Simulating Root Density Dynamics and Nitrogen Uptake – Can a Simple Approach be Sufficient?

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Objective for this work

Our use and purpose of a root sub-module in a soil plant model

– Model used as a management tool in field scale

What do we observe in our field trials?

– Highly difference in root development between species

Lack of flexibility in soil plant model

– Models we are using can not simulate all crop species as regards to root profilation and N uptake from deeper soil layers

Improvement of root model

– Contribution to root modeling for better simulation of N uptake in different soil layers in field scale

Next step

– ***Paramatisation and validation of model to field data - In progress now!***

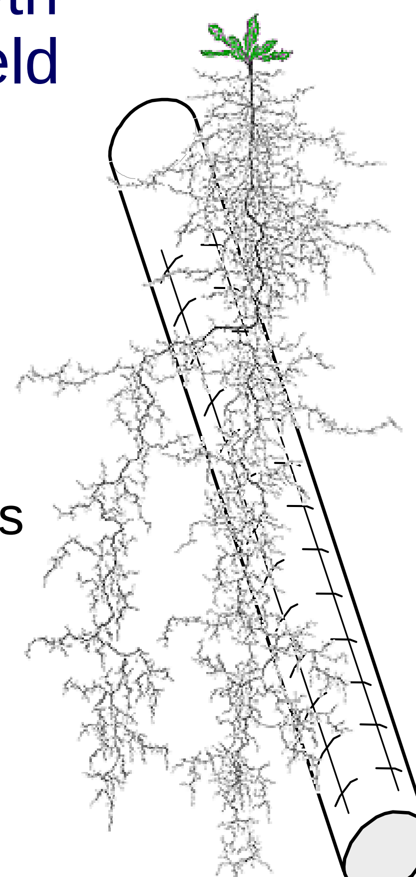
- Our use of a plant soil model:
  - Simulate 1-5 years of a rotation
  - Predict N uptake and the amount of residual N in the rooting zone
  - In general as a management tool to avoid N losses
  - Rotation includes cereals, vegetables, catch crops

15 years of field trials at University of Aarhus, (Former DIAS), has given insight into root development and soil mineral N dynamic

Field observations of root growth by using minirhizotrons in field plots:

Information:
- Rooting depth
- Rooting intensity
- Below and between crops rows

Further measurements:
- Biomass production
- Soil mineral N in rooting zone



Observations of root development in field trials

Arable crops

- Mono/dicot
  - » Eg. Spring cereals ~1m, Winter cereals ~1.5m, sugar beet, oil seed rape >2m

Vegetable crops

- Mono/dicot, short/long season, harvest over season
  - » Eg. Onion, leek ~0.35m, cauliflower ~1m, white cabbage >2m

Catch crops

- Mono/dicot, winter persistent
  - » Eg. Ryegrass ~1m, fodder radish >2m

Field Data:

- Some species had deep root growth and high root density in deeper soil layers
- Some species show affinity to N uptake from deeper soil layers

Our approach for the root model:

- Flexible with a simple root model setup to adapt root development, for covering the significant different root pattern we observed between mono/di-cot species

- Simple setup to manage root development and N-uptake

- The root model should improve N dynamic calculations influent by crop N uptake in **FIELD SCALE**

Root module contains:

Rooting depth

Accumulated temperature with individual T_{min} T_{max} for crops and a crop specific root penetration rate

Control

Rooting depth

Row crops: Horizontal / Vertical growth

Root profilation

Exponential decrease of root density in soil profile

One form parameter adjust root density

Control

Root density at different depth

Row crops: Root density below or between rows

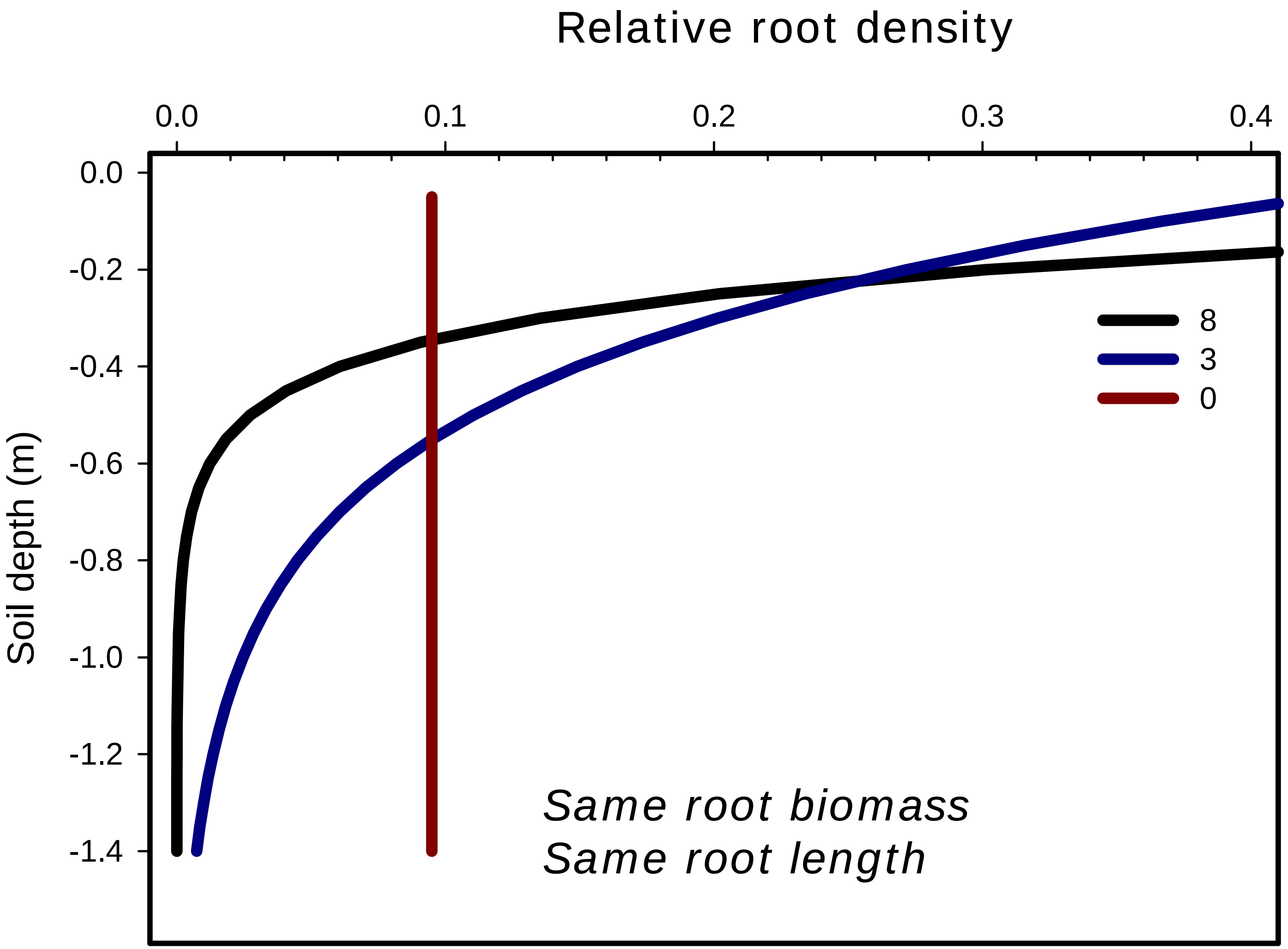
N-uptake

N-uptake is calculated by each unit of root length

Other relation for the root module to soil module and crop calculation above ground:

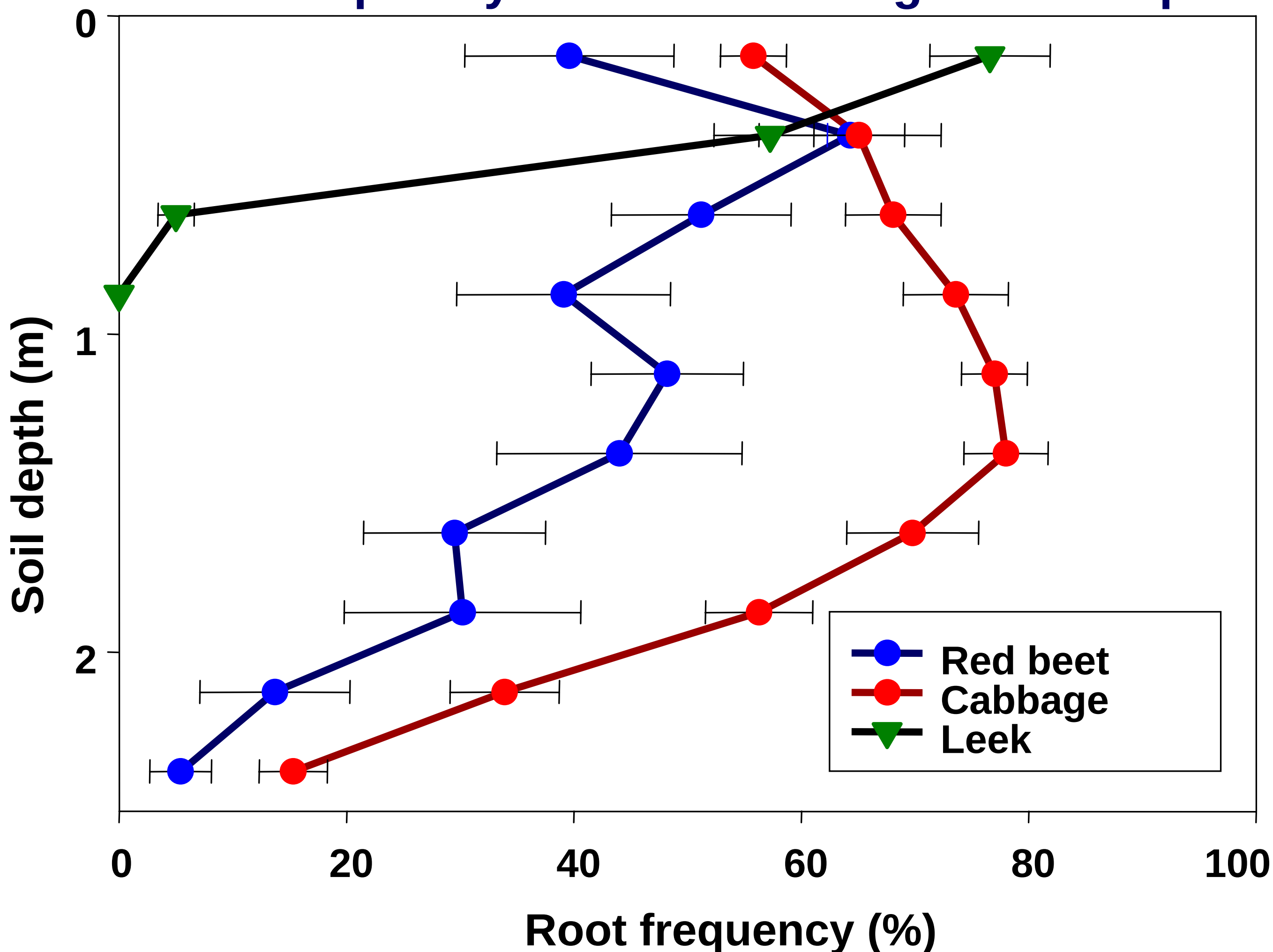
Shoot/root ratio, daily water and N-demand, min. and max. temperature for growth, water uptake, soil water content, soil bulk density

Root density – One form-parameter



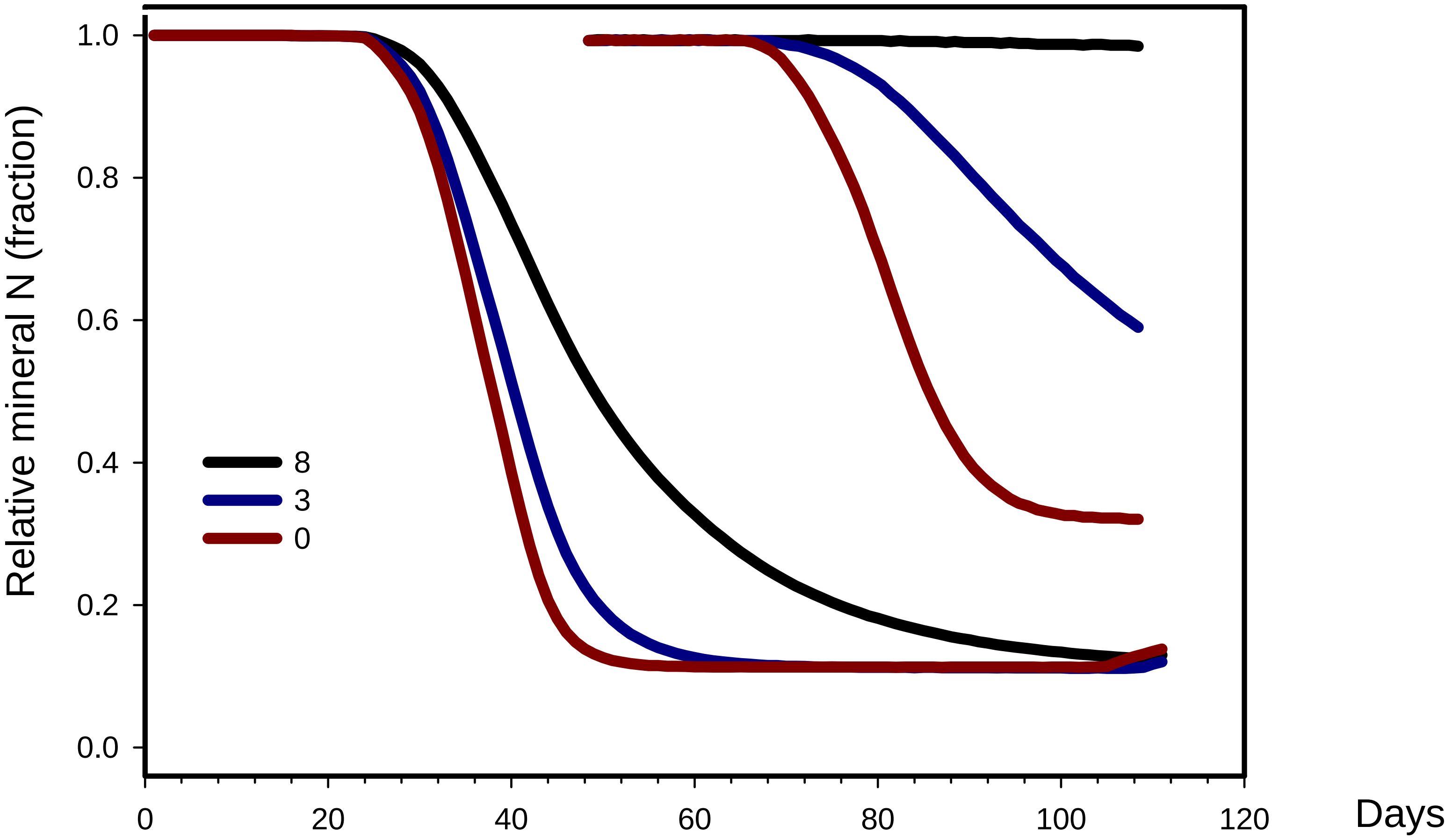
Pedersen et al. In prep.

Root frequency at harvest of vegetable crops



N uptake (Low N conditions)

Soil layer 0.25-0.50 m Soil layer 1.00-1.25 m



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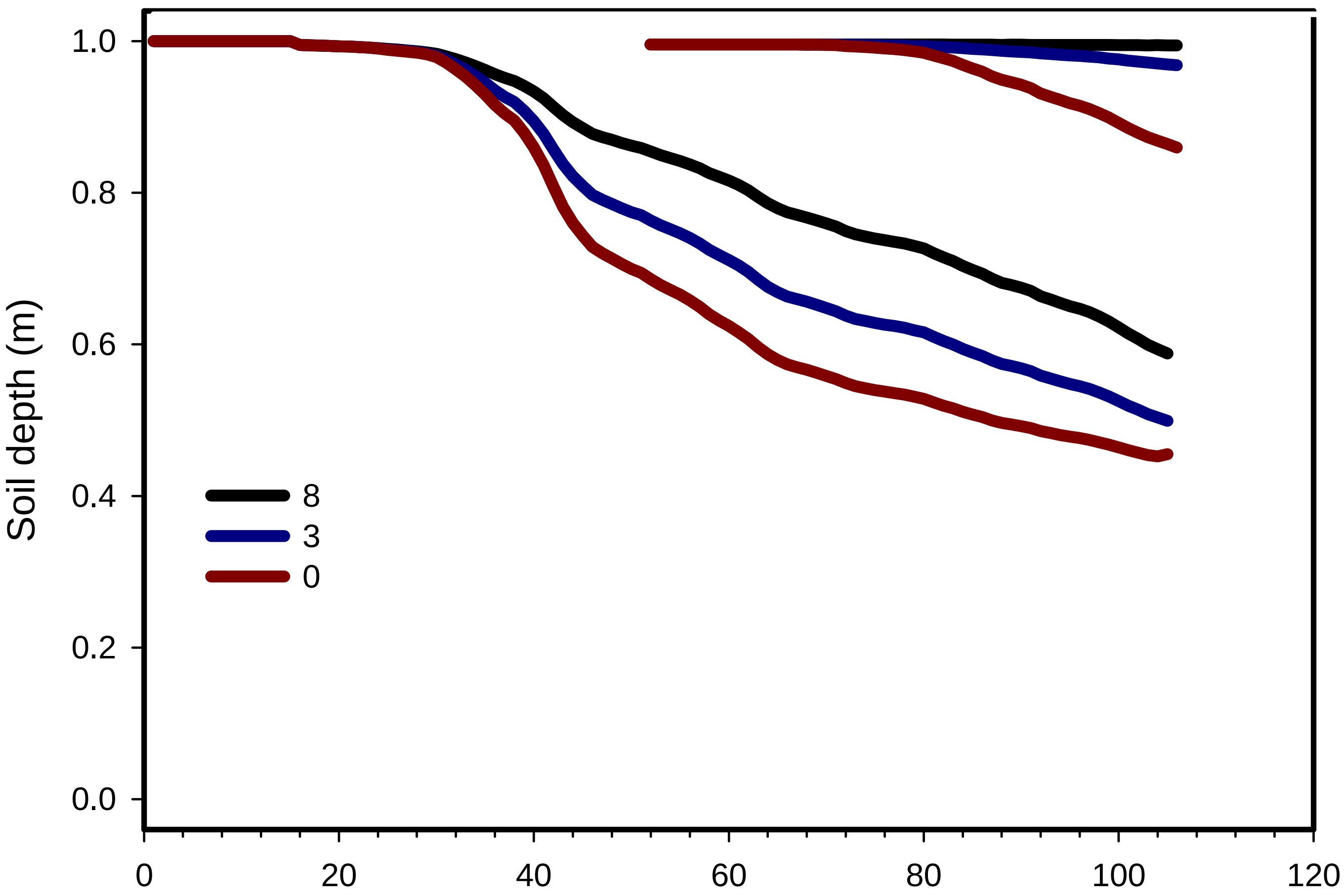
N uptake (High N conditions)

Soil layer 0.25-0.50 m Soil layer 1.00-1.25 m



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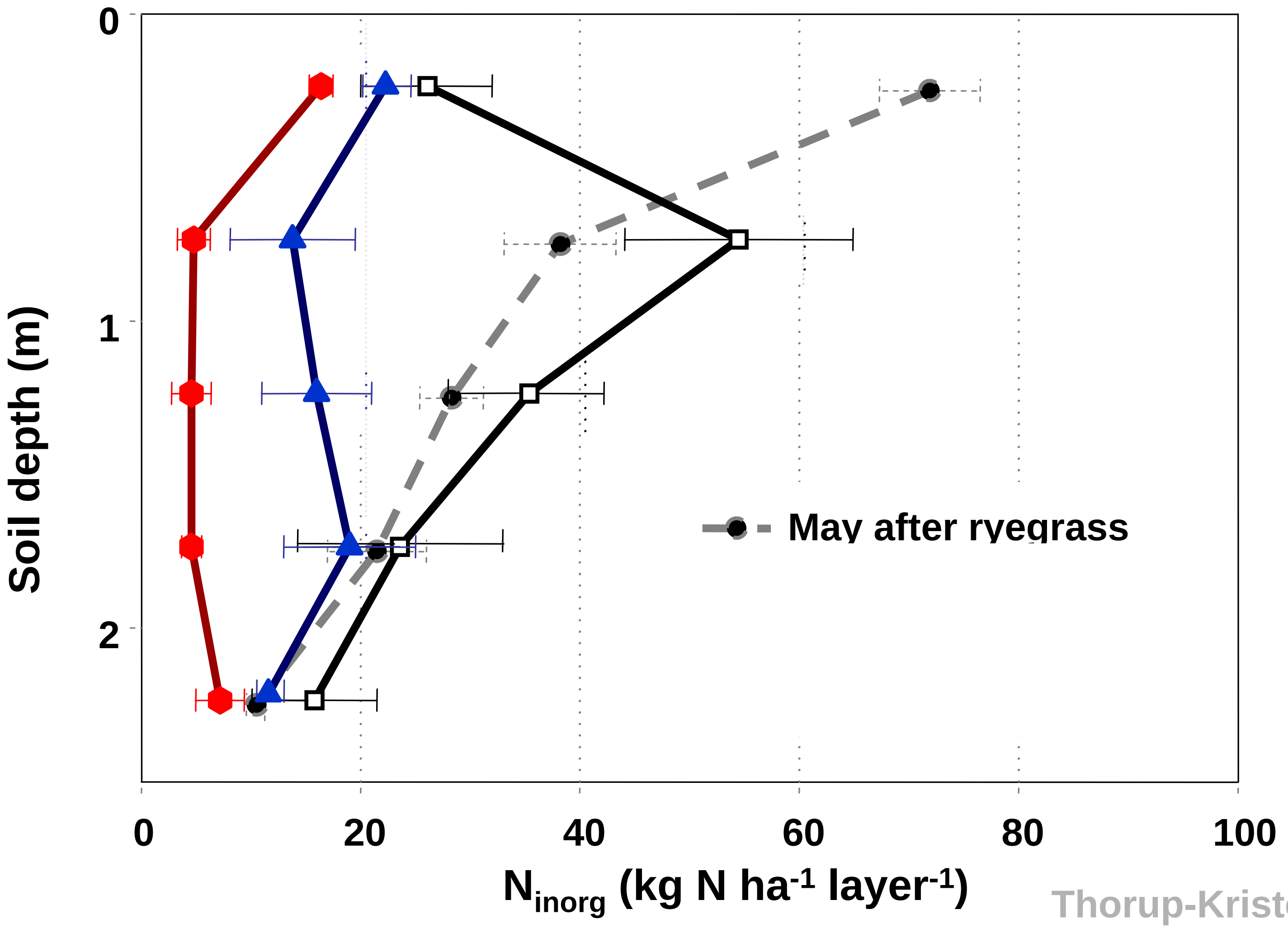
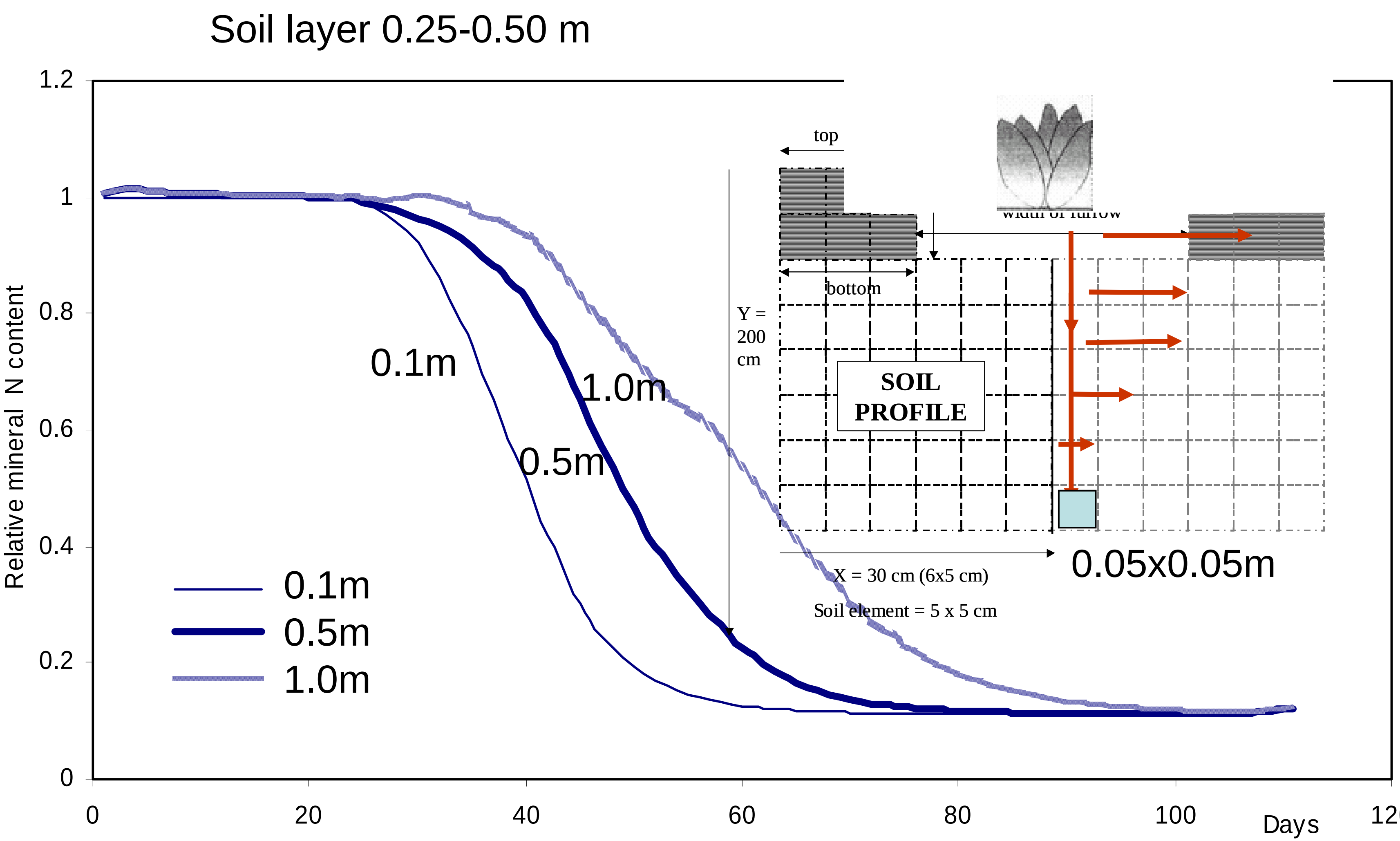
N uptake in the soil profile

Vegetable effect on N profile at harvest
- after ryegrass catch crop



Thorup-Kristensen K 2006

Row crops, Increasing row width and N uptake



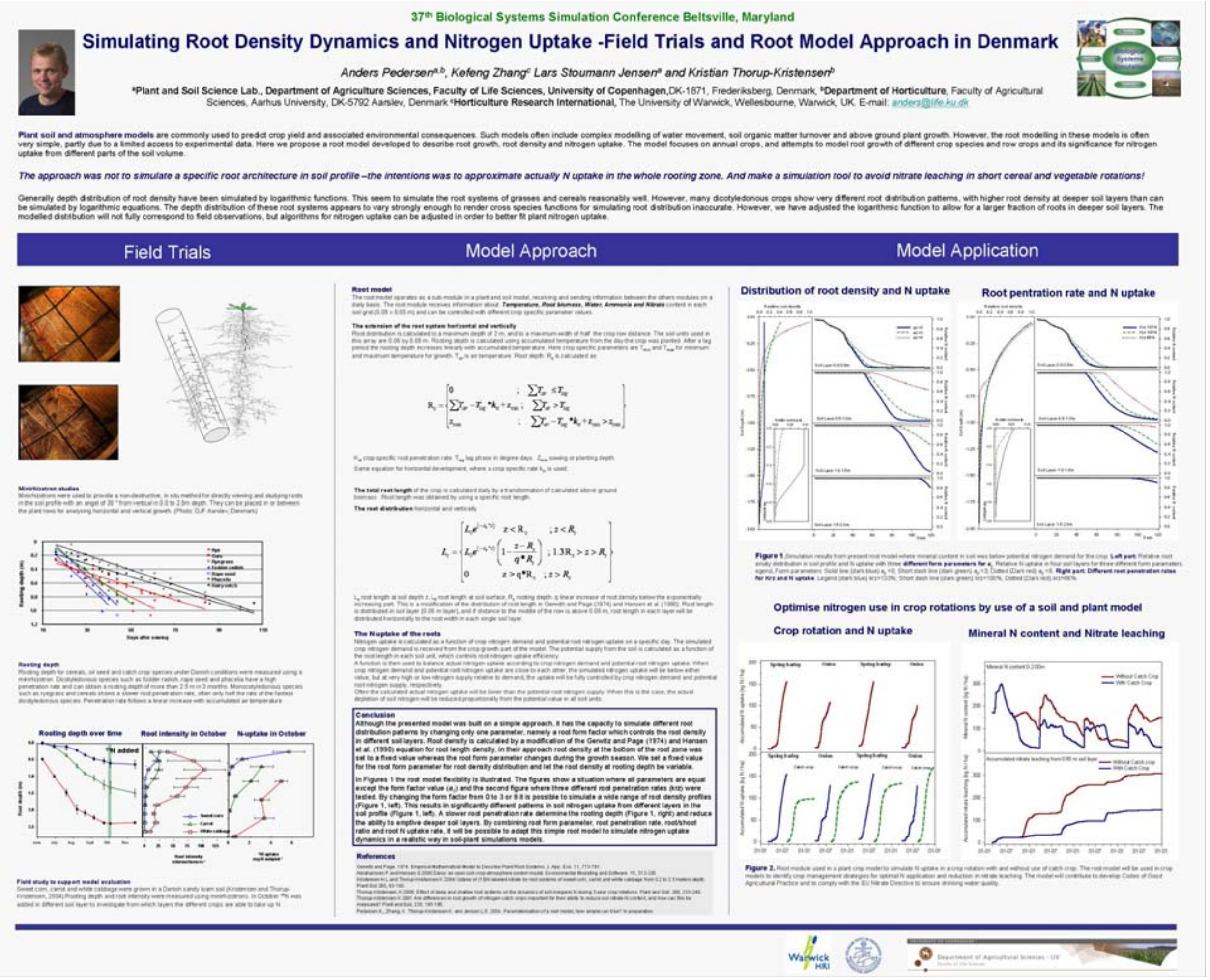
Pedersen et al. In prep.

Conclusions

- Simple approach
  - To simple application for:
    - Calculating root length in the surface layer
    - Identical root density calculation as measured in field trials
  - Possible to model:
    - Rooting depth
    - Manage high or low root density in deeper soil layers
    - Simulate N uptake from deeper soil layers
    - Simulate different crop species in relation to N-uptake

Future work –paramatisation and validation of model to field data!

- More information at my poster



- Thank you for your attention

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- **EU-Rotate_N** *European Community network to develop a model based decision support system to optimise nitrogen use in horticultural crop rotations across Europe*
- *http://www.hri.ac.uk/eurotate/index.htm*

- **Simulating Root Density Dynamics and Nitrogen Uptake – Can a Simple Approach be Sufficient?**

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