# Roots – finding a deeper understanding
# 25 November 2019

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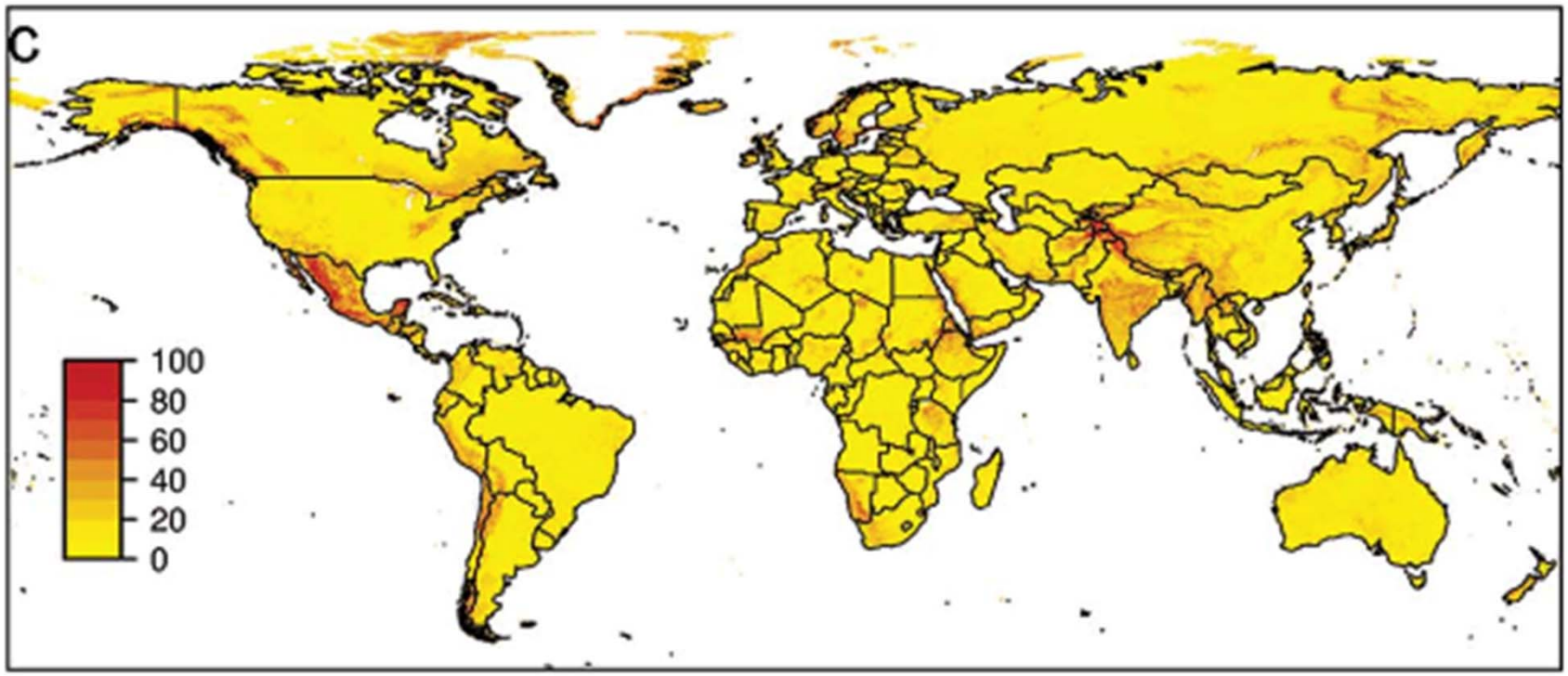
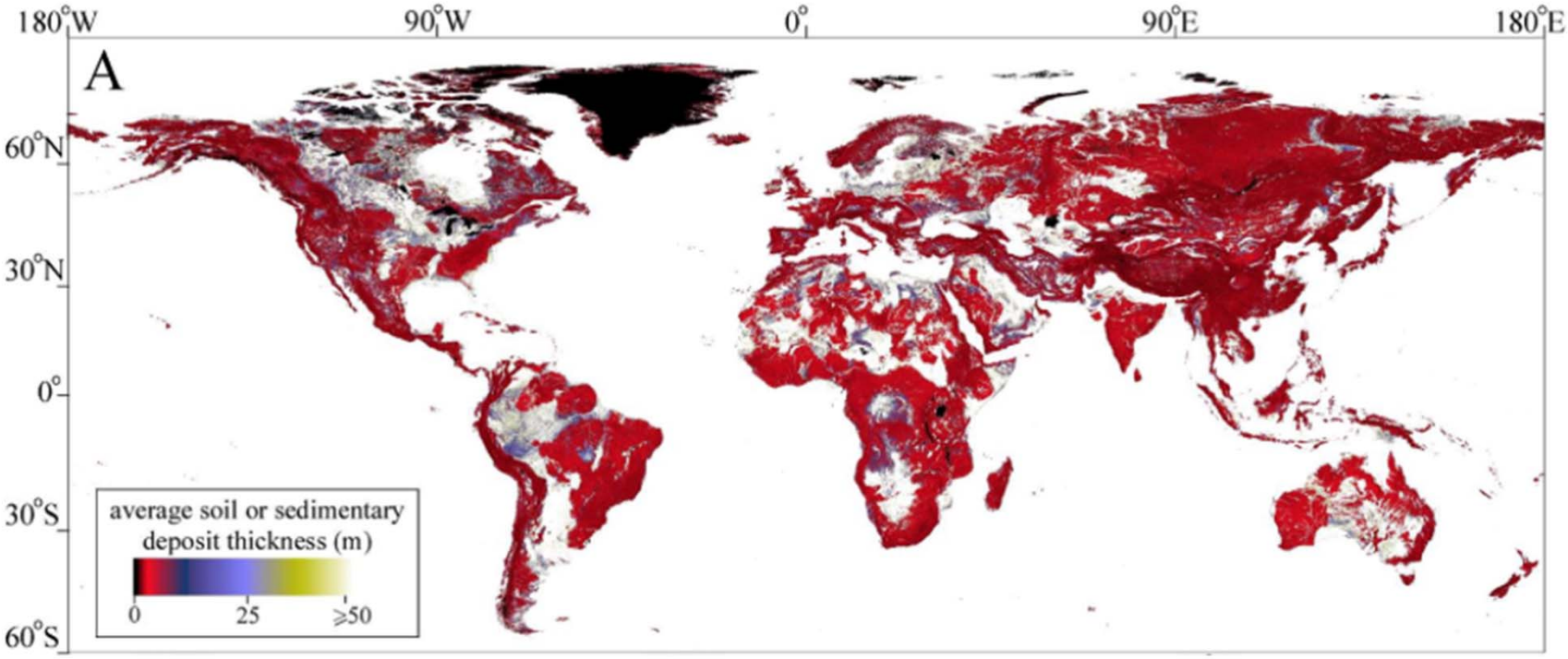
# Outline

- How much of the globe has soil/sediment deeper than 2 m?
- What is deep rooting? Which plants root deeply?
- How can deep roots and their activities be investigated?
- Important issues
- Pertinent research questions

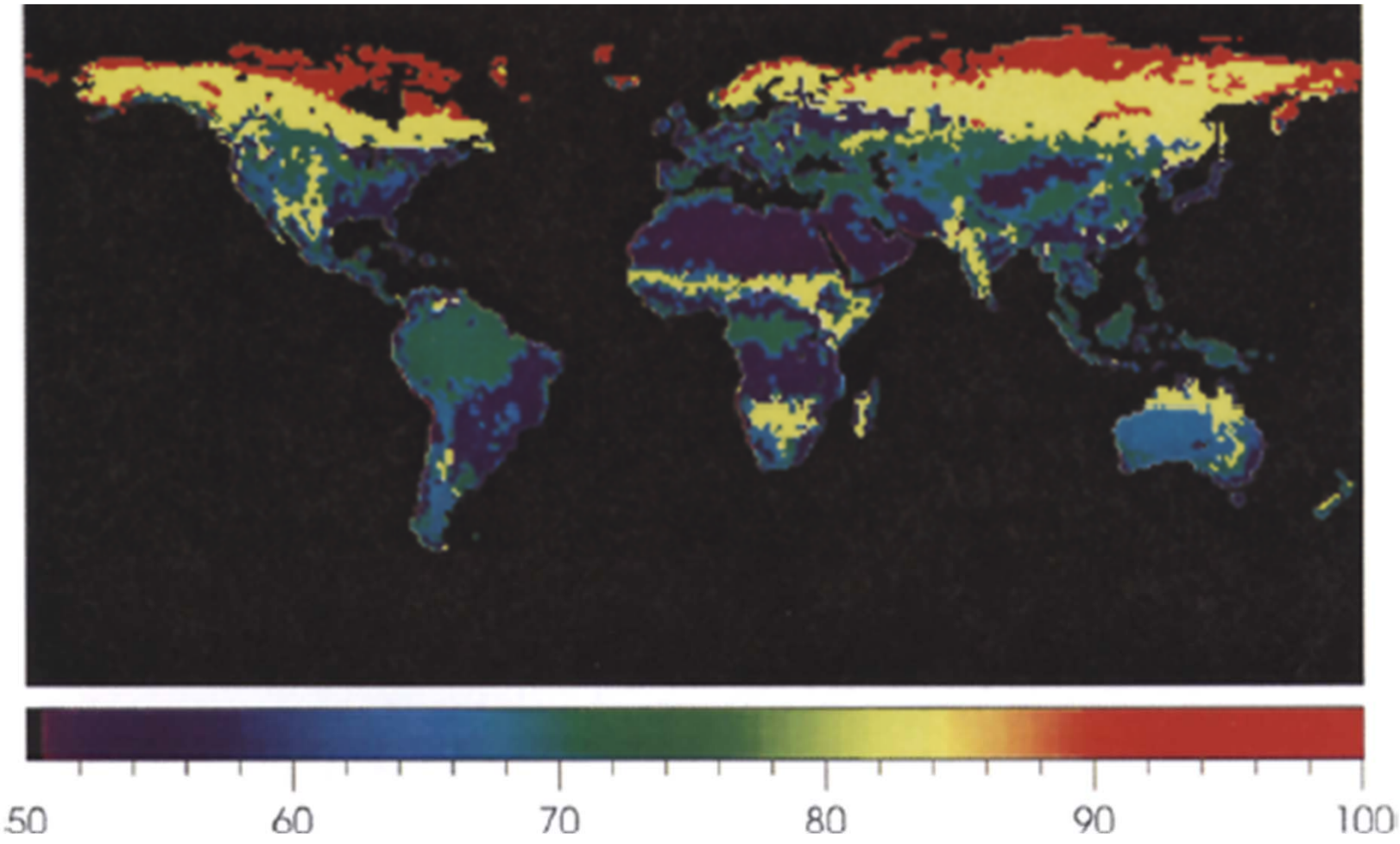
# Probability of bedrock being within 2 m of surface (Shangguan et al., 2017)



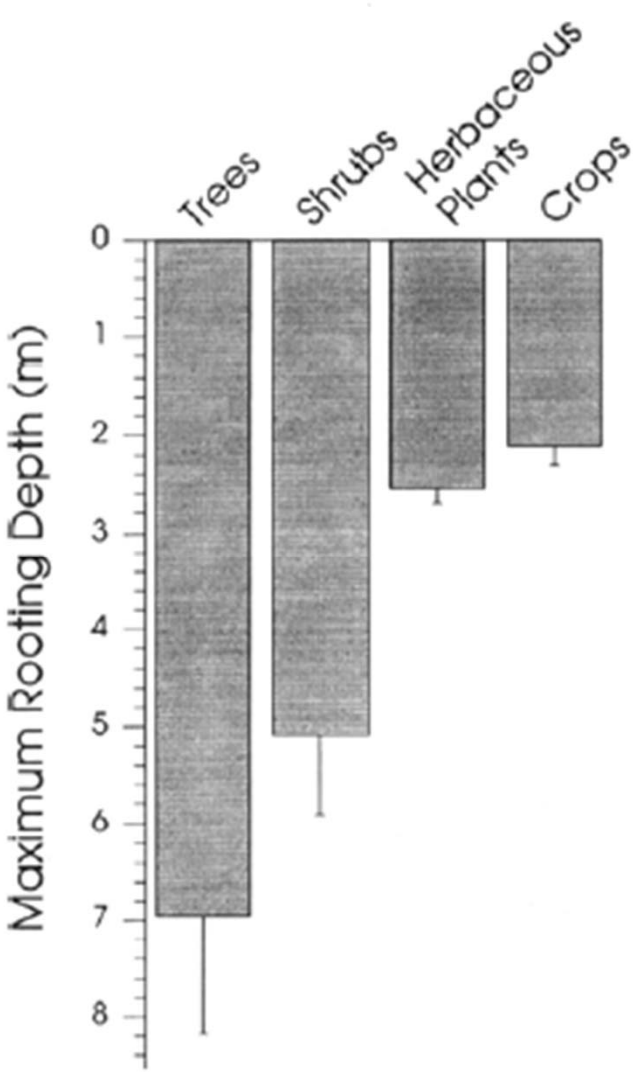
# Average soil or sedimentary deposit thickness (m)



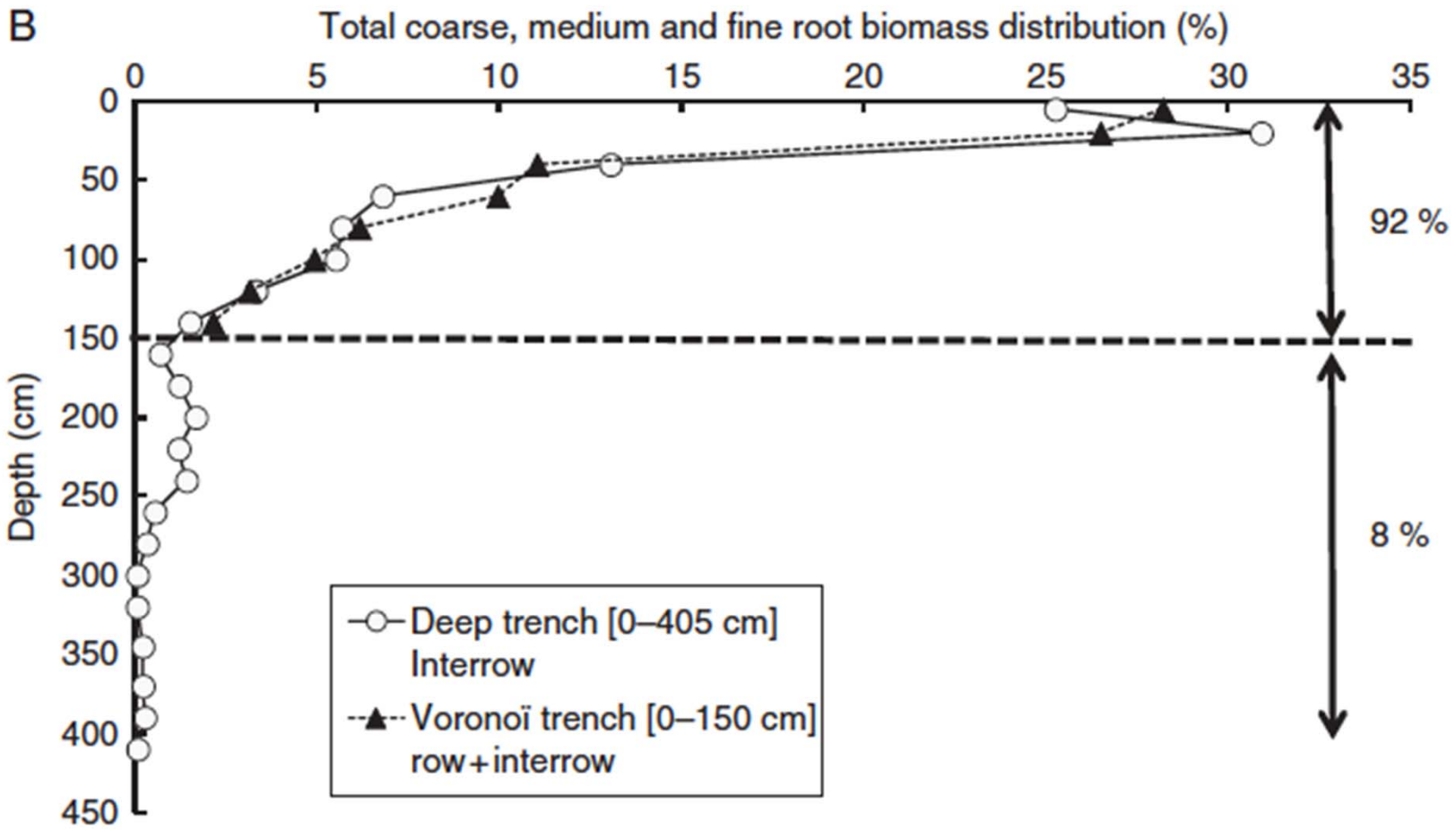
Global map of the percentage of root biomass located in the upper 30 cm of soil profiles (from Jackson et al. 1996)



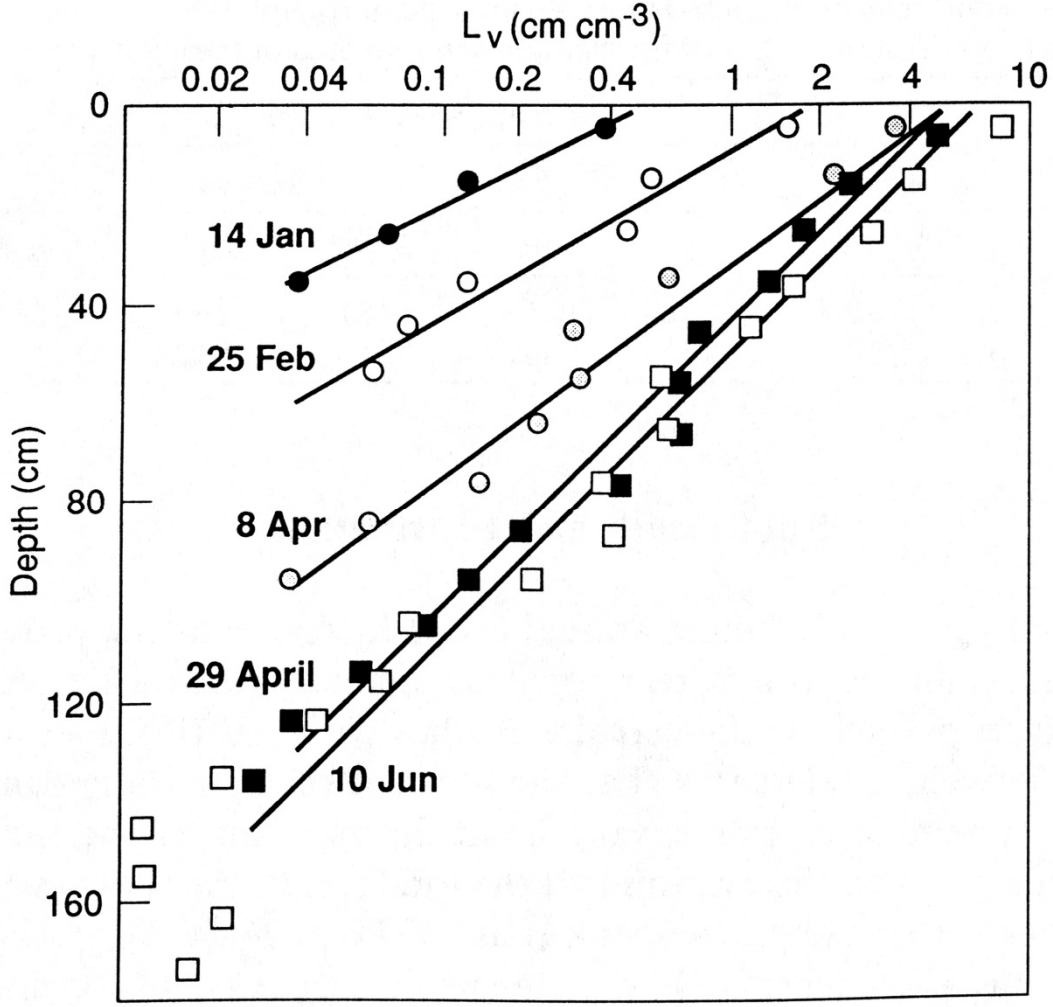
Mean and SE of reported maximum rooting depth (m) by three major functional groups (trees, shrubs, and herbaceous plants) and crops (from Canadell et al. 1996)



# Distribution of coffee roots on a deep Andisol in Costa Rica (Defrenet et al. (2016)



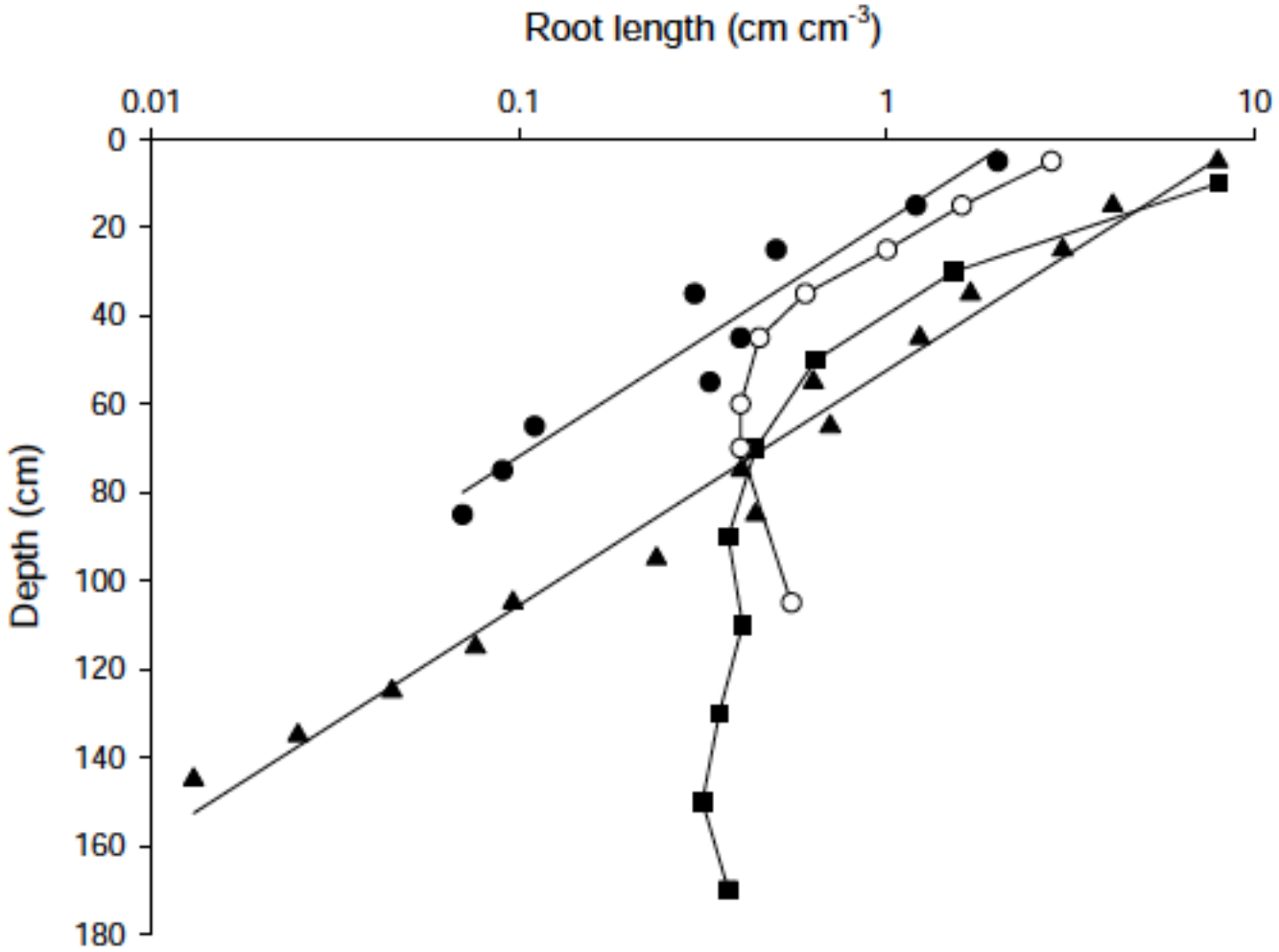
# Distribution of root length for winter wheat crop, Sutton Bonington, UK, 1975



# Comparison of relative water use from different soil layers with the relative root distribution (Gregory et al., 1978)

| **Period** | **Water uptake/** | **Root dry wt** | | |
|---|---|---|---|---|
| | 0 – 30 cm | 30 – 60 cm | 60 – 100 cm | >100 cm |
| 9 Apr – 13 May | 100 58 | 0 22 | 0 17 | 0 3 |
| 13 May – 17 Jun | 71 63 | 16 22 | 13 13 | 0 2 |
| 17 Jun – 8 Jul | 39 59 | 17 21 | 25 17 | 19 3 |
| 8 Jul – 29 Jul | 86 54 | 6 22 | 2 18 | 6 6 |

Distribution of root length with depth for cauliflower (•), oilseed rape (■), winter wheat (triangle) and sugar beet (open circle)



# Wheat roots growing through a lucerne root biopore at about 60 cm

# Investigation of deep roots

- Excavation of holes to reveal all or part of root system
- Permanent holes (rhizolabs) allowing repeat observations
- Extraction of soil cores
- Ground penetrating radar to identify coarse roots
- Measures of root activity (e.g. water uptake)

Excavation to reveal roots in an agroforestry system in Kenya (some health and safety issues!)

# Excavated apple tree root system

# The East Malling Rhizotron 1968

DESCRIPTION

Interior veiw of Root Lab. 2 (wide angle lens)

INDEX SECTION

R00/MET

NEGATIVE NUMBER

R6979

DATE

2/2/68

WHERE TAKEN

REMARKS

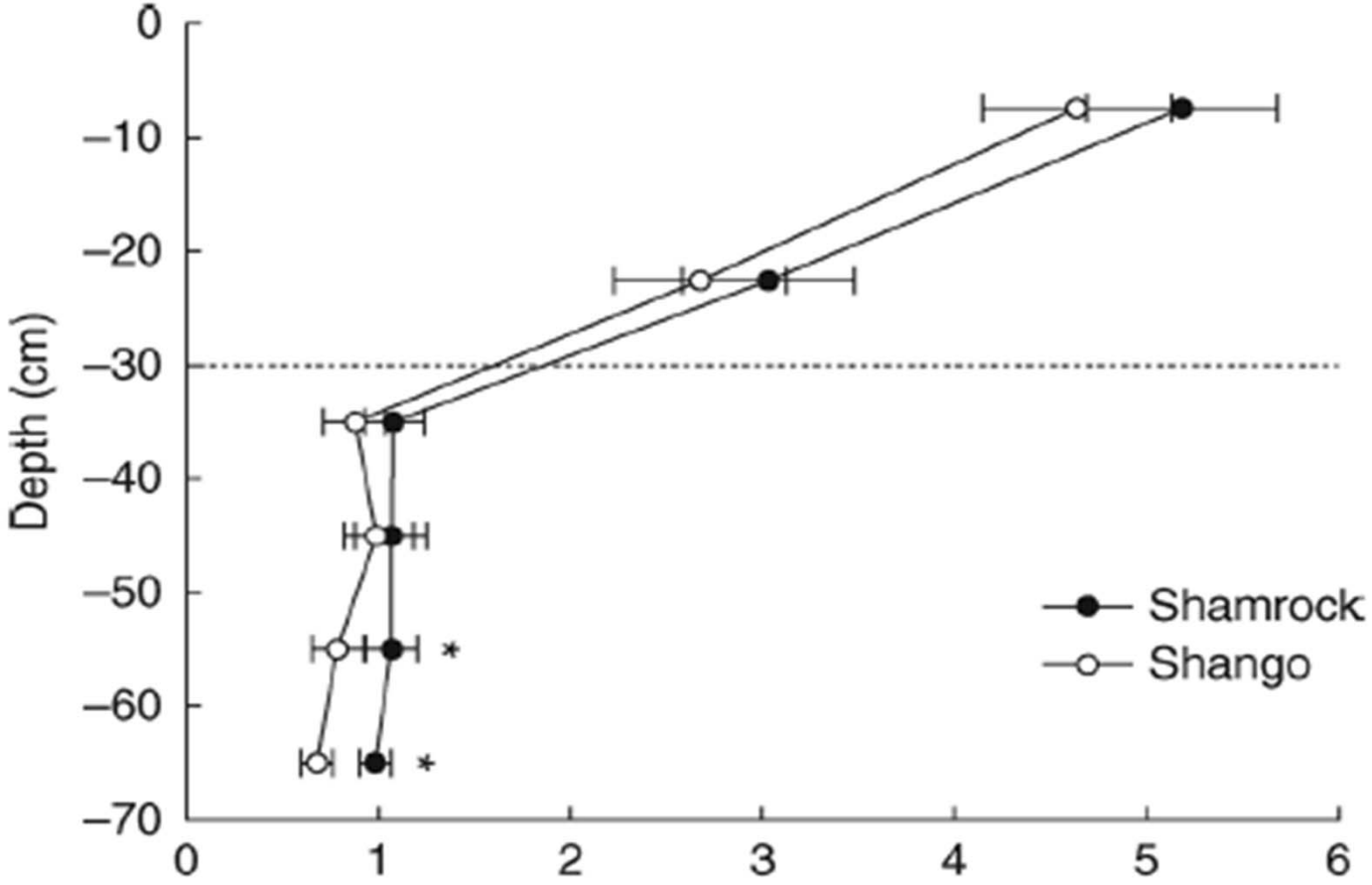
BLOCK AND/OR SLIDE

# The refurbished rhizolab – East Malling 2013

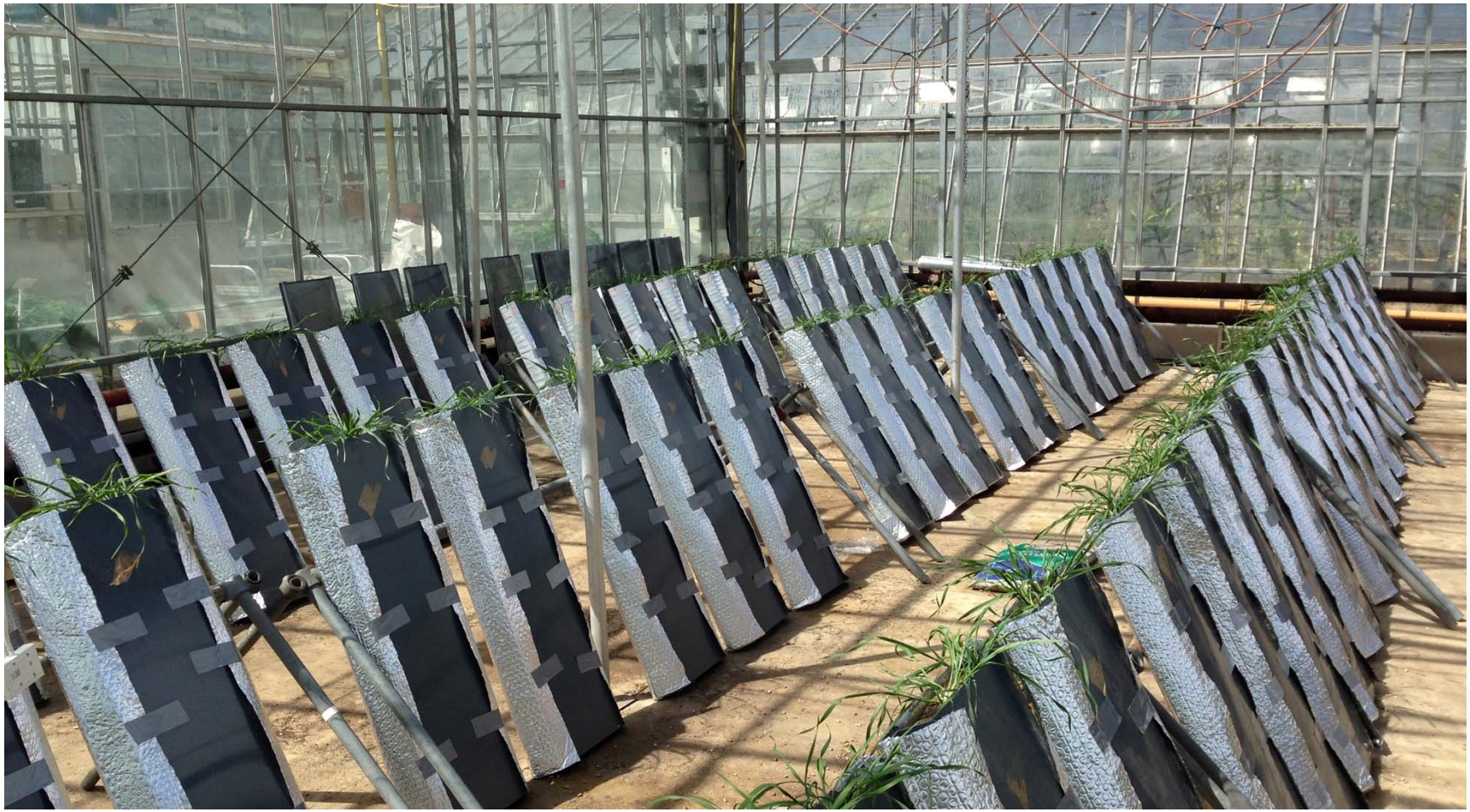
# The refurbished rhizolab – East Malling 2013


HYDRO
CARE

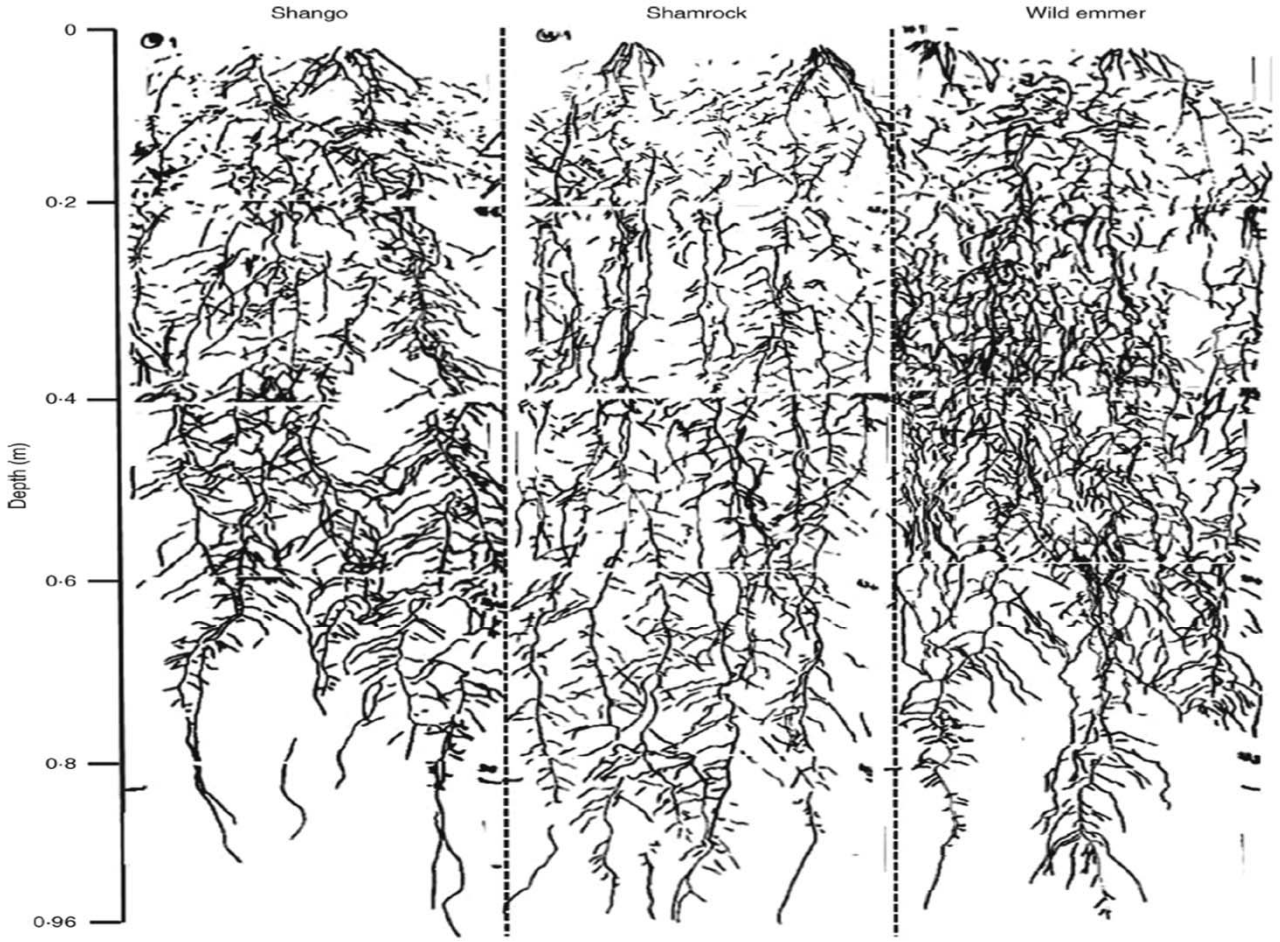
# Differences in roots at depth for two genotypes of winter wheat (Clarke et al., 2017)



# Rhizoboxes in a glasshouse



# Acetate tracings of roots at the soil/glass interface at 45 days after sowing (Clarke et al., 2017)

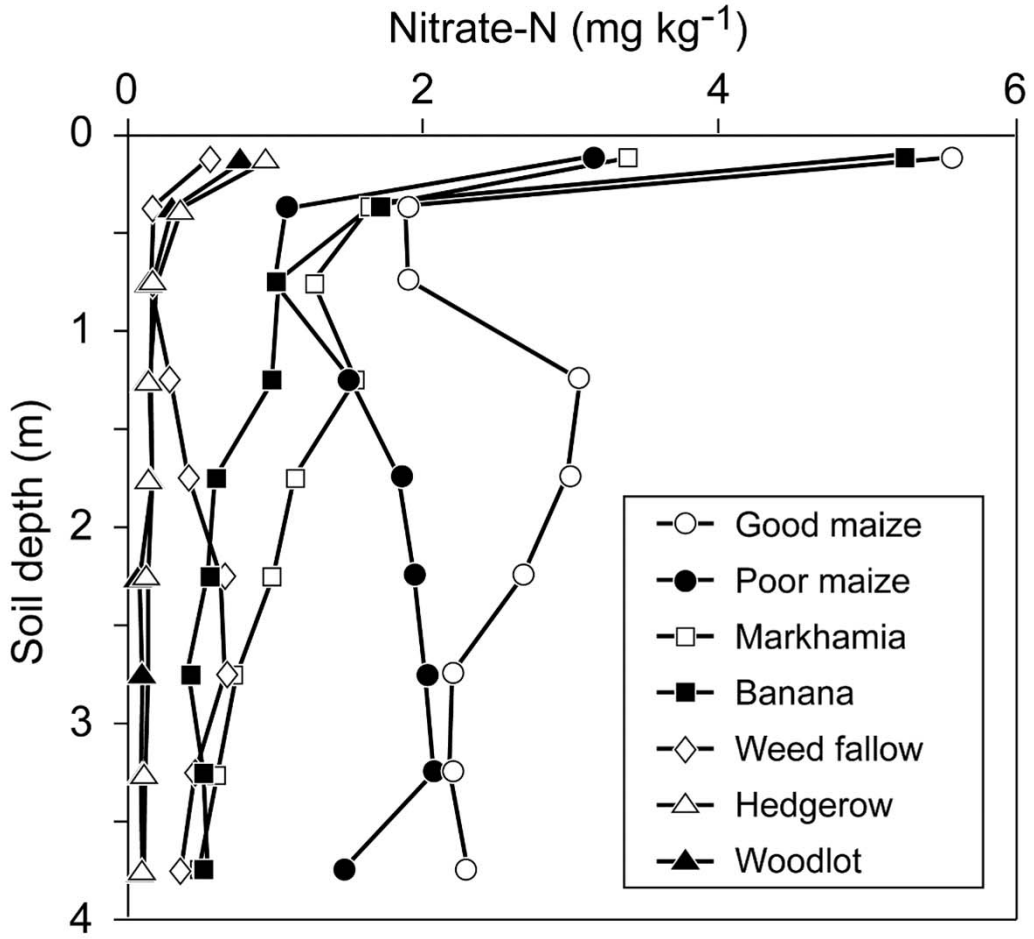


# Use of Ground Penetrating Radar (Guo et al., 2013)

- Coarse roots can be identified and growth measured with repeat scans over time
- Best results obtained on well-drained and electrically-resistive soils (e.g. sands) under dry conditions
- Results influenced by:
  - Local soil conditions
  - Root electromagnetic properties
  - GPR antenna frequency and placement

# Typical mixed cropping in central Kenya

Nitrate concentrations at the time of maize harvesting under seven different vegetation types on smallholder farms in western Kenya (Shepherd et al., 2000)



# Important issues

- Deep roots require deep soils
- Deep roots occupy a tiny proportion of the soil volume – finding them is hard work
- It is often easier to measure the consequences of deep roots rather than their direct presence
- Non-invasive techniques are desperately needed.

# Pertinent research questions

- Is a non-invasive method for measuring deep roots feasible?
- Given the costs involved, should the results of deep root activity be measured rather than the presence of roots *per se*?
- Under what circumstances do deep roots confer long-term (sustainable) advantages to crops and trees?