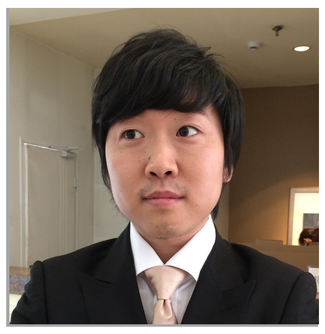

Eusun Han

Dorte Bodin Dresbøll and Kristian Thorup-Kristensen

Department of Plant and Environmental Sciences
University of Copenhagen, Denmark
Contact: eusun.han@plen.ku.dk

Determining deep root activity in arable fields by the core-labelling technique (CLT)

DeepFrontier - Exploring Potentials of Deep Roots

Deep roots, are they active? If so, how can we measure it?

- ***Deep roots*** have potential to exploit the hidden plant resources.
- We developed a unique system that can simultaneously measure root system in the subsoil (Figure 1a and 1d) and its contribution to plant resource acquisition (Figure 1c).
- It is called, **Core-Labelling Technique (CLT)**, which embeded two pre-exisiting approaches; i.e., **Ingrowth-core method** and **Tracer technique** (Figure 1b).

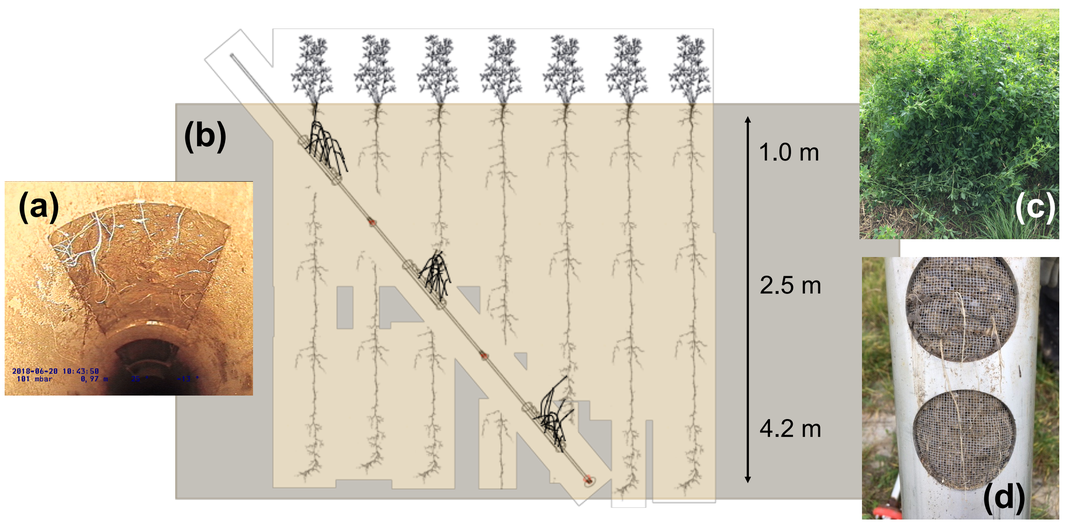

Figure 1: Visible roots on the opening area inside access-tube at 1.0 m (a); A schematic diagram of Core-Labelling Technique (CLT) in action (b). Lucerne growing as model plants (c); Roots grown into ingrowth-core (b).

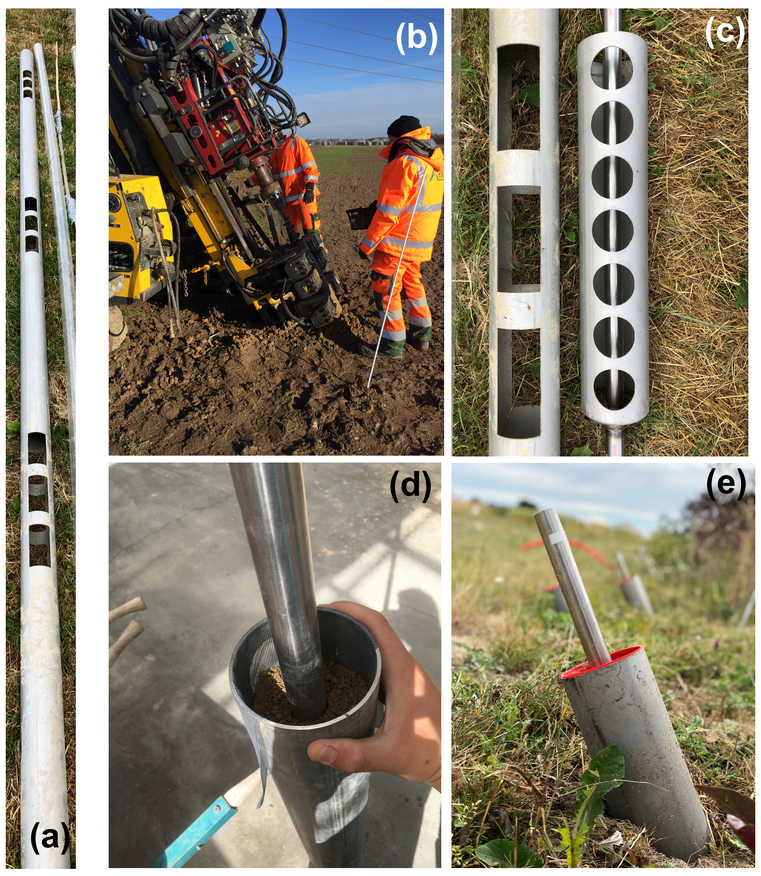

Figure 2: A 5.85 m-long access-tube with 3 openings (a); Drilling of an access-tube (b); A matching-view of ingrowth-core and access-tubes opening (c); Re-packing of labelled soil into the ingrowth-core (d); Ingrowth-core placed into the access-tube in the field (e).

CLT detects root activity beyond 4 m of soil depth!

- Distribution of root-length density (RLD) of lucerne *(Medicago sativa)* at 1.0, 2.5 and 4.2 m was 0.004, 0.009 and 0.006 cm cm^{-3}, respectively.
- Overall, core-labelling increased tracer concentration (^{15}N, Li and Cs) in aboveground biomass of lucerne by 55 % at 1 m and 26 % at 2.5 m and 4.2 m.
- When core-labelled, concentration of ^{15}N (‰) was significantly higher compared with control but the effects were not shown at 2.5 and 4.2 m (Figure 3a).
- Li revealed significant effects of core-labelling up to 2.5 m of soil depth (Figure 3b), whereas the effects were further extended to 4.2 m for Cs (Figure 3c).

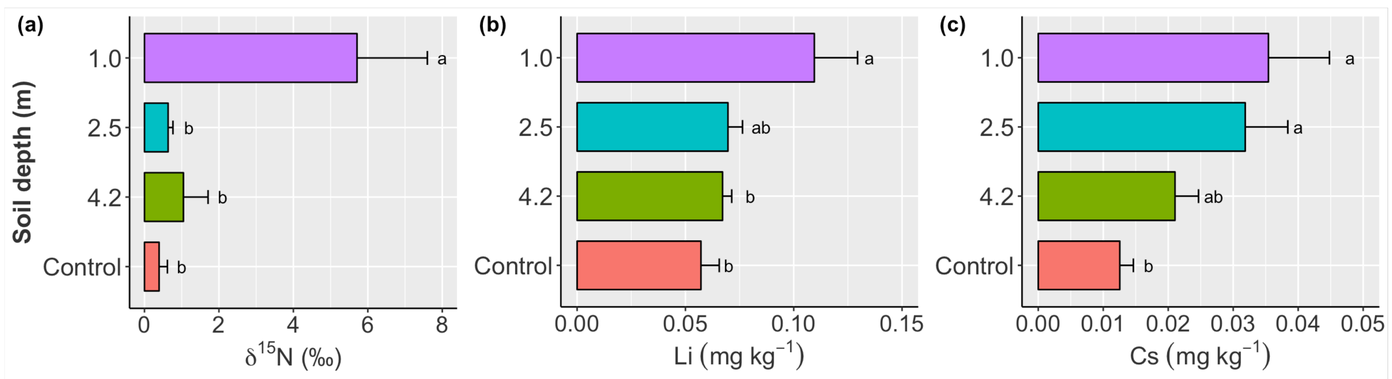

Figure 3: Tracer Concentration of ^{15}N (a; ‰), Li and Cs (b and c; mg kg^{-1}) in aboveground biomass of lucerne collected from the labelled area with ingrowth-cores inserted at 1.0, 2.5 and 4.2 m of soil depth. Small letters indicate significant differences between the treatments (Tukey HSD; $P \leq 0.05$).

How come CLT goes down so deep?

- Stainless access-tubes with a total length of 6 m and a diameter of 10 cm (Figure 2a) was inserted into the soil at 30º from the vertical line (Figure 2b).
- It had 55 cm-long openings at three depth-levels, viz., 1.0, 2.5, and 4.2 m.
- Stainless ingrowth-cores were made to be placed into the access tubes matching the opening areas for root growth (Figure 2c).
- ^{15}N, Li and Cs were used as nutrient tracers.
- The labelled subsoil medium was re-packed into the ingrowth-cores (Figure 2d) and placed into the access-tubes (Figure 2e).

Take CLT to your root research platform, because...

- CLT can quantify a **direct root-shoot relationship** at depths.
- CLT can be applied in different **depth/spatial/temporal** scales.
- CLT can be used for various **varieties/species/cropping systems.**
- CLT can be a **long-run** method, once installed.

DeepFrontier

The DeepFrontier project is developing methods, facilities and ideas for future research into sustainable food production.

Our aim is to improve the understanding of deep rooting, i.e. what determines deep rooting, the activities of deep roots and which resources from deep soil layers are utilized by plants. The project will also study cropping systems with deep rooted species.

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