Root methods in field trials

Eusun Han
Aarhus University
4th NFTN Conference

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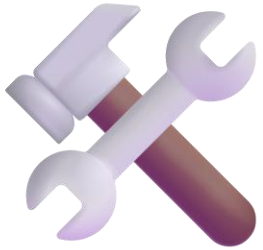
Root enthusiast



Aarhus University
Associate Professor in Perennial Cropping Systems
Koreankr
B.Scin - M.Sc derw - PhD de – Postdoc dkau

NNF starting package
DFF Sapere Aude
DFF – Research I
DFF – Green Research

Field crops
Roots
Production + Ecosystem service

[Field] Root research was laborious.

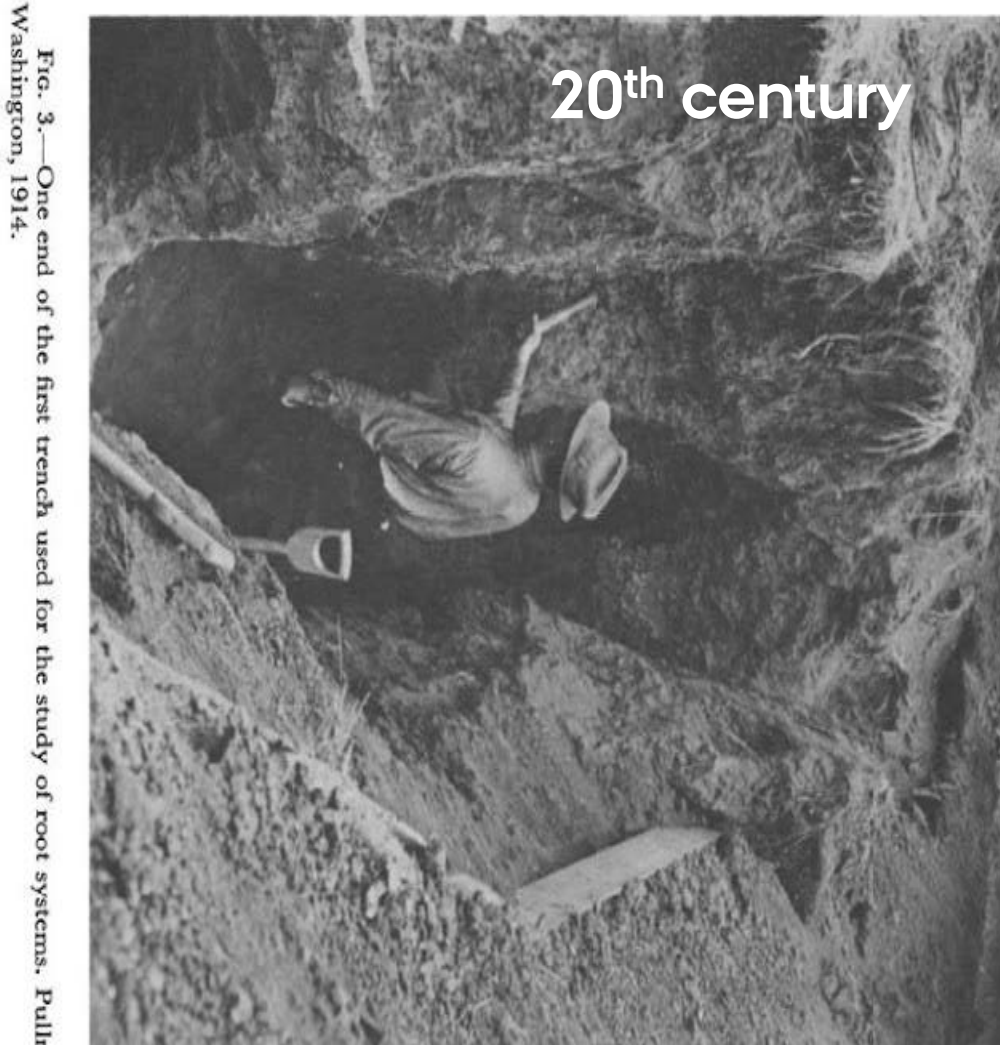


Fig. 3.—One end of the first trench used for the study of root systems. Washington, 1914.

Weaver (1968) p6 : Photo taken in 1914

- Roots are present inside the soil.
- Soil is an opaque medium.
- Therefore, observing roots means digging the soil.

(Gregory 2022)

This restricts the research scale;

- Depth <50 cm
- Time <5 sampling
- Treatments, replicates...few

..and impairs the accuracy of the measurement.

(Han et al. 2025)

And it still is laborious.....

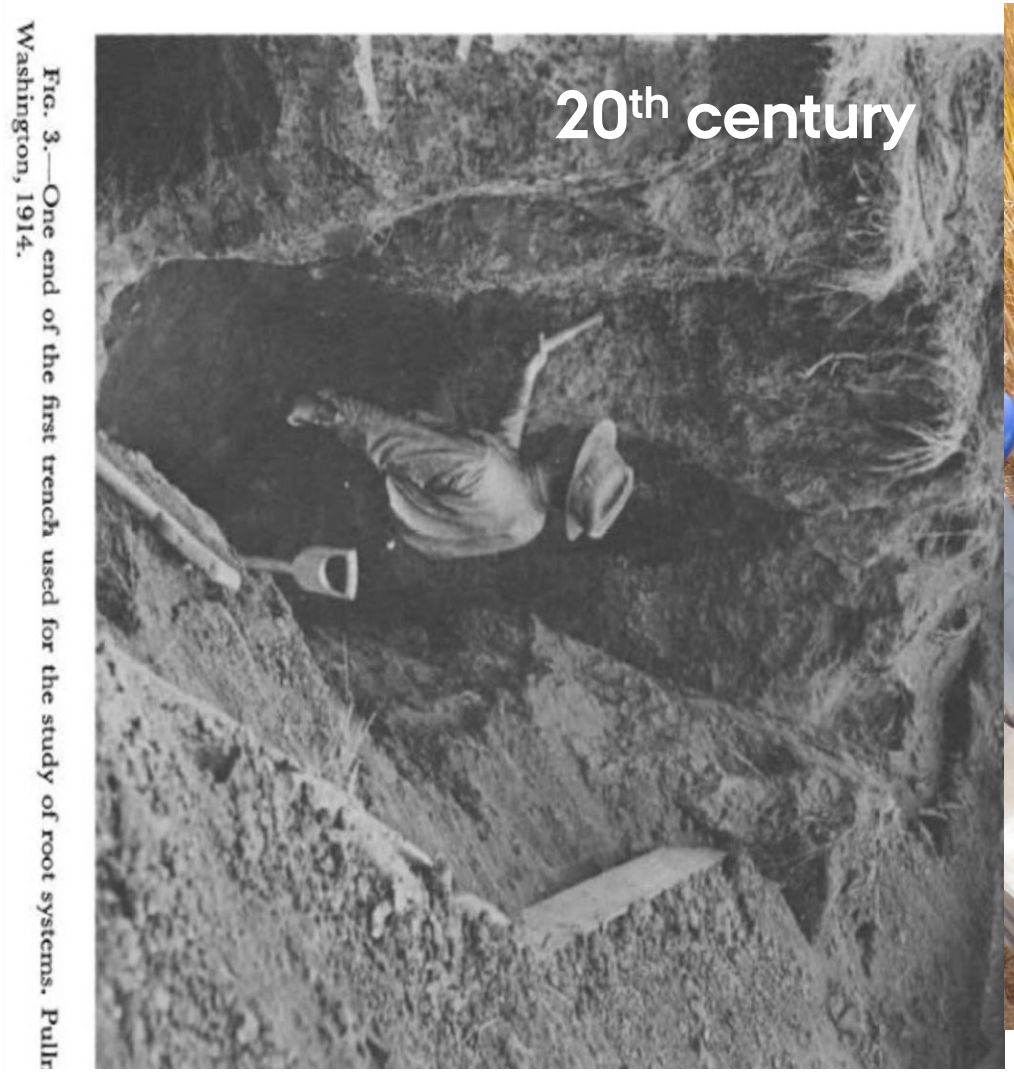


Fig. 3.—One end of the first trench used for the study of root systems. Pullr
Washington, 1914.

Weaver (1968) p6 : Photo taken in 1914

What can we measure from roots?

In other words, which root characteristics or "traits" are important to measure?

In fact, what are traits?

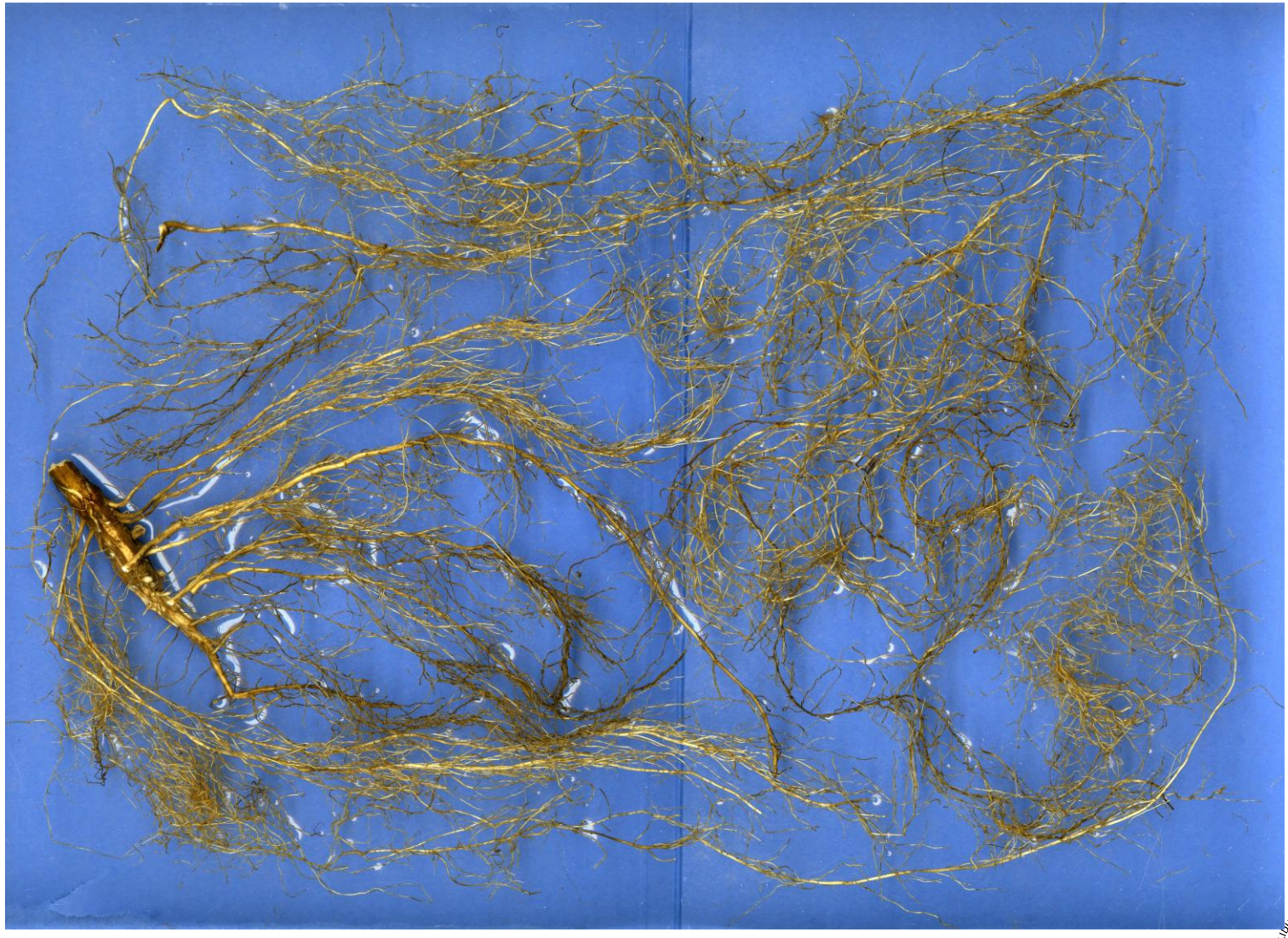
> "..morphological, anatomical, physiological or phenological features **measurable** at the individual level."
>
> Kattge et al. (2011)

A few examples of root traits

Density-based

Root-length density
= How many roots?
e.g. 12 cm cm^{-3} soil volume

Function: Nutrient/water uptake



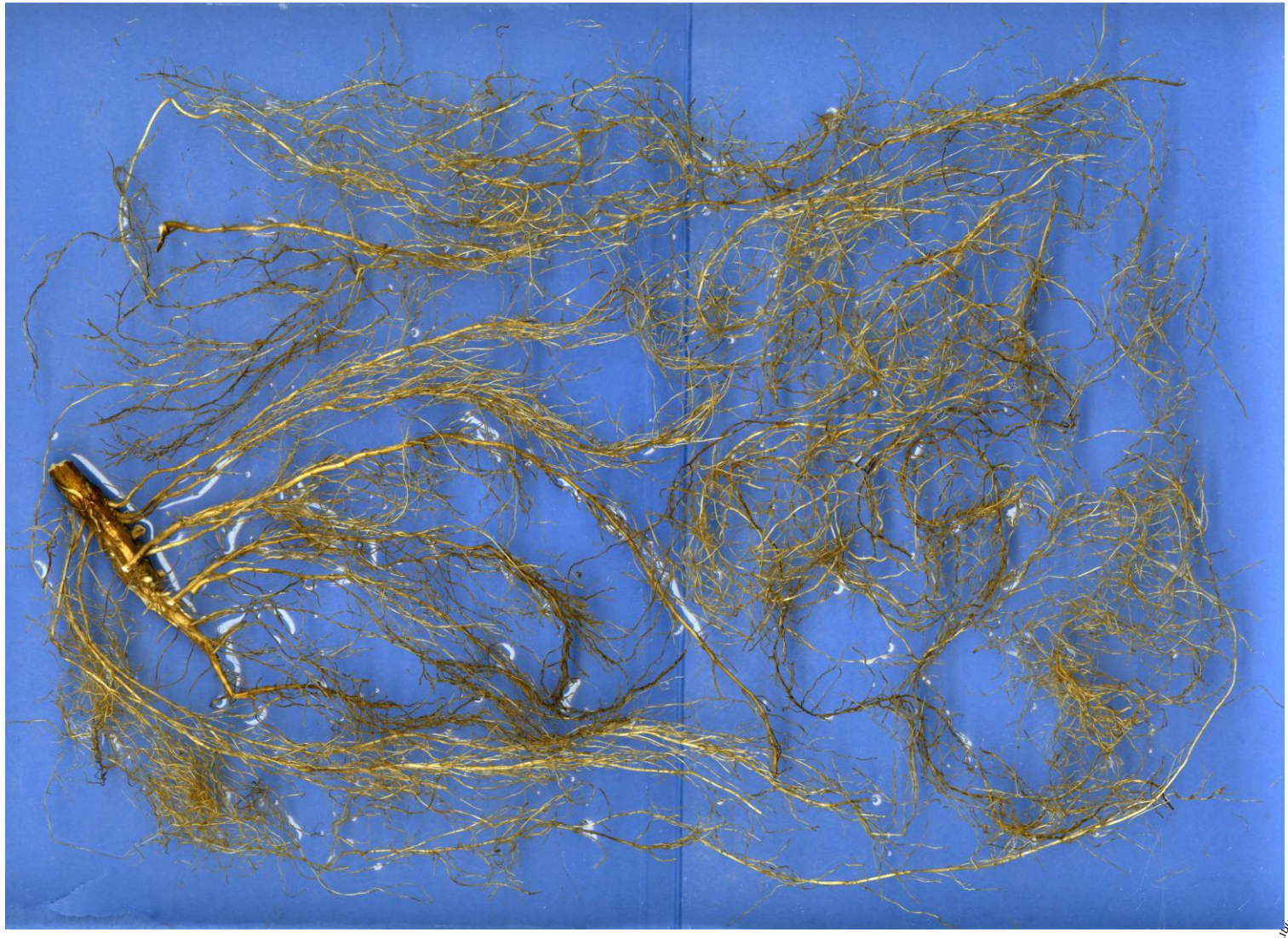
A few examples of root traits

Morphological

Root diameter
- How big/small?

= e.g. 5 mm root thinkness

Function: Soil penetration capacity



A few examples of root traits

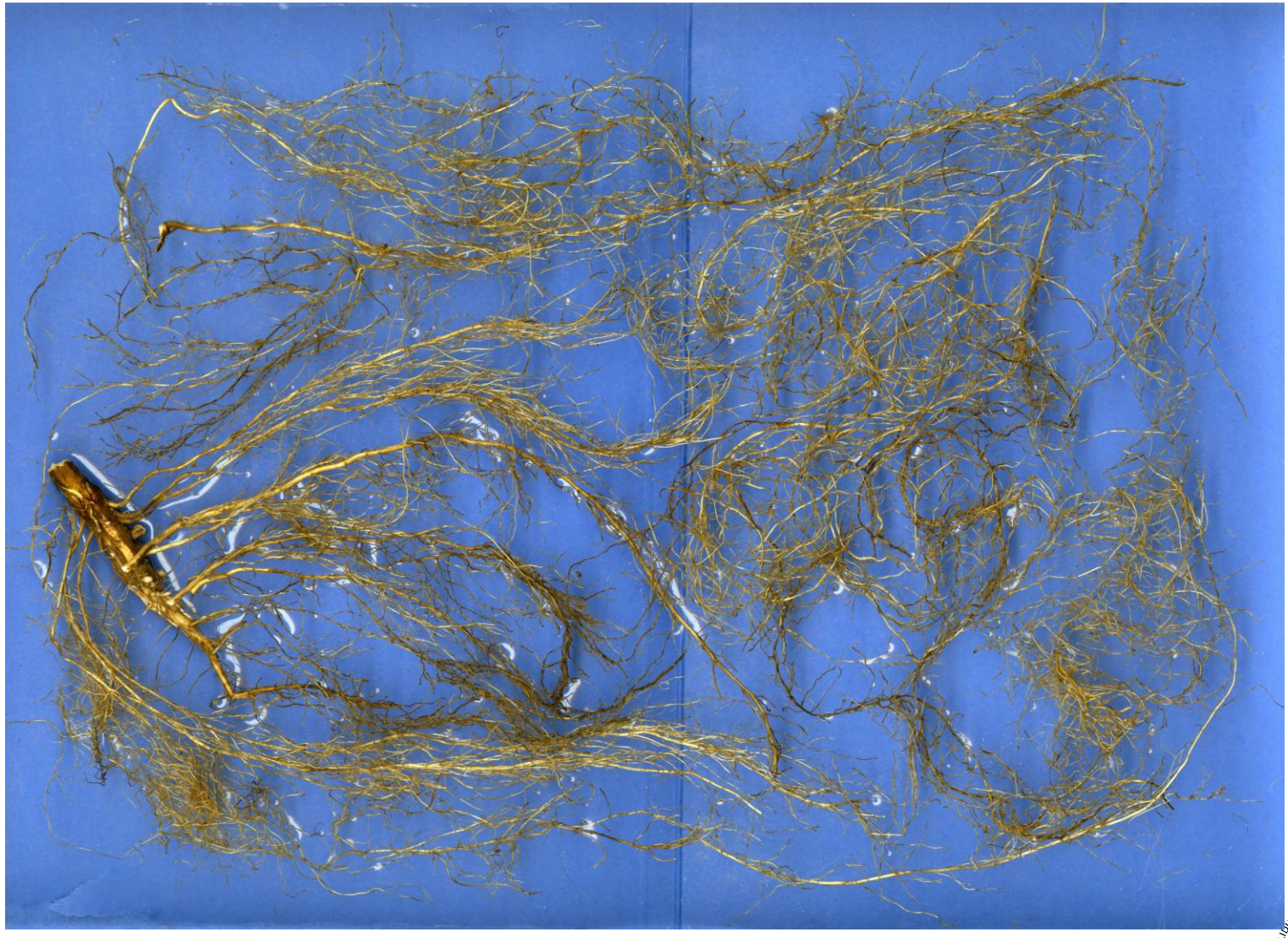
Architectural

Root branching

- How roots are constructed?

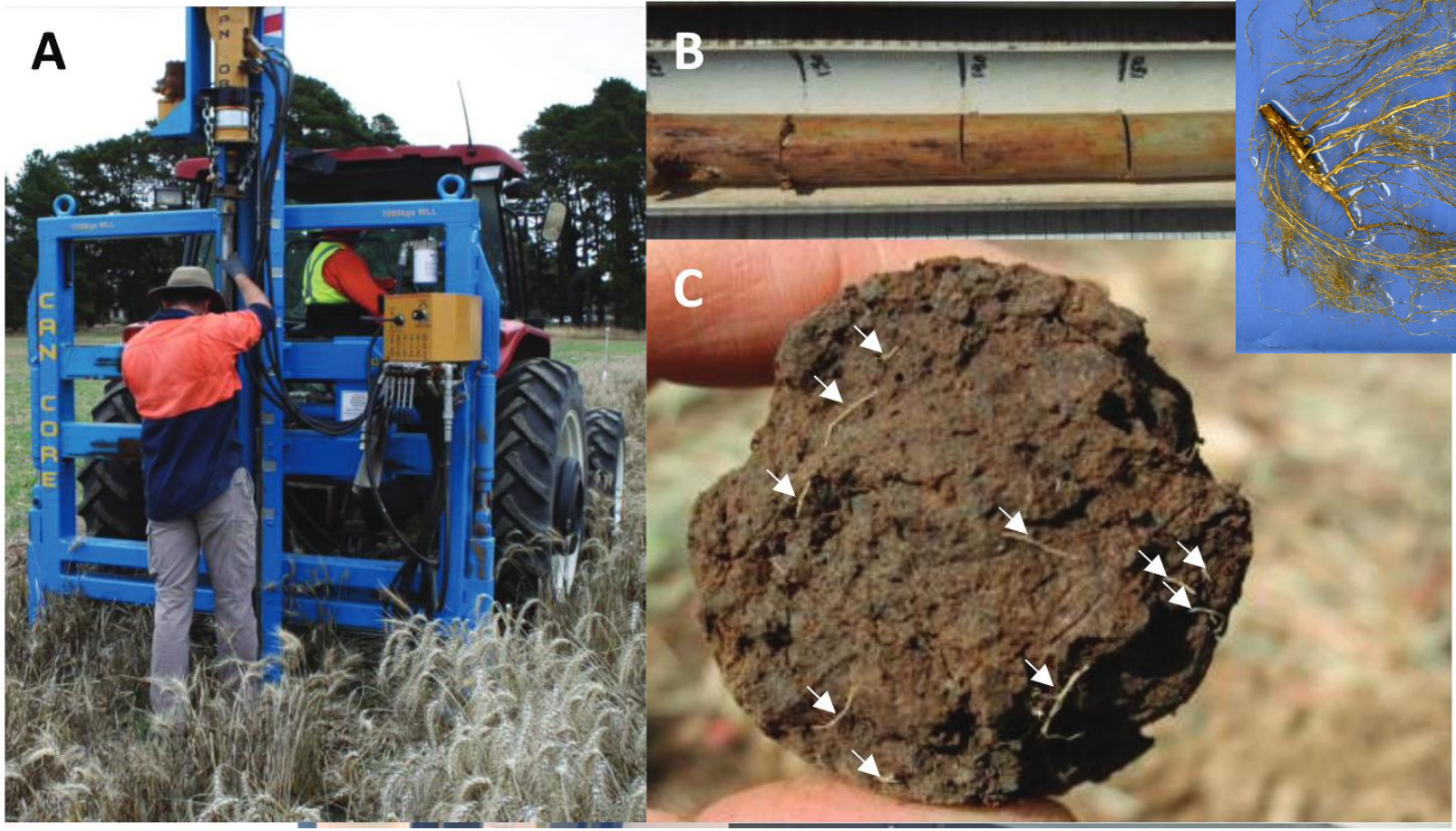
e.g. 6 branches per 1 cm of roots

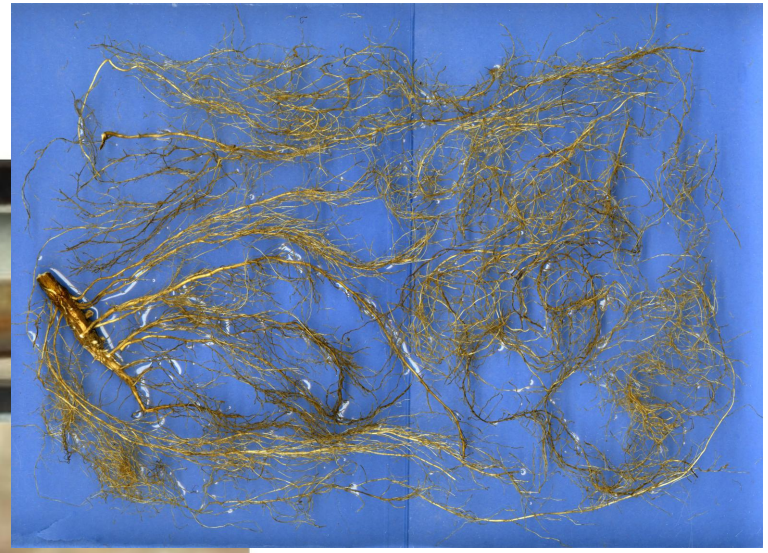
Function: Root foraging



Field root methods
Digging...
Destructive and laborious

Soil coring method

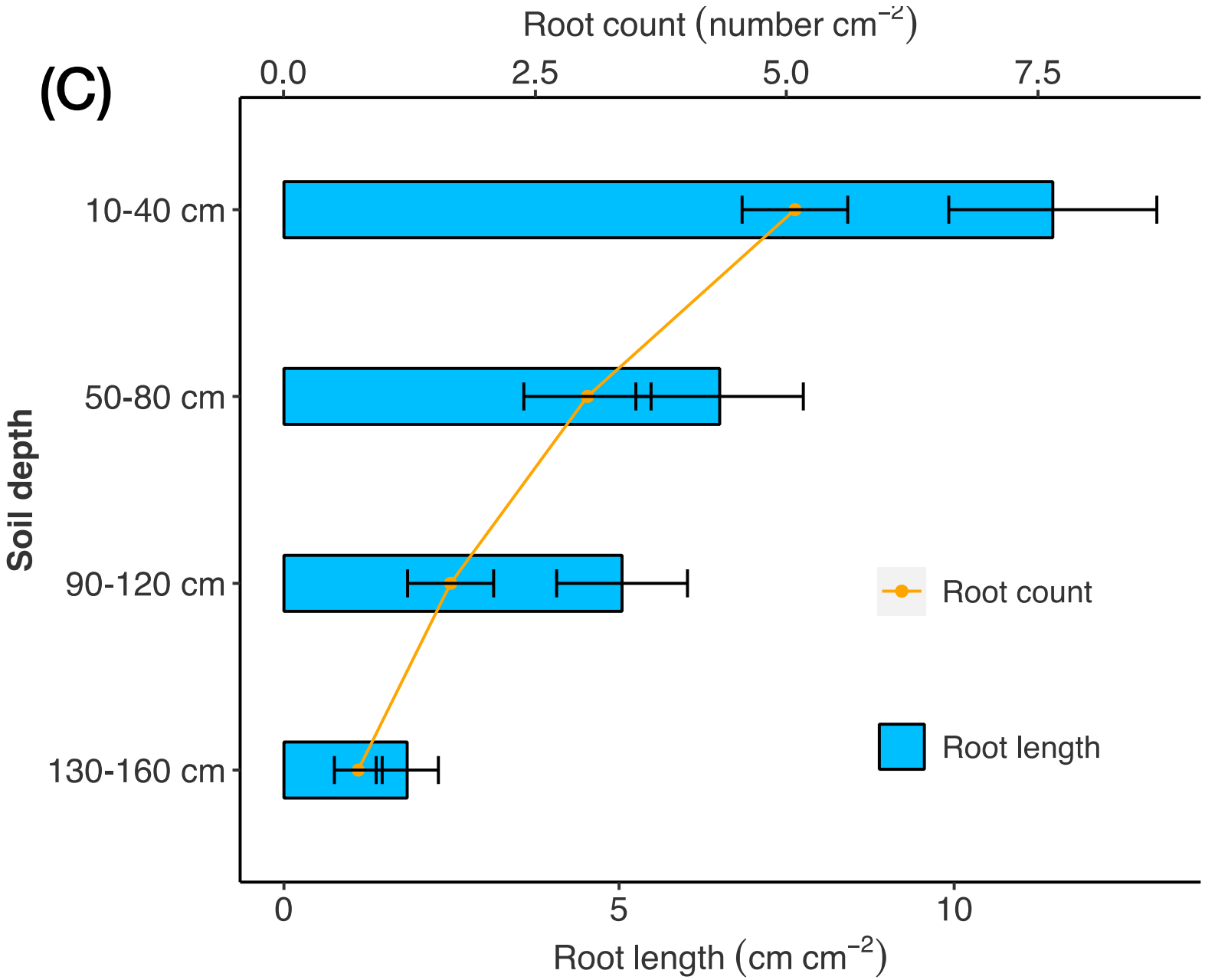




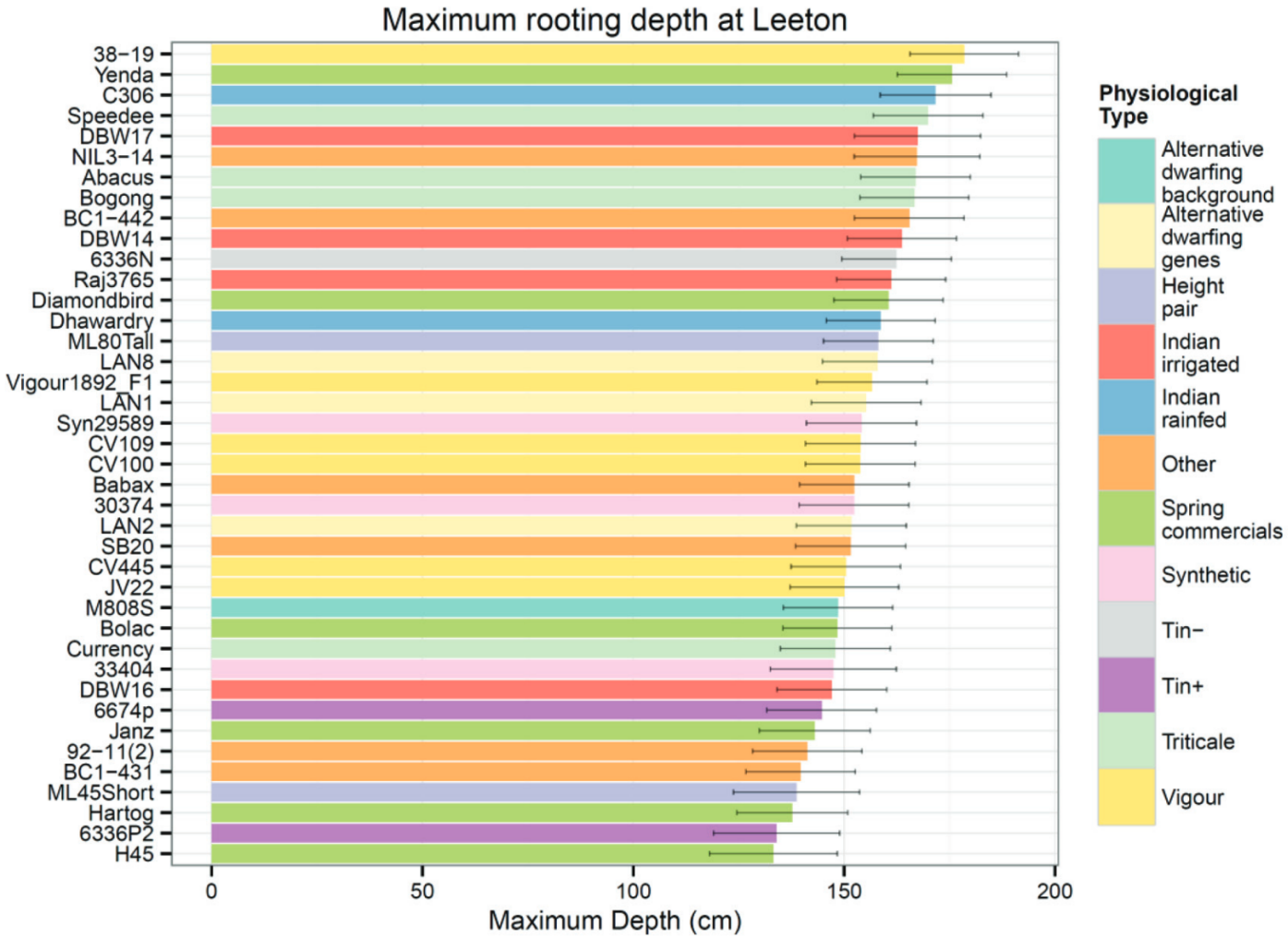
Wasson et al. (2015)

Hands-

(C)


Root count (number cm^{-2})
0.0
2.5
5.0
7.5
10-40 cm
50-80 cm
90-120 cm
130-160 cm
Soil depth
Root count
Root length
0
5
10
Root length (cm cm^{-2})

Fast - one of very few methods for field root phenotyping



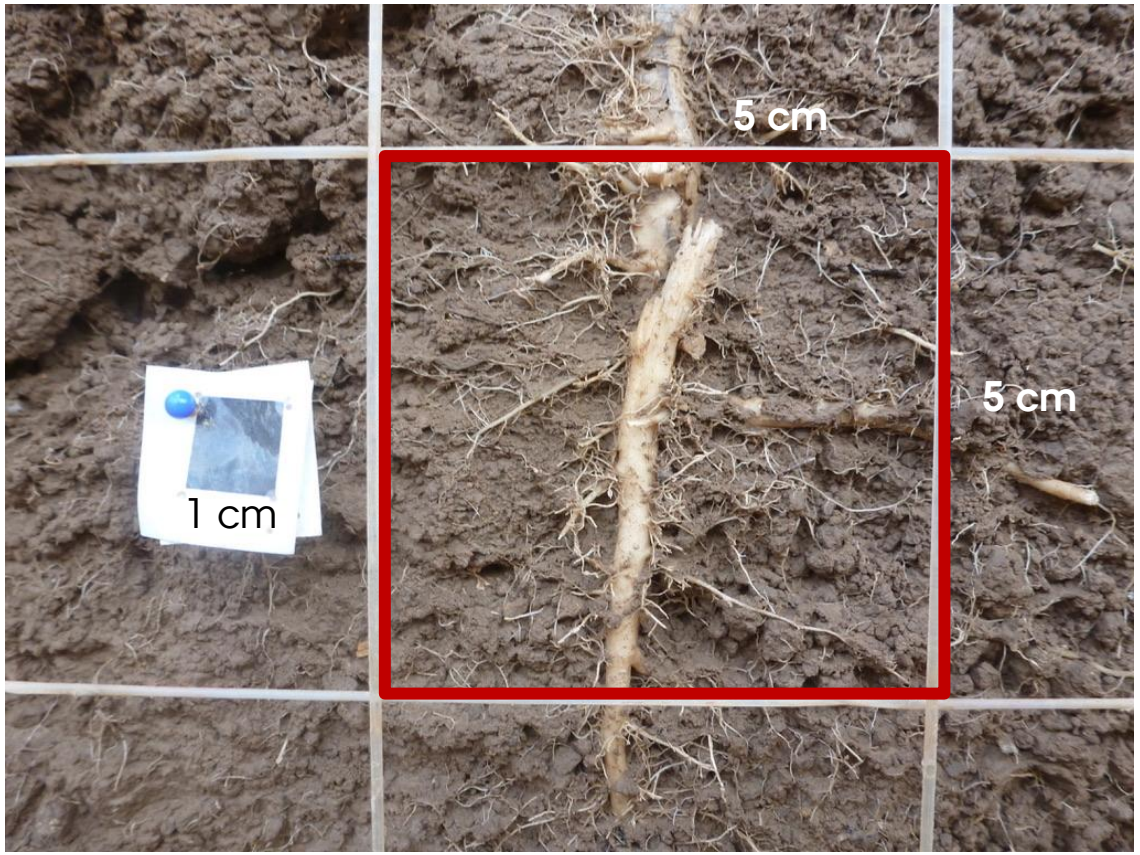
Thinking of one variable
Root depth

Wasson et al. (2014)

Profile wall method: Hands-on

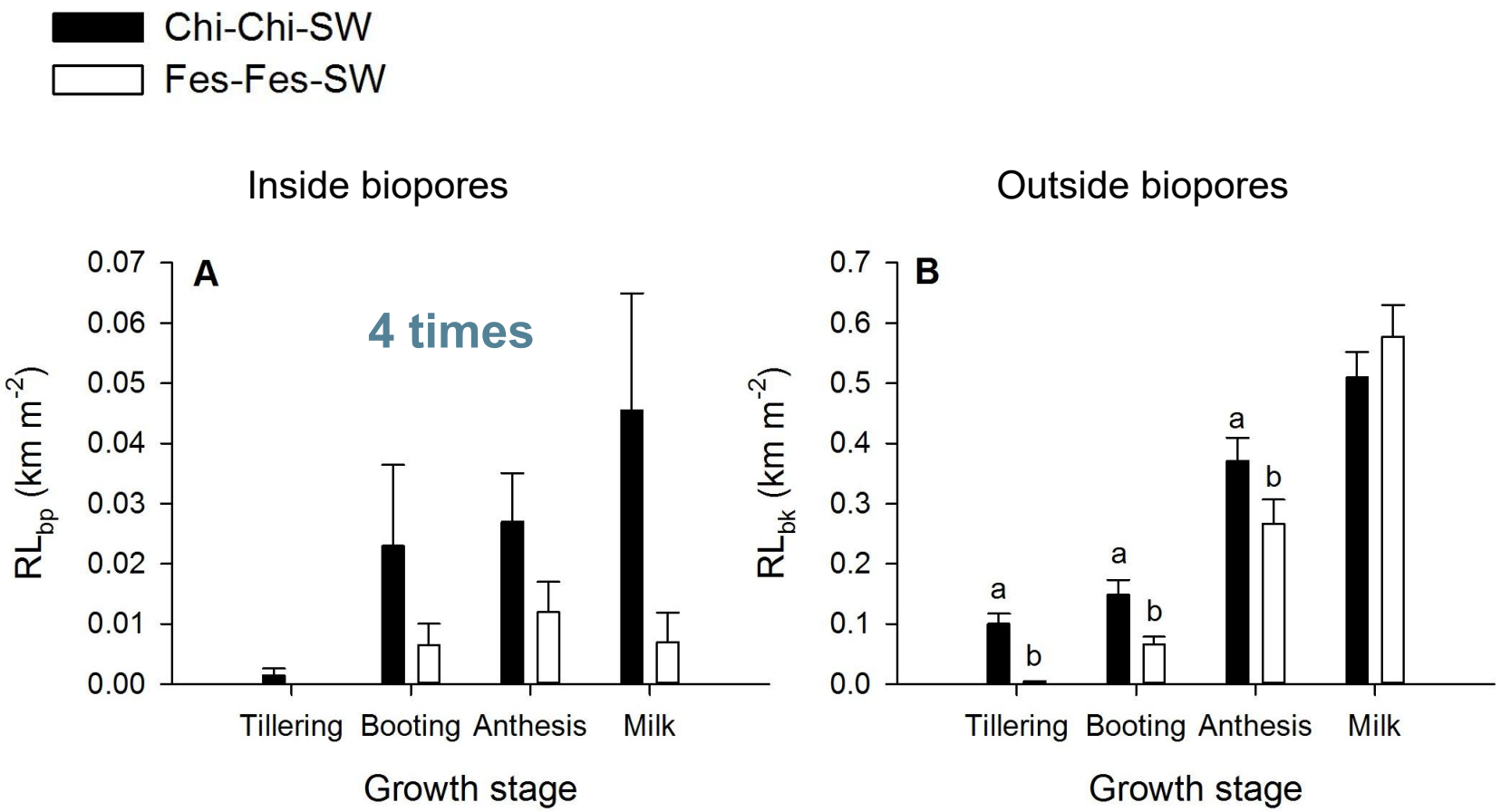
Recording the Root Length Unit (1 RLU=1 cm)

30 RLU??

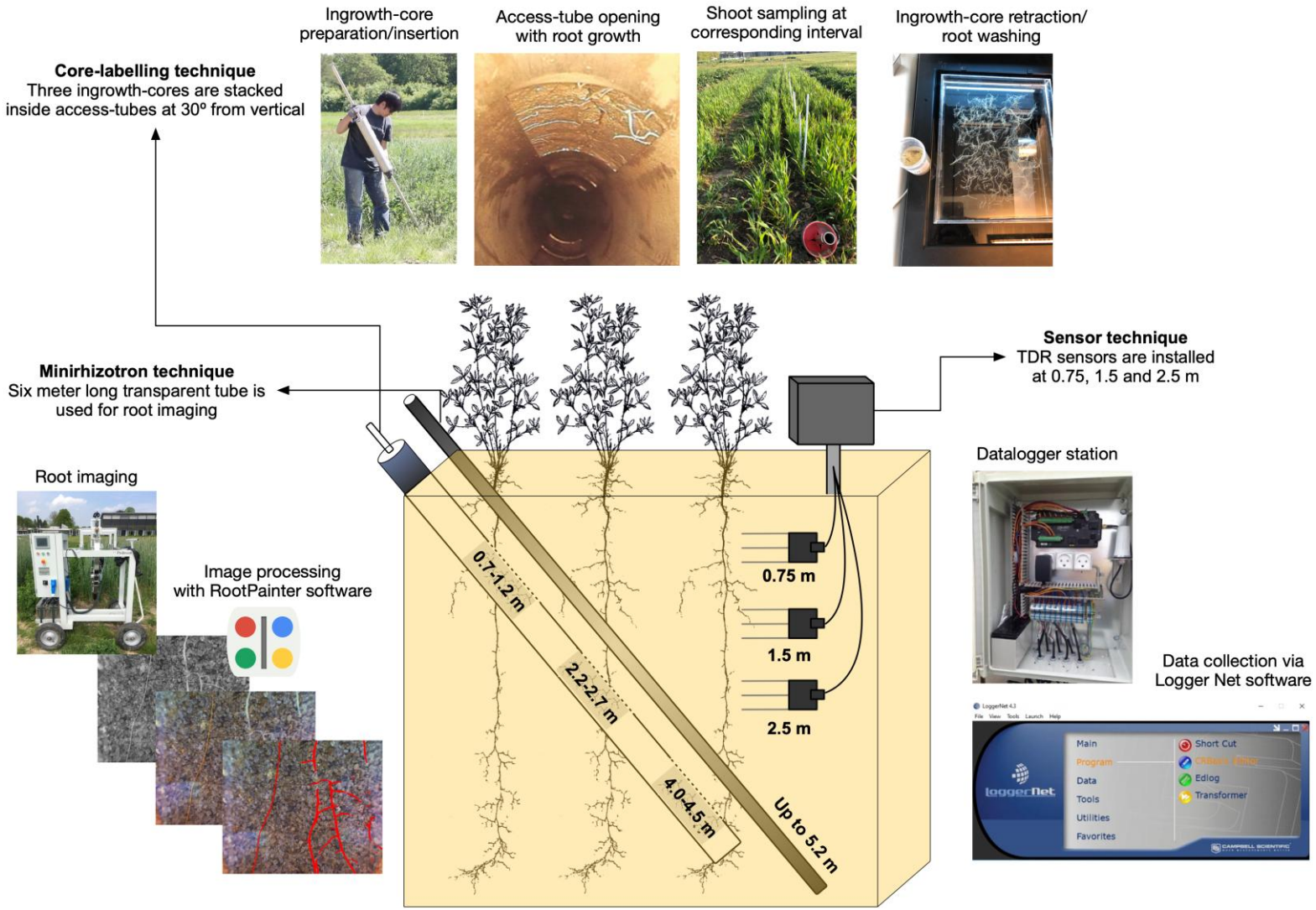


Dirty, Rough, slow but unique data

Han et al. (2015)



Facilitating root research – Less invasive approach



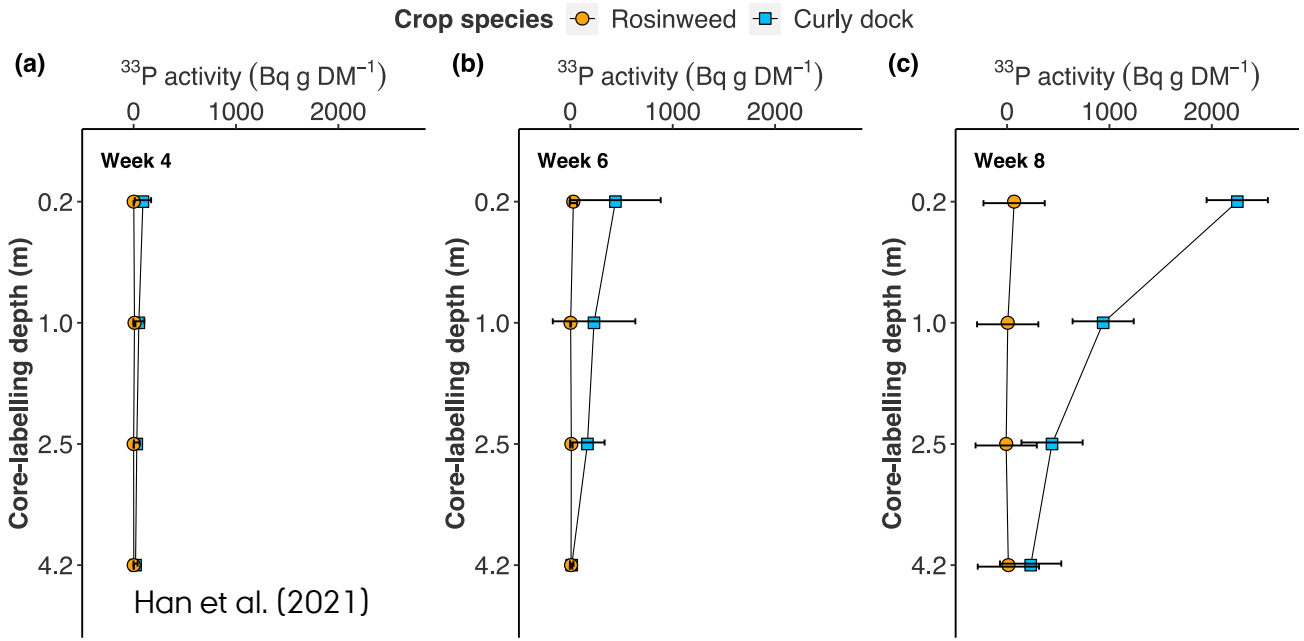
Han et al. (2025)

“Extending” the ingrowth-core method

Fig. 3

Hansen et al. (2020)

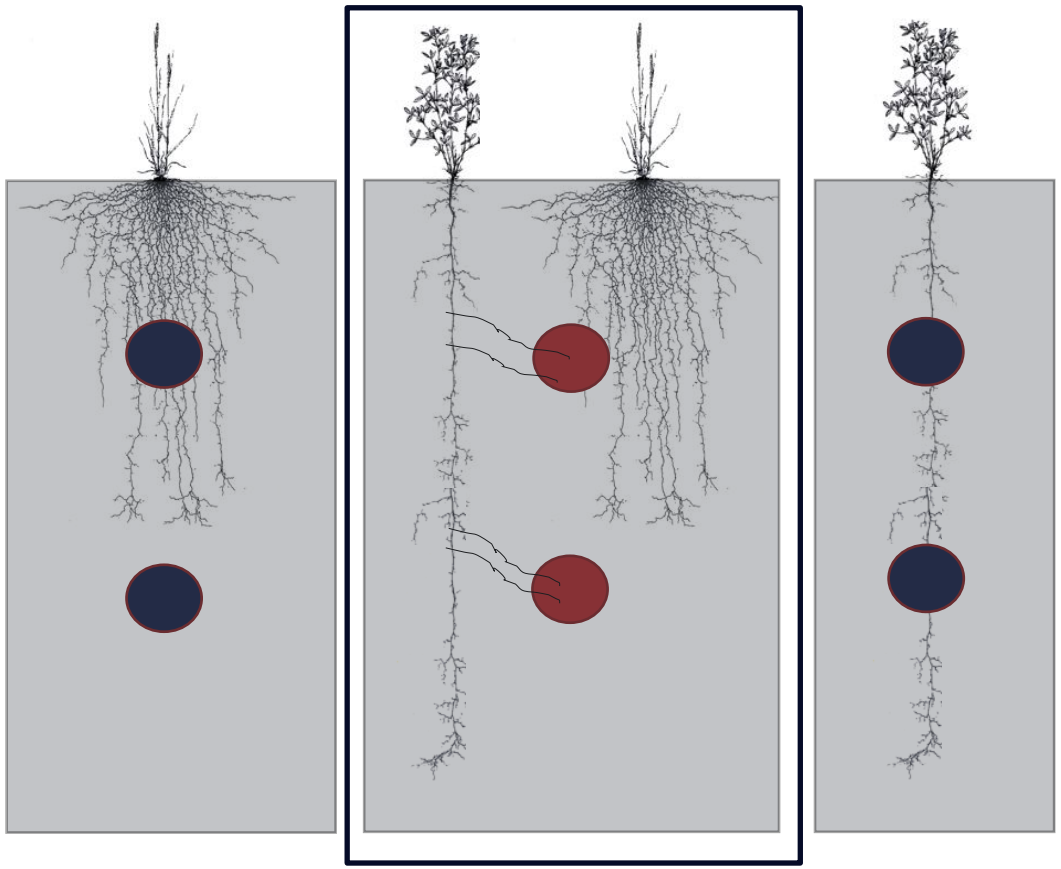
Root + Shoot = function??

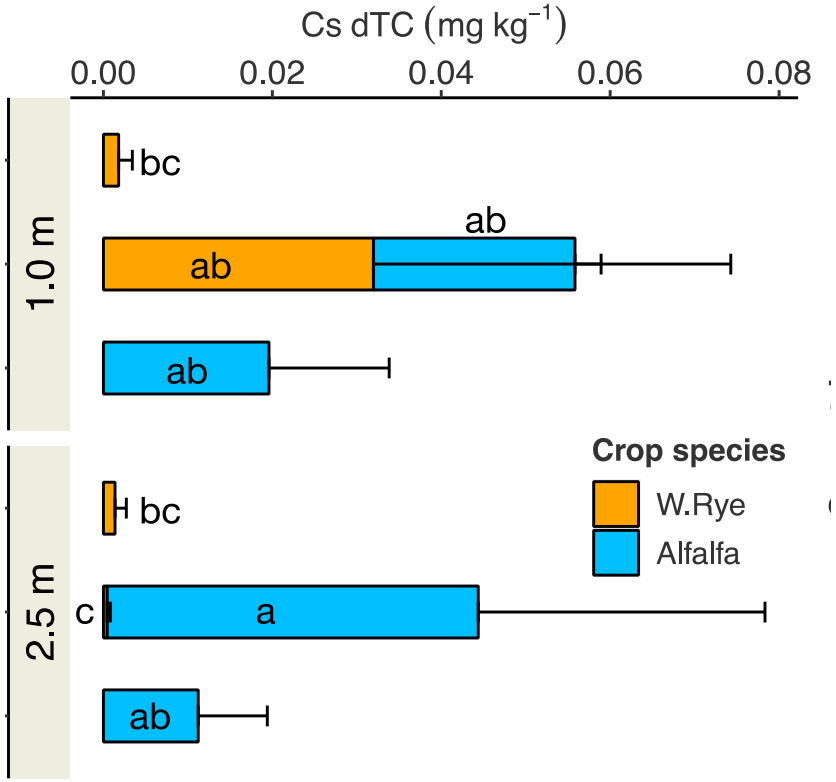


Han et al. (2021)

(2025)

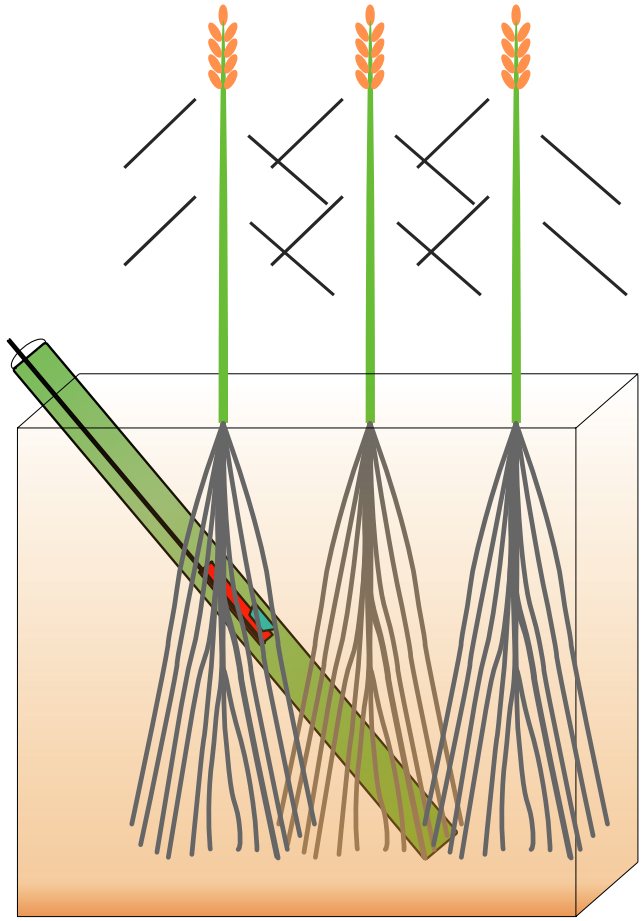
Functional detection – under crop mixture





Han et al. (2022). AEE

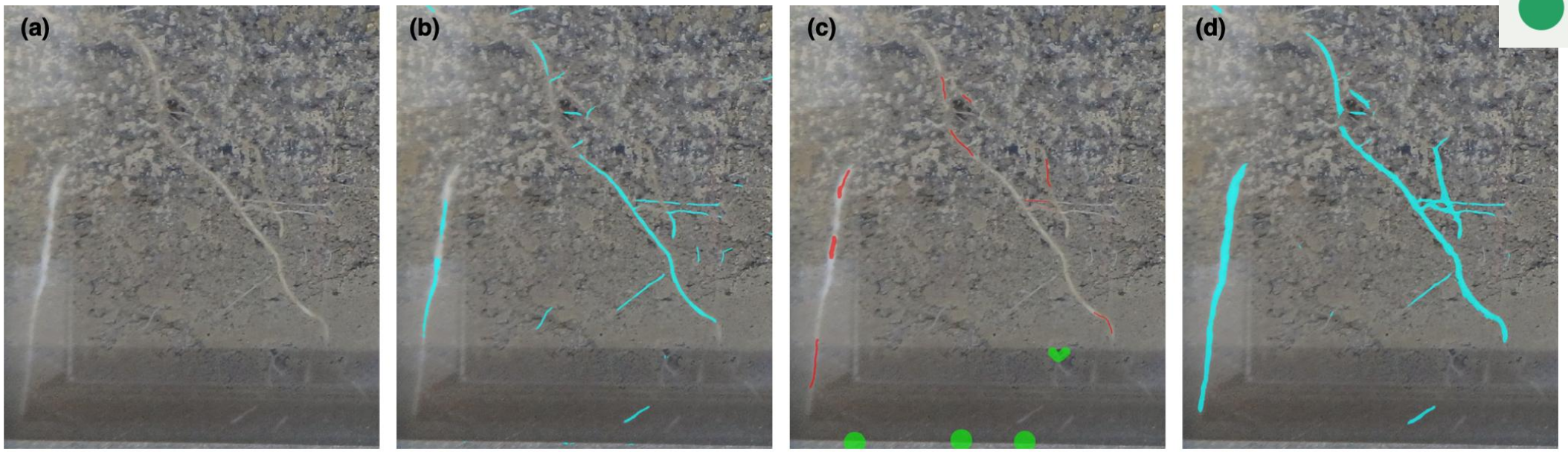
Minirhizotron/rhizotron method – image analysis



Hands-on

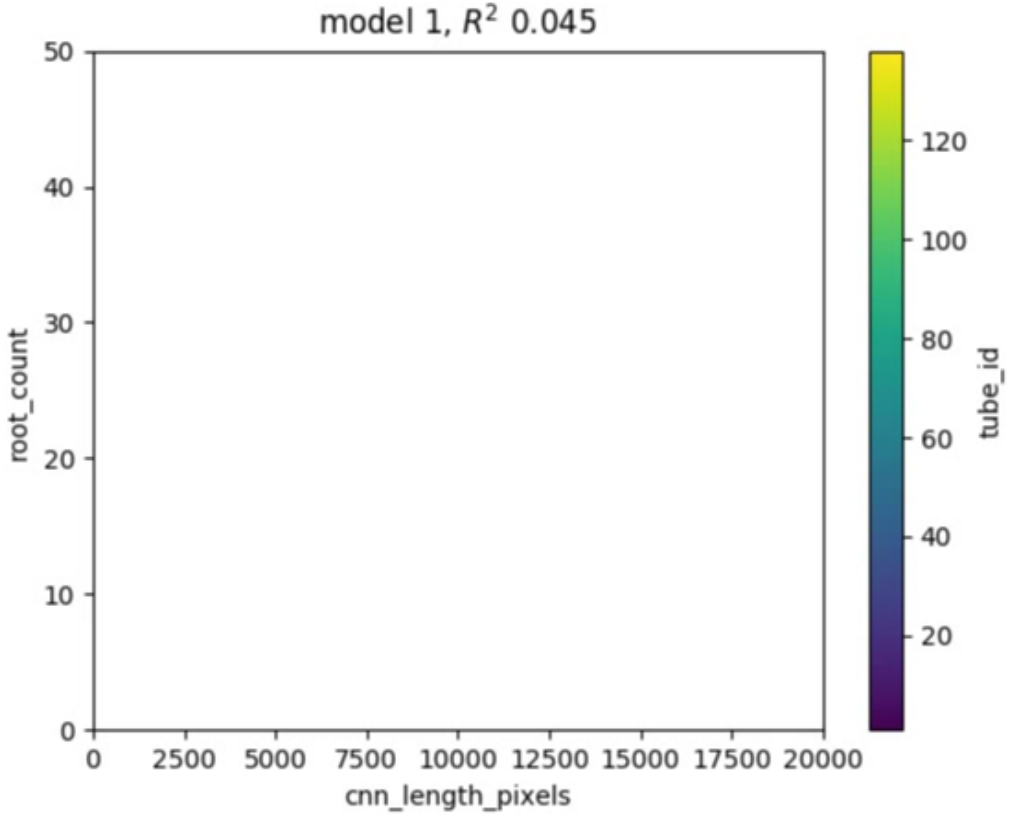
6?

RootPainter – AI software

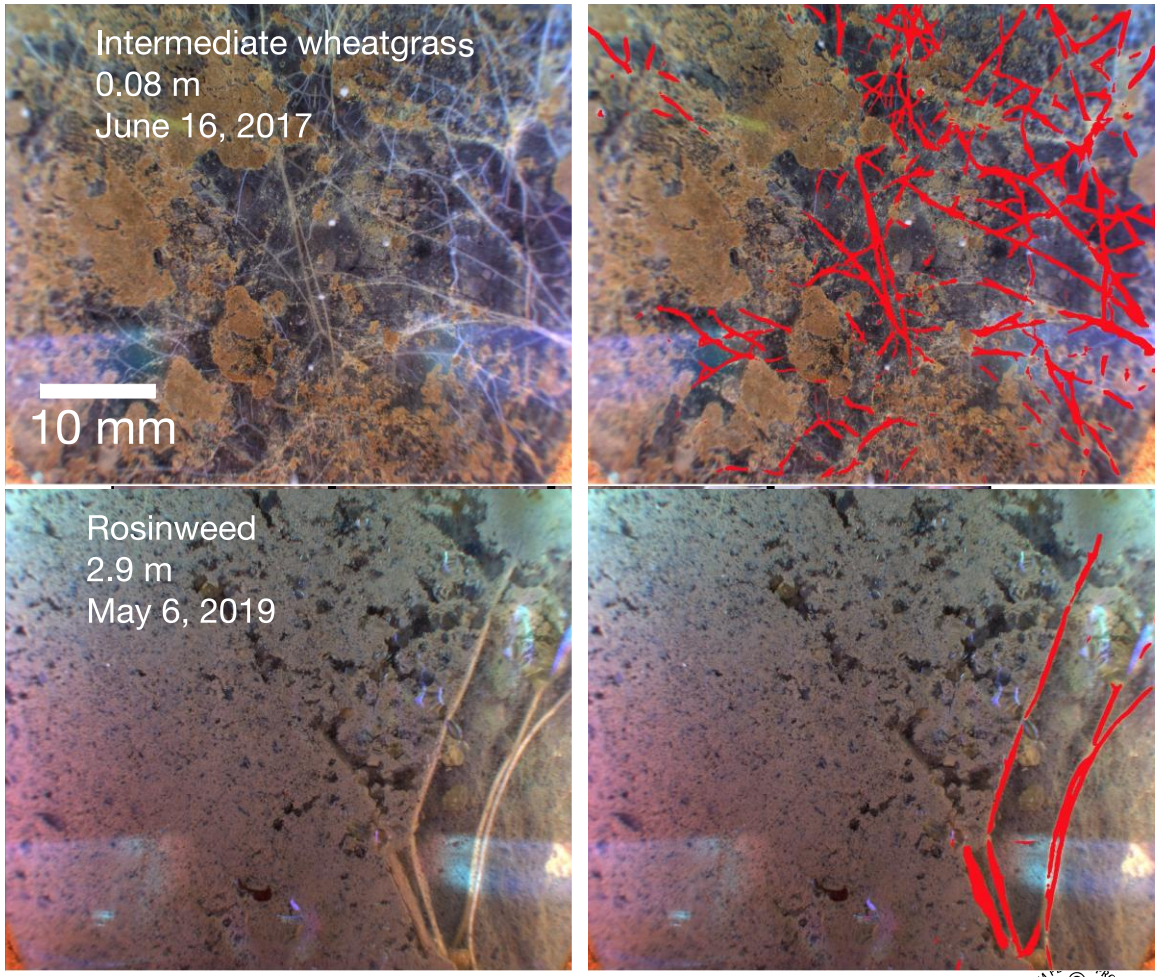


Smith et al., 2022

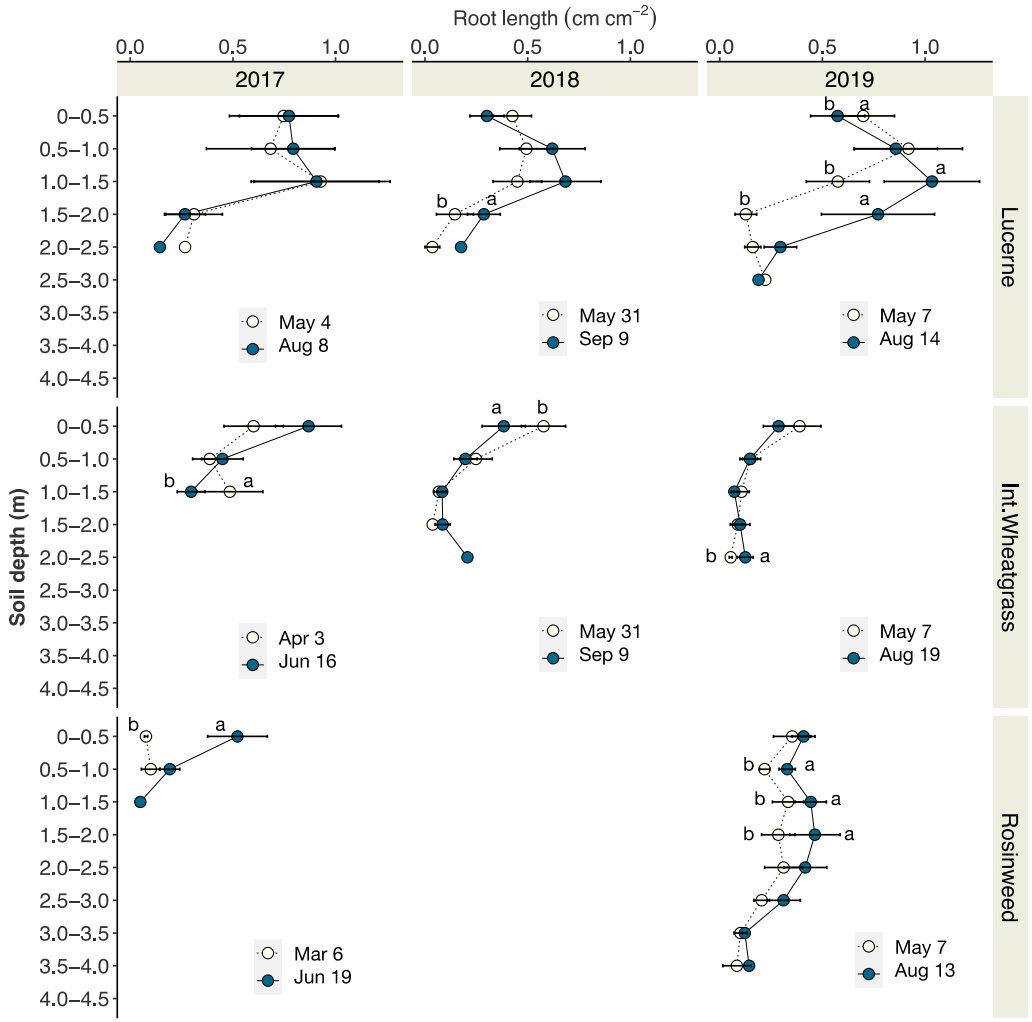
Corrective annotation – quick and accurate

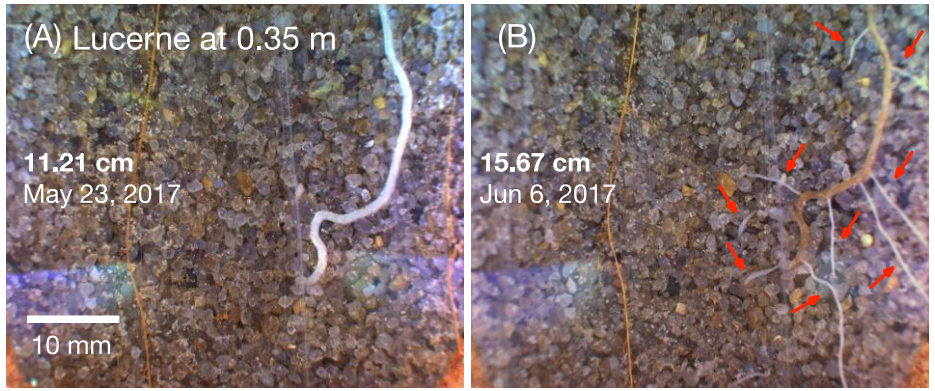


~ 3 hours

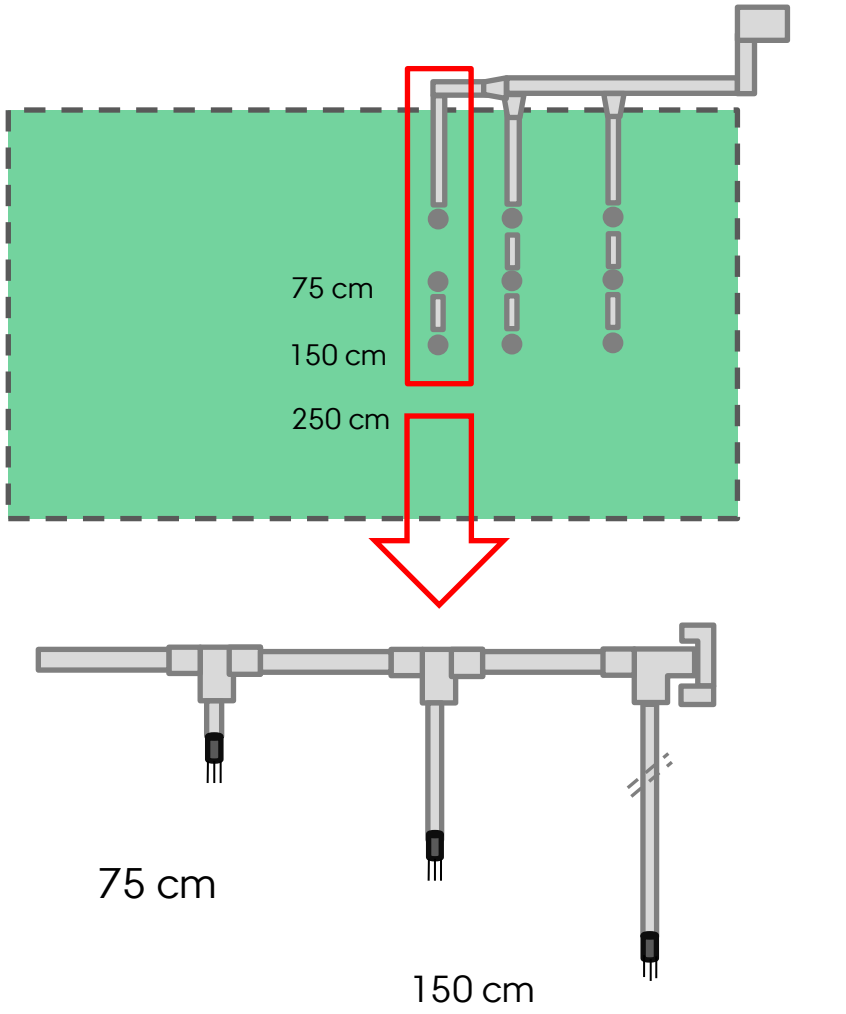


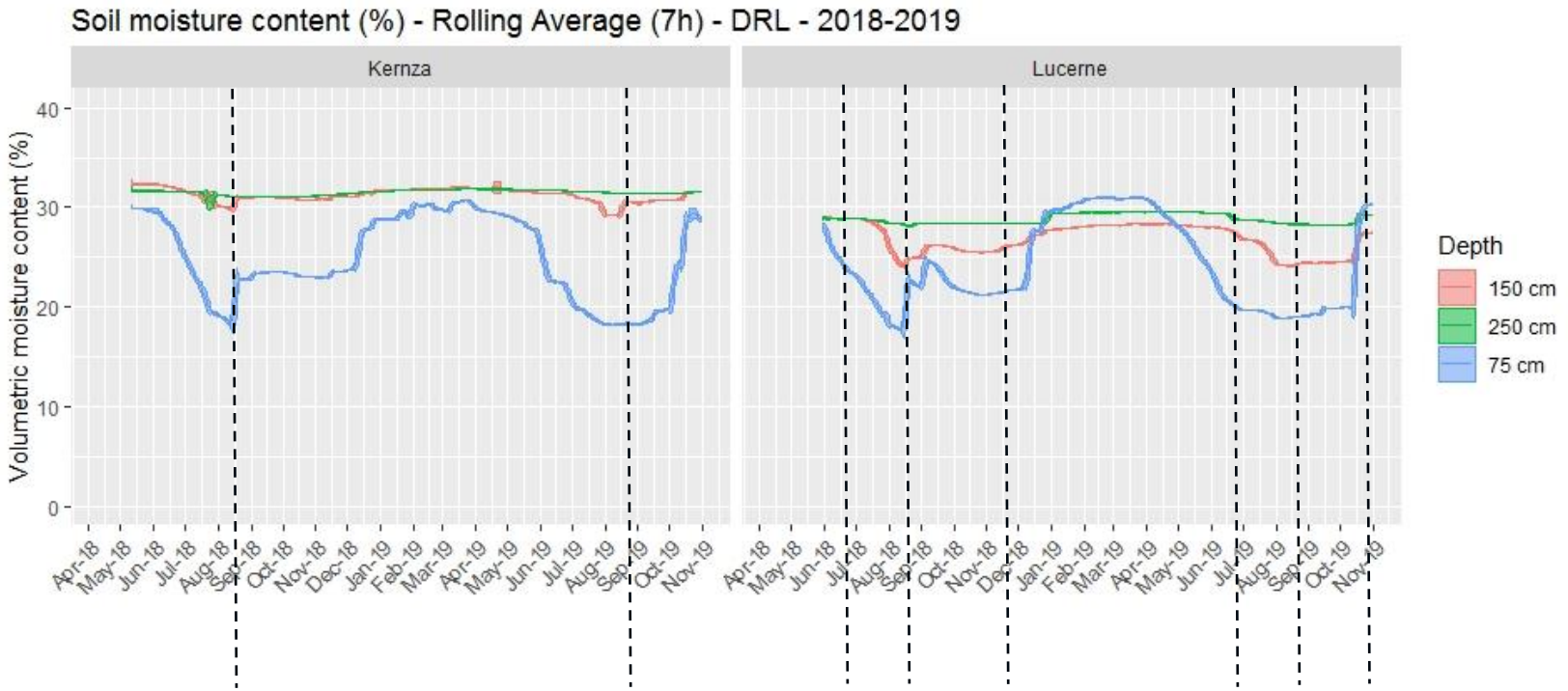
Frequent measurement





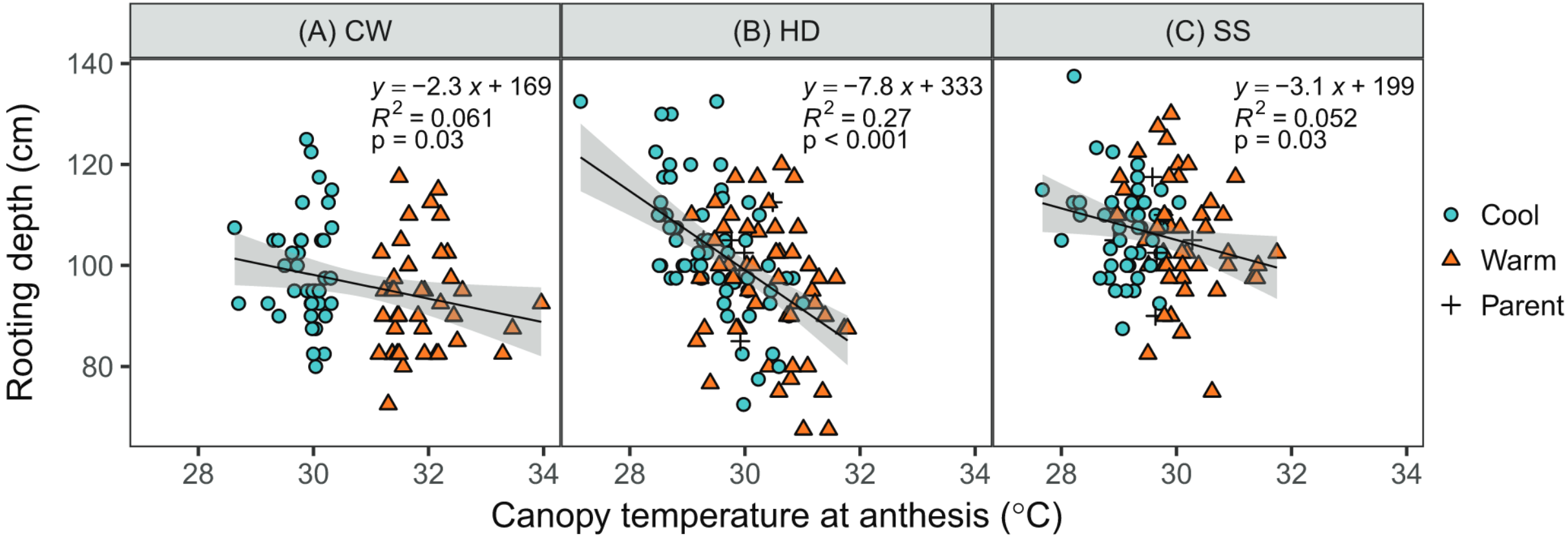
Water sensing





Harvest time

Canopy/remote sensing



Take home message

That said.....
Good luck
Thank you for listening

1. Field root research is hard

2. There are ways to make it easier and more scalable (e.g. AI)

3. There is no perfect “root method” – interpretation always matters

4. Hypotheses should drive methods, not the other way around

.....**But** in reality, such luxury often doesn’t exist and we work with what we have

Root Methods: PhD course

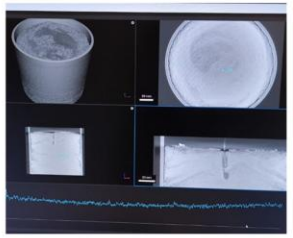
18-22 May 2026

Aarhus University at Viborg Campus, Denmark

Registration

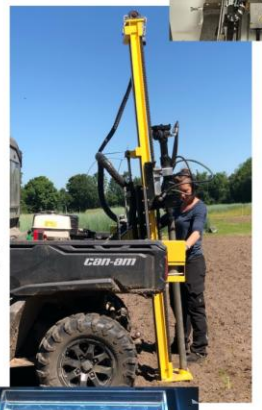
CT scanning

3D root construction



Soil sensing

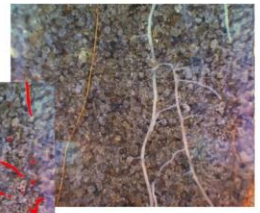
Soil sampling



Root imaging

Root processing

AI-based Image segmenation



Isotope-labelling

Lysimeter sampling

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