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Soil Moisture in a Precision Farming Context. Importance and Information Requirements

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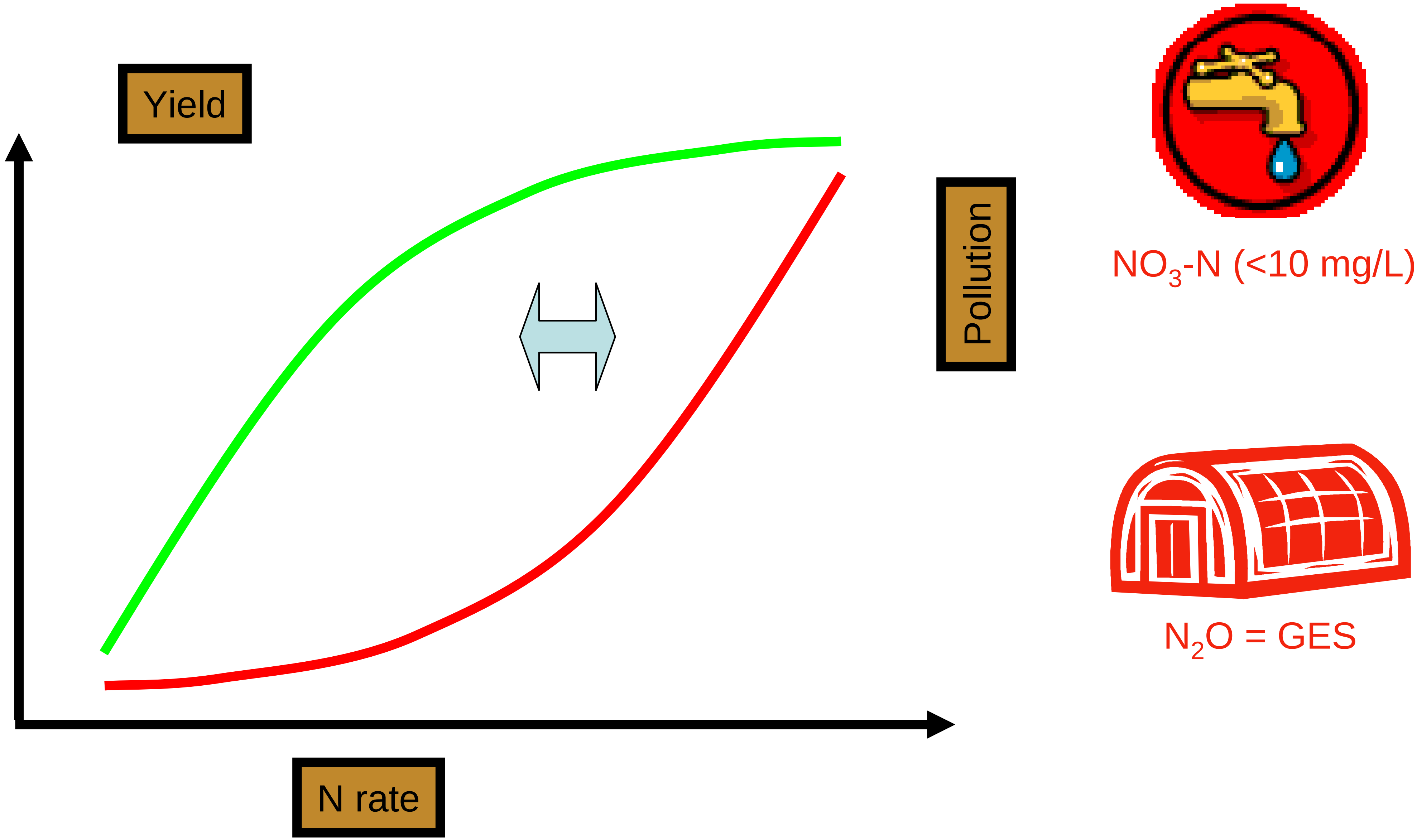
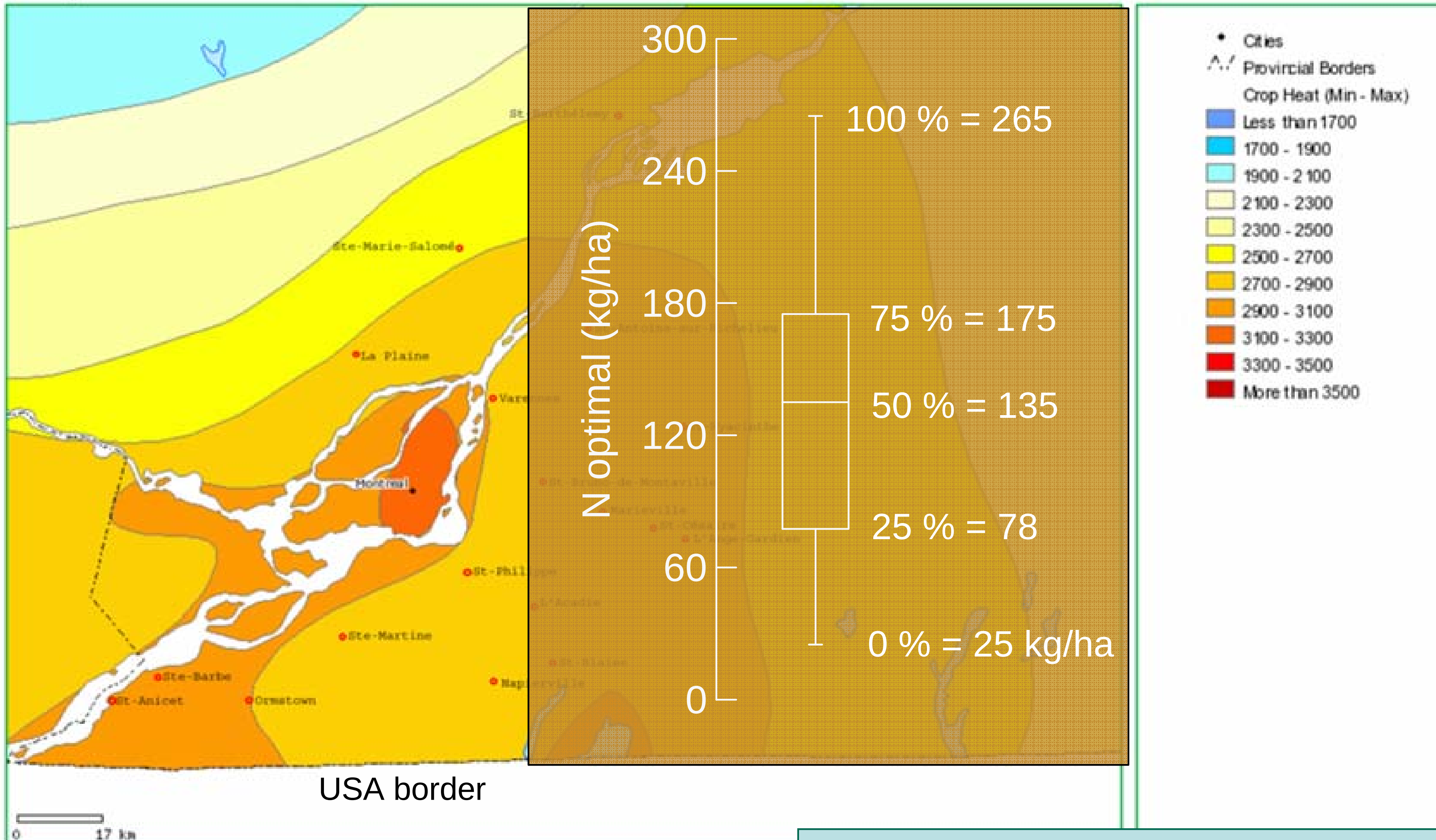
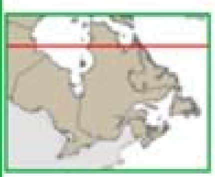
Targeting N_{op}



Crop Heat Units

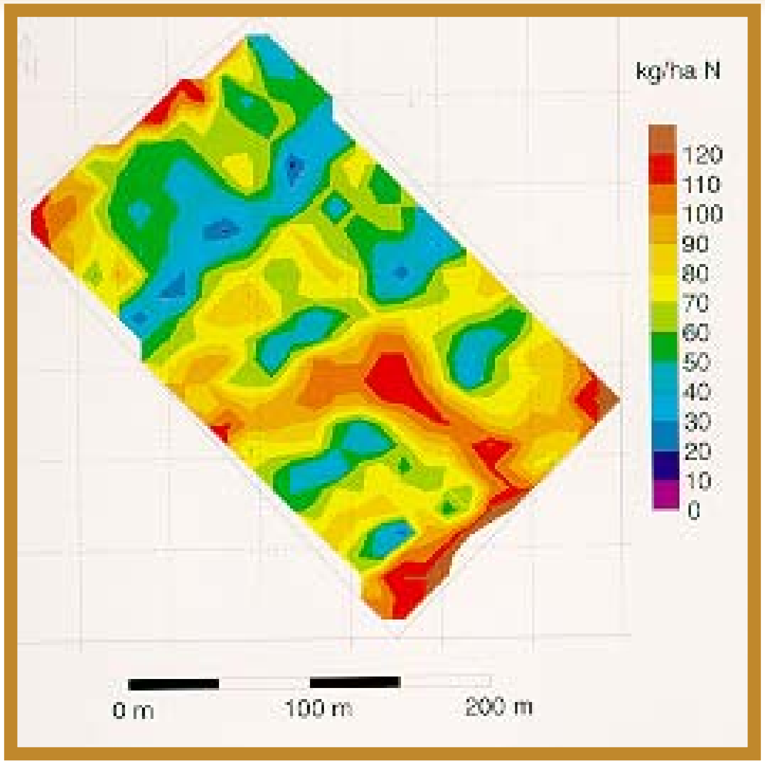




Database:
Gilles Tremblay, CEROM

- 1997 to 2005 inclusive
- Five to six N (40 to 240 kg/ha)
- 840 obs. yield-N (avg of 4 reps)
- 19 regions in Quebec

Precision farming



- Early developments
  - P, K, micronutrients
    - Not profitable
  - Lime applications
    - OK
- Second wave
  - Yield maps for management zones
    - Highlighted seasonal variability (due to water conditions)
- New wave
  - Real-time crop sensing for in-season nitrogen application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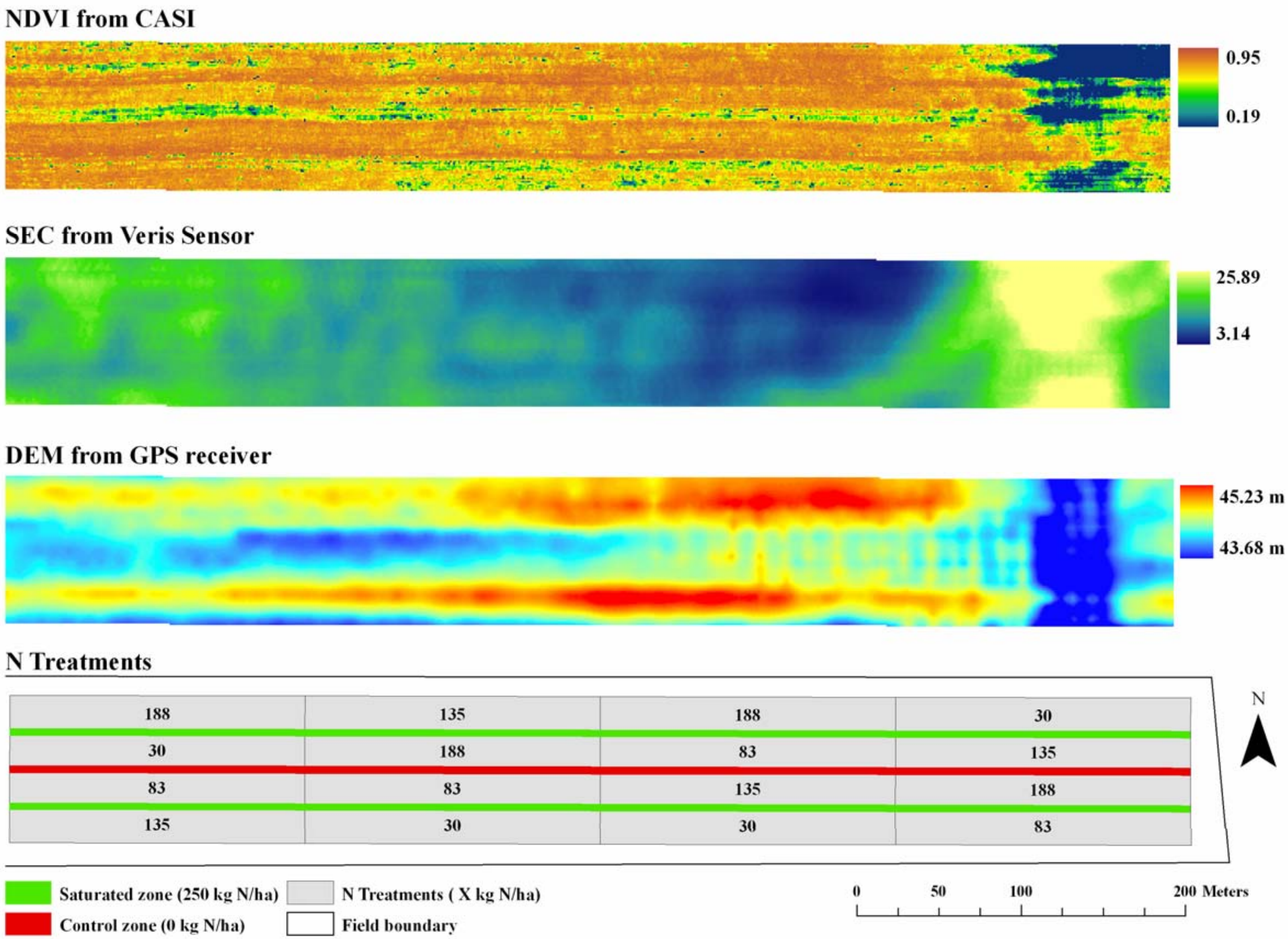
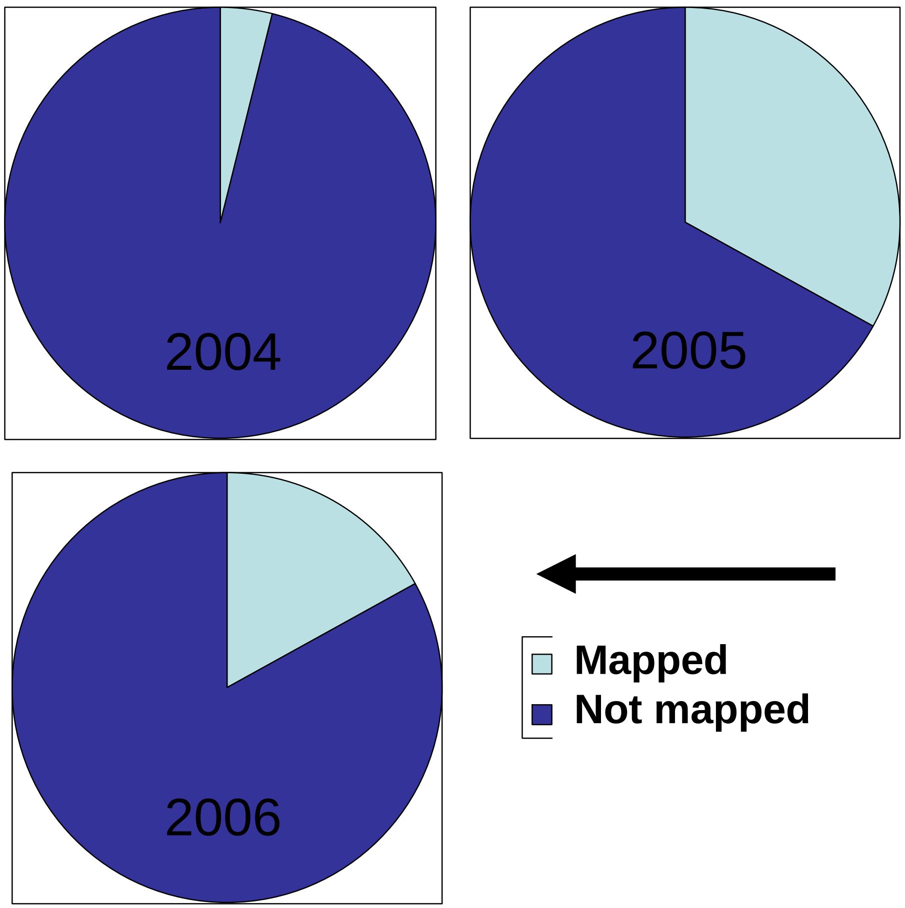
Projet GAPS 333
Améliorer la qualité de l'eau par une gestion de l'azote basée sur les propriétés spectrales des cultures
Parcelles de recherche en collaboration avec
Ferme Landry & Associés et Club Techno-Champ 2000
Canada
synAgri

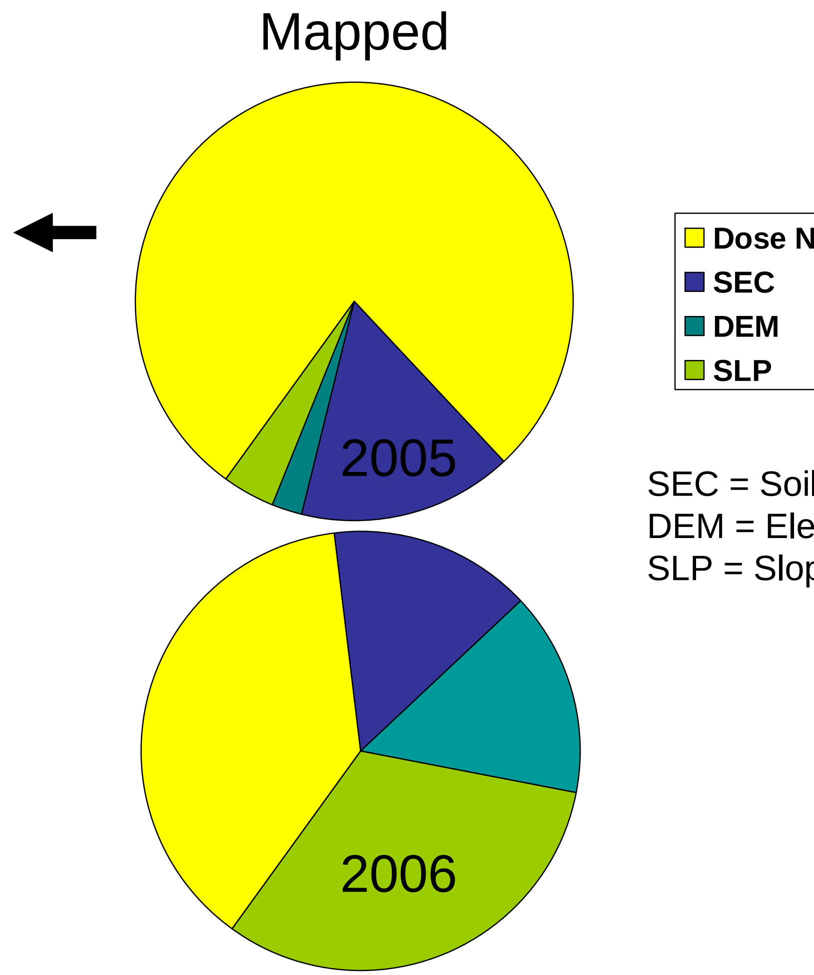
St-Valentin - 2005



- Higher elevation: Sandy loams of the Lacolle and St-Valentin series
- Lower elevation: Loam or clay-loams of the Lacolle, Providence and St-Marcel series

What is driving corn growth ?



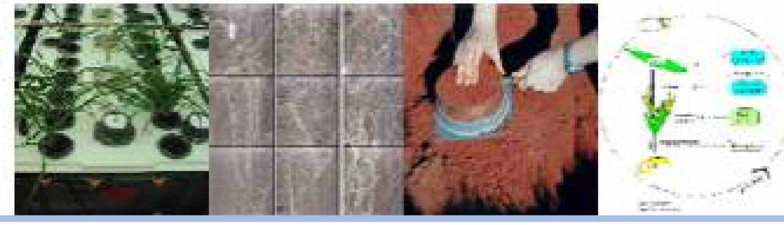


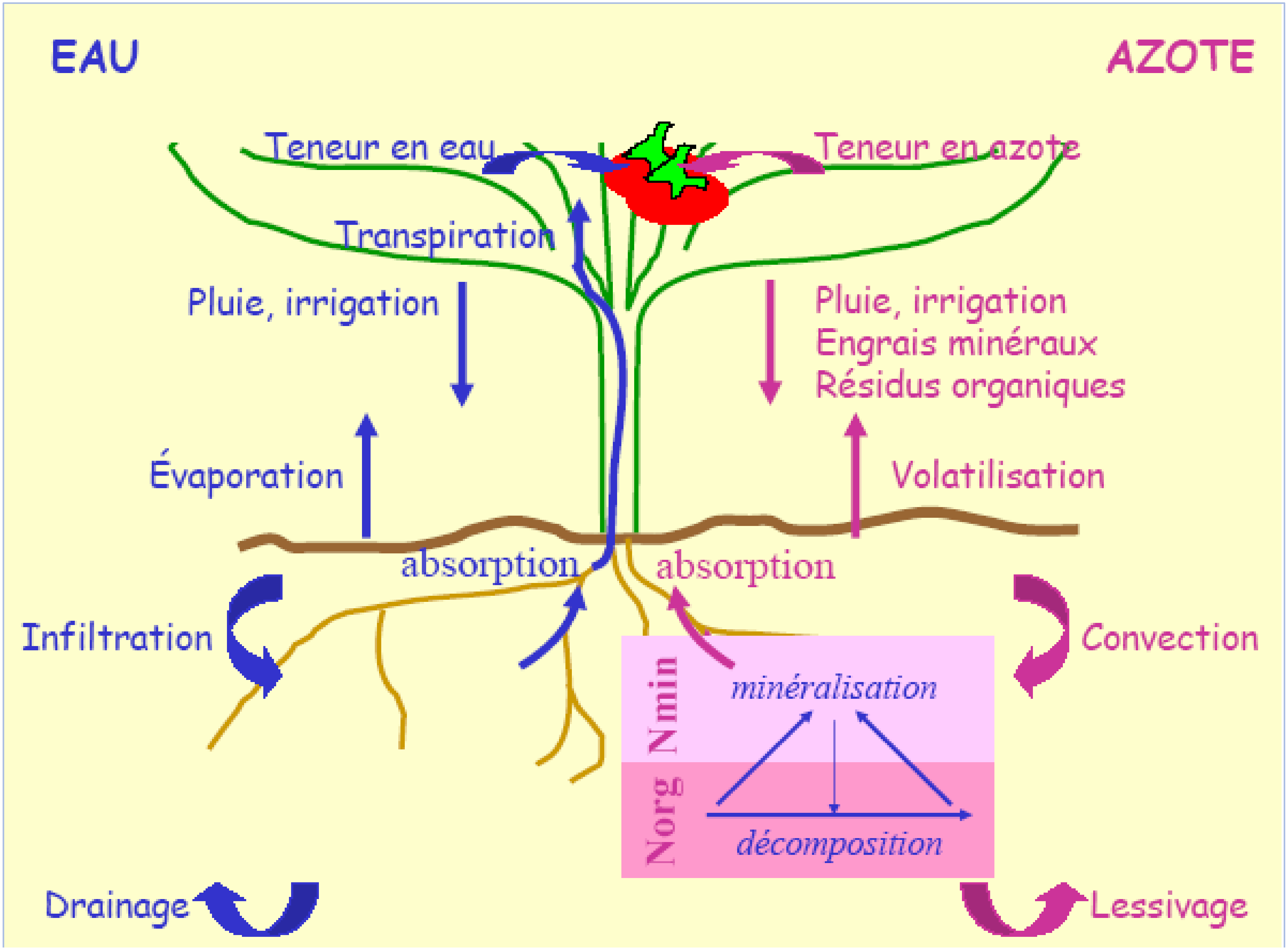
SEC = Soil EC
DEM = Elevation
SLP = Slope

2004: Experimental farm L'Acadie
2005 + 2006: Producer at St-Valentin

Couplage de l'Eau et de l'Azote dans les Peuplements Cultivés

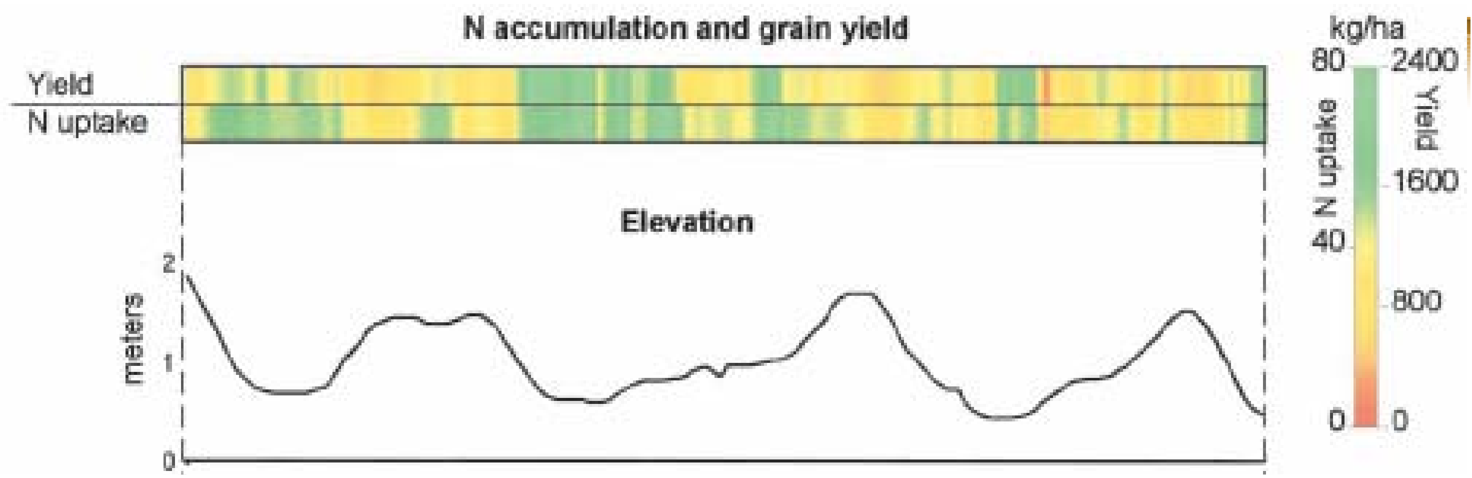
ECCO (PNBC)





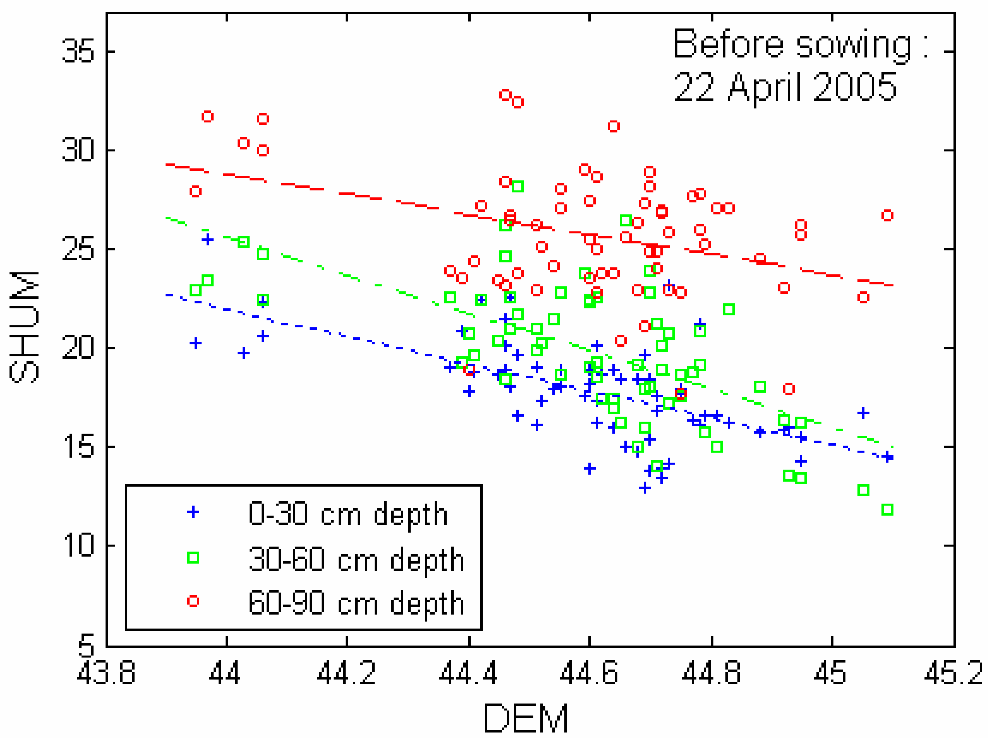
http://www.poitou-charentes.inra.fr/ceapc

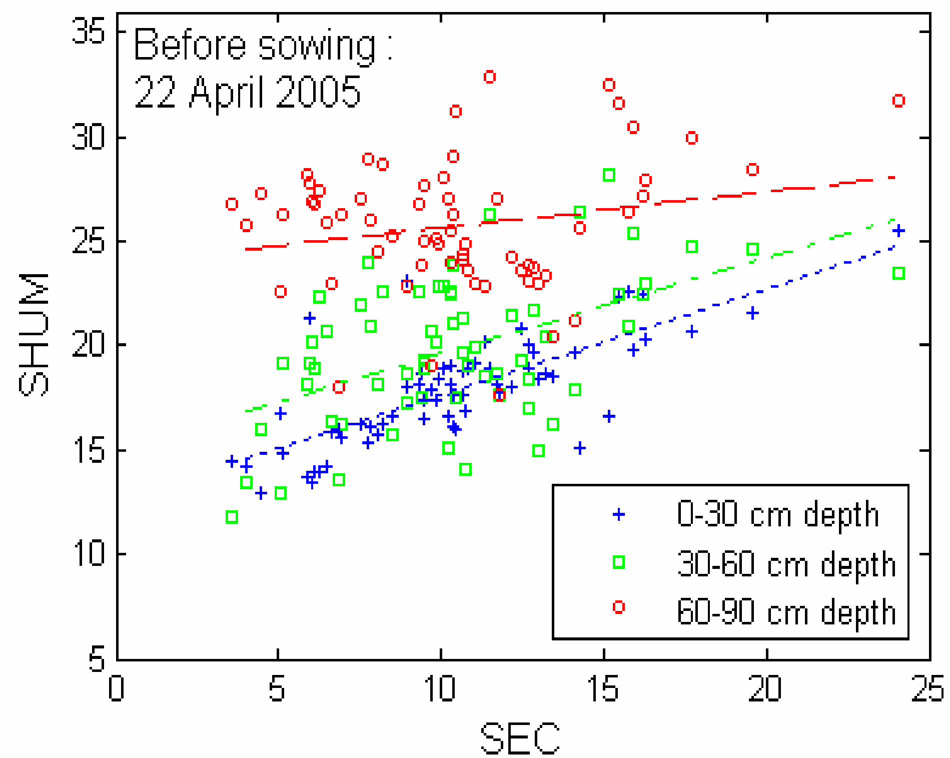
Yield, N uptake in an agricultural landscape



Walley et al. 2002

Soil Water is related to Elevation (DEM) or Apparent Soil Electrical Conductivity (SEC)





SHUM = g water / 100 g soil

Apparent soil EC mapping – very useful in precision ag

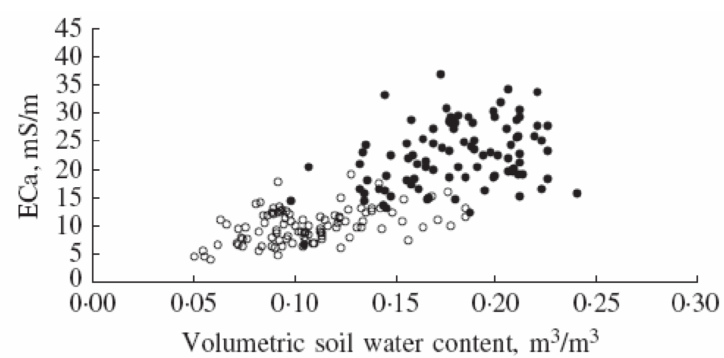
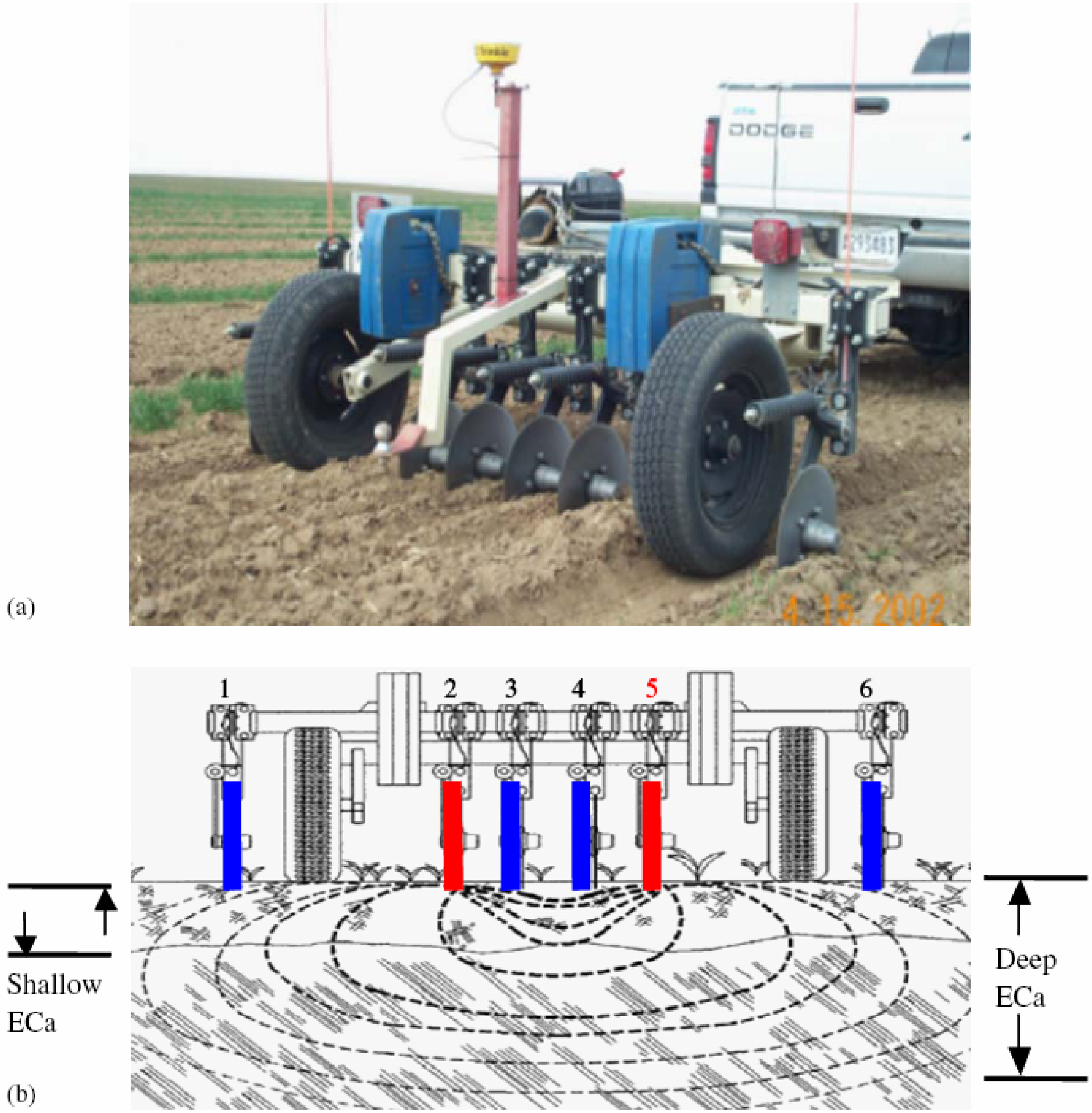


Fig. 5. Shallow apparent soil electrical conductivity (ECa) versus volumetric soil water content at 103 sample locations across stubble strips and 95 sample locations across fallow strips on 12 September 2001: ●, fallow strips; ○, stubble strips



(a)

(b)

Effect of soil water content on N mineralization

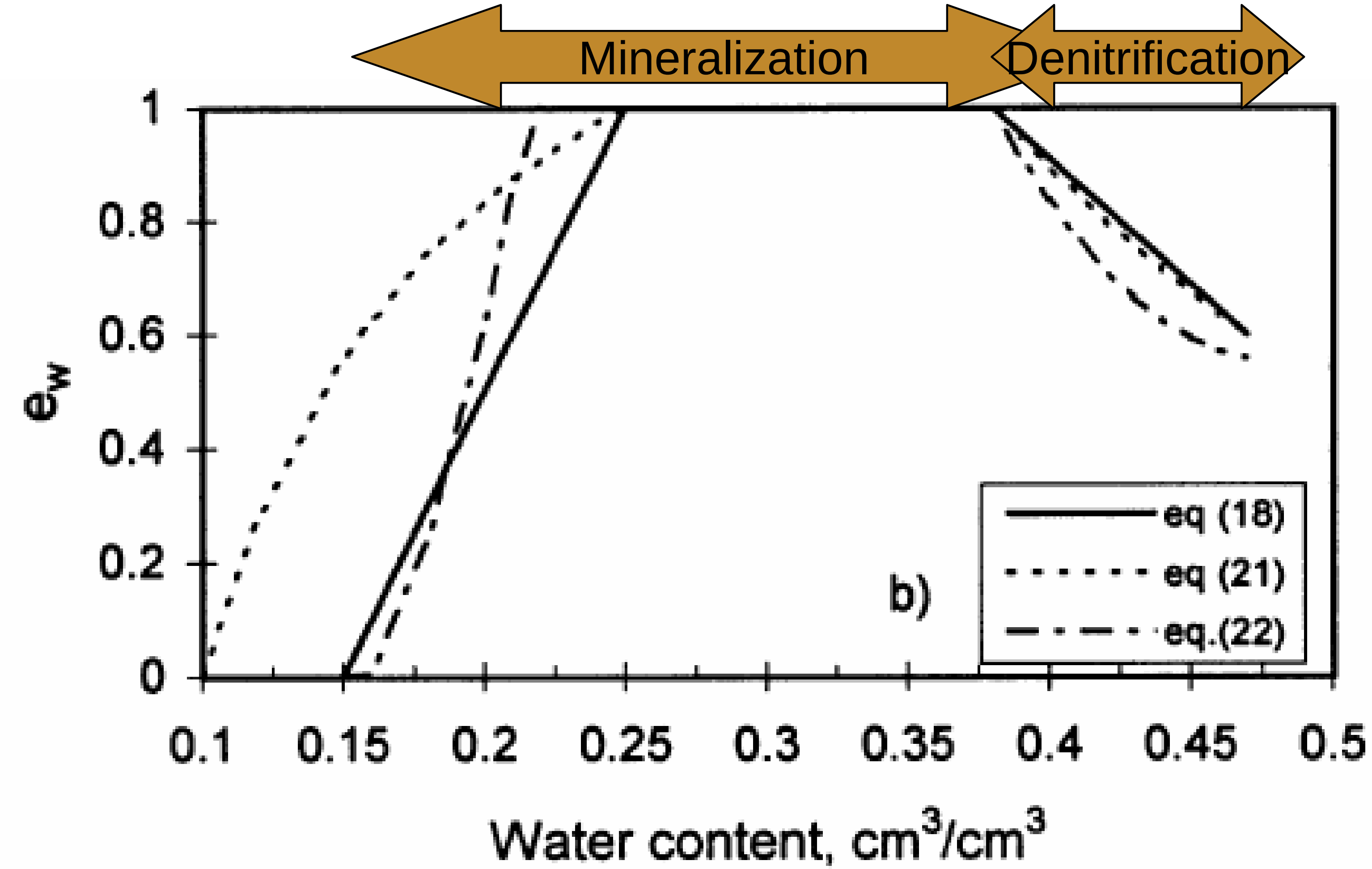


Figure 2: The water content factor as a function of soil water content in different models.

Antonopoulos 1999

Mineralization *f* organic matter and clay

- Spatial distribution of soil mineral N hard to predict from easily mapped variables
- Varies among years, probably owing to differences in soil moisture
- *%Water filled pore space* better than *water potential* to relate to N mineralization (De Neve and Hofman 2002)

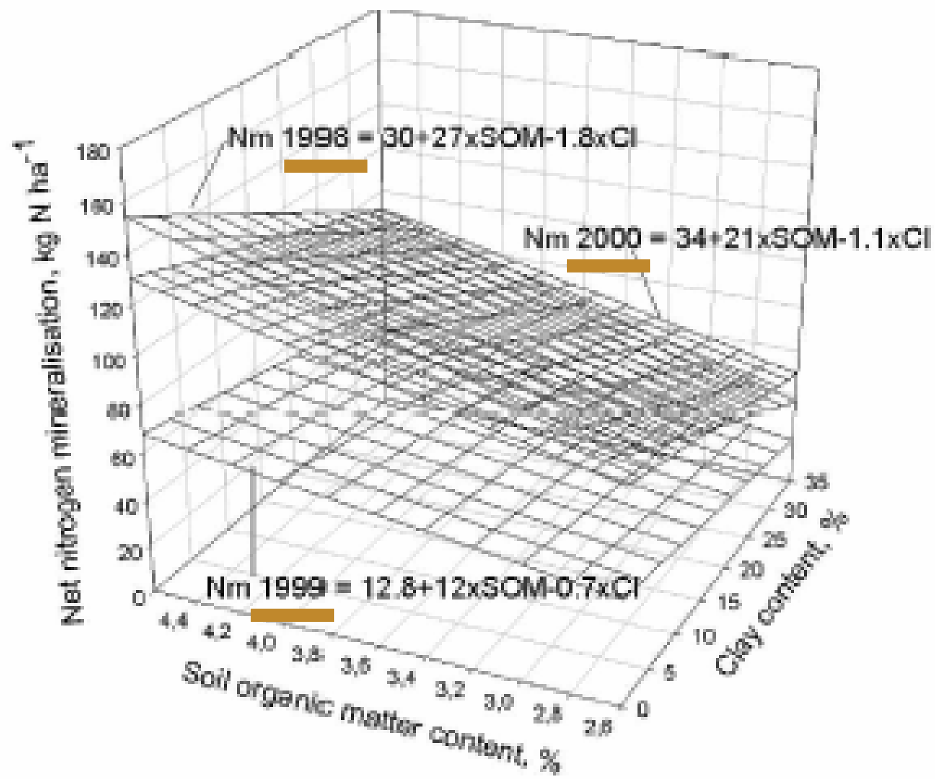
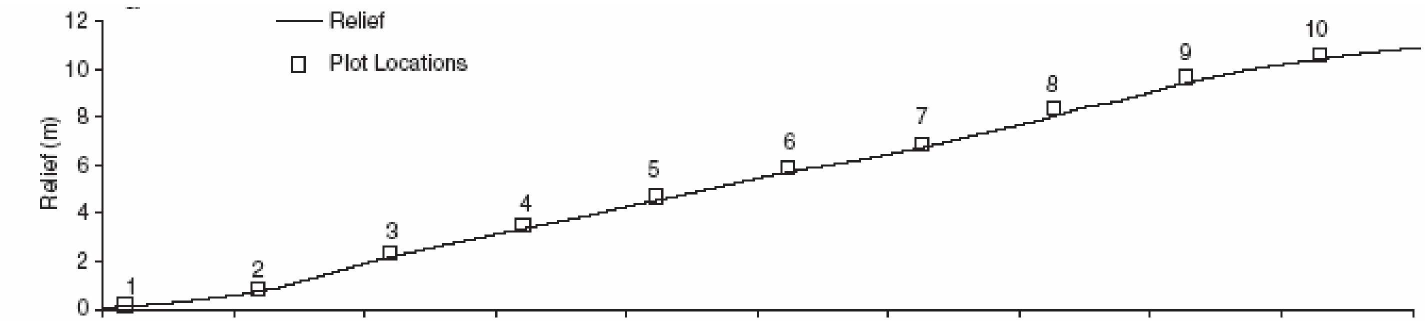


Fig. 3. Plots of multiple linear regression equations for net nitrogen mineralization (Nm), soil organic matter content (SOM) and clay (Cl) in different years (1998, 1999 and 2000).

Delin and Linden 2002

Topography, dates and soil water status



The relationship between economically optimal nitrogen rate (EONR) and the change in soil profile water content (0–90 cm) between 30 June and 25 July (representing the driest and wettest soil conditions early in the growing season) was the defining relationship in this study… (Schmidt et al. 2007)

How much yield have we lost due to water ?

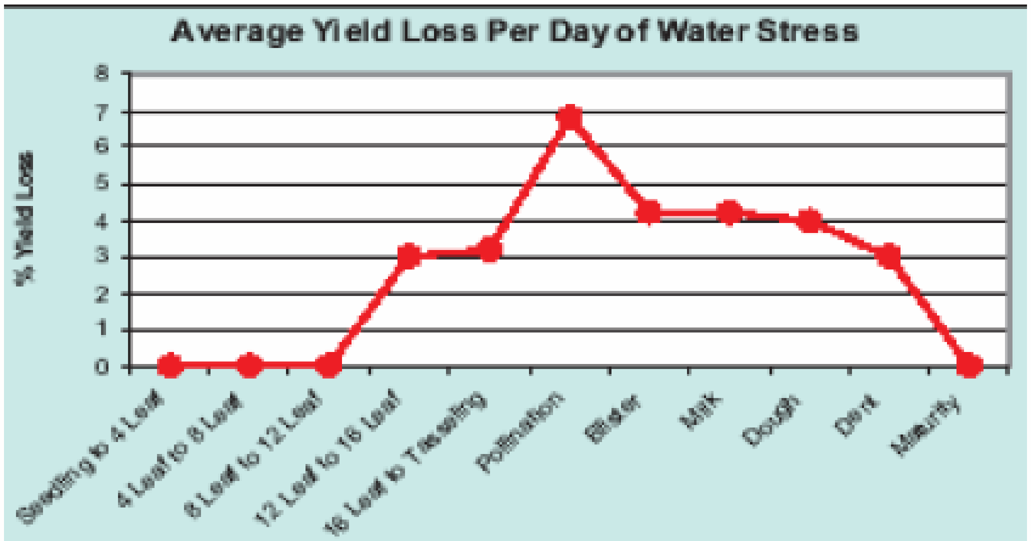
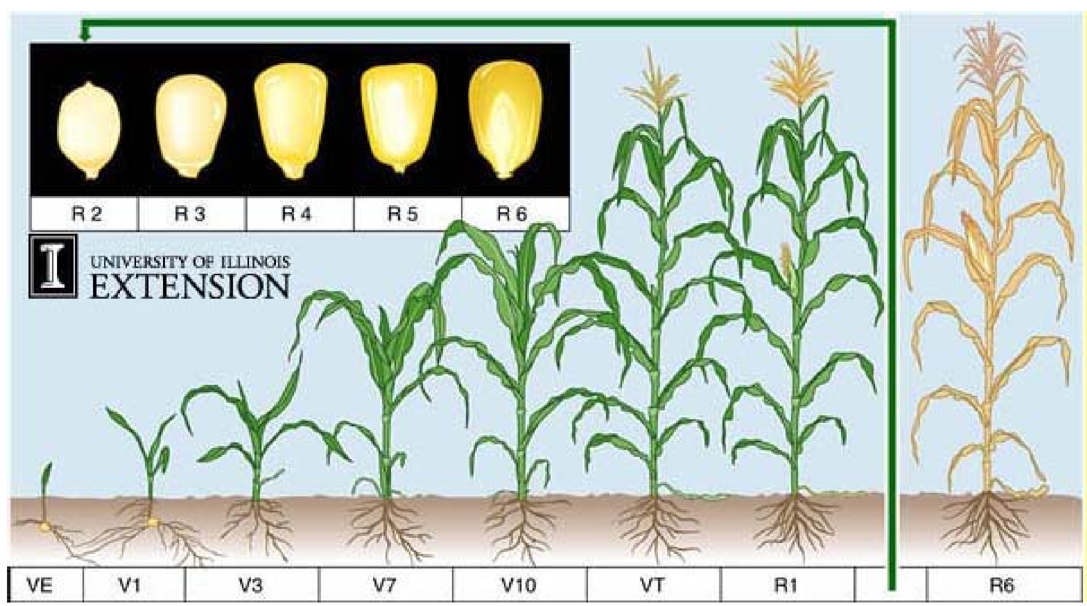


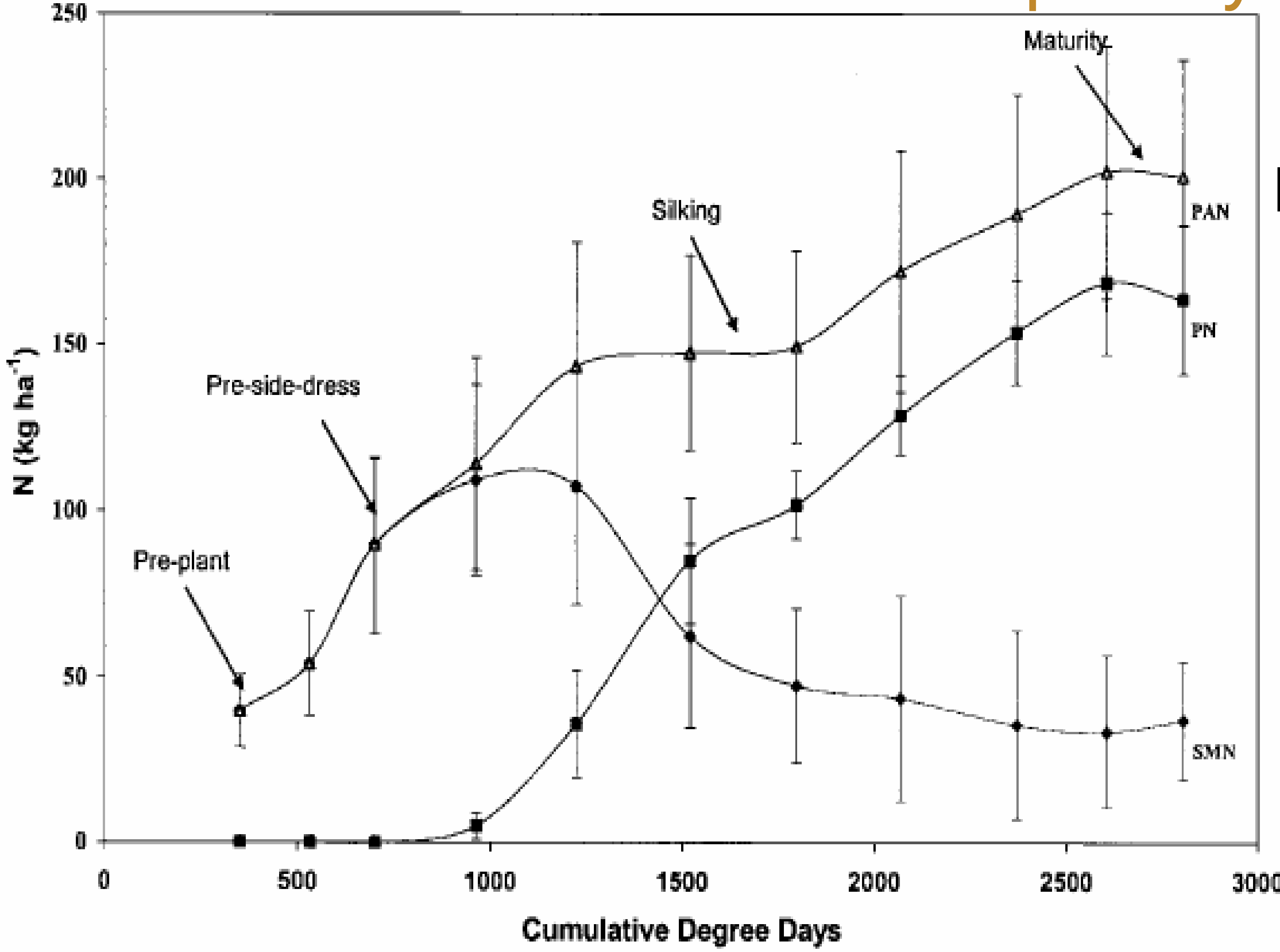
Figure 3. Average yield loss per day of moisture stress[8]



Impact of Drought on Corn Physiology and Yield.pdf

Seasonal evolution of N in the corn soil-plant system

0-30 cm



Plant + Soil

Plant only

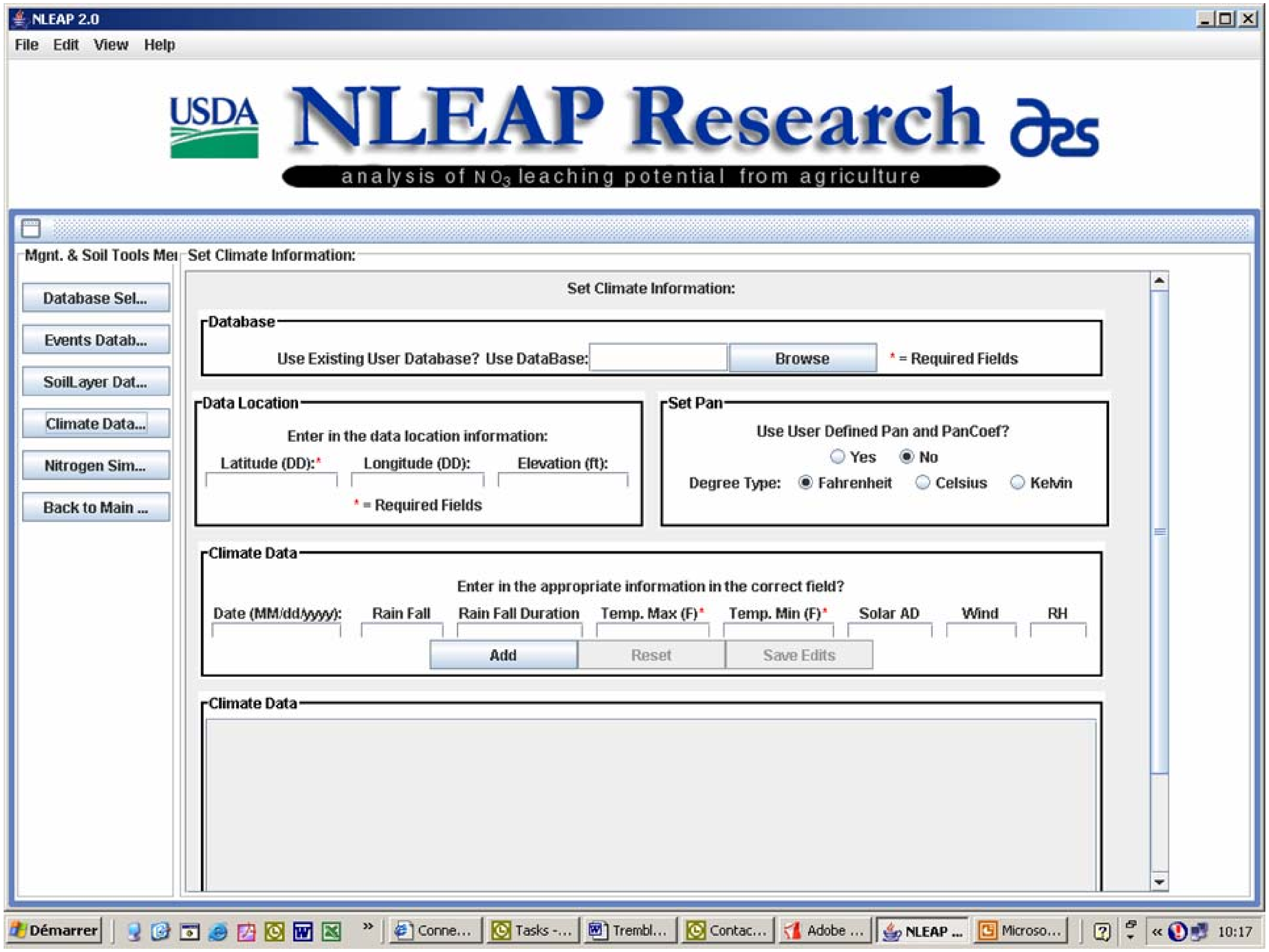
Soil only

Fig. 3. Accumulation of soil mineral N (SMN), total shoot N (PN), and plant available N (PAN) in the 0N plots over the growing season (average across reps, management treatments, landscape positions and all years except 2000). Bars describe standard deviation among years of average across reps, management treatments and landscape positions.

"…the potential benefits of site-specific management would only be fully captured if N management could be adjusted annually in response to changing weather conditions, especially those early in the growing season".

Soil water

- Crop growth
- N mineralization
- N losses
  - Leaching
  - Denitrification
- Erosion events
  - P losses
- Variability
  - Space
  - Time
  - Depth

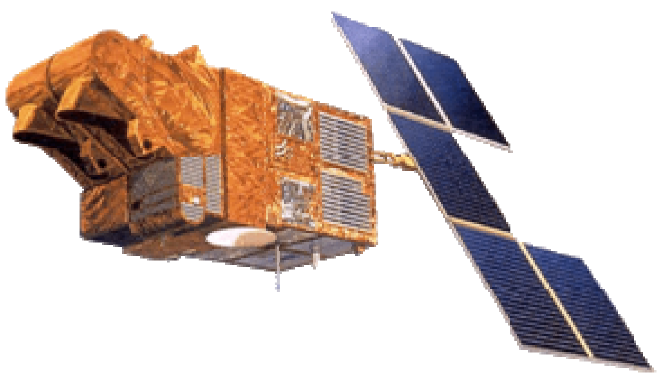


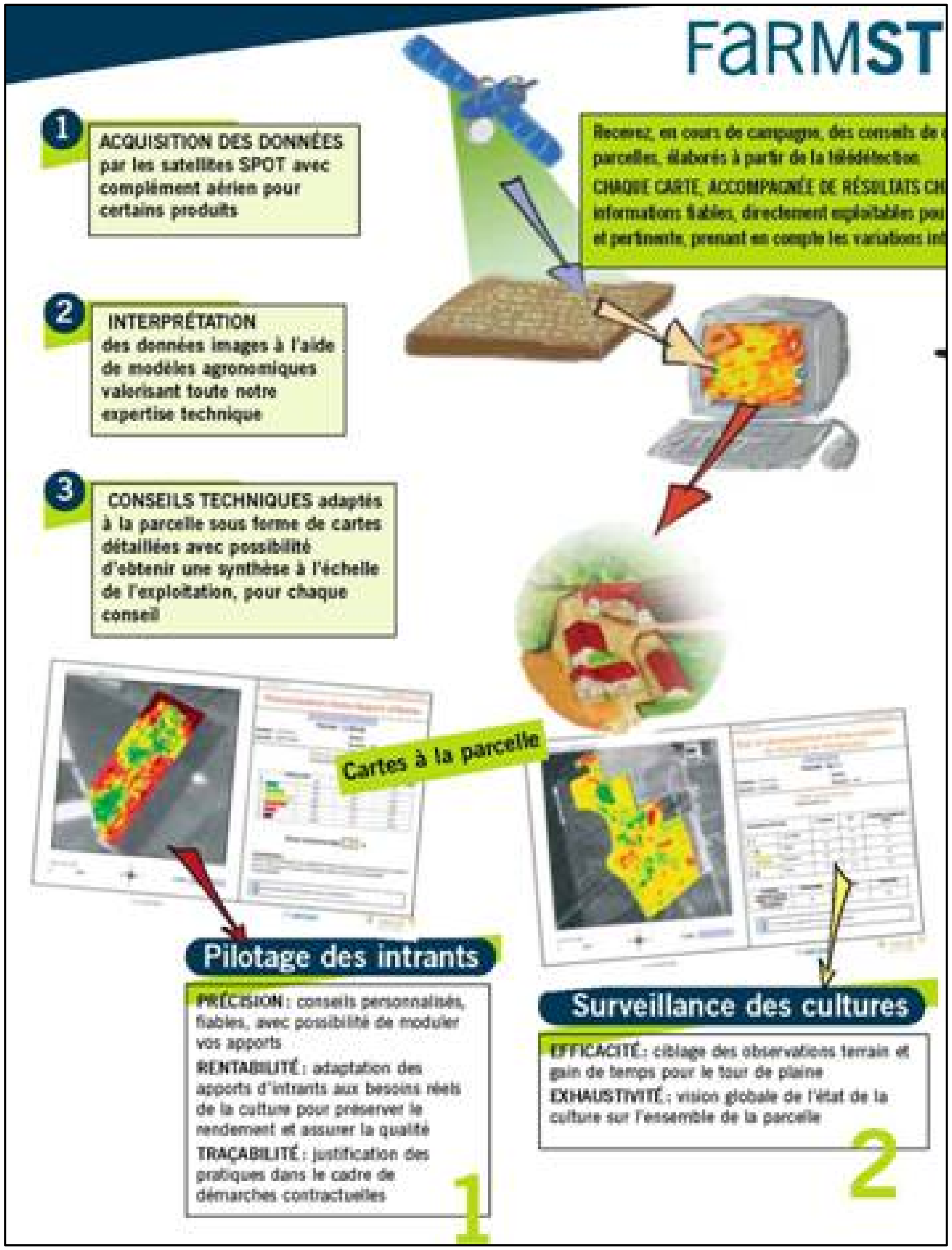
User's requirements

- Lack of science
  - How does soil water actually influences the parameters we are interested in?
- To estimate
  - Unrecoverable yield losses
  - N losses by leaching and denitrification
  - N mineralization
- High temporal resolution
- Need detailed maps at resolution 25 to 400 m^2
  - Soil physics: Texture, bulk density, hydraulic conductivity
  - Precipitations
- In situ / embarked sensors
  - Already NDVI (Chl + growth)
  - Infrared

FarmStar (EADS Astrium)

- SPOT
- Marketed on wheat, colza, barley, corn
- In 2006: 10,000 customers on 250,000 ha
  - France, Germany, England
- http://www.farmstar-space.com





Would a common data access portal be useful?

- Yes for farm level data
  - Soil
  - Precipitations
  - ETP
  - Delta NDVI
- Out of reach for typical precision farming needs
  - Spatial resolution cannot possibly be there

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Thank you !

For more information:

- –Contact Nicolas Tremblay: tremblayna@agr.gc.ca
- –web: http://res2.agr.ca/stjean/personnel/tremblay_e.htm

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