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3rd International Congress on Planted Forests

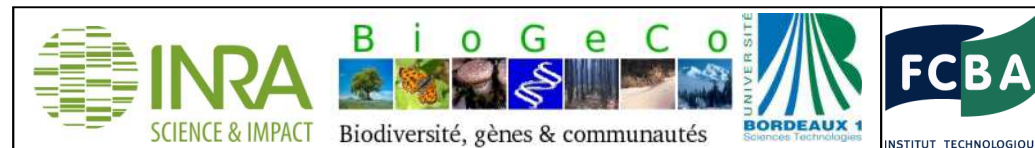
Influence of reafforestation techniques on architectural development of the root system and on toppling in *Pinus pinaster* saplings

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Background

Aerial structure



Wind resistance



2009 : Klaus storm

Standing volume 140 M m³ (1999)

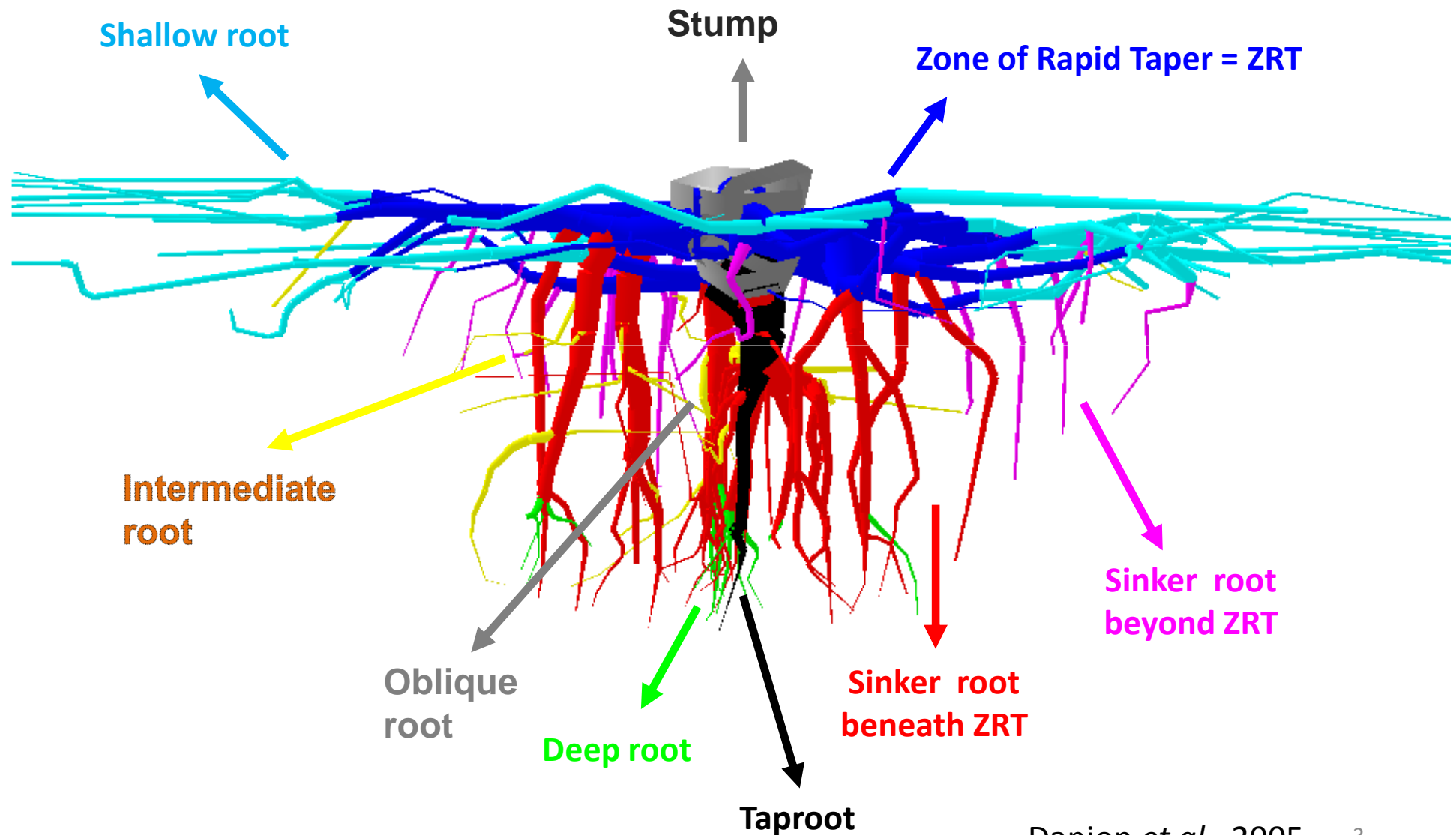
➔ 74 M m³ (2009)



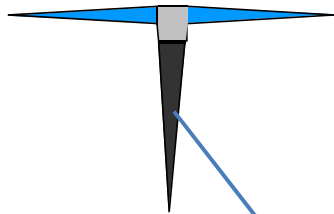
soil * root system = anchorage

Roots are subjected to wind force

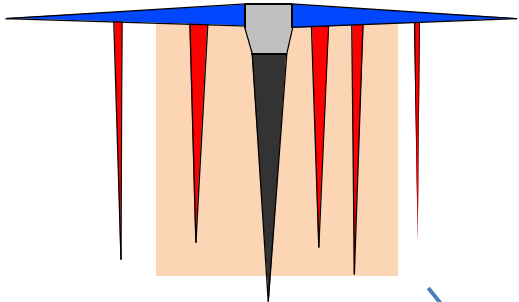
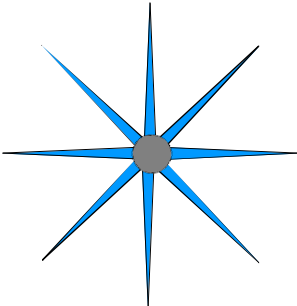
Schematic representation of the nine architectural compartments of the root system of maritime pine



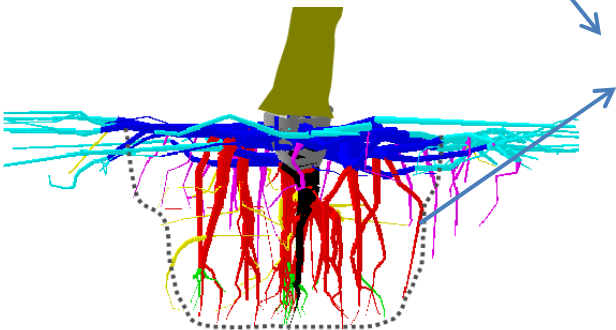
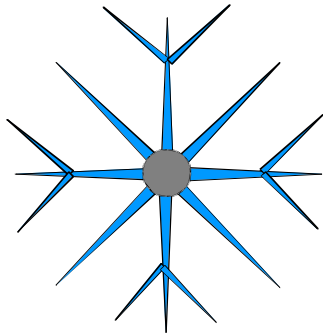
Development of maritime pine root system



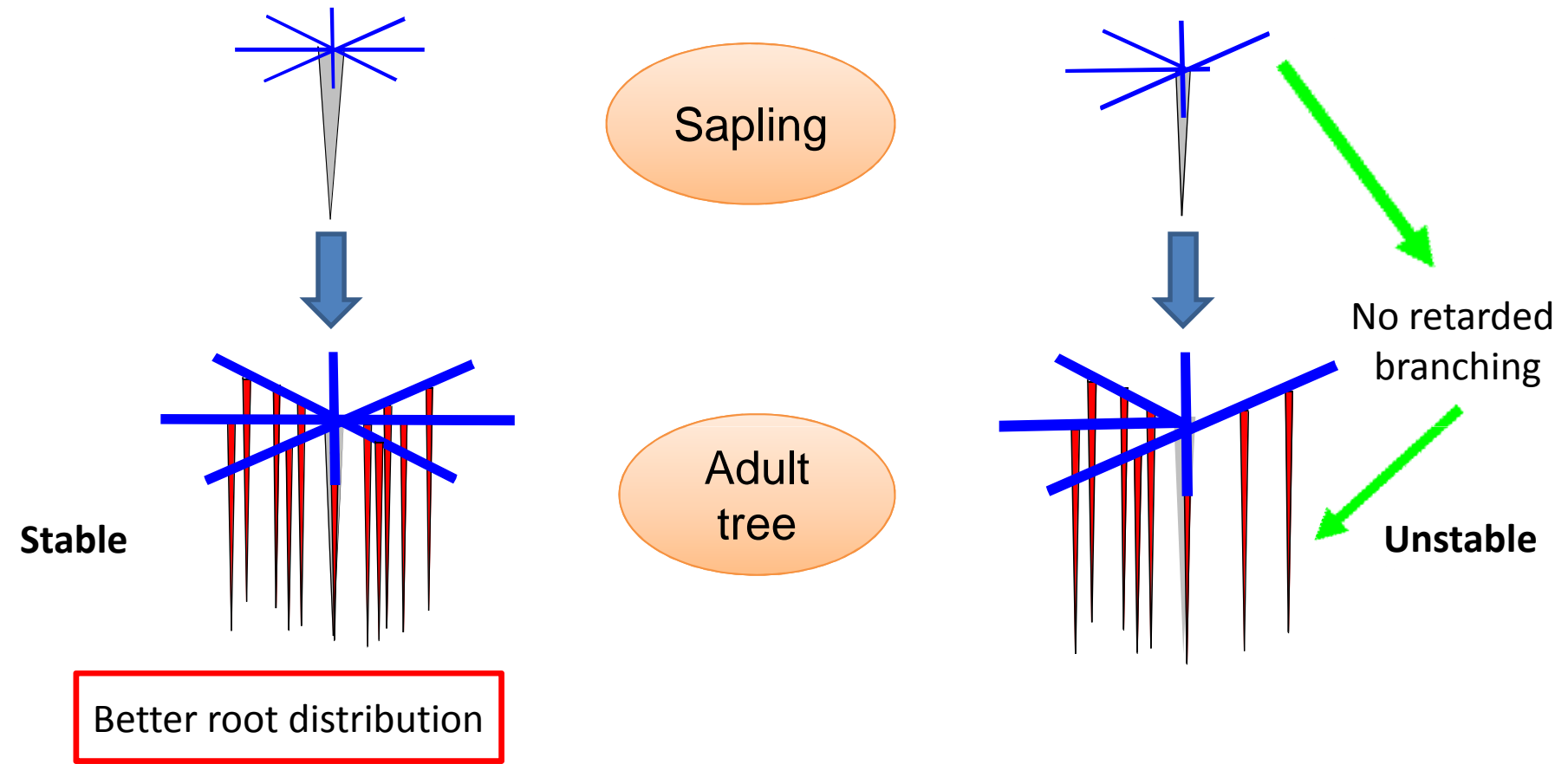
Sapling



Adult tree



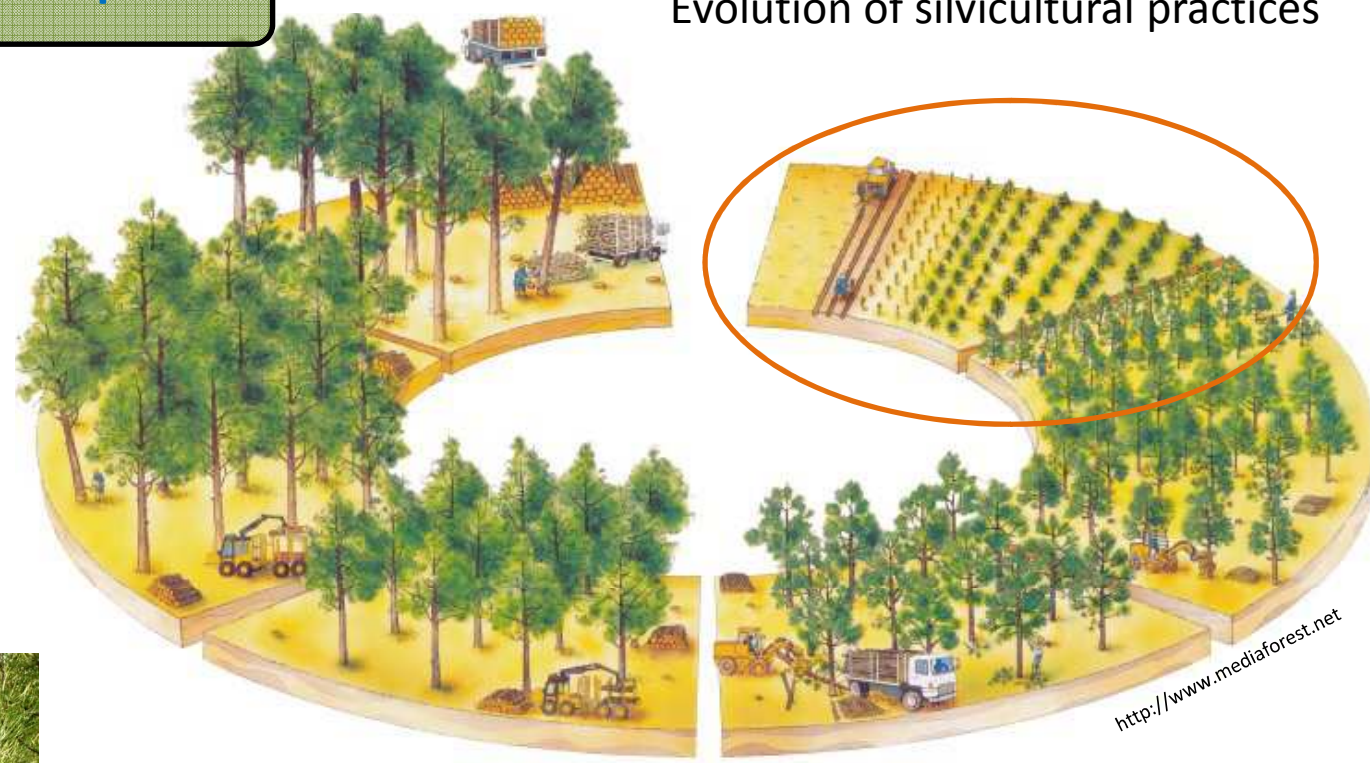
Development of maritime pine root system



If the circular distribution of the roots of the sapling is not homogeneous,
➔ the cage will be incomplete

Reafforestation techniques

Evolution of silvicultural practices



≠ type of tillage

Example of Strip ploughing

Planted or seeded trees

40% → 80% of planted trees

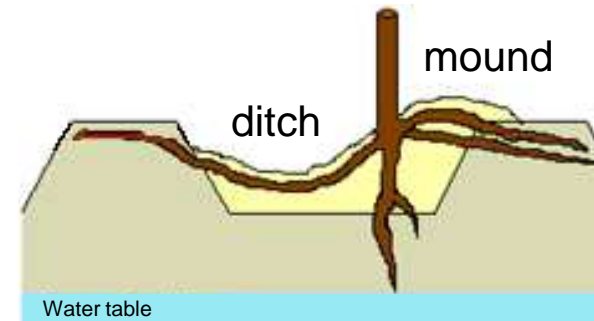


Hypotheses

How does the **microtopography** influences the development of the maritime pine root system?

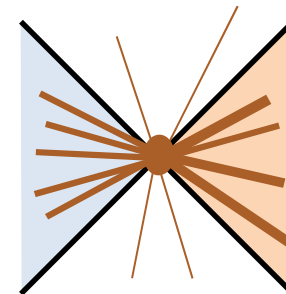
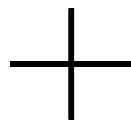
Microtopography affects

- the geometry of the root system
 - the soil volume around the tree
- ➔ changing its wind resistance ?



What are the differences in root development between different toppling levels?

Undamaged pines have a bigger and deeper taproot and also a larger volume of roots, leeward and windward.



How does the **establishment** (seeded or planted trees) influences the development of the maritime pine root system?

Choice of observation stands



Seeds



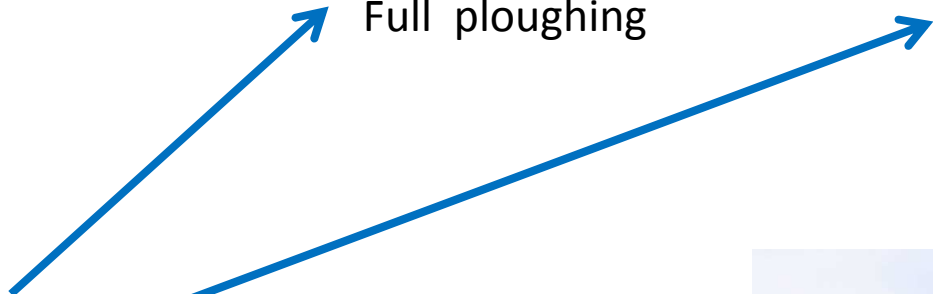
Full ploughing



Rotary ploughing



Planted trees



Strip ploughing



tree sampling for root architecture assessment

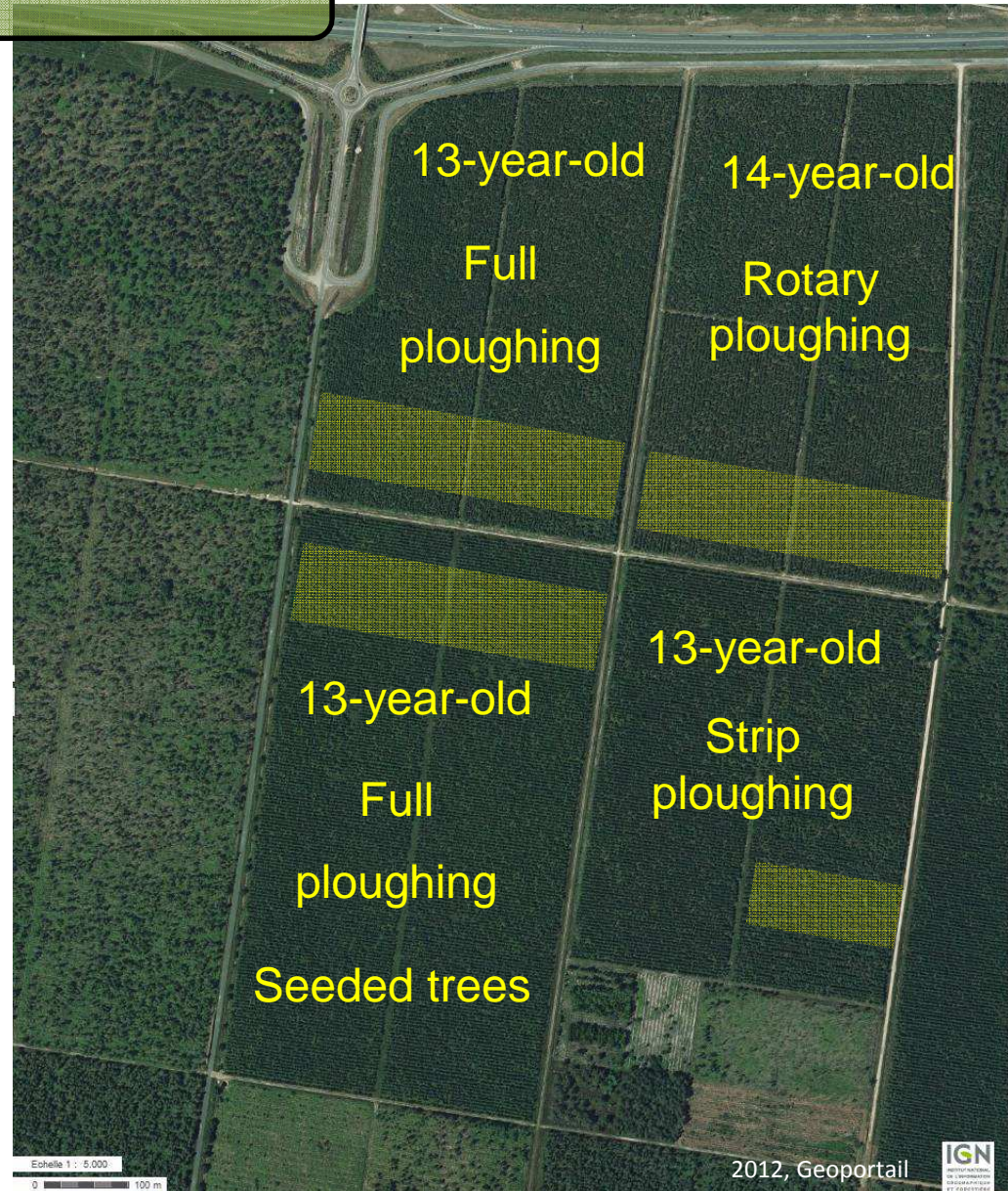


damaged by
Klaus Storm in 2009

In each stand 9 trees

- ||| Undamaged trees
- /// Leaning trees
- /// Toppled trees

Same tree dimensions



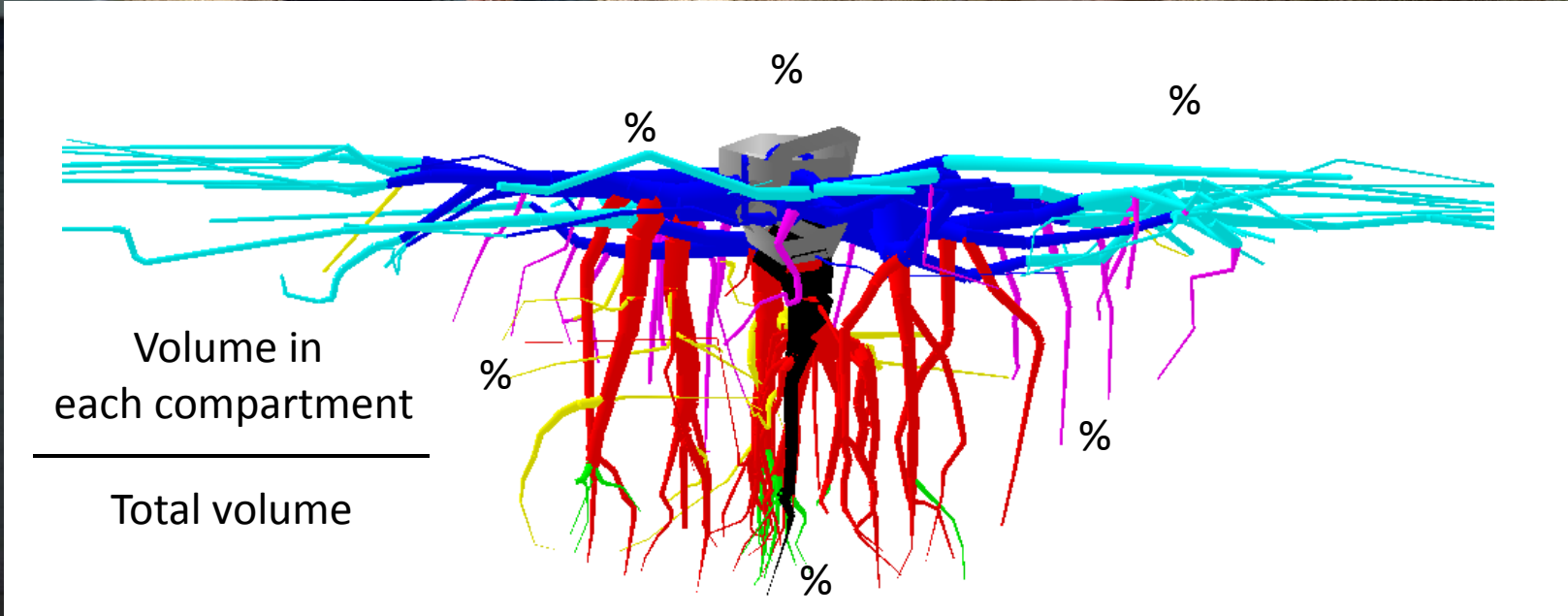
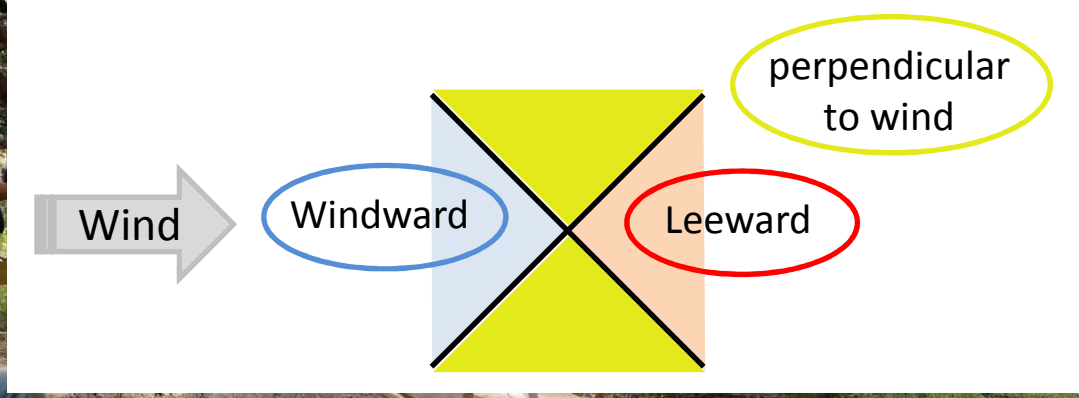
uprooting of (9 x4) root systems



3-D digitizing of root systems

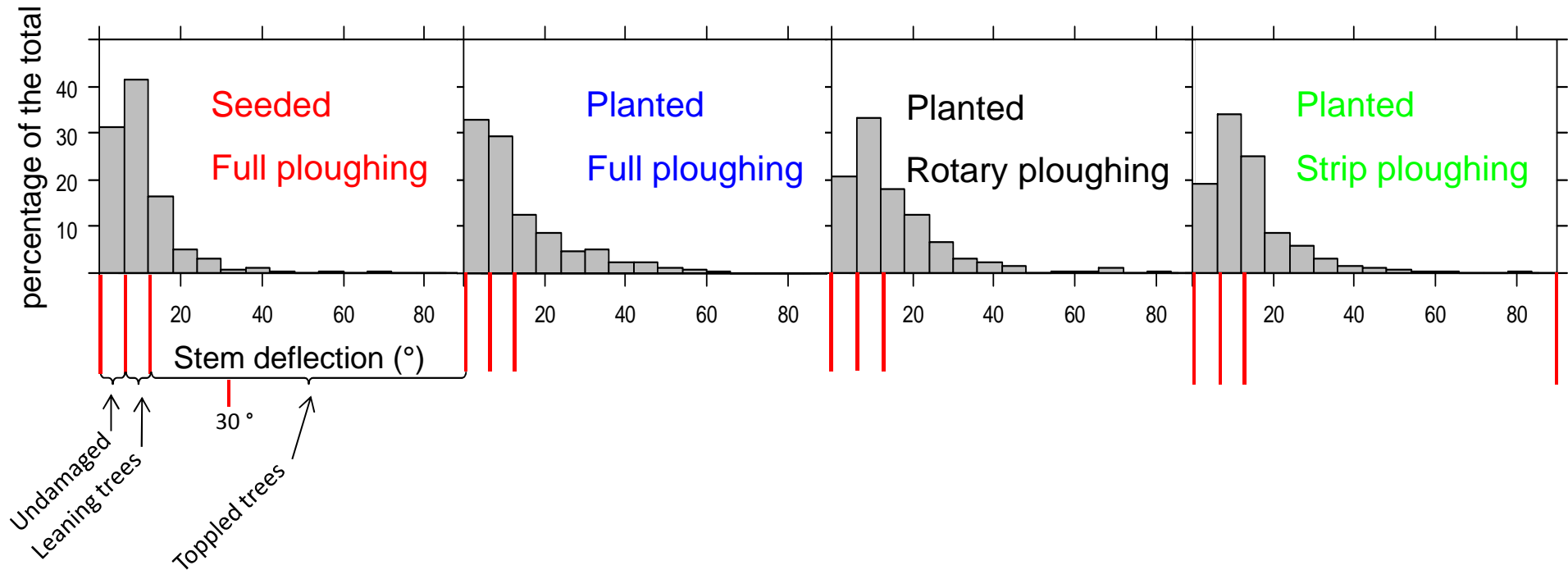


3-D digitizing of root systems



Analysis of variance on 300 variables

RESULTS: Inventory of damage at stand level

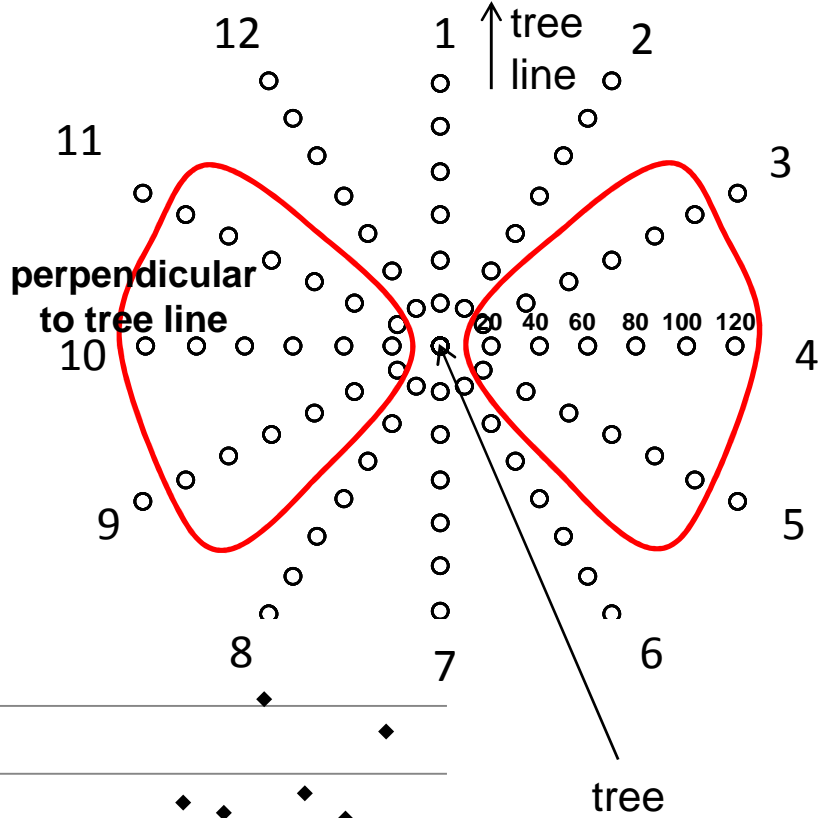


- ➔ There are more undamaged trees on "planted, full ploughing" stand than on "planted, rotary ploughing" and "planted, strip ploughing" stands
- ➔ There are more topped trees on the "planted, full ploughing" stand than on "seeded, full ploughing" stand.

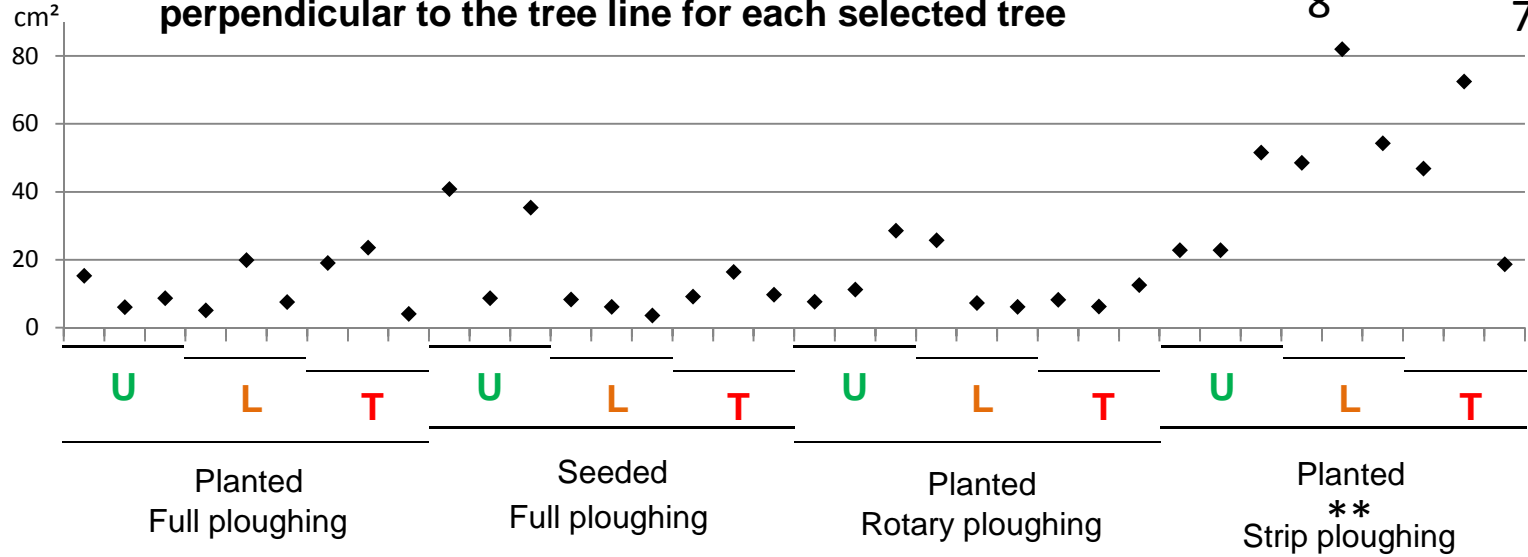
RESULTS: Microtopography measures around the selected trees



Microtopography comb



average altitude variance of the 6 radius perpendicular to the tree line for each selected tree



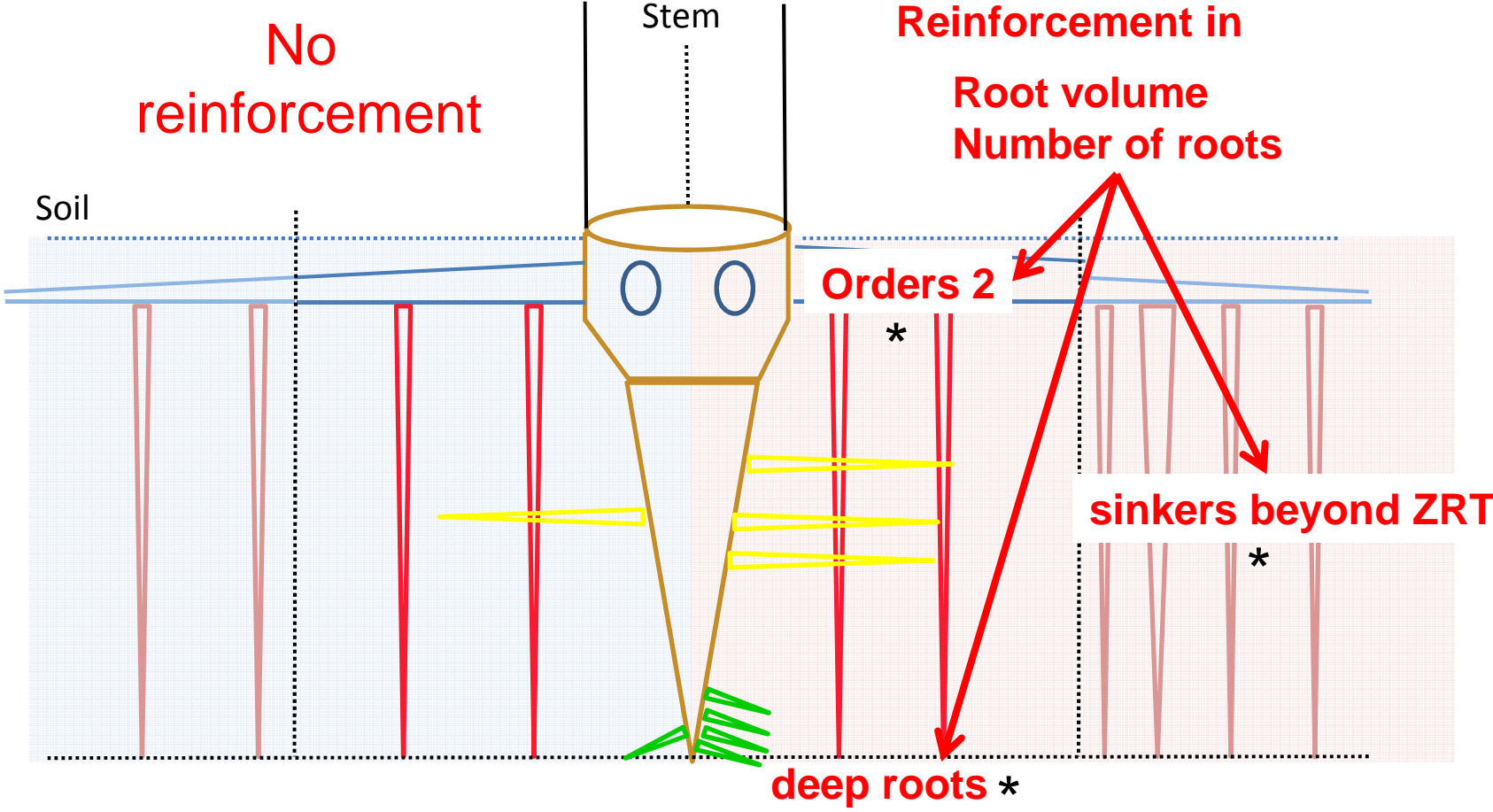
- legend
- U : Undamaged tree
 - L : Leaning tree
 - T : Toppled tree

RESULTS: Undamaged / Toppled trees

Windward

Undamaged trees

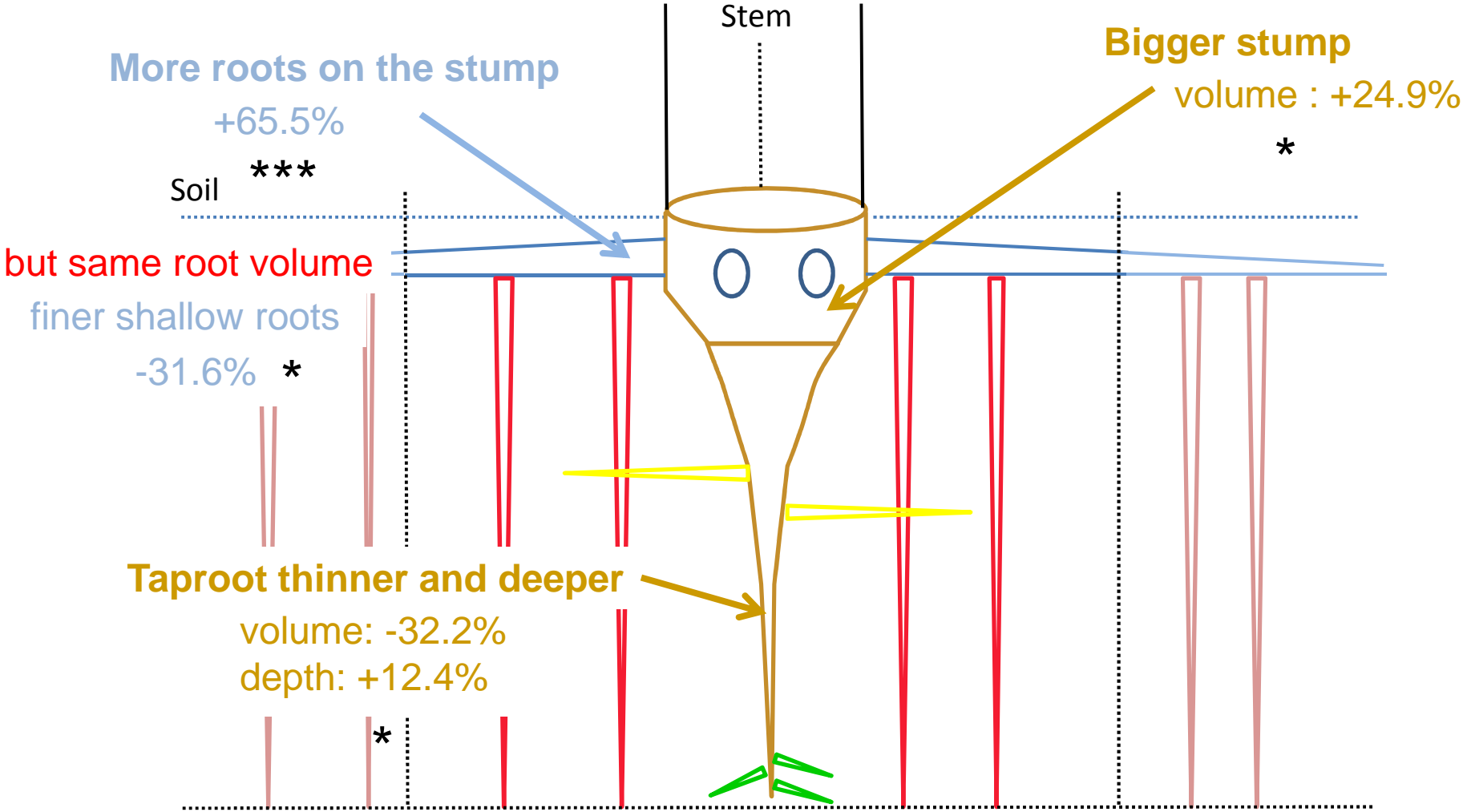
Leeward



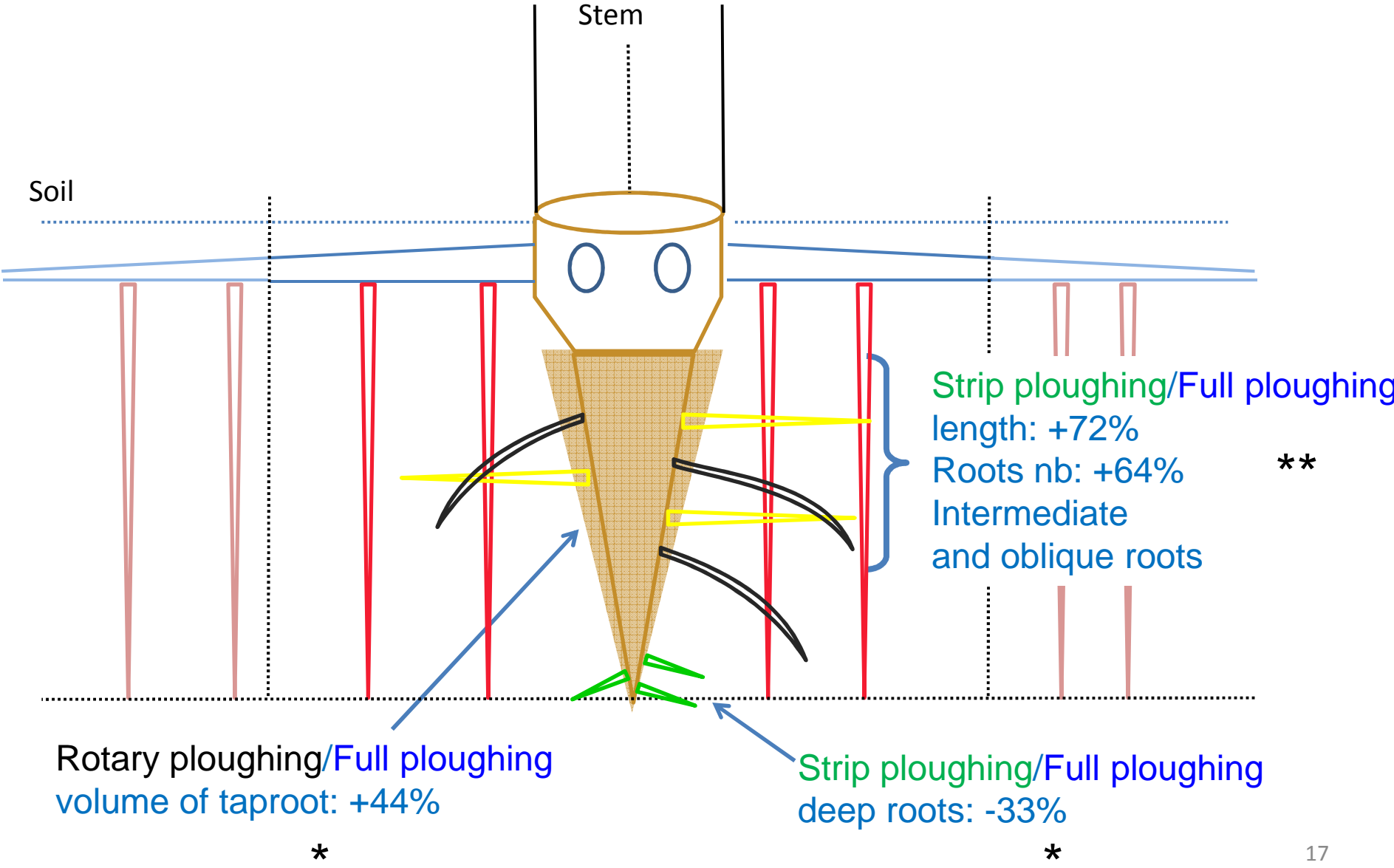
**For the undamaged trees
Not the same reinforcements leeward**

RESULTS: Planted / Seeded trees

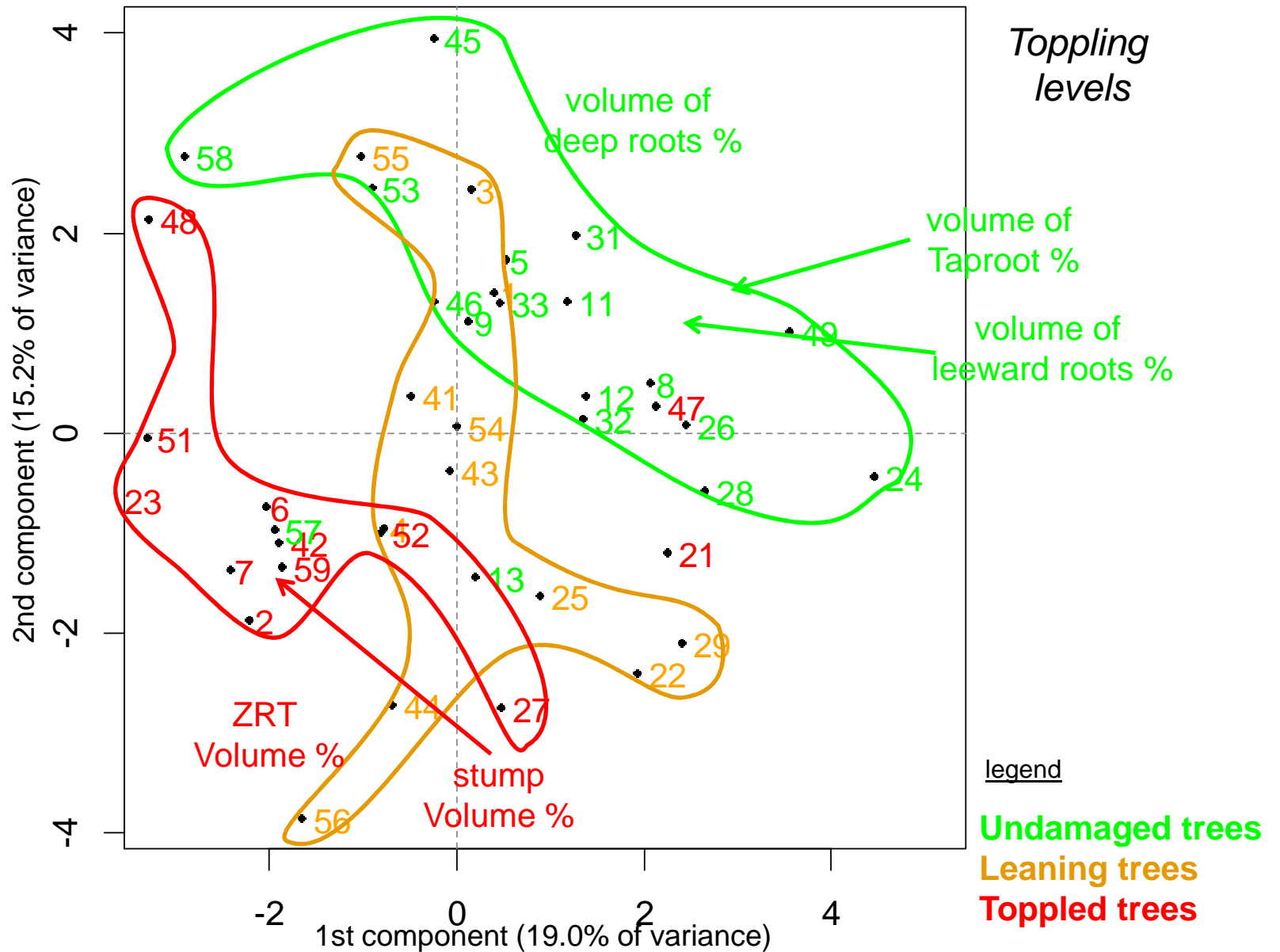
Planted trees



RESULTS: Tillages



RESULTS: Principal component analysis (PCA) of tree characteristics



Discussions

Differences in the reinforcement between planted trees and seeded trees

could be explained by morphology differences

Planted trees

bigger stump,
numerous thinner shallow roots



not the same
biomass distribution

BUT

Seeded trees

bigger taproot,
thicker shallow roots



same percentage
of undamaged trees



several optimal root systems resisting to the wind

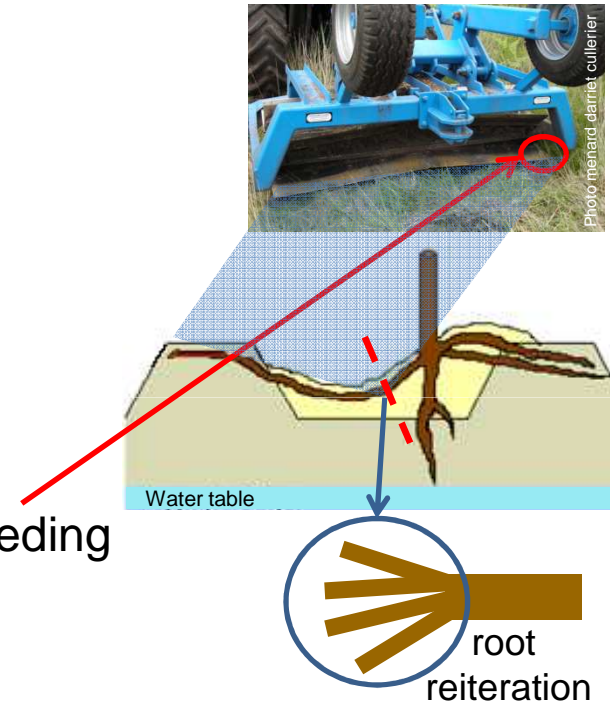
Discussions

Differences in the root system of trees from different tillages

Only few differences between the 3 tillages

Trees of rotary ploughing stand have a bigger taproot
➡ better planting bed ?

Volume and number of intermediate and oblique roots
in the strip ploughing ➡ Injuries by mechanical weeding



No differences linked to toppling level

Ditch of the strip ploughing ➡ wind direction

It would be interesting to have a ditch perpendicular to wind direction

Discussions

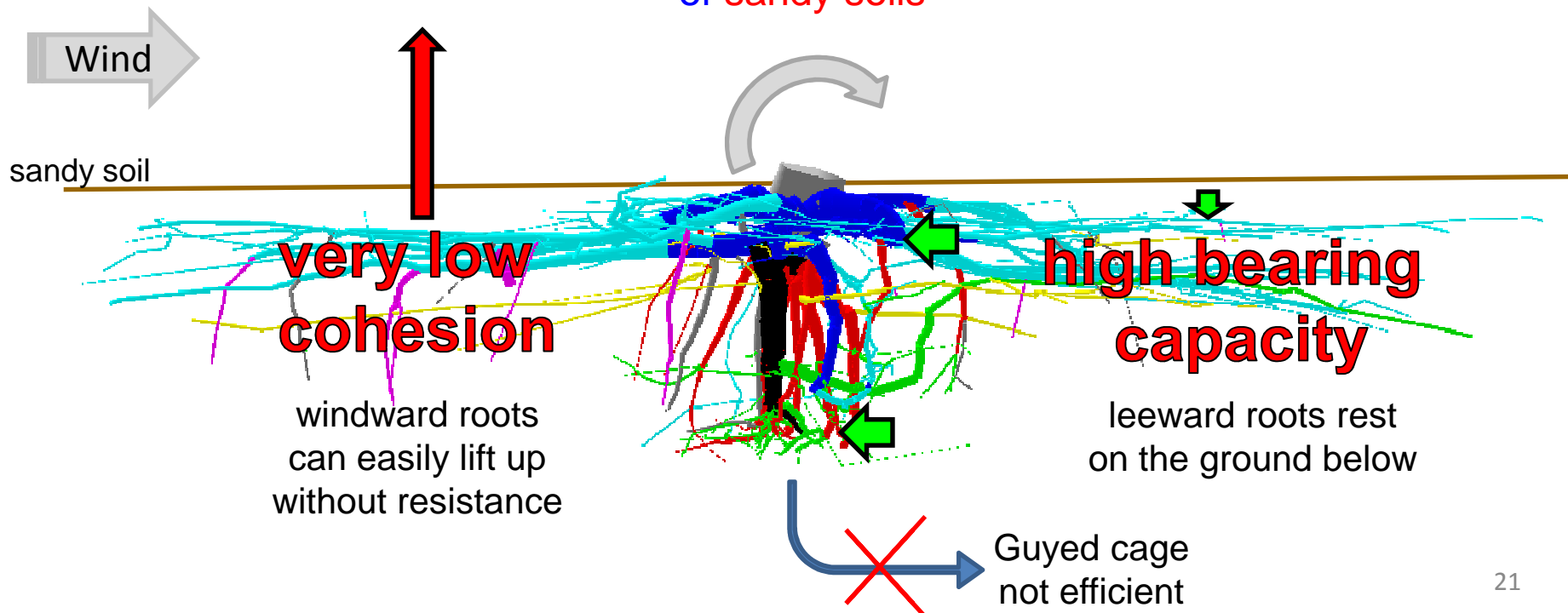
According to tree size, the mechanical design of root system changes.

For 8m trees

➔ the influence of **windward** roots in the stability is limited

➔ there is reinforcement in **leeward** roots

explained by the properties
of **sandy soils**





Thanks for
your attention

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