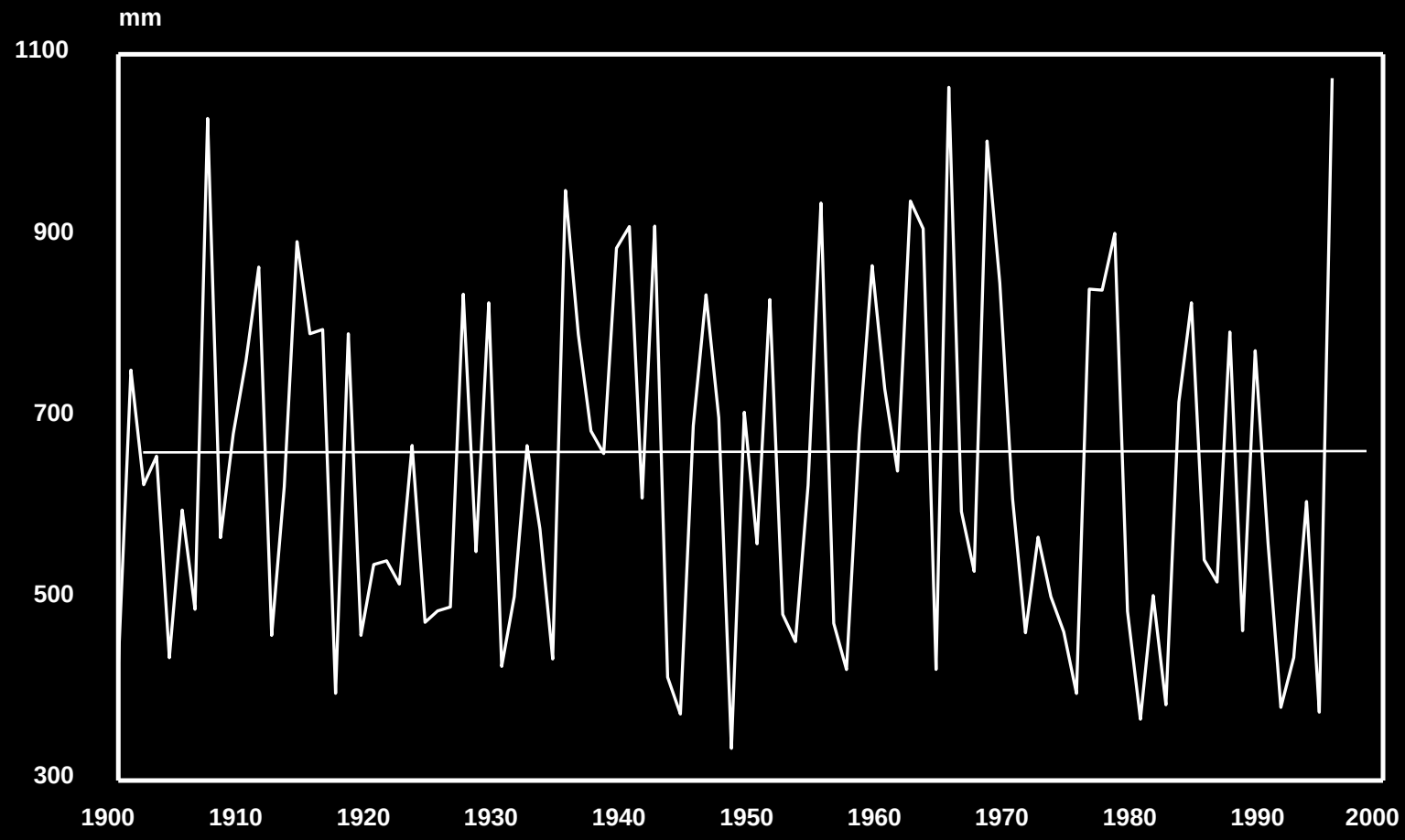
Efficient use of water under Mediterranean conditions: Agronomic tools

Mário Carvalho

Variation of Annual Rainfall (Évora)



Water deficit in spring
Rainfall variability
Complexity of agronomic solutions

Agronomic tolls discussed

Amount of Water Available to the Crop

- Runoff
- Storage porosity
- Evaporation
- Root depth

→ Tillage

- Water transference between seasons → Crop Rotation

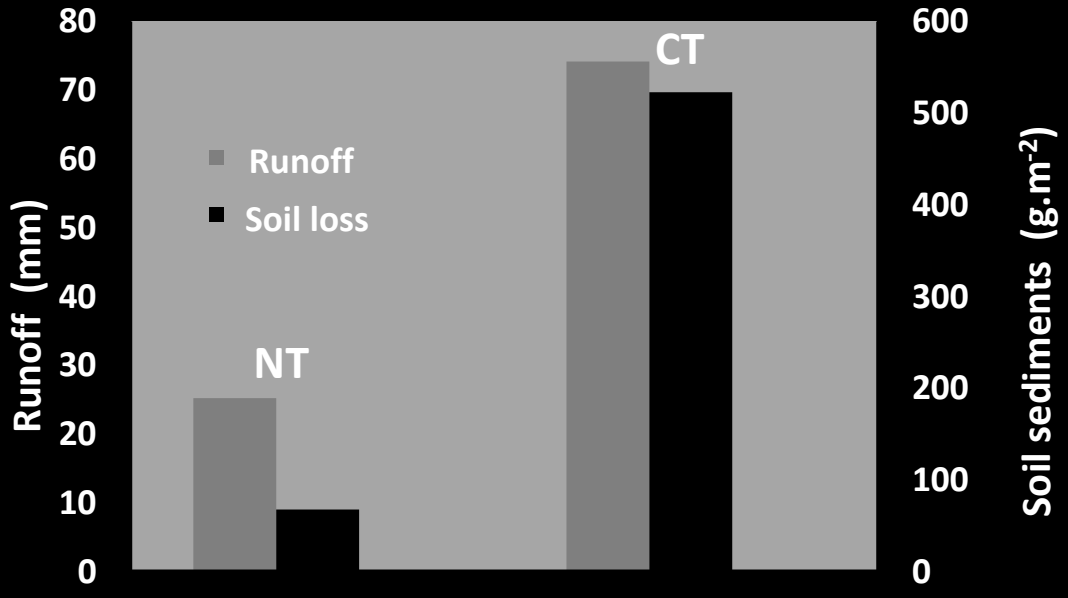
Water use efficiency by the crop

- Seeding time and choice of cultivar
- Fertilizers application
- Weed control

→ Soil trafficability

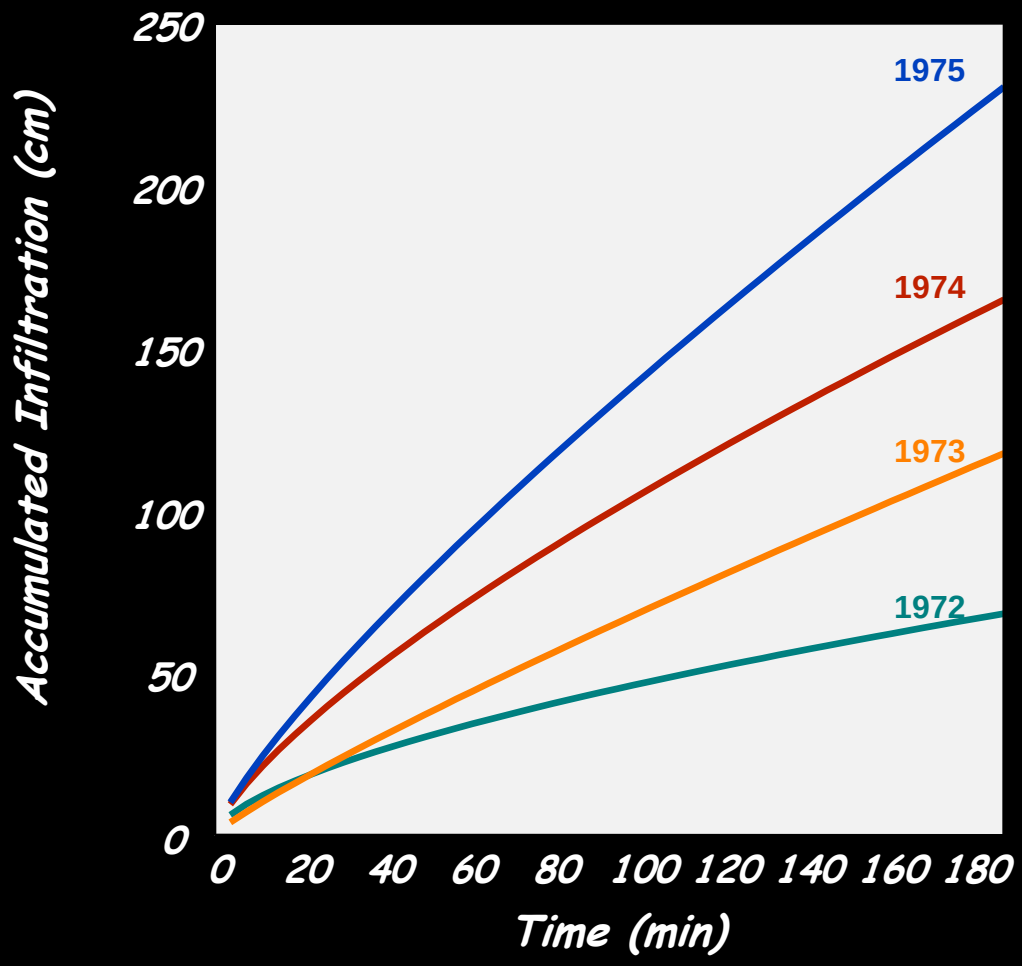
Tillage System and Soil and Water Conservation

Effect of tillage system on runoff and soil Losses by erosion during a wheat crop Évora – Average of two years



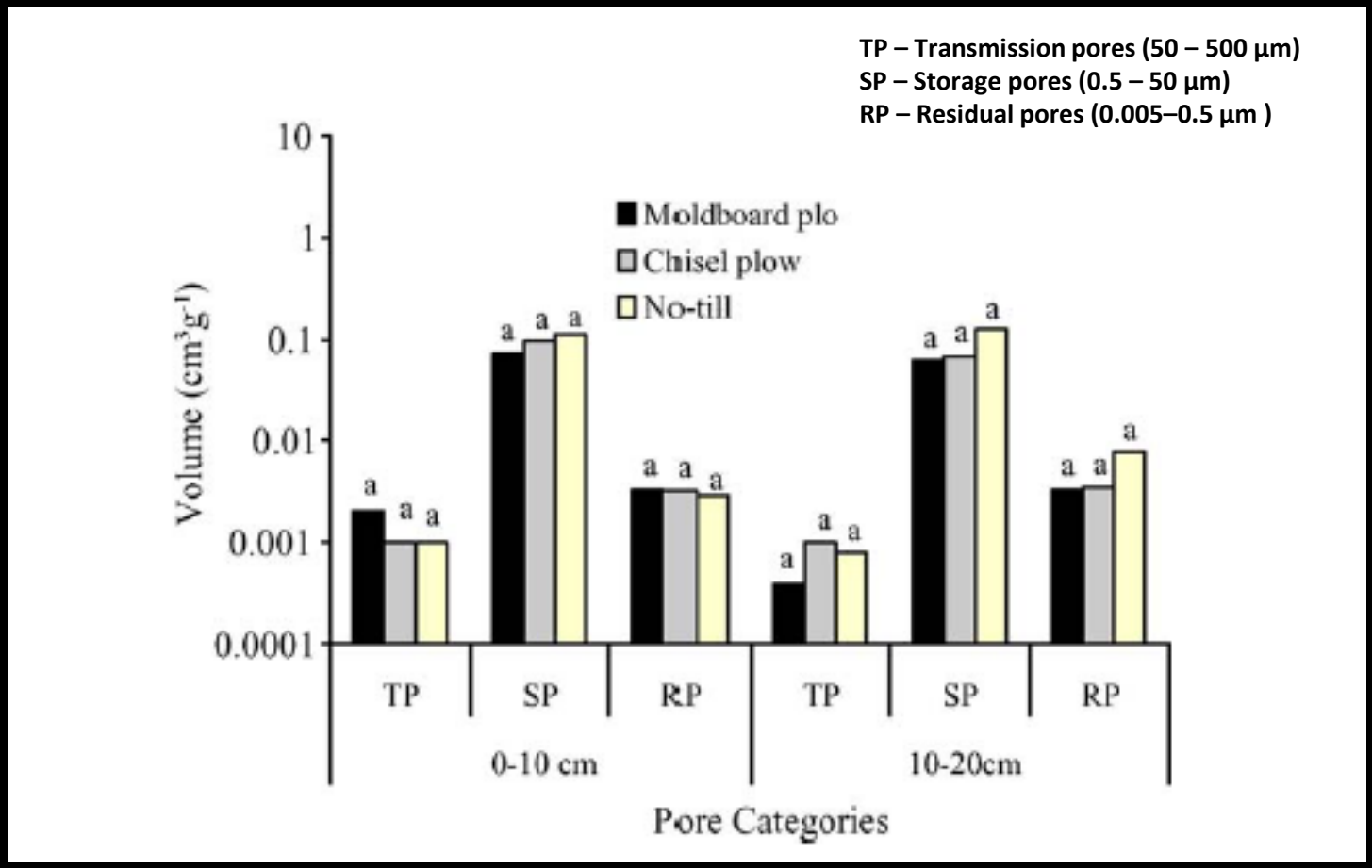
Adapted from Basch and Carvalho (1990)

Effect of time under No-Till on the infiltration rate



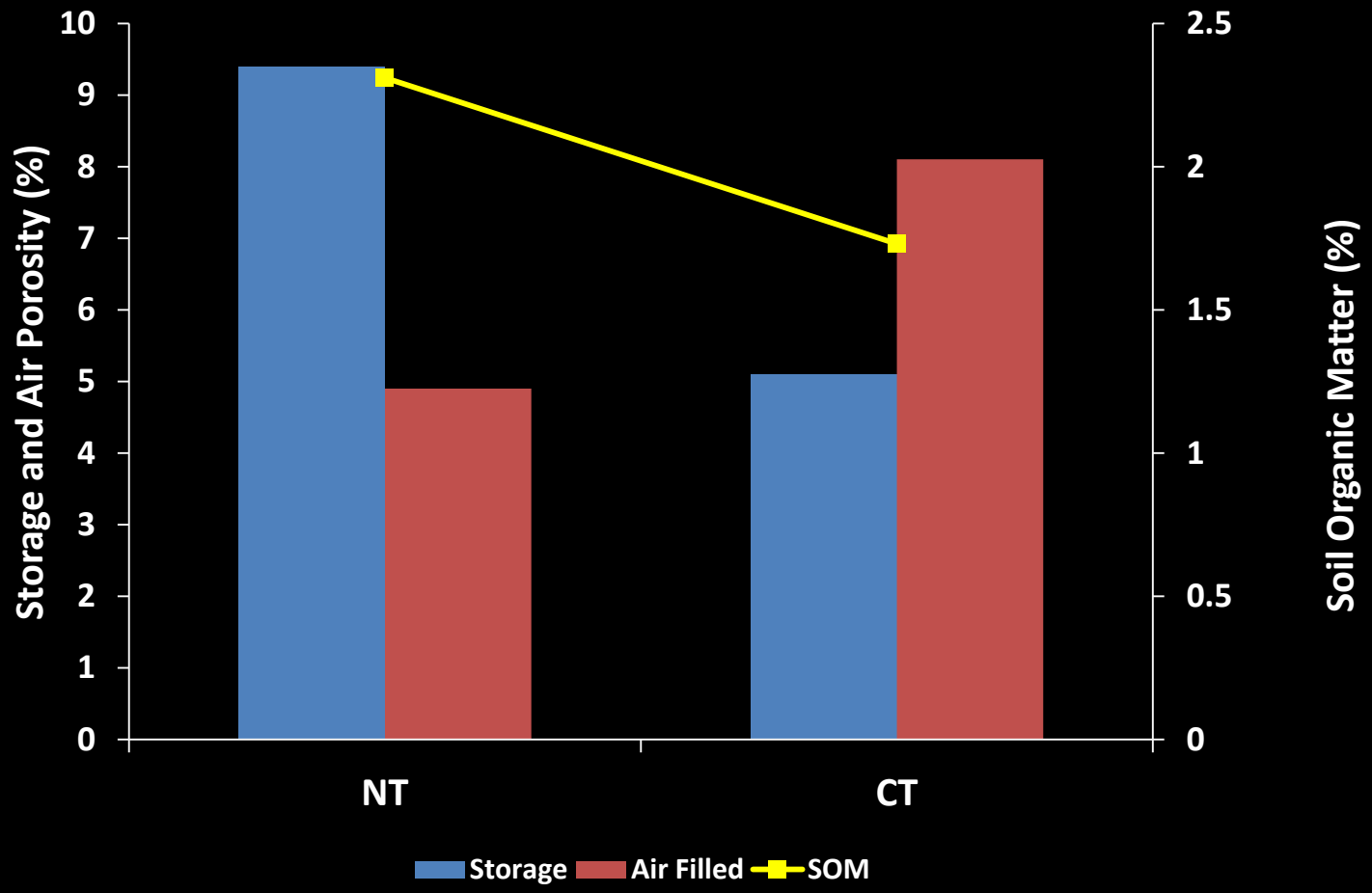
adapted from Lal (1978)

Effect of tillage system on the porosity of a Silt Loam Soil – Ohio



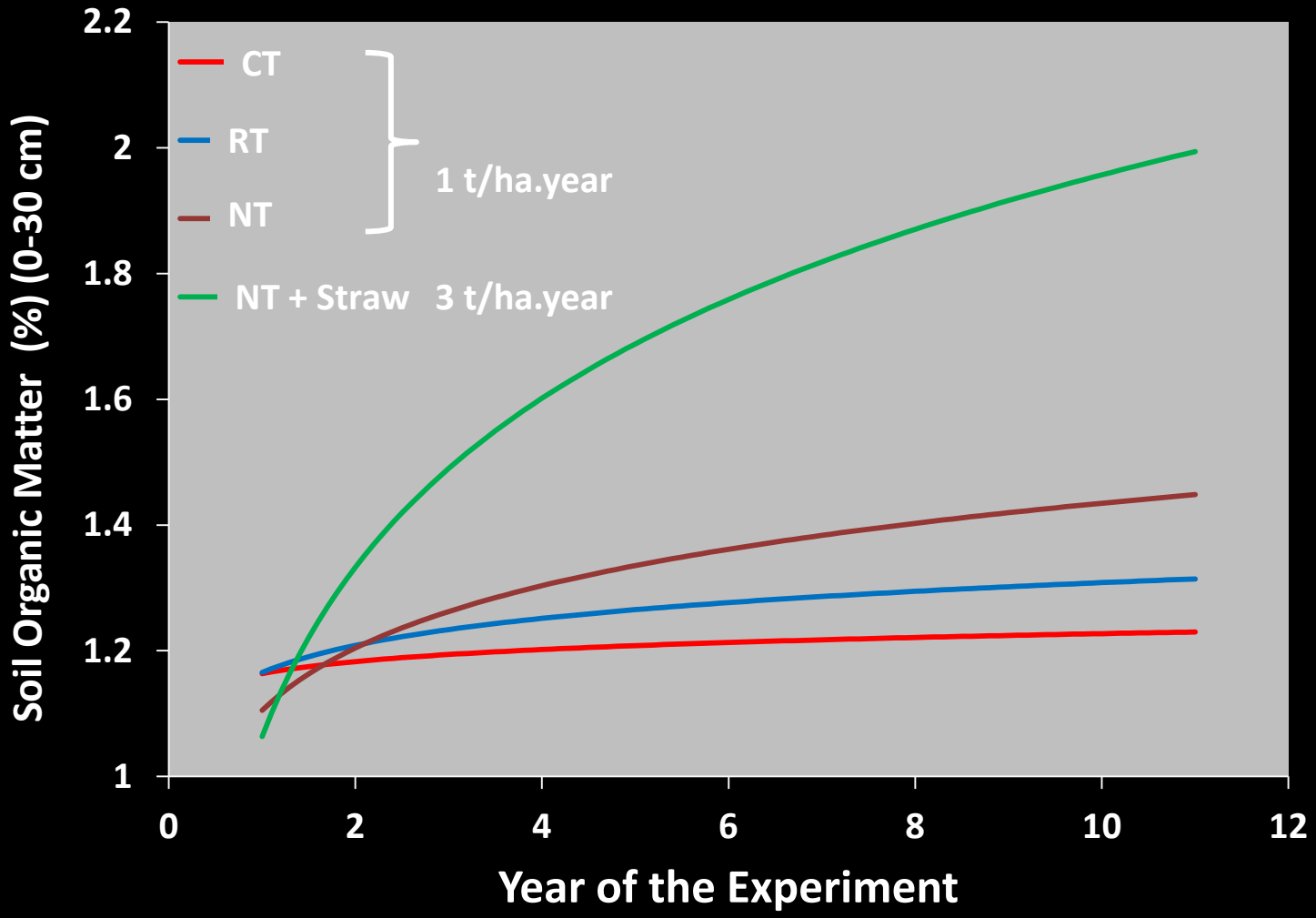
Wairiu and Lal (2006)

Effect of Tillage on the Porosity and Soil Organic Matter (0-30 cm) of a Vertic Clay Soil – Beja - Results after 6 Years



Adapted from Carvalho and Basch (1995)

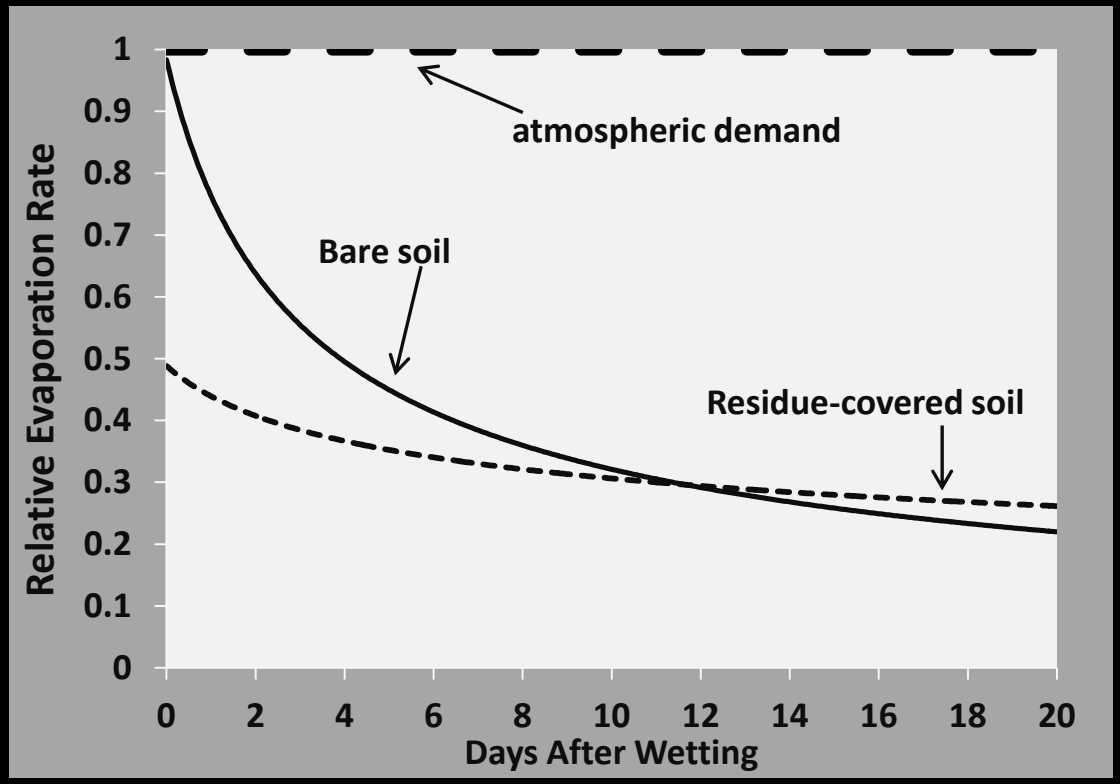
Soil Organic Matter Evolution under Different Tillage Systems
Revilheira Experimental Farm- Luvisol



Lupines -> Wheat -> Oat for Hey -> Barley

Carvalho et al (2012)

Conceptual diagram
Evaporation rates, relative to atmospheric demand, from bare and residue-covered soil after a single wetting event (irrigation or rainfall).

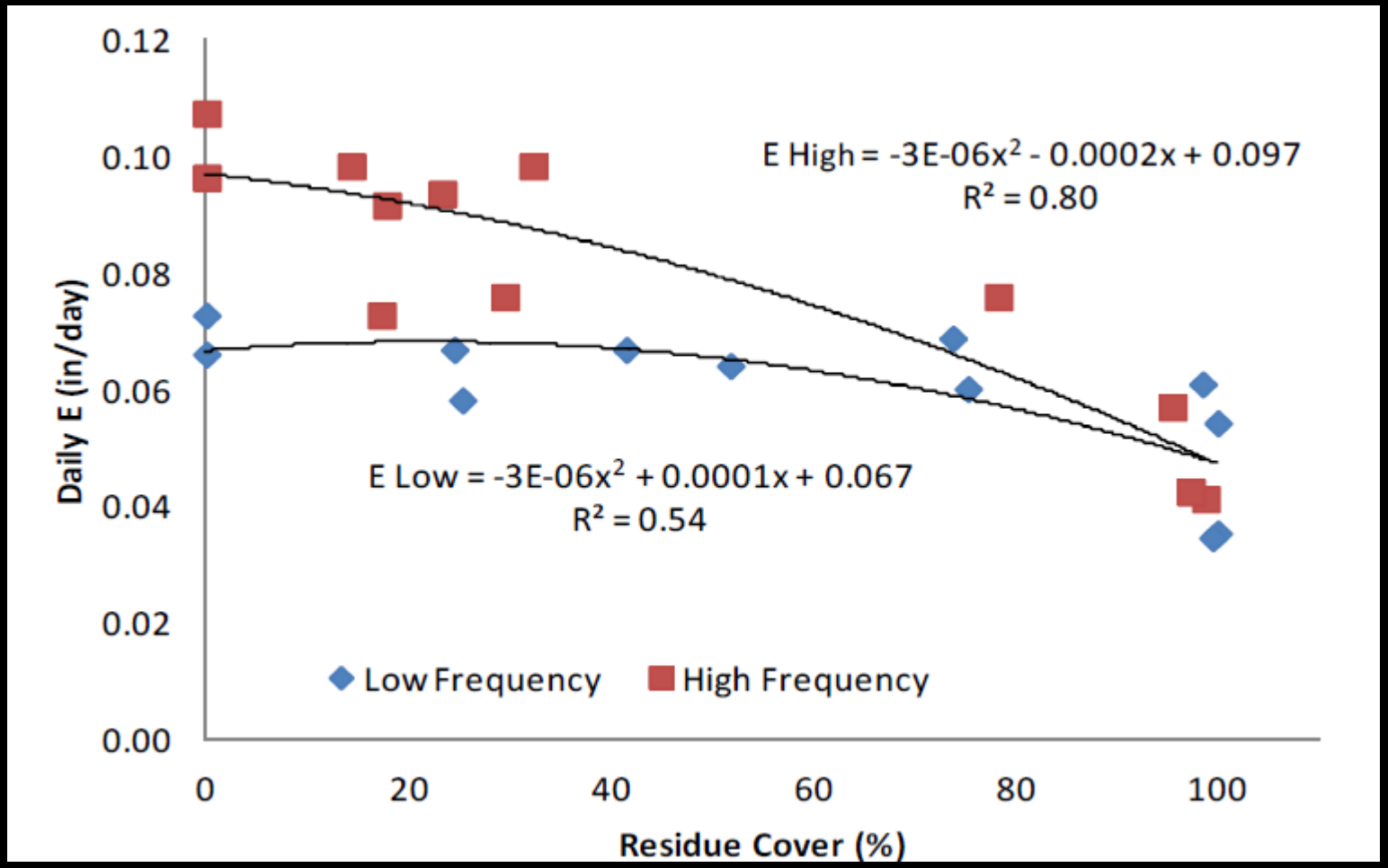


After van Donk and Klocke (2012)

Daily soil water evaporation from soil surfaces

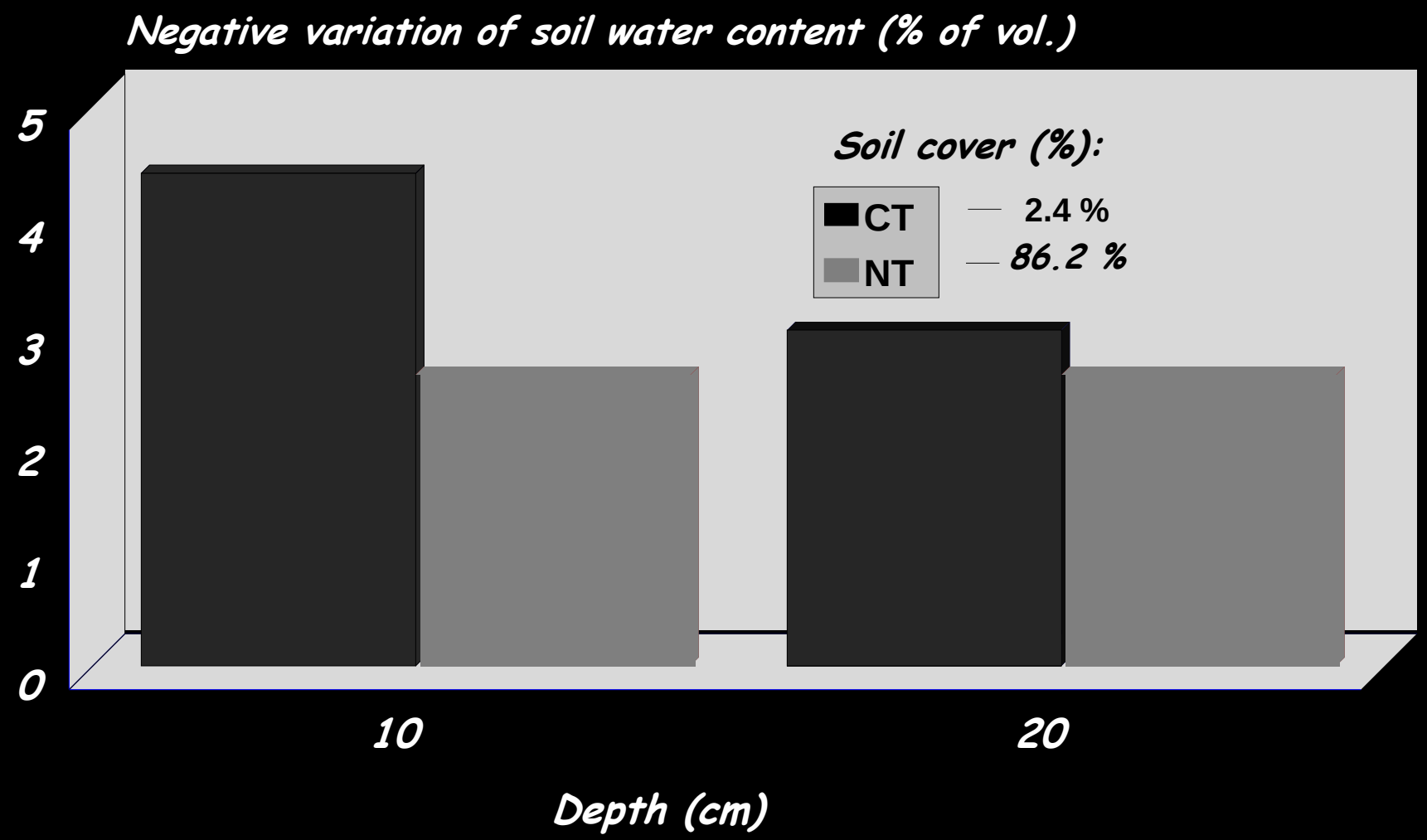
Low frequency – soil wetted once a week

High frequency – soil wetted twice a week



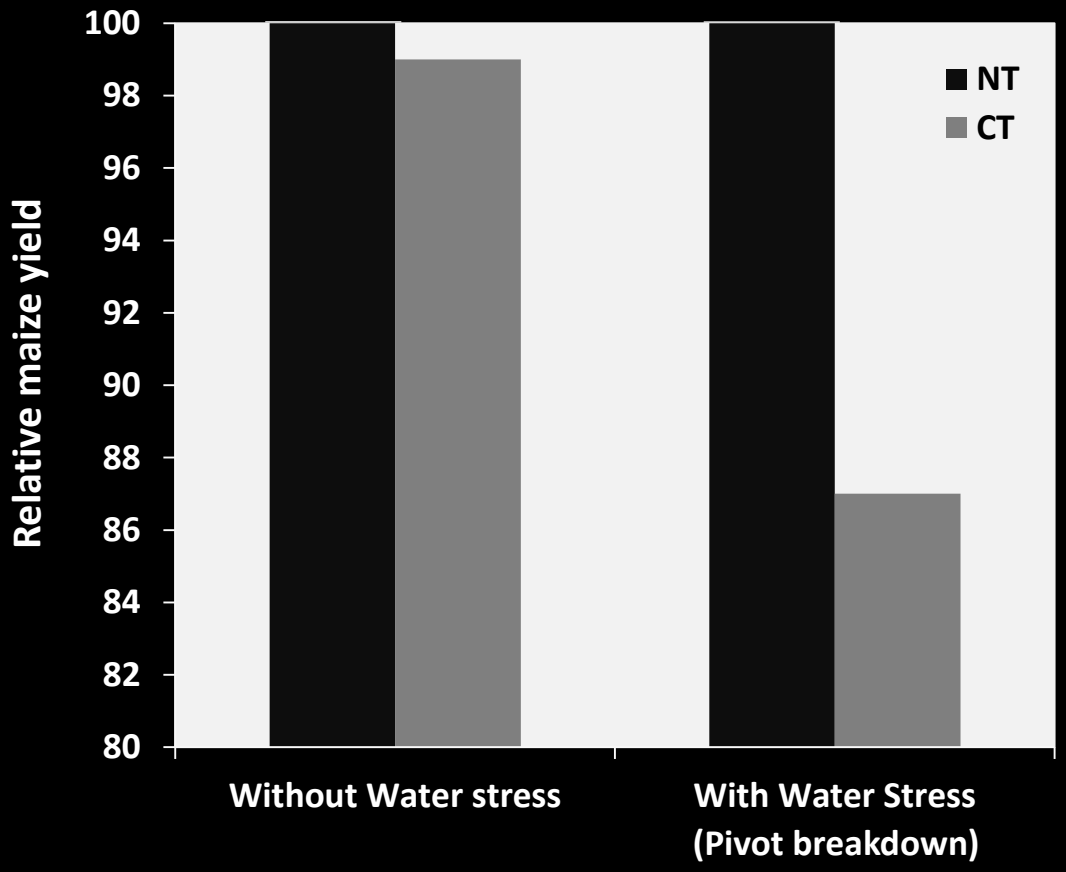
After van Donk and Klocke (2012)

Effect of Tillage System on the Water Lost by the Soil During 36 Hours after a Irrigation of a Maize Crop – Luvisol



Adapted from Carvalho et al. (1995)

Effect of Tillage System on the Relative Maize Yield – Luvisol

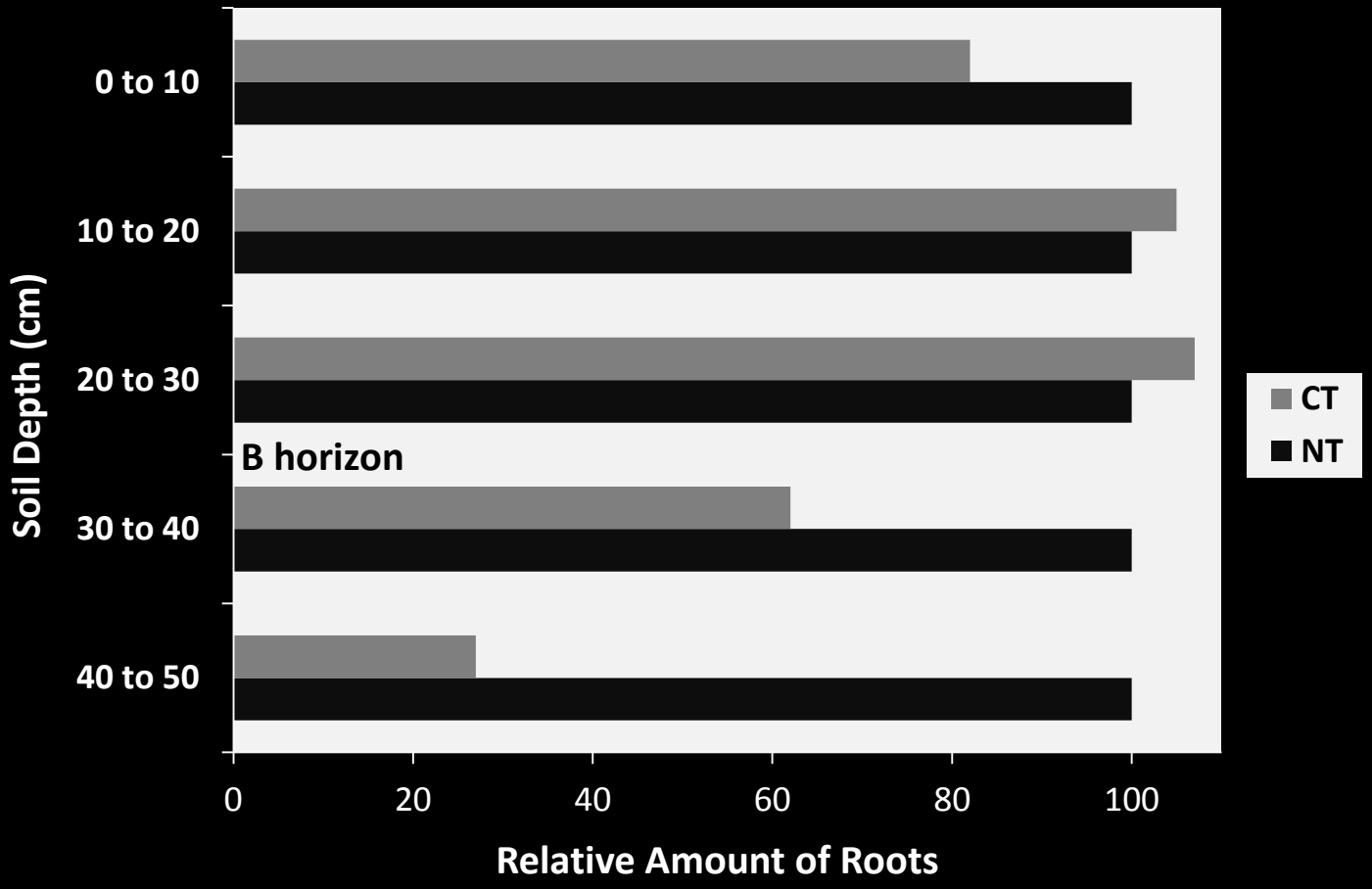


Adapted from Carvalho et al. (1995)

Water stress symptoms of maize
1 week after the pivot breakdown

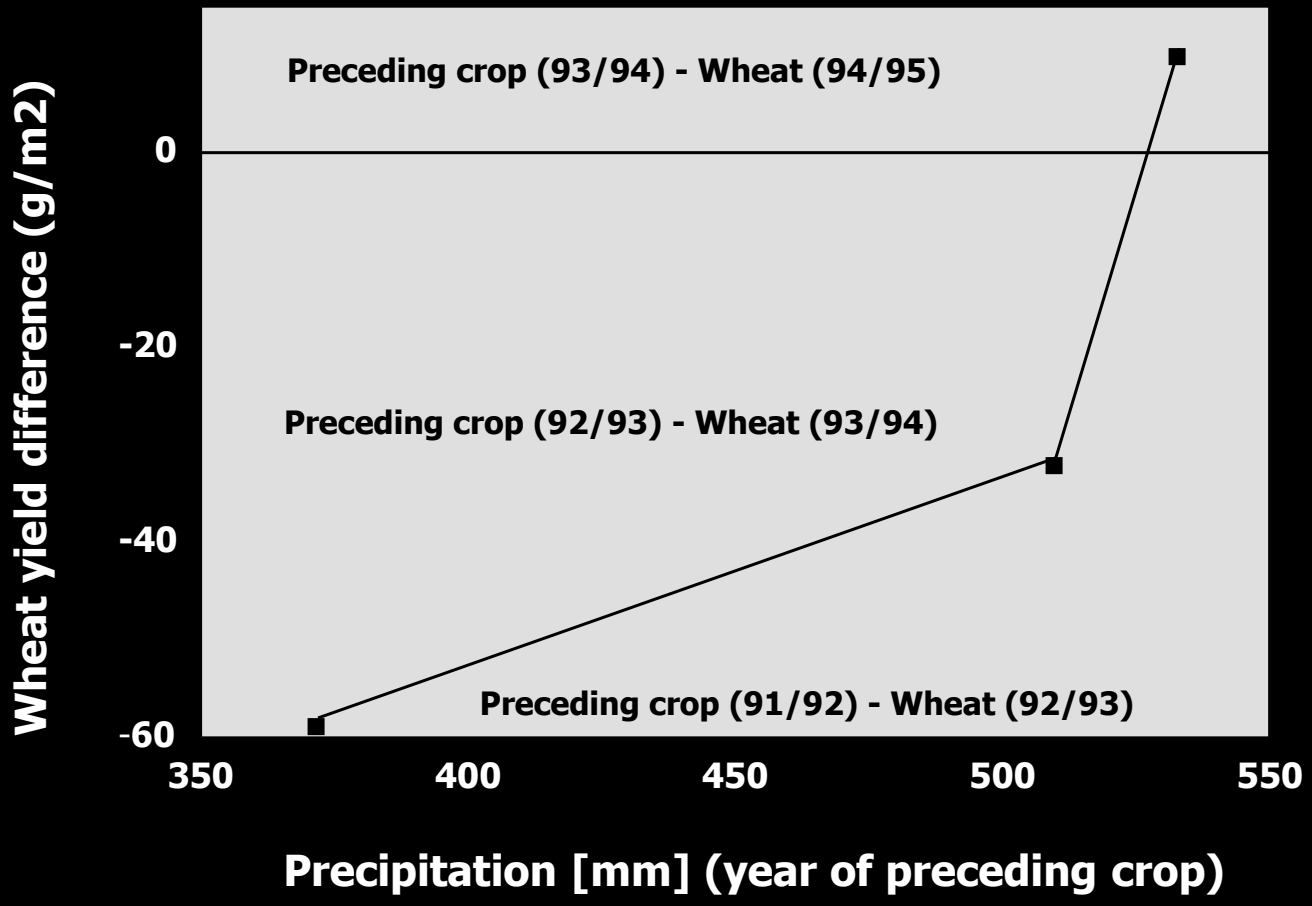
Wheat root growth at stem elongation – profile wall method – nº of counting

Luvisol after 9 years of pasture



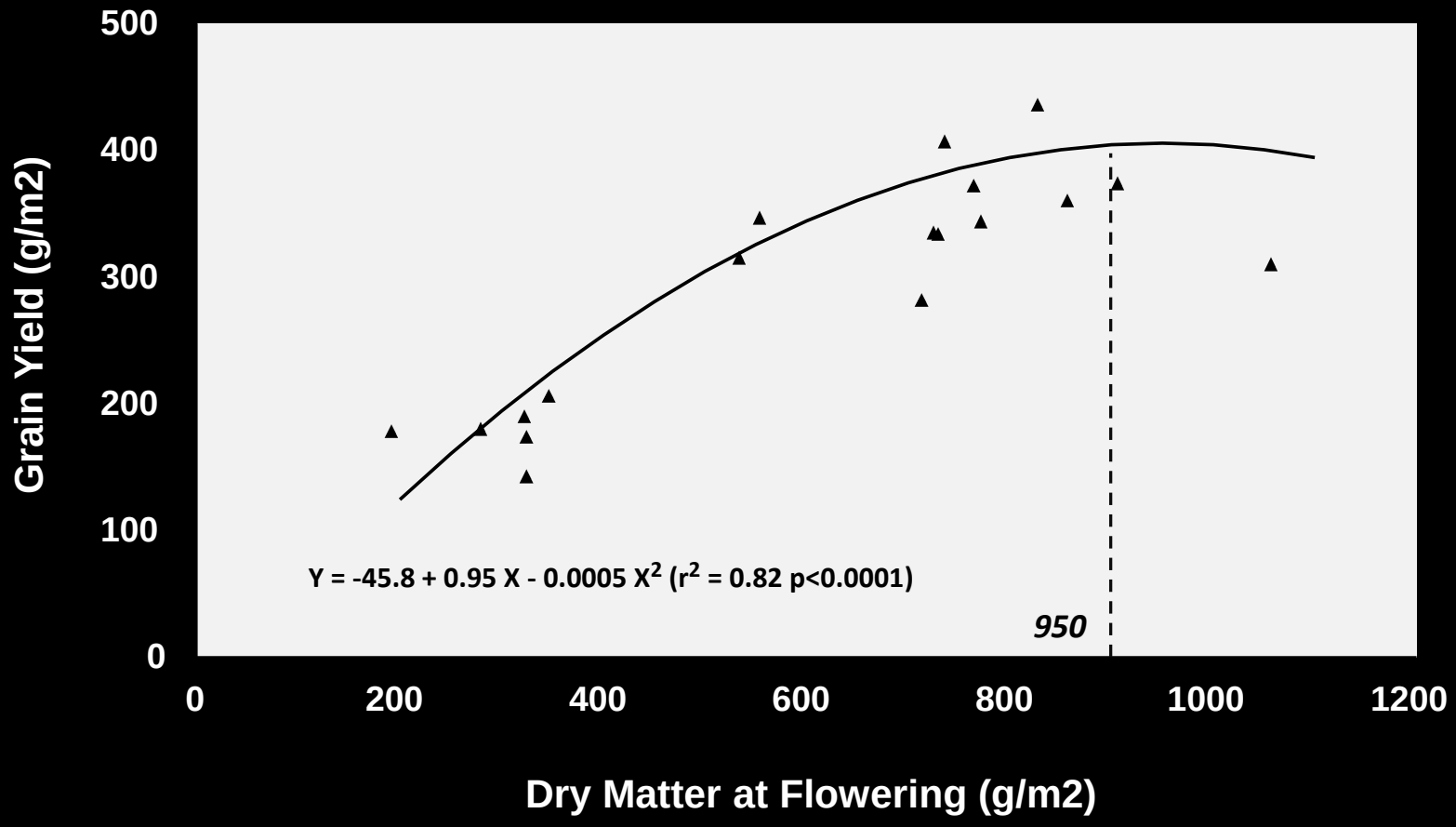
Adapted from Carvalho et al. (1988)

Wheat yield difference after two preceding crops (Yield after sunflower – Yield after pea) Vertic Clay Soil – South of Portugal



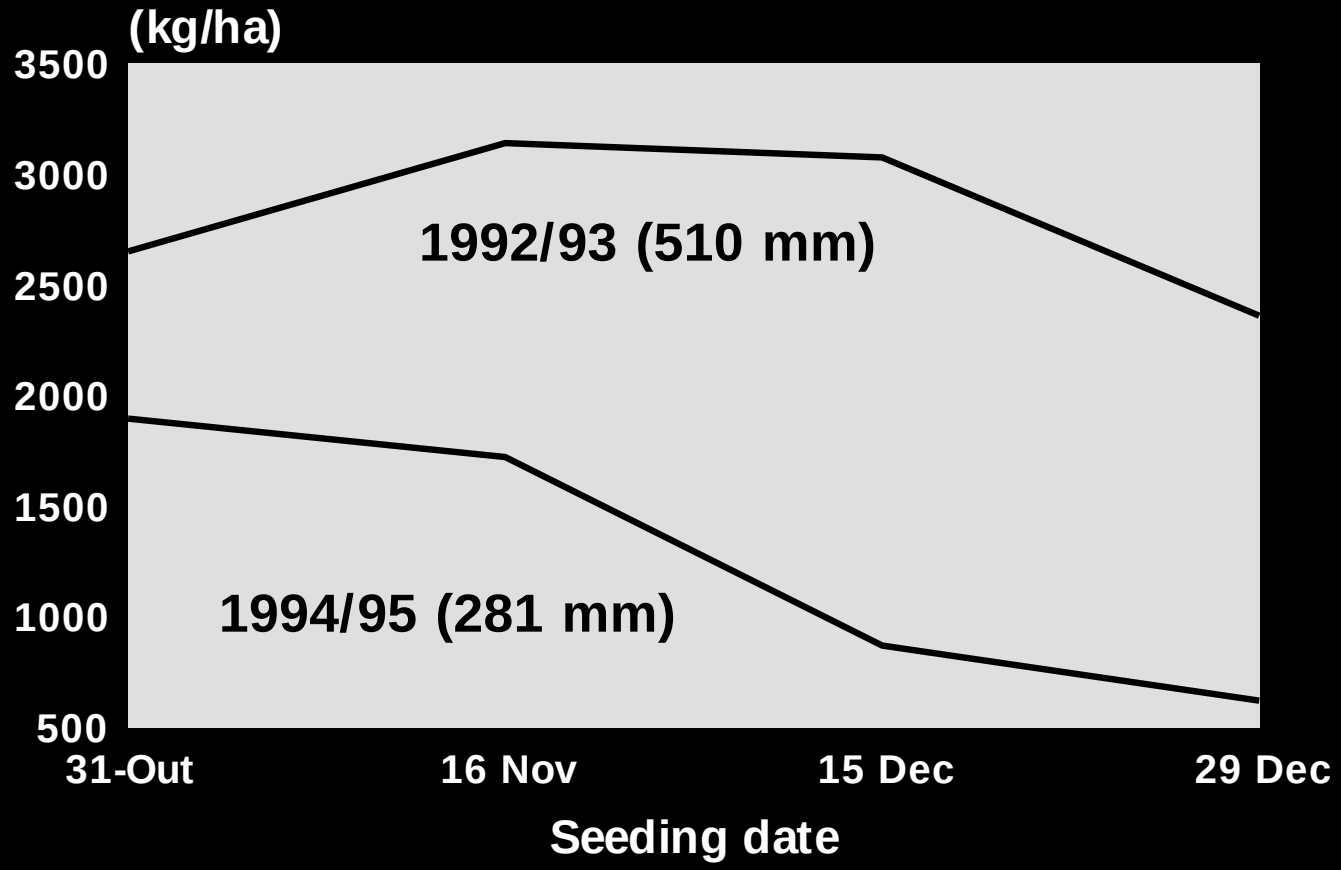
Carvalho and Basch (1999)

Relationship between dry matter at flowering and Wheat grain yield – Vertic Clay soil – South of Portugal



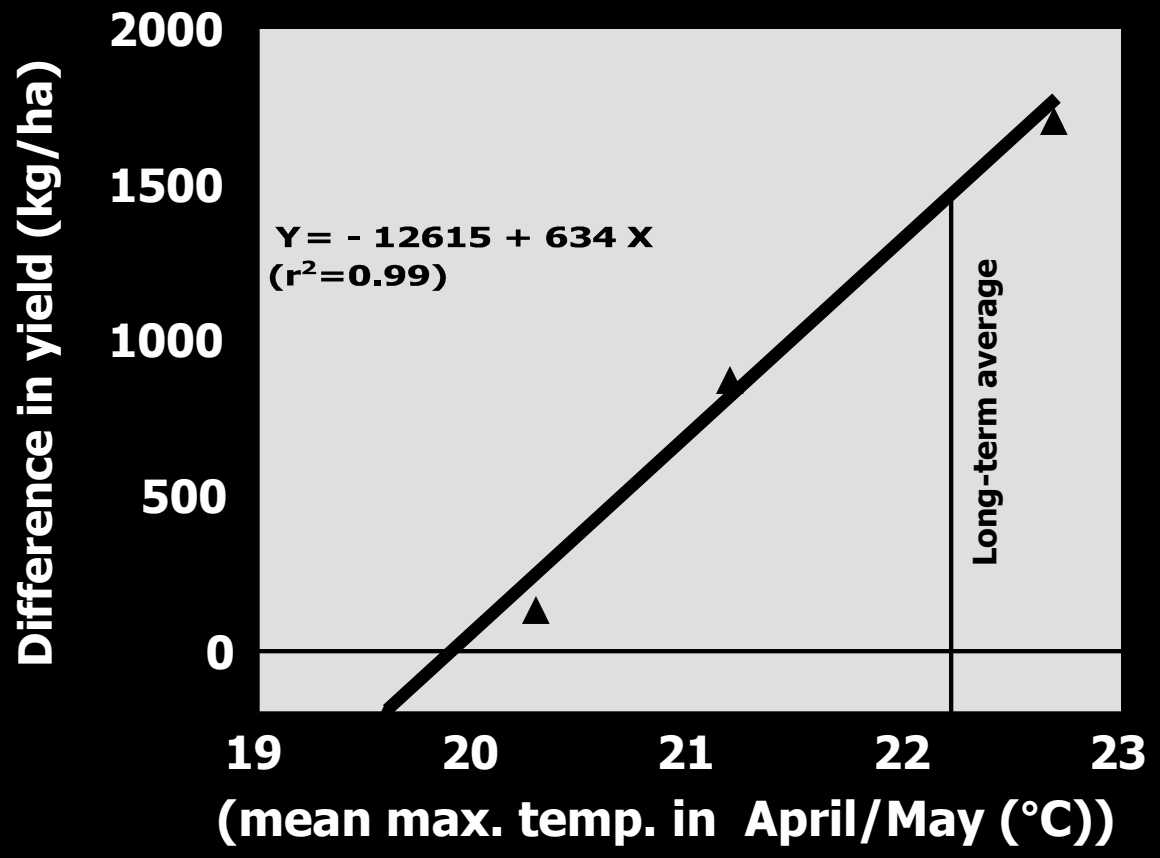
Adapted from Carvalho (1987)

Effect of seeding time on wheat grain yield
South of Portugal



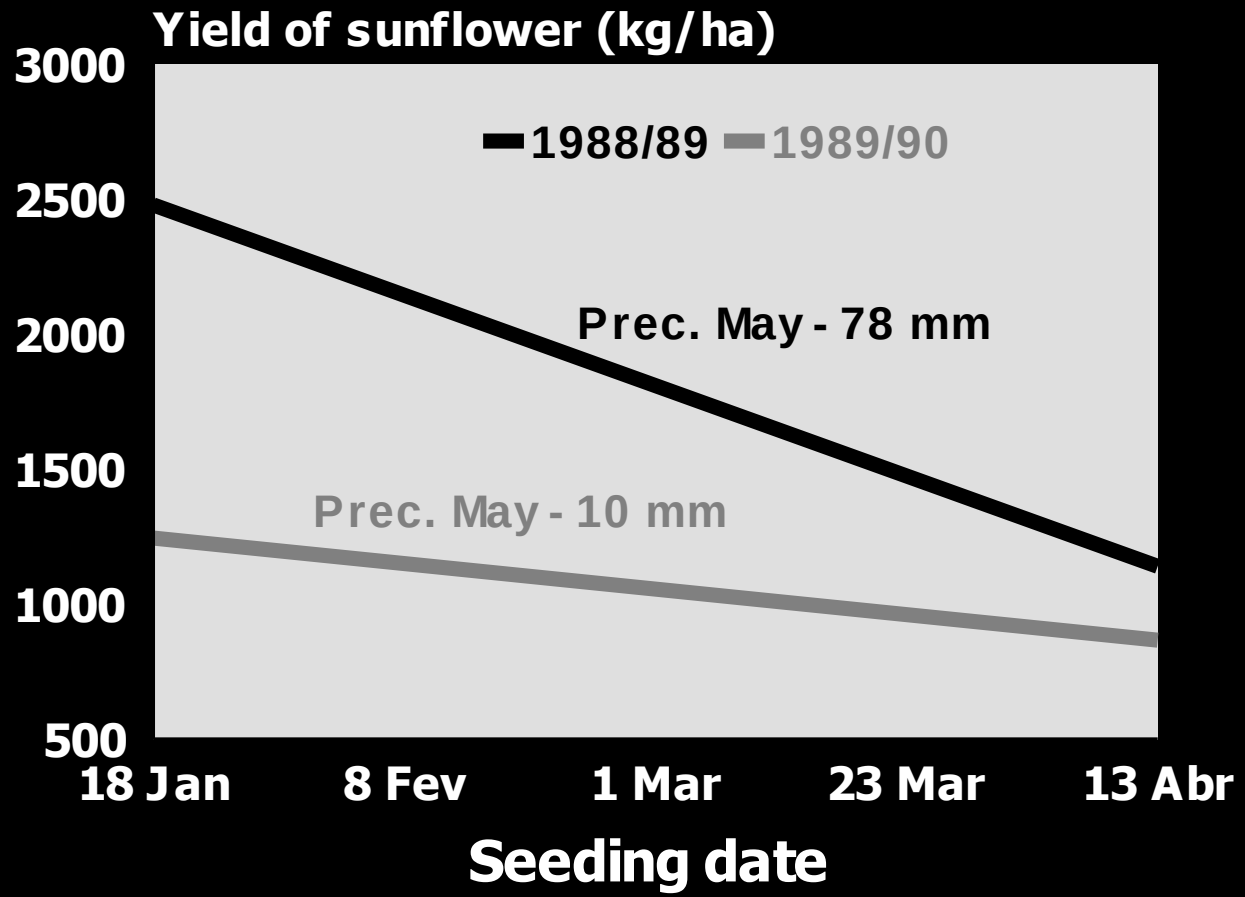
Carvalho and Basch (1999)

Effect of spring temperature on the yield of two wheat varieties
Difference between the yield of the short and the long cycle



Adapted from Carvalho (1987)

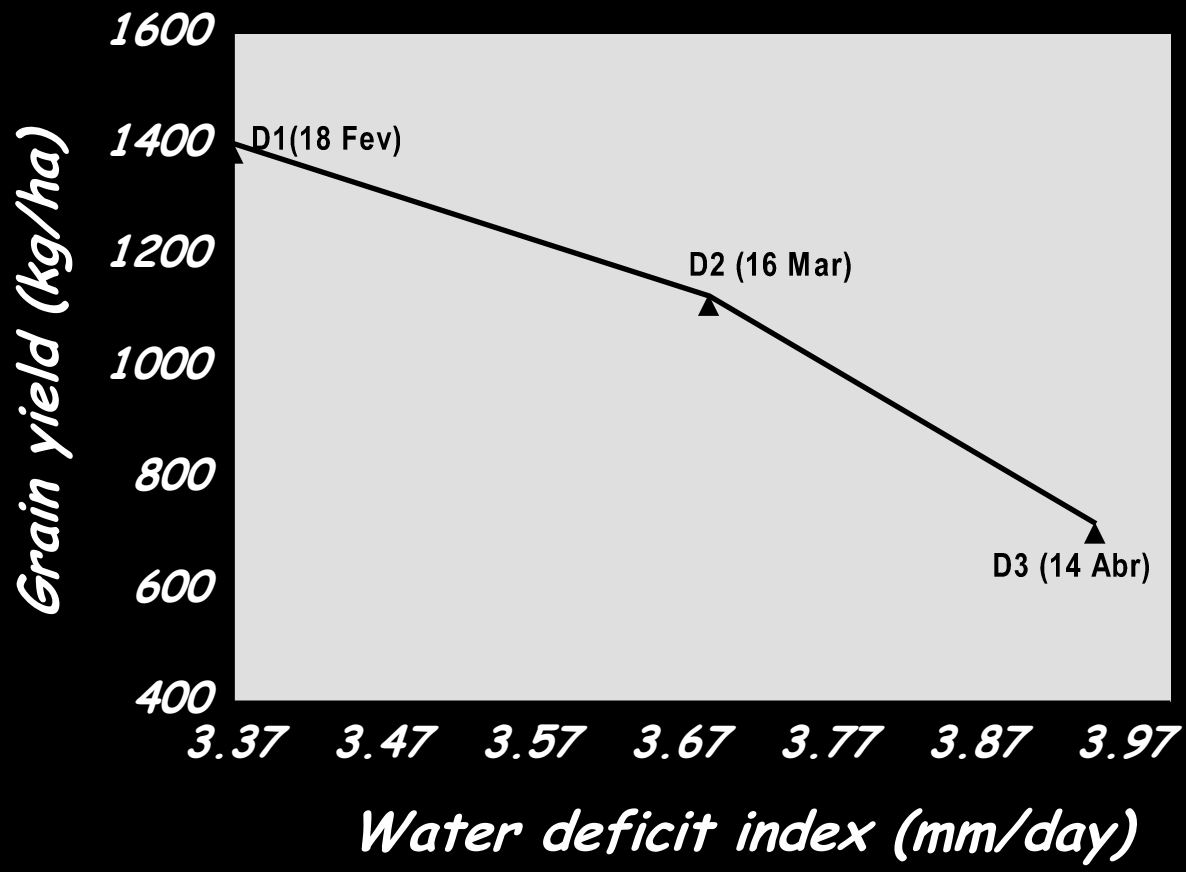
Effect of seeding time on sunflower grain yield
South of Portugal



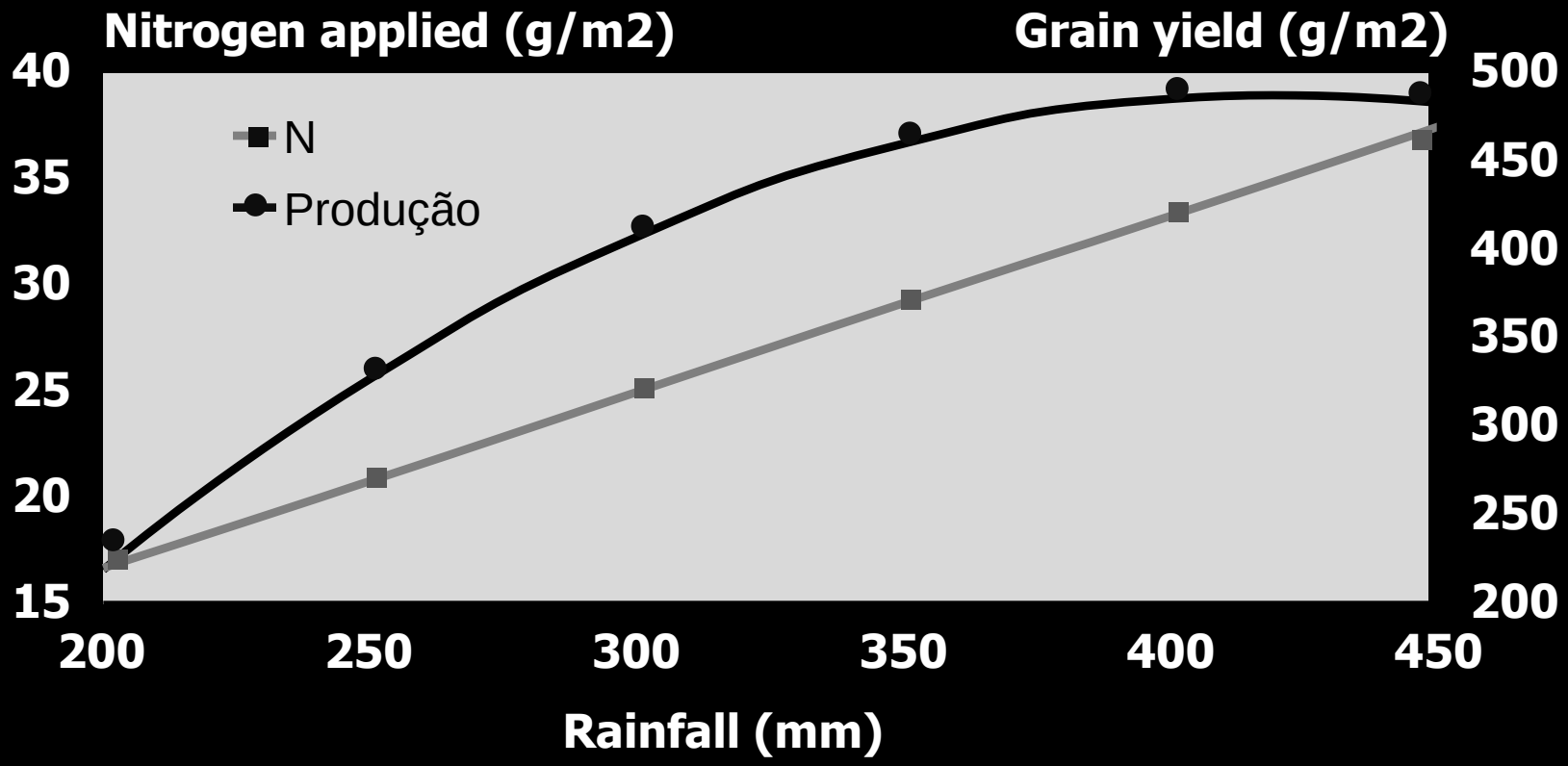
Carvalho and Basch (1999)

Effect of seeding time on the sunflower grain yield and Water deficit index between flowering and maturation

Vertic Clay Soil – South of Portugal

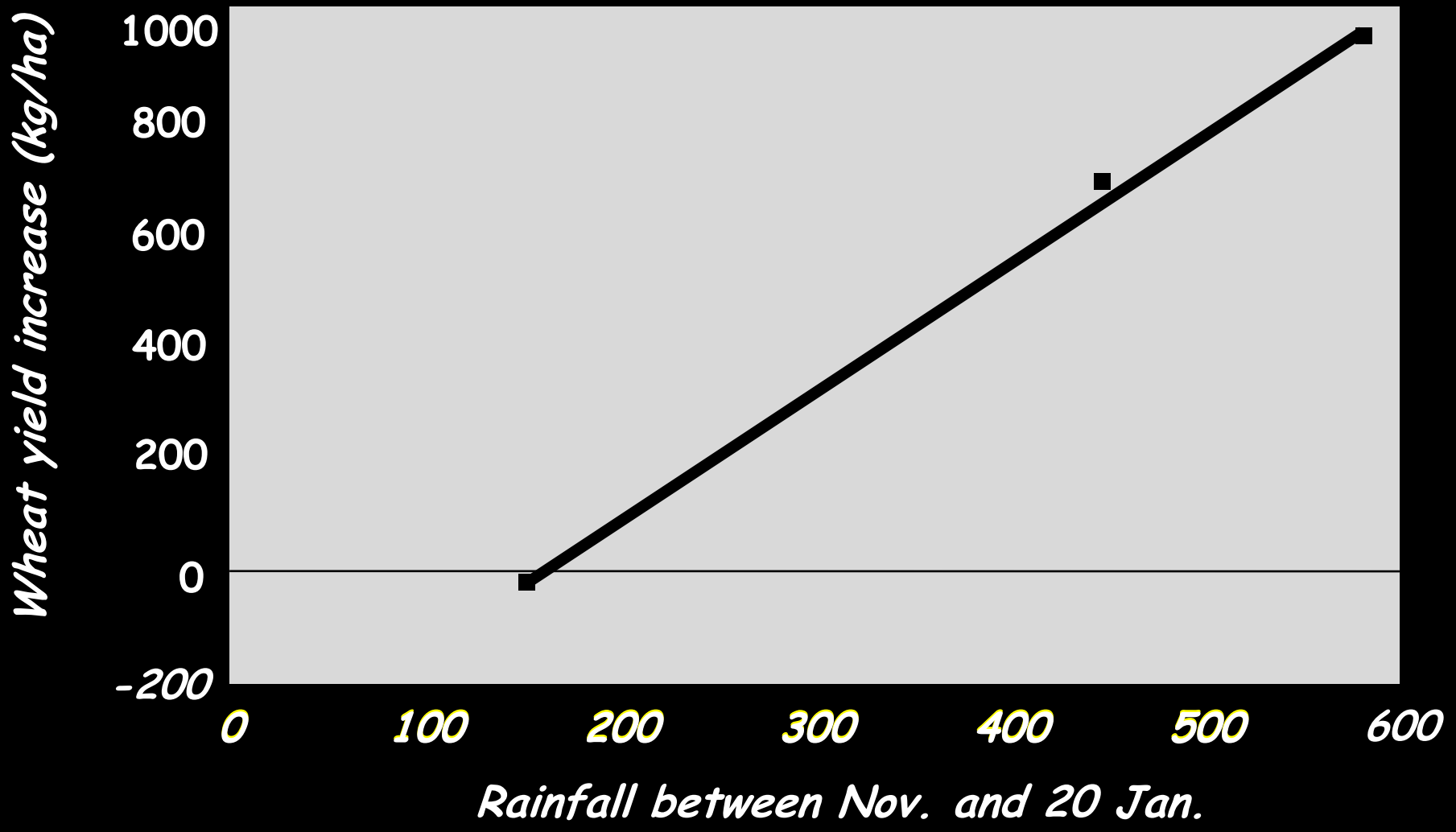


Relationship between rainfall applied nitrogen and wheat yield
Vertic Clay Soil - Beja – South of Portugal



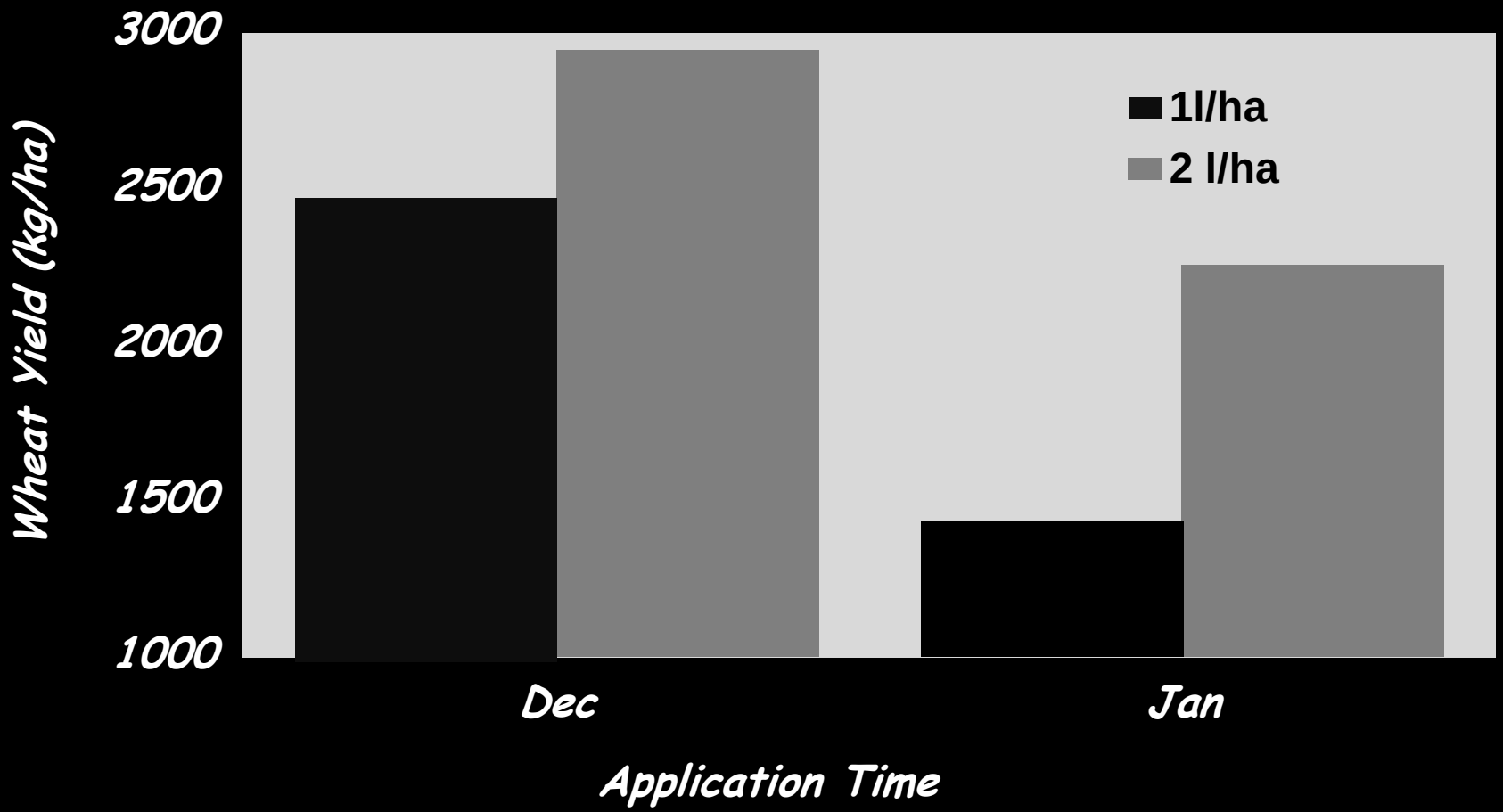
Carvalho et al (1996)

Effect of rainfall on the wheat response to 60 kg N/ha applied at 20th of Jan. 120 kg N/ha were applied at 28th of Feb.



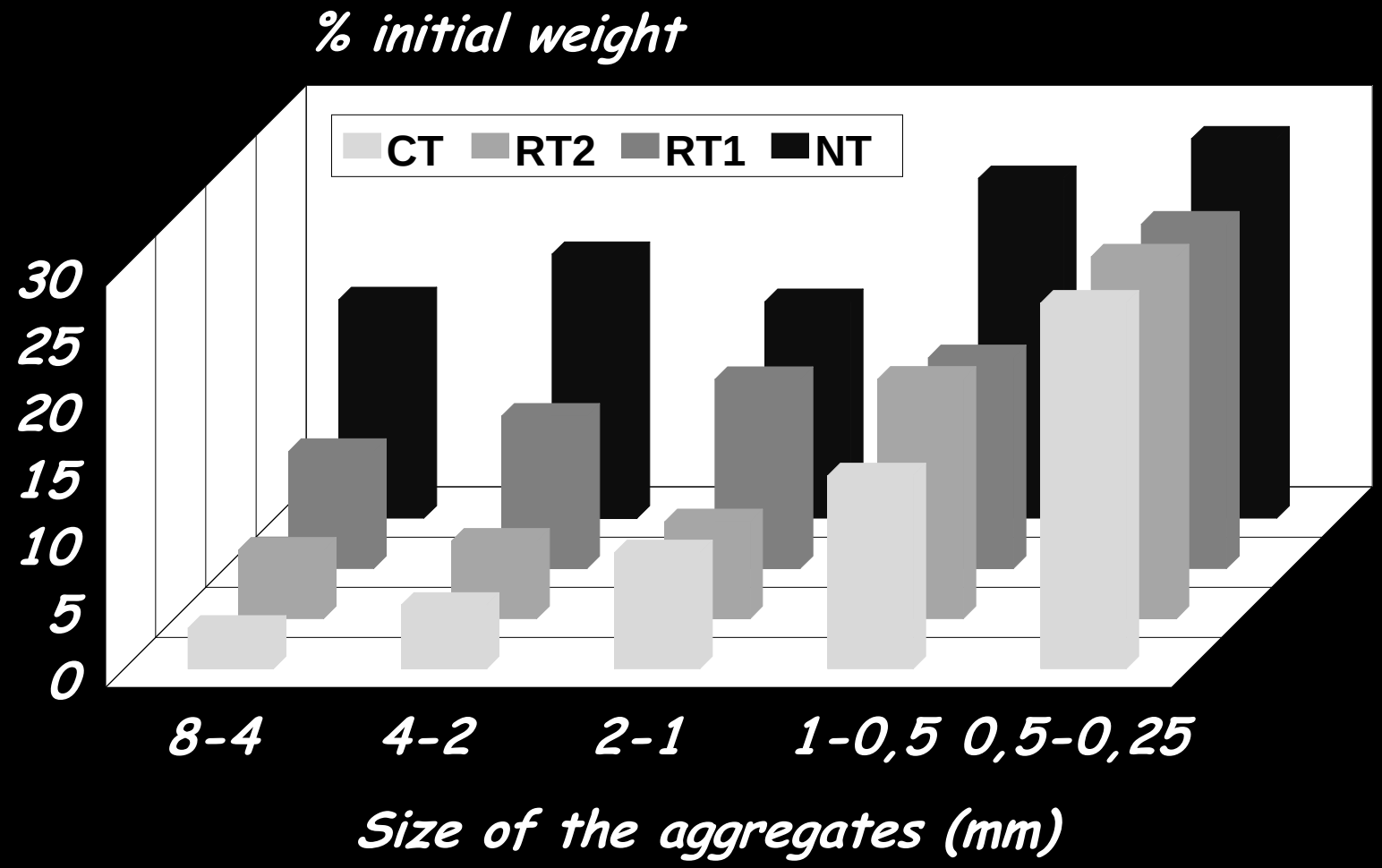
Carvalho et al (2005)

Effect of the application time of post-emergency herbicide



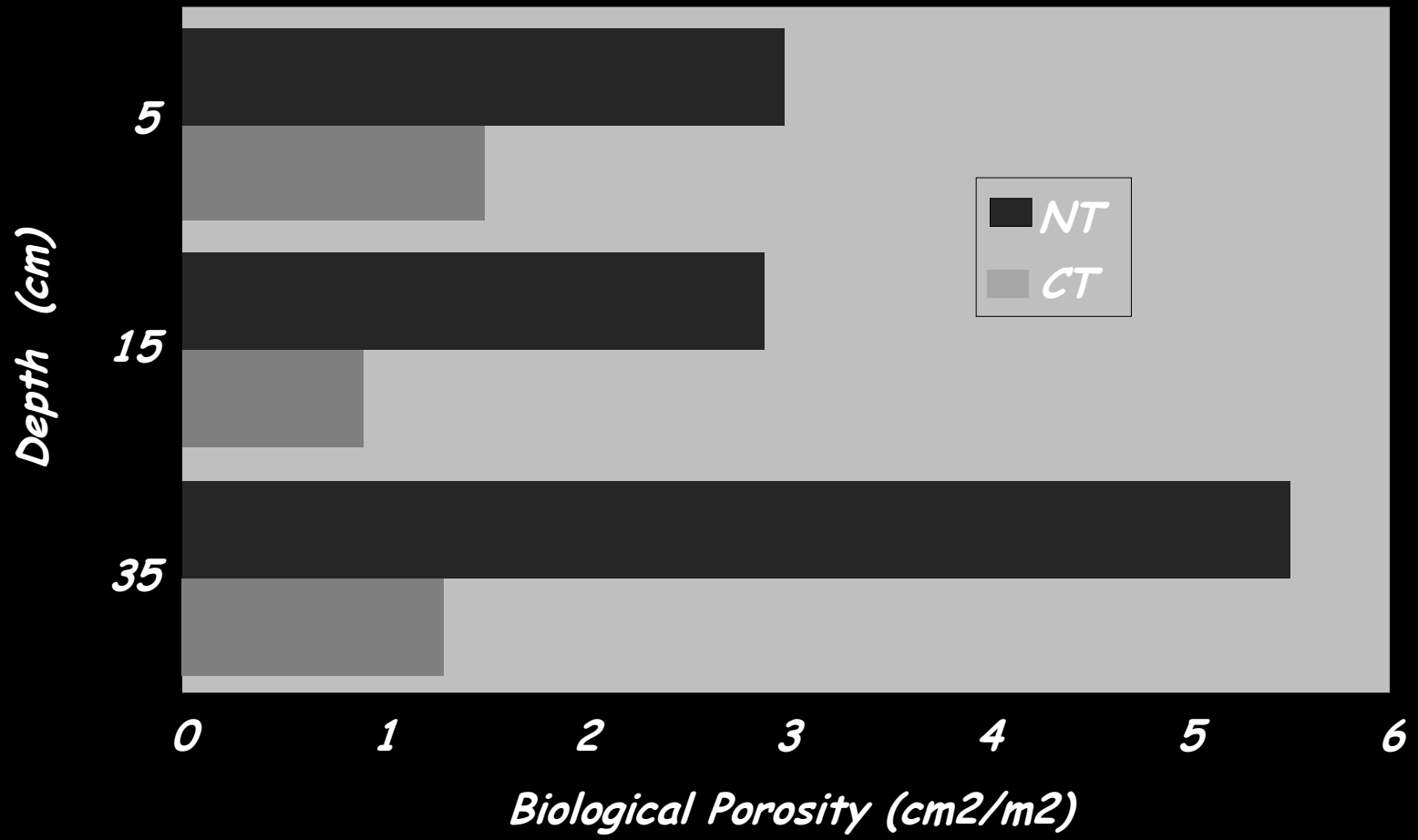
Herbicide: Dopler (diclofope-metilo + fenclorazol-etilo + fenoxaprope-p-etilo
Dose recommended by Bayer for wheat: 2- 3.5 l/ha

Effect of tillage on the aggregate stability (wet sieving) – Luvisol – 3trd Year



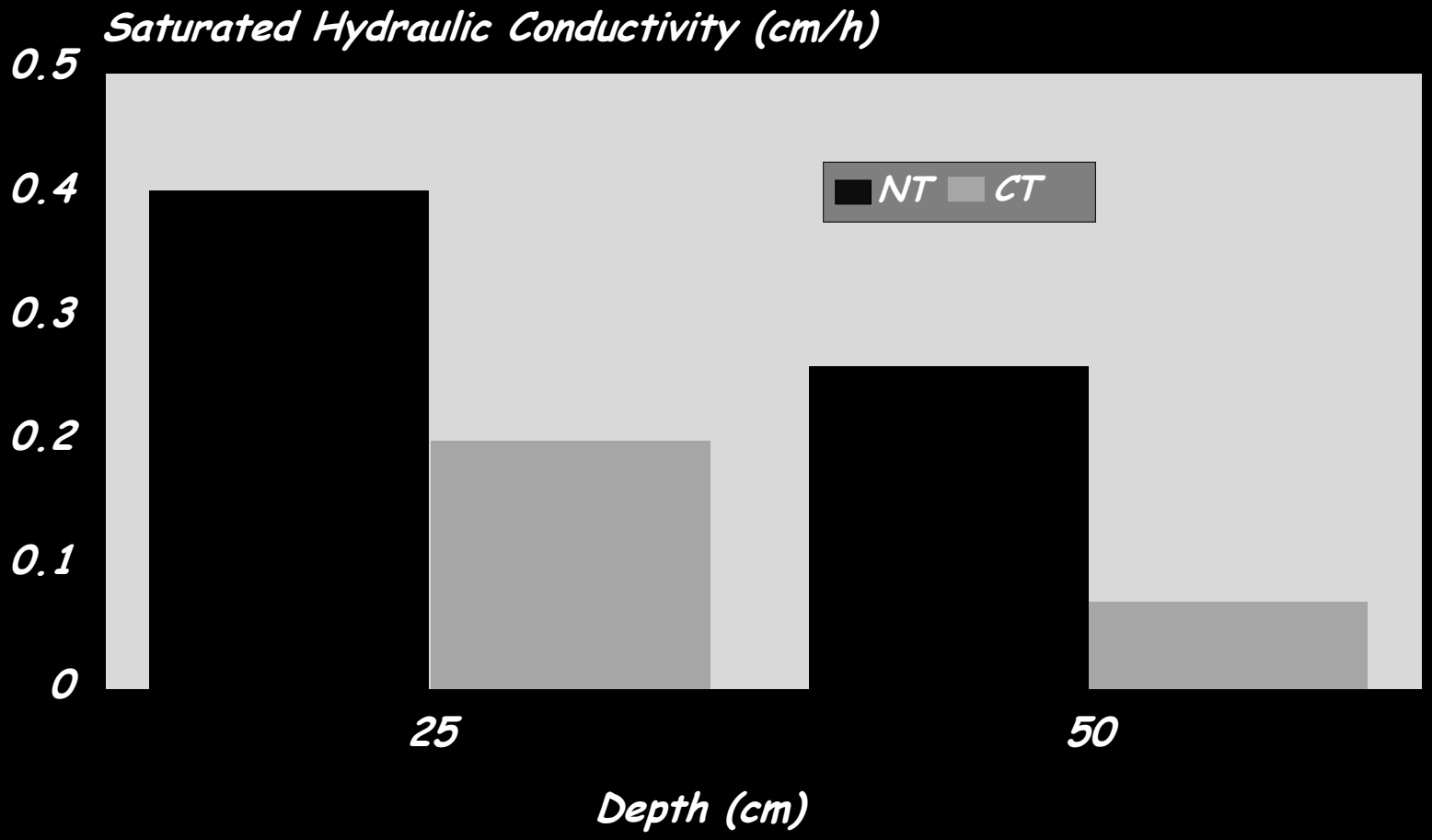
Adapted from Carvalho and Basch (1995)

Effect of tillage on biological porosity
Vertic clay soil – 6th Year



Adapted from Carvalho and Basch (1995)

Effect of tillage on the saturated hydraulic conductivity Vertic Clay Soil– 6th Year



Adapted from Carvalho and Basch (1995)

Drainage + Soil Cohesion = Better soil trafficability

Conclusions

- No-Till plays a central role on a strategy to improve water use and its efficiency under Mediterranean conditions
- It improves water available to the crop by reducing runoff, direct evaporation and improving water holding capacity of the soil, water stored at deep layers and rooting depth
- It improves soil trafficability allowing a timelier field operations which are crucial for a efficient use of water by winter crops
- Spring long season crops under rainfed conditions are depleting water stored in the soil by the end of summer, which has a negative impact on water available to the next crop on dry years.