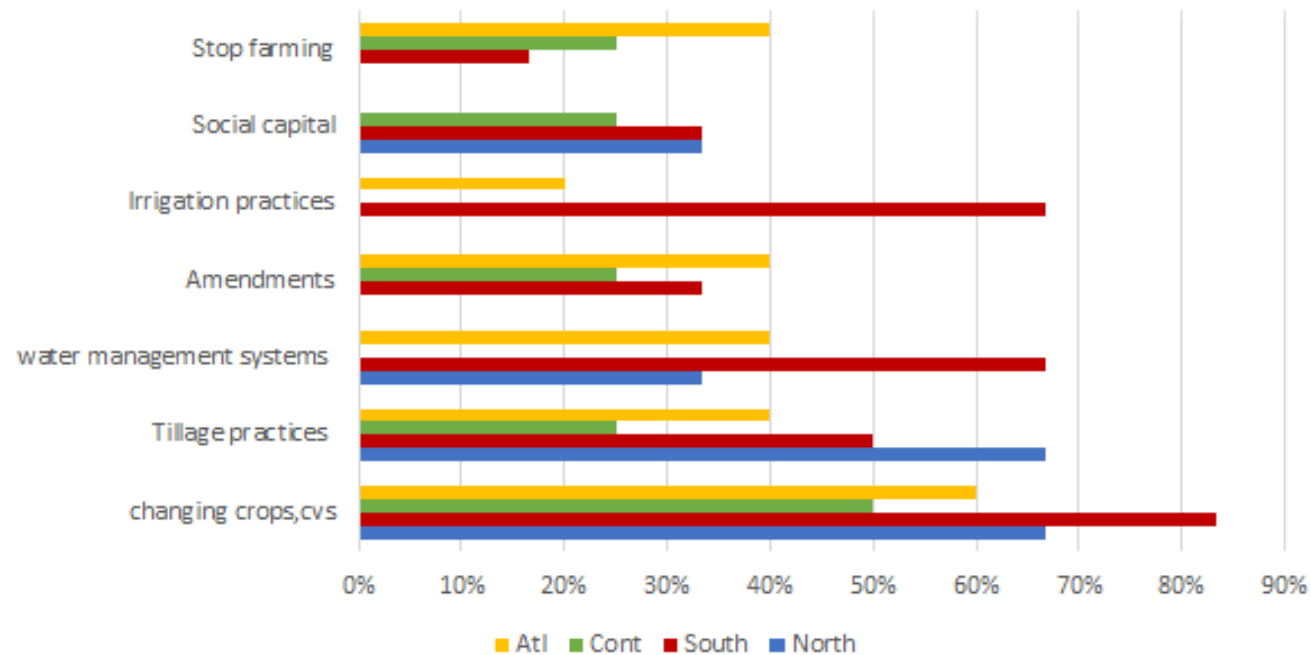




# Farmer preferences for adaptation measures (Climate change literature)



Map source:  
Agri Adapt (<https://agriadapt.eu/>)



# Soil management as a means for climate change adaptation

## Conclusions and some suggestions



Incentivize the implementation of a year-round soil cover with financial help and/or legislation.



Make sure organic matter from agricultural activities stays or returns as much as possible to the field and encourage addition of organic amendments.



Reward a reduction of traffic on agricultural land rather than focus only on a reduction of tillage.



Farmer engagement is crucial - connect with farmers and their motivations for adaptation



Use existing instruments via the CAP and the Green Deal

- Pedo-climate regions and other context specific factors are missing
- Engagement strategies need to consider the context & needs of the farm as well as type of farmer

CONTEXT IS KEY – NO ONE SOLUTION WILL FIT ALL  
Technologies , techniques, farmers or regions/landscapes

## POLICY BRIEF

### HOW TO BETTER INTEGRATE SOIL MANAGEMENT PRACTICES INTO CLIMATE CHANGE ADAPTATION STRATEGIES



#### INTRODUCTION

CLIMASOMA's aims include identifying and summarising the socio-economic and political barriers and enablers for the application of soil and crop management in climate adaptation strategies.

The results presented are from a stocktake of EU policies and their instruments that impact agricultural management and barriers and drivers at the farm level in relation to improving soil health and climate change adaptation. The work includes perceptions of farmers and drivers that co-determine the willingness of farmers to act and adapt to climate change.

#### THE ROLE OF SOIL IN CLIMATE ADAPTATION STRATEGIES

Risk is inherent to agriculture and the increased frequency of extreme events has led to a heightened awareness of how vulnerable and sensitive to climate change the sector truly is. The agricultural sector is one of the most affected by climate change, but it is also an active driver.

The sector needs to adapt to climate change by applying best, site and sector specific strategies while reducing greenhouse gas (GHG) emissions. Soil related strategies may include, for example, soil nutrient and water management to improve soil health, through adopting more diverse crop rotations and planting more resilient crop varieties. Specific soil-related adaptation strategies are often not the most prioritised measures being mentioned by farmers in the context of climate change adaptation. The key focus of many farmers is on their crops and associated yields. However, the attention for soil health as an integral part of the farm strategy has increased in recent years, indicating a growing recognition of soil and its importance for a sustainable agricultural sector.

#### WHAT NEEDS TO BE DONE?



Farmer engagement is crucial, connected with farmers and their motivations for adaptation



Do not avoid difficult issues related to risks such as abandonment and insurance



Use existing instruments via the CAP and the Green Deal



Design a transparent and adaptive regulating system to support learning and accountability



Periodically reassess the goals and instruments, select goals and pathways, learning and accountability approaches if appropriate

## POLICY BRIEF

### SOIL AND CROP MANAGEMENT PRACTICES FOR CLIMATE ADAPTATION



#### INTRODUCTION

Soil management and cropping systems affecting soil at various scales are key to support the sustainable adaptation of EU agriculture to climate change. The occurrence of extreme weather events, such as drought in summer and floods in winter, will increase almost everywhere in the EU. Guidance on management practices to help farmers adapt to these situations is necessary. Many practices exist and have already been subject to scientific research for several decades. Nevertheless, it is not always clear which practices have really proven effective in which contexts, what trade-offs have to be taken into account and which synergies might occur.

We investigated the implications of agricultural management practices for soil hydrological functioning under European agroecosystem conditions as a part of the European Joint Partnership Soil. We analysed the results of 36 selected meta-analyses (representing data from 2853 unique studies) studying the impact of soil and crop management practices on soil hydrological functioning. As such, we identified the effectiveness of the selected practices, and also remaining knowledge gaps. Important trade-offs and synergies related to crop production, water quality, and greenhouse gas emissions were also assessed based on the results of additional published meta-analyses. This information is crucial to decide which actions to stimulate through policy instruments.

A meta-analysis is a statistical analysis that combines the results of multiple scientific studies.

#### WHAT NEEDS TO BE DONE?



Inventory the implementation of a past trend and currently financial help and/or legislation



Make sure support neither from agricultural activity days or national research is possible in the field and encourage addition of organic amendments



Reverse a reduction of traffic management and reduce tillage



# PREPARING THE SOIL FOR CLIMATE CHANGE

Farmers have always depended on influences from outside, especially the weather. Recently the weather has been more extreme, and this underlines the vulnerability of our food system. There will be more of both heavy rainfall and droughts, and farmers will pay the costs.

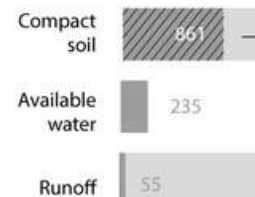
Crop and soil management are the key for farmers to adapt to the changing weather. Scientists have analyzed hundreds of studies to find evidence for the impact of farming methods on the soil. They also researched the willingness of farmers to learn and change, because farmers must know of

Almost 10.000 observations were found:

Beneficial effect    Detrimental effect    Effect uncertain

## 1. ZERO OR REDUCED TILLAGE

No, or a minimum of tilling between crop rotation



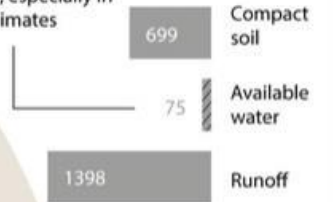
The soil will become more compact if it is still compressed by machines



## 2. COVER CROPS

Close-growing crop between periods of normal crop production

There will be less water for production crops, especially in dry climates



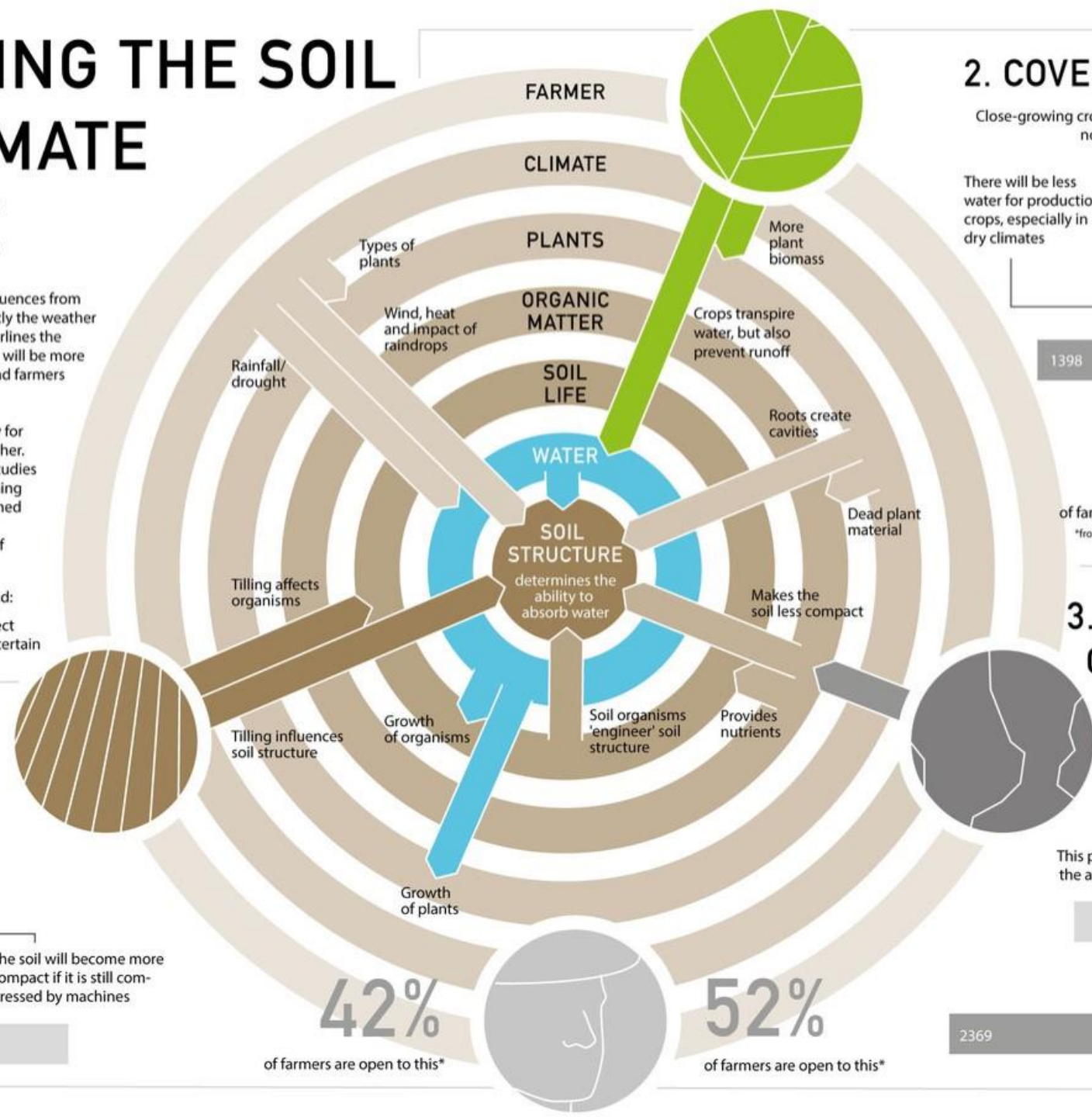
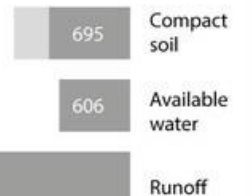
63%

of farmers are open to this\*  
\*from the EUPF7-CATCH-C project

## 3. ADDING ORGANIC MATTER

Examples are compost, wood chips, biochar, animal manure, straw.

This practice is restricted by the availability of materials.



42%

of farmers are open to this\*

52%

of farmers are open to this\*





Nicholas Jarvis  
*WP Leader Literature  
review*



Sarah Garré  
*Project coordination*



Guillaume Blanchy  
*Machine Learning*



John Koestel  
*WP Leader Meta-  
analysis*



Lukas Albrecht  
*Machine Learning*



Jan Hassink



Jan Verhagen



Sinéad O'Keeffe



**Socio-economic  
and Agroecosystems**

**Agroecosystems, Policies, and  
Meta-analysis**



Claudia Di Bene  
*WP Leader project  
network mapping*



Pasquale Nino



Gilberto Bragato



Sergio Pellegrini



Roberta Farina



Guido Bonati



WAGENINGEN  
UNIVERSITY & RESEARCH

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