SOERE-PRO

# Assemblée générale du SOERE PRO

*Mardi 24 novembre 2015*
*INRA de Colmar*

INRA SCIENCE & IMPACT

cirad LA RECHERCHE AGRONOMIQUE POUR LE DÉVELOPPEMENT

IRD Institut de recherche pour le développement

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# CRUCIAL: a long-term field trial to assess waste recycling impacts on environment and production system integrity

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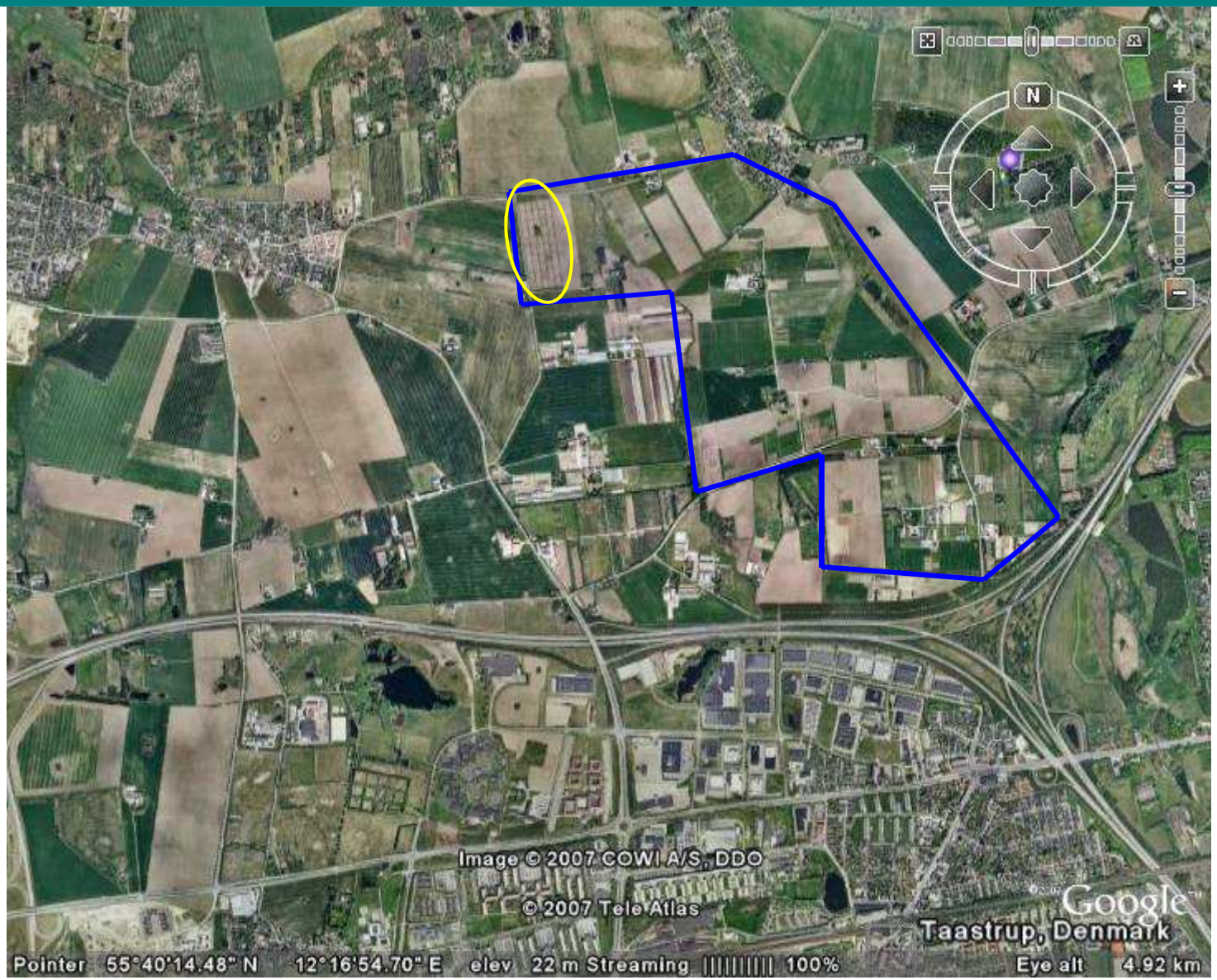
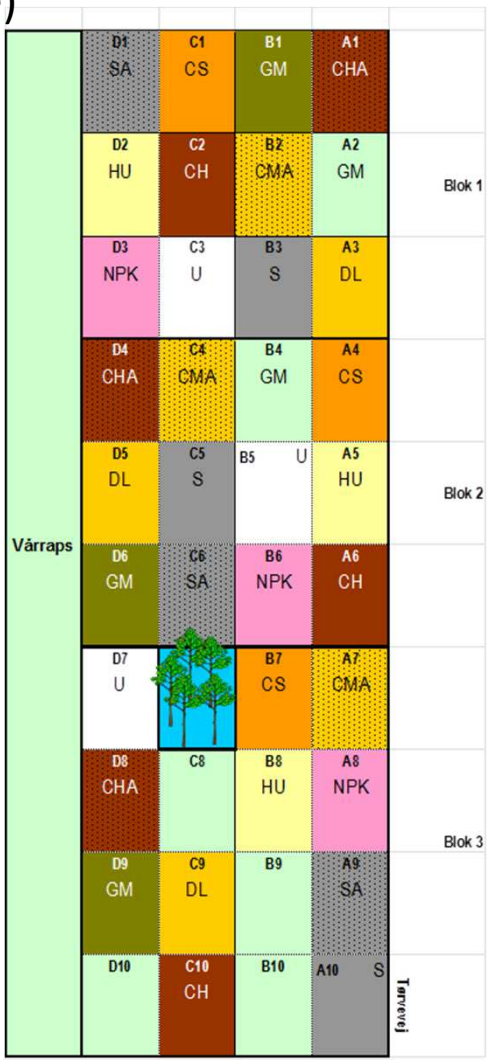
# The CRUCIAL experiment



# The CRUCIAL experiment

- Taastrup exp. Farm
- Luvisol sablo-limoneux (13% argile)
- Démarré en 2003
- Traitements:

- Compost ordures ménagères résiduelles (Dose normale: CH et accélerée:CHA)
- Boue d'épuration (Dose normale: S et accélerée:SA)
- Urine humaine
- Fumier de bovin (dose accélerée: CMA)
- Litière épaisse (DL)
- Lisier bovin (CS)
- Engrais NPK (NPK)
- Non fertilisé avec trèfle (GM)
- Non fertilisé (U)




# The CRUCIAL experiment

## Rationale

L'essais de longue durée CRUCIAL mis en place afin de:

- Contribuer à notre connaissance des cycles de matières (carbone, nutriments, métaux lourds, xenobiotiques, pathogenes, micro-organismes et gènes

- Etudier l'impact environnementale et l'intégrité des agroécosystèmes

# The CRUCIAL experiment

## Hypothèse

Lorsque les limites écotoxycologiques sont approchées de manière réaliste, il n'y a pas d'effet adverse (non attendus) sur la qualité du sol, l'environnement et l'intégrité du système de production

# The CRUCIAL experiment

## The Frankenstein effect

How bad can it get?

⇒ Accelerated treatments

# The CRUCIAL experiment

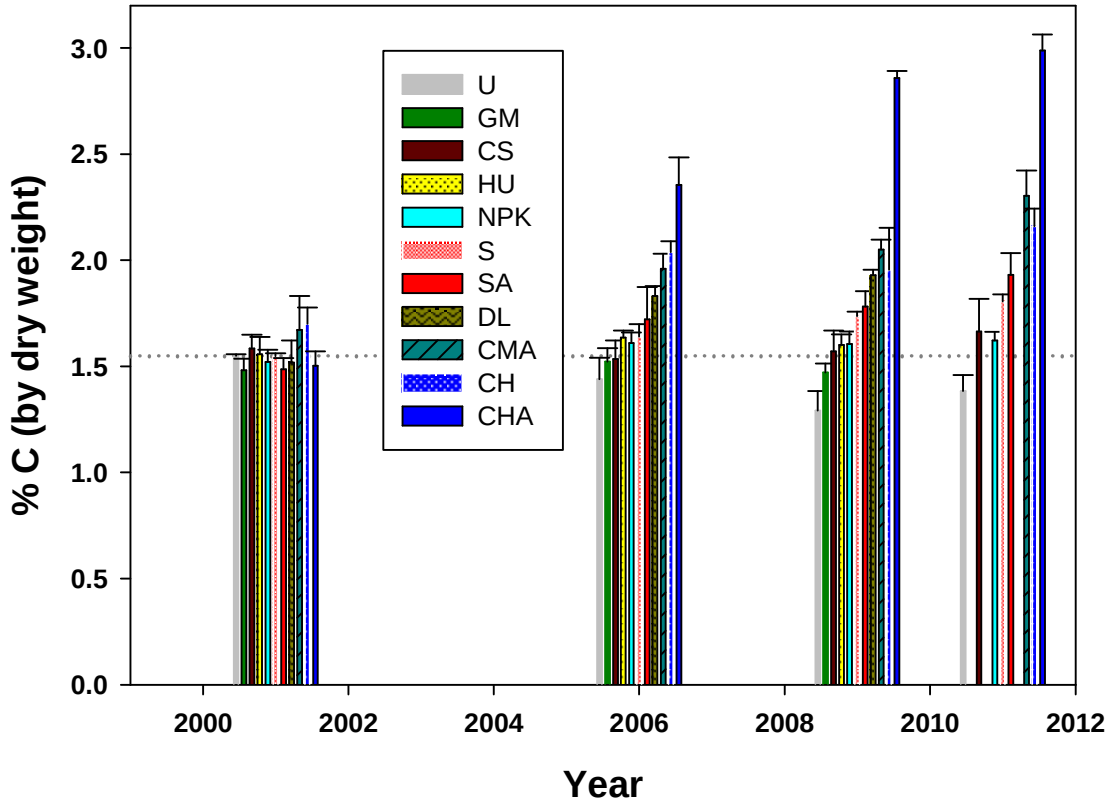
## Pourquoi des traitements accélérés ?

Table 2. Estimated number of years for reaching eco toxicological limits for Zn and Cu, with rates of export (leaching and plant uptake) based on Witter (1996), under the assumption that the limits would be reached by net addition of 195 kg Zn $ha^{-1}$ (75 ppm) and 52 kg Cu $ha^{-1}$ (20 ppm).

| | average quality | | worst quality | |
|---|---|---|---|---|
| | Zn yr | Cu yr | Zn yr | Cu yr |
| Sludge | 38 | 27 | 18 | 11 |
| Sludge accelerated | 10 | 7 | 5 | 3 |
| MSW Compost | 41 | 31 | 20 | 13 |
| MSW Compost accelerated | 10 | 8 | 5 | 3 |
| Cattle slurry | 9750 | 7738 | 9750 | 3158 |
| Cattle Dung accelerated | 2438 | 1970 | 2438 | 804 |

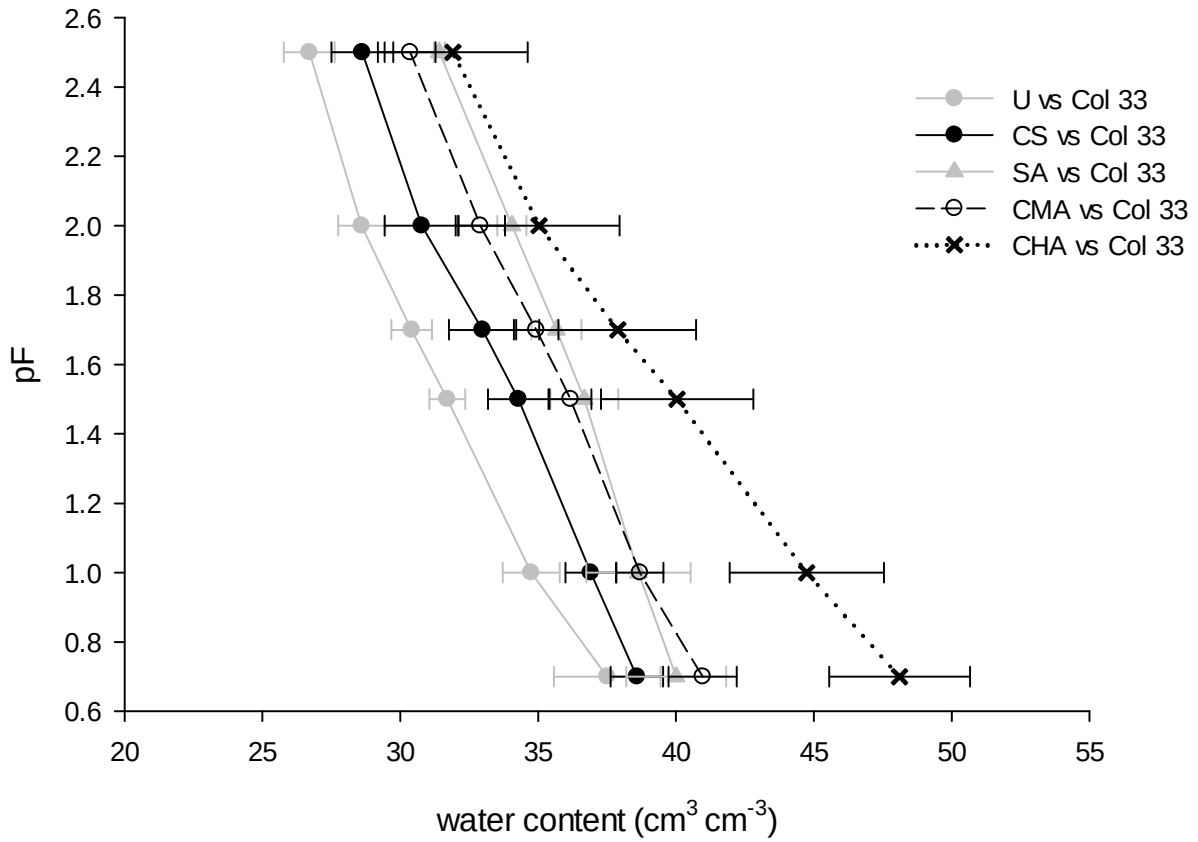
# The CRUCIAL experiment

## Teneur en carbone total du sol (2001 -2011)



# The CRUCIAL experiment

## Courbes de rétention en eau




**Retention curves for 100 cm³ samples. Each point is a mean of six replicate samples (+/- sd). Amendments: U) unfertilized; CS) Cattle Slurry; SA) Accelerated Sludge; CMA) Cattle Manure Accelerated; CHA) Composted Household waste Accelerated**

# The CRUCIAL experiment

## Résumé des principaux résultats

**Microbial activity is closely related to input levels, microbial function unaffected**

*Poulsen, P.H.B., Magid, J., Luxhoi, J., de Neergaard, A., 2013b. Effects of fertilization with urban and agricultural organic wastes in a field trial - Waste imprint on soil microbial activity. Soil Biology & Biochemistry 57, 794-802.*

**Highly robust system – when measuring procariotic diversity**

*Poulsen, P.H.B., Abu Al-Soud, W., Bergmark, L., Magid, J., Hansen, L.H., Sorensen, S.J., 2013a. Effects of fertilization with urban and agricultural organic wastes in a field trial - Prokaryotic diversity investigated by pyrosequencing. Soil Biology & Biochemistry 57, 784-793.*

**Antibiotic resistance of pseudomonads is only affected in the very short term (3 weeks) by waste application treatments**

*Riber, L., Poulsen, P.H., Al-Soud, W.A., Skov Hansen, L.B., Bergmark, L., Brejnrod, A., Norman, A., Hansen, L.H., Magid, J., Sorensen, S.J., 2014. Exploring the immediate and long-term impact on bacterial communities in soil amended with animal and urban organic waste fertilizers using pyrosequencing and screening for horizontal transfer of antibiotic resistance. FEMS Microbiol Ecol 90, 206-224.*

# The CRUCIAL experiment

## Résumé des principaux résultats

**There is no indication of increased tolerance towards Cu, as determined by the PICT assay**

*Lekfeldt, J.D., Magid, J., Holm, P.E., Nybroe, O., Brandt, K.K., 2014. Evaluation of the leucine incorporation technique for detection of pollution-induced community tolerance to copper in a long-term agricultural field trial with urban waste fertilizers. Environ Pollut 194, 78-85.*

**Structural stability is increased by application of high loadings of nutrients ( less leaching of colloids, and metals associated with colloids)**

**No increased leaching of heavy metals from waste ammended treatments, apart from Cu associated with high DOC concentrations in the compost ammended soil**

From a PhD thesis defended on 26th June 2015:

*"The effect of organic waste fertilizers on soil structure and leaching of solutes and colloids from intact soil columns depends on the type of fertilizer applied", to be submitted*

*"The effect of urban waste fertilizers on the leaching of metals in a long-term agricultural field trial", to be submitted*

# The CRUCIAL experiment

## Objectifs

i. **Etudier l'effet d'apport de PROs sur l'énergie et le carburant nécessaire pour le labour**

ii. **Etudier les modifications de la composition de la MOS après l'apport de PROs**

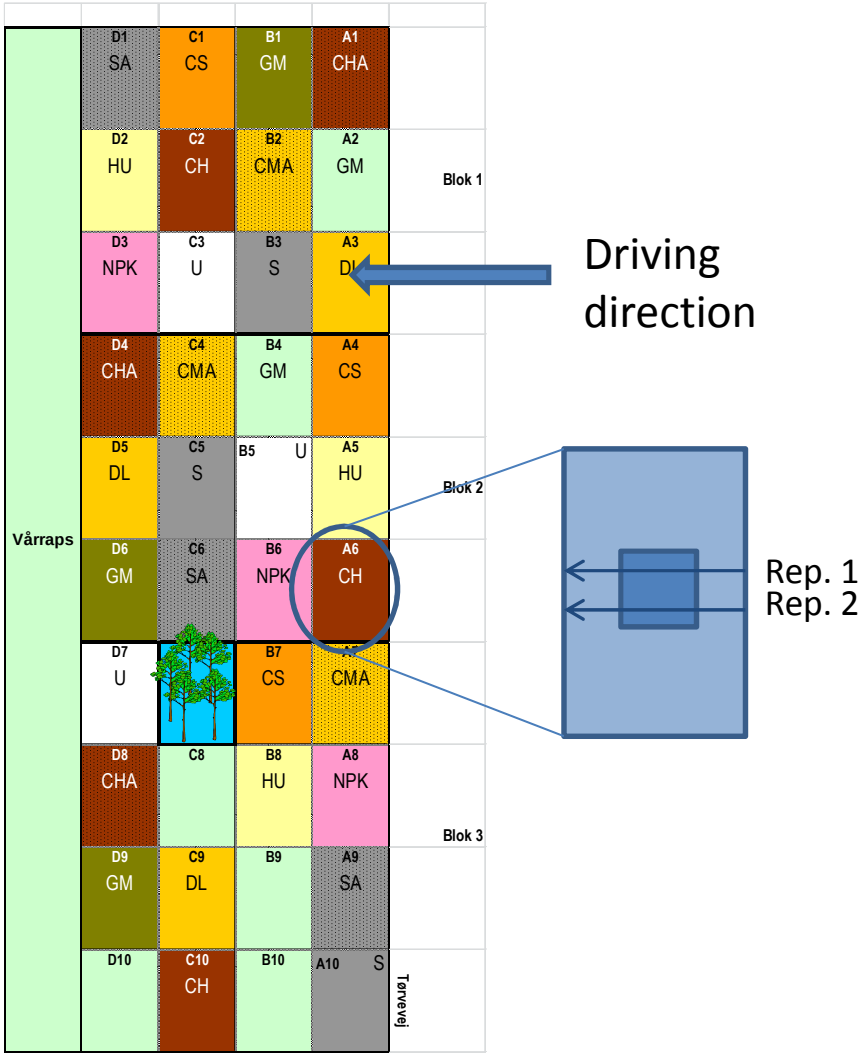
# The CRUCIAL experiment

## Objectifs

i. **Etudier l'effet d'apport de PROs sur l'énergie et le carburant nécessaire pour le labour**

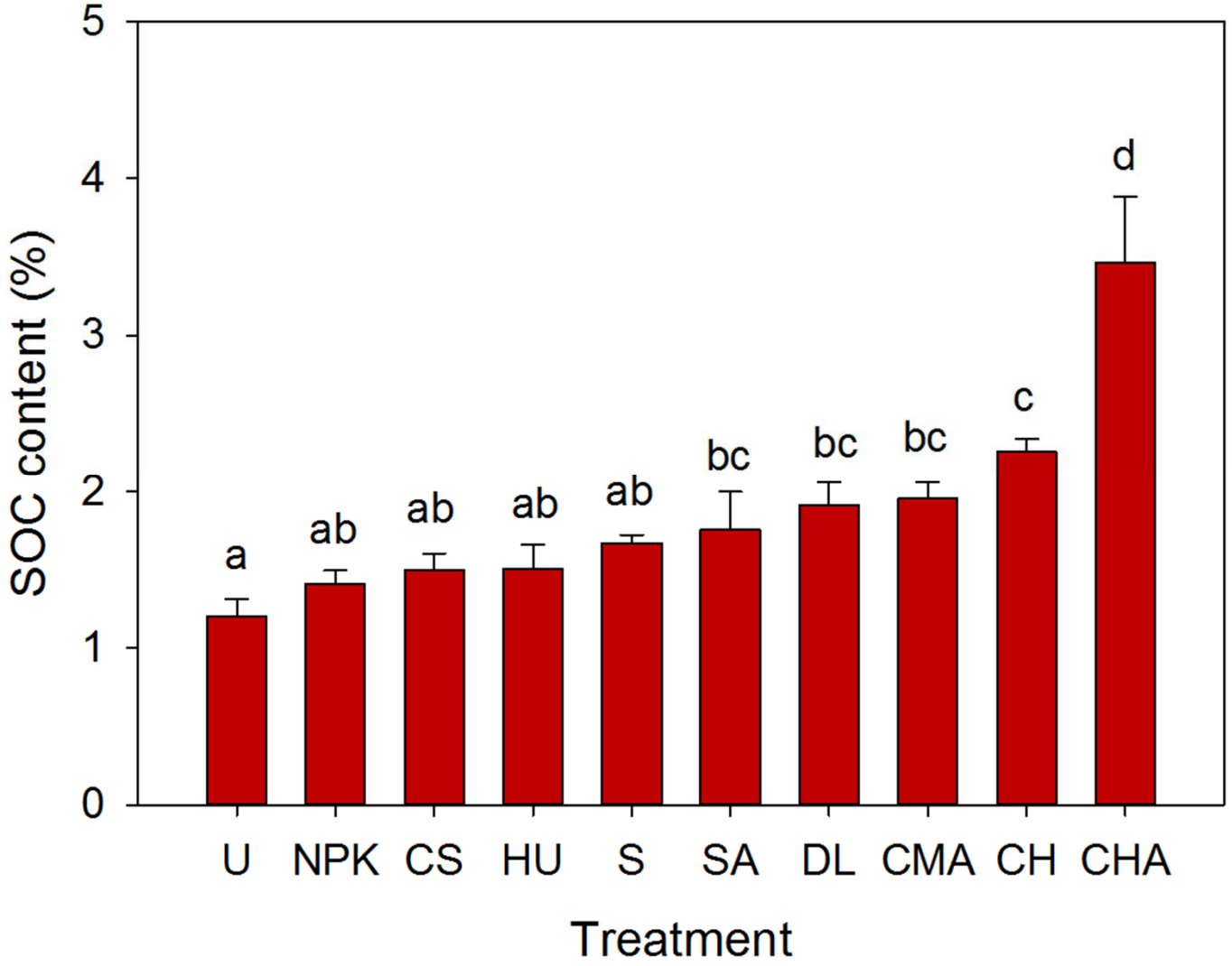
# The CRUCIAL experiment

## Mesure de la force de traction pour le labour



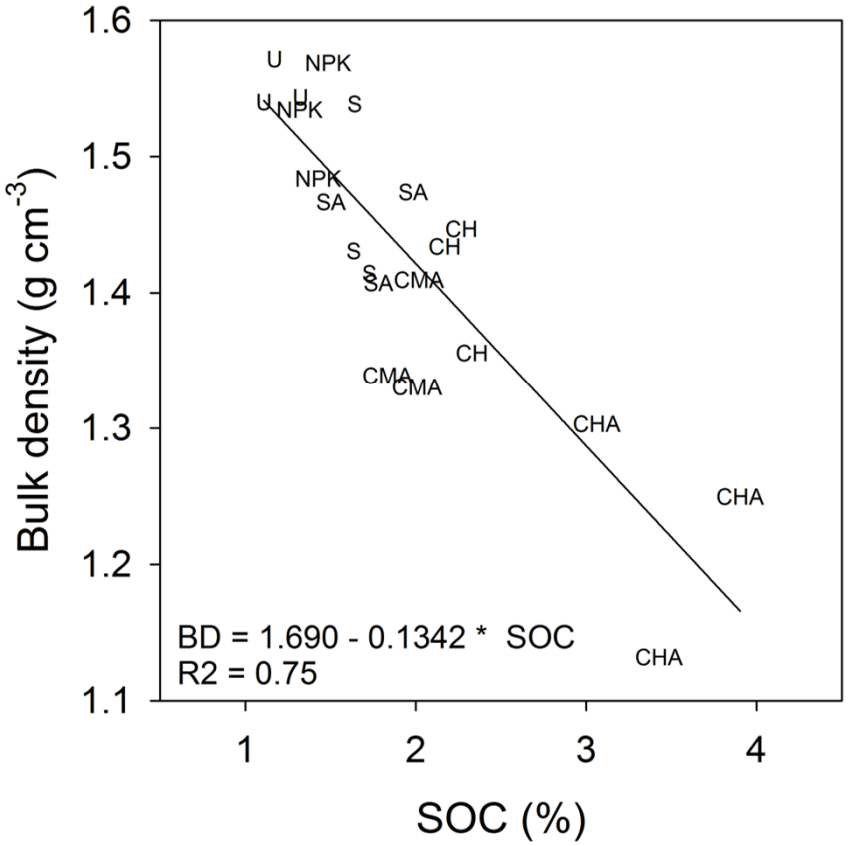

# The CRUCIAL experiment

## Teneur en carbone du sol



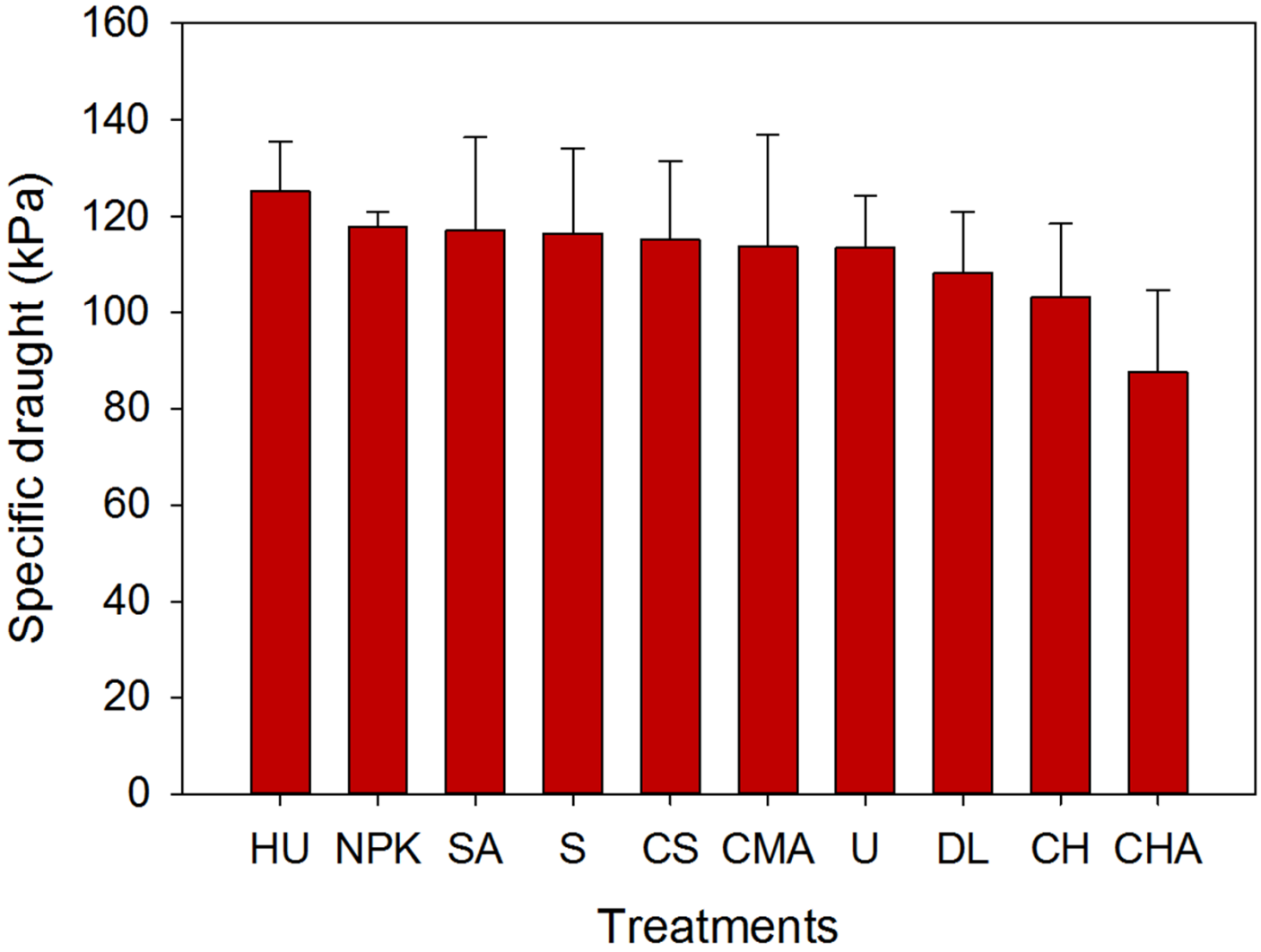
# The CRUCIAL experiment

## Relation densité apparente - COS



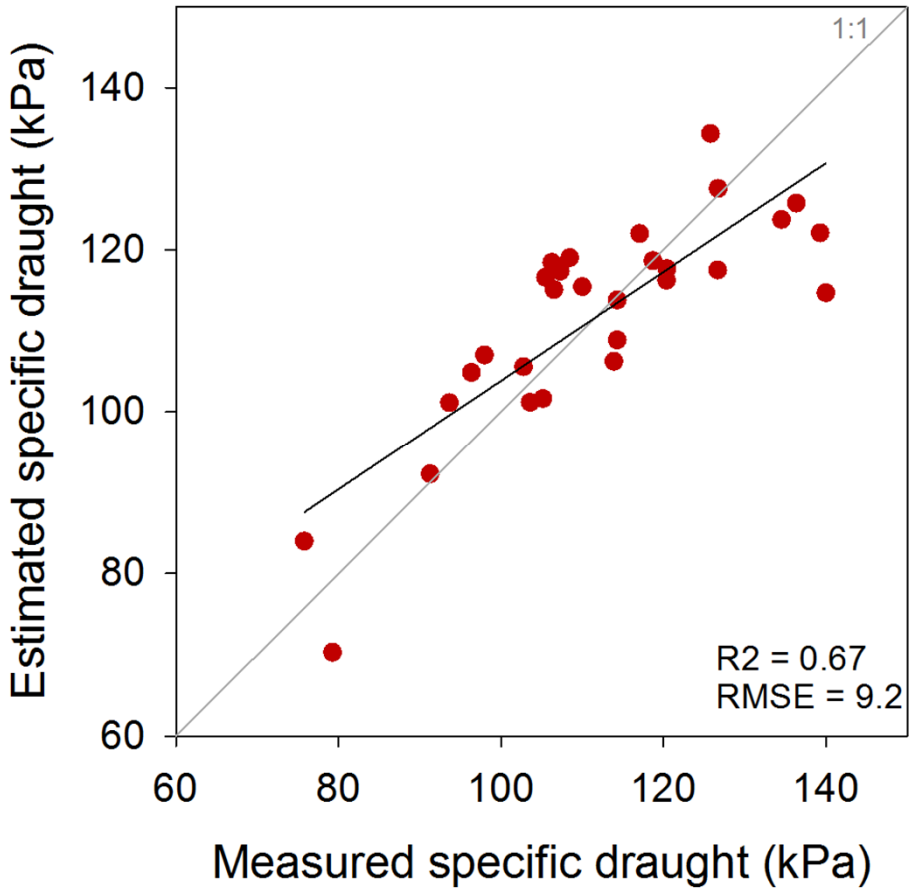
# The CRUCIAL experiment

## Force de traction



# The CRUCIAL experiment

## Relation force de traction en fonction de COS et argile




**SDf = 58.85 + 6.76 x argile – 17.35 x COS**

(Peltre et al., 2015 AGEE)

# The CRUCIAL experiment

## Consomation de carburant

| | Fuel for operation (L $h^{-1}$) | Fuel savings (% of difference compared to NPK treatment) |
|---|---|---|
| CHA | 3.4 (0.5) | **-25%** |
| CH | 3.8 (0.5) | **-14%** |
| DL | 4.0 (0.4) | -11% |
| U | 4.1 (0.3) | -7% |
| CMA | 4.1 (0.7) | -7% |
| S | 4.2 (0.5) | -5% |
| CS | 4.2 (0.5) | -5% |
| SA | 4.2 (0.6) | -5% |
| NPK | 4.5 (0.4) | |
| HU | 4.7 (0.1) | +5% |

(Peltre et al., 2015 AGEE)

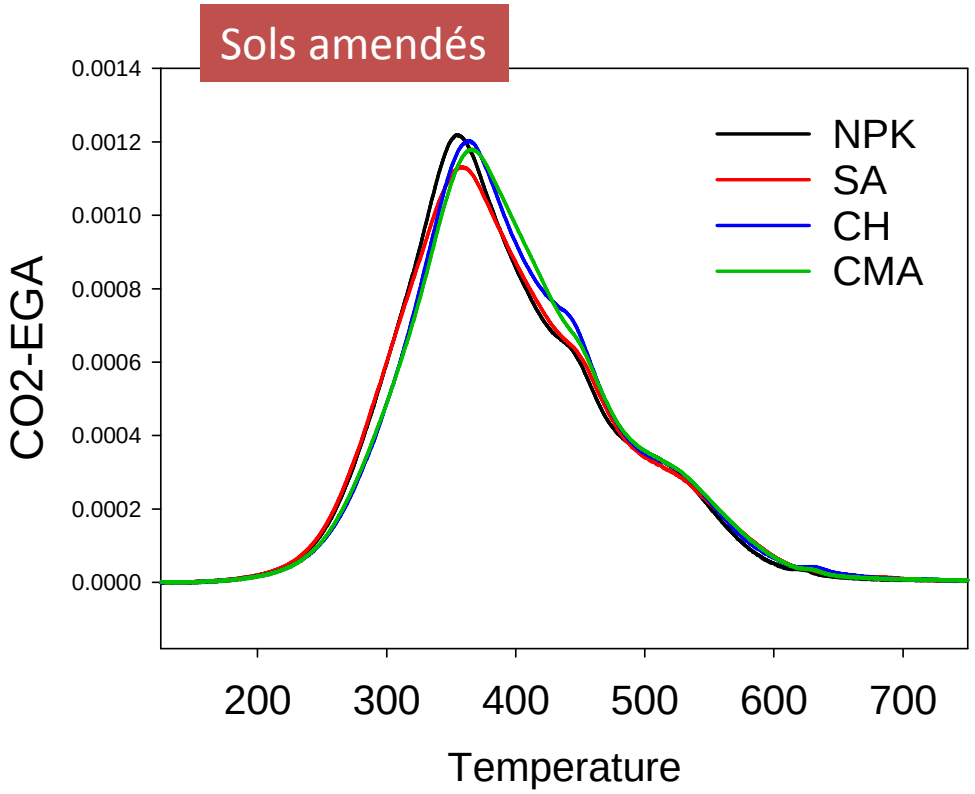
# The CRUCIAL experiment

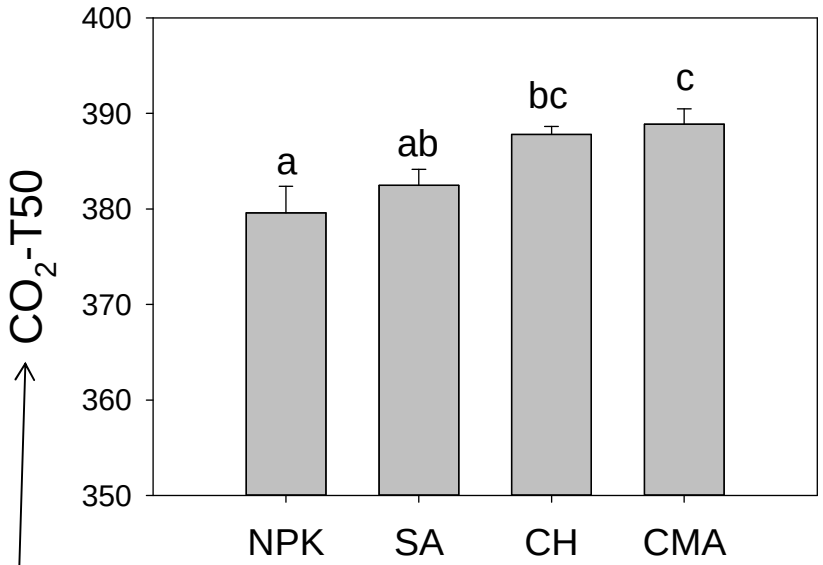
i. Etudier l'effet d'apport de PROs sur l'énergie et le carburant nécessaire pour le labour

**ii. Etudier les modifications de la composition de la MOS après l'apport de PROs**

# The CRUCIAL experiment

## Analyse thermique

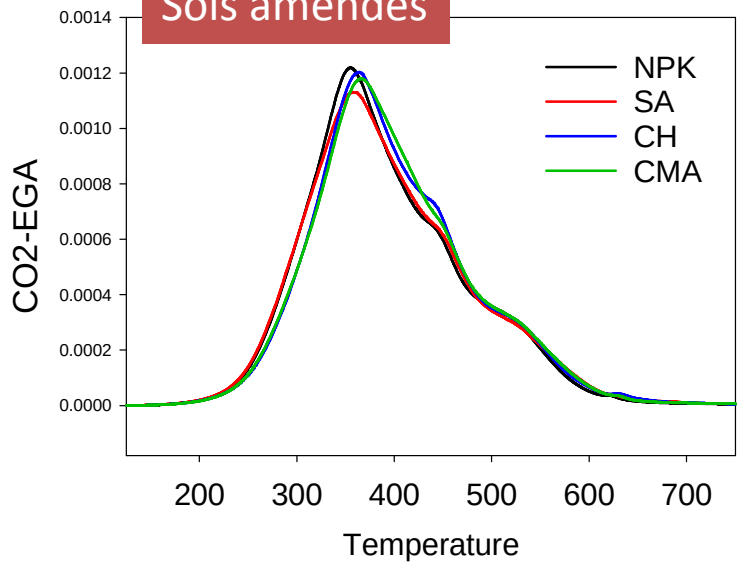


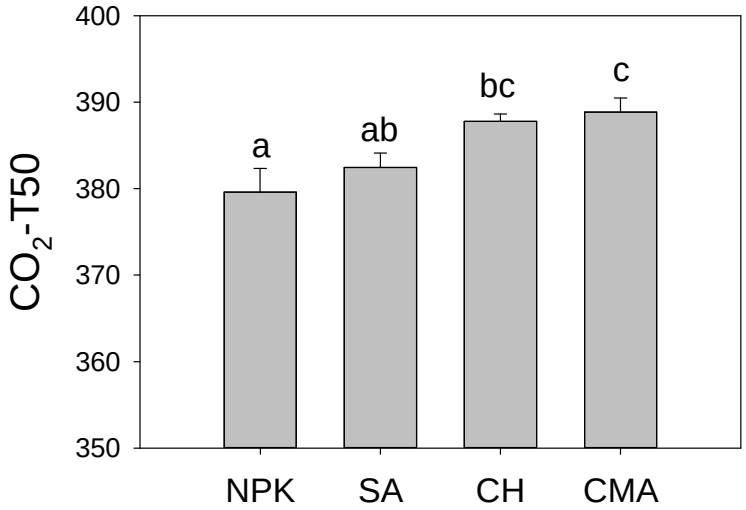




Temperature à laquelle la moitié du $CO_2$ est dégagé

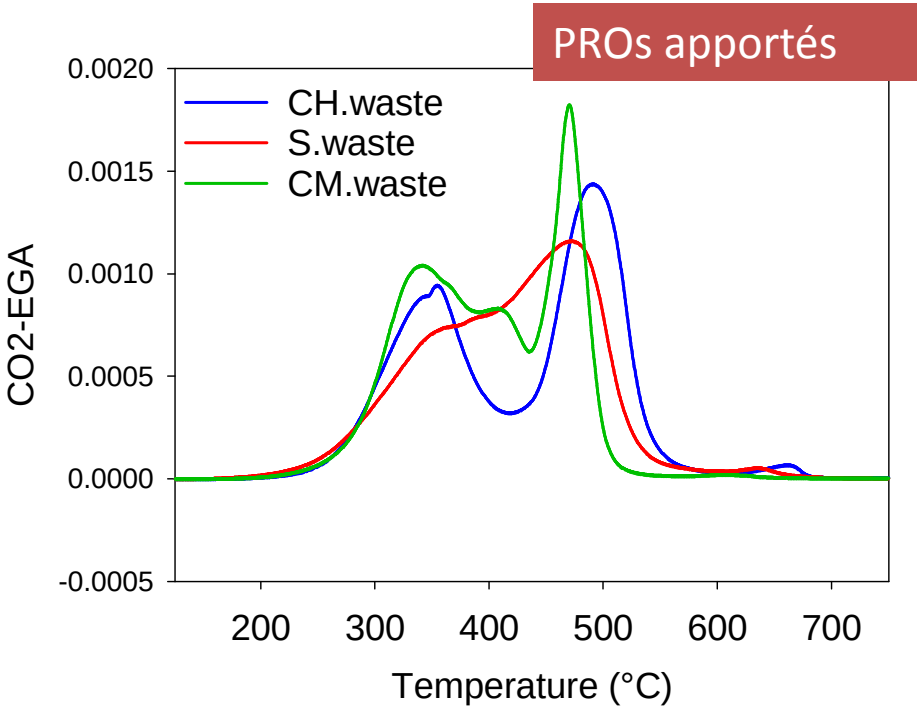
# The CRUCIAL experiment

Sols amendés



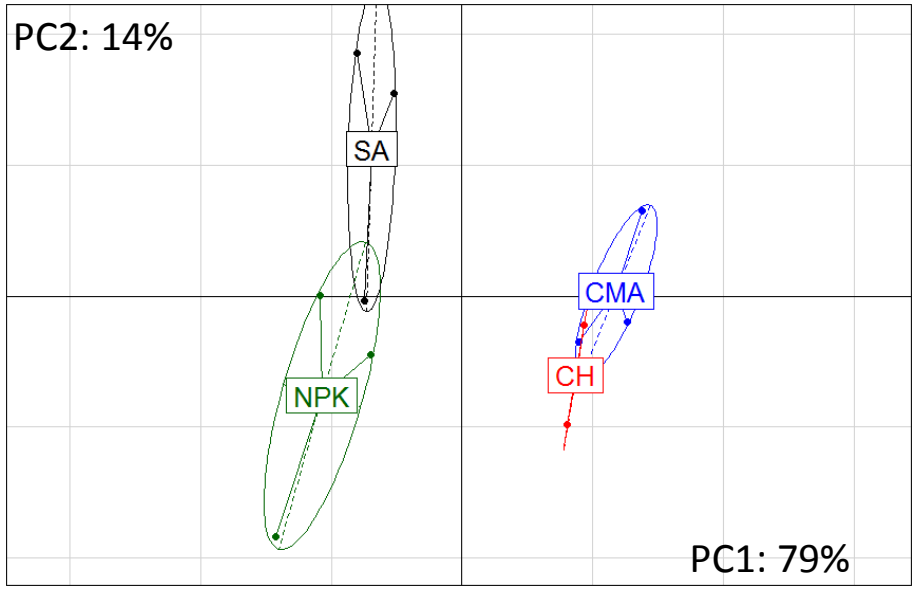



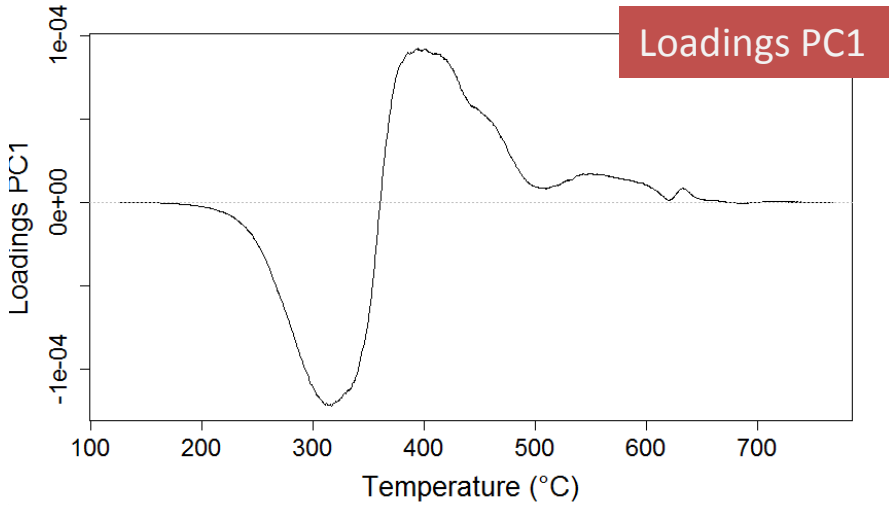

PROs apportés



# The CRUCIAL experiment

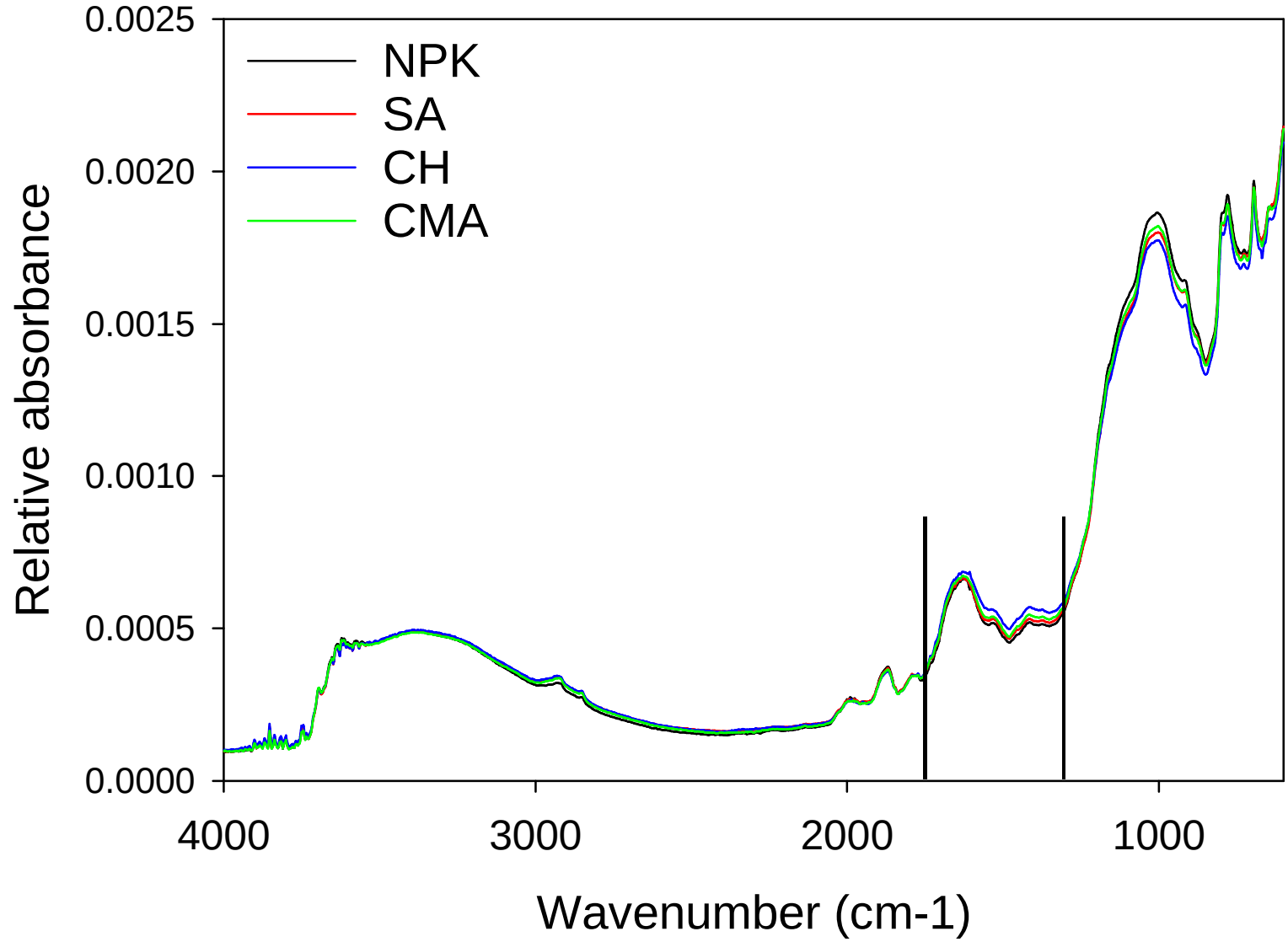
## Analyse thermique: ACP



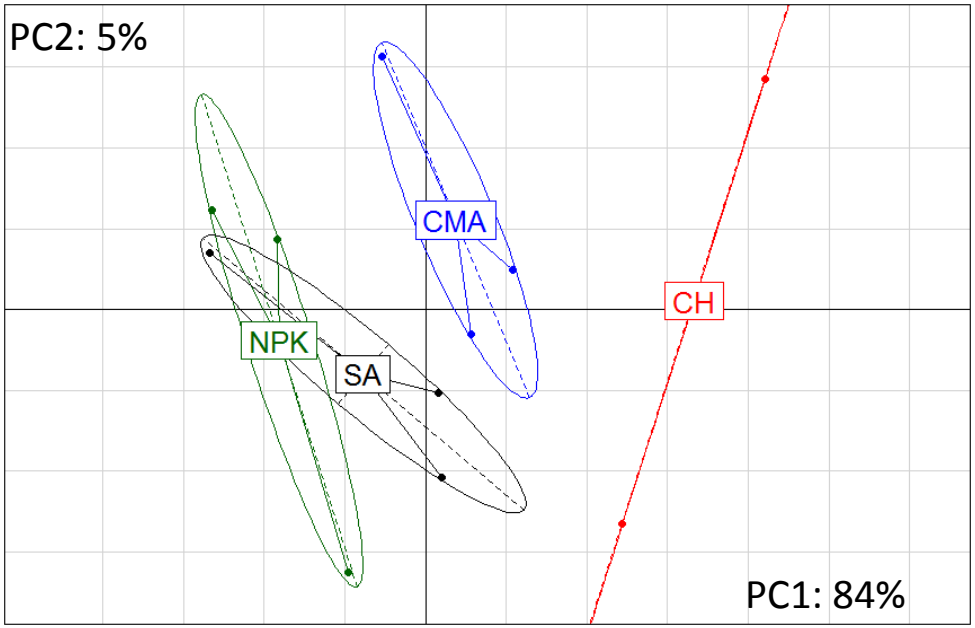
# The CRUCIAL experiment

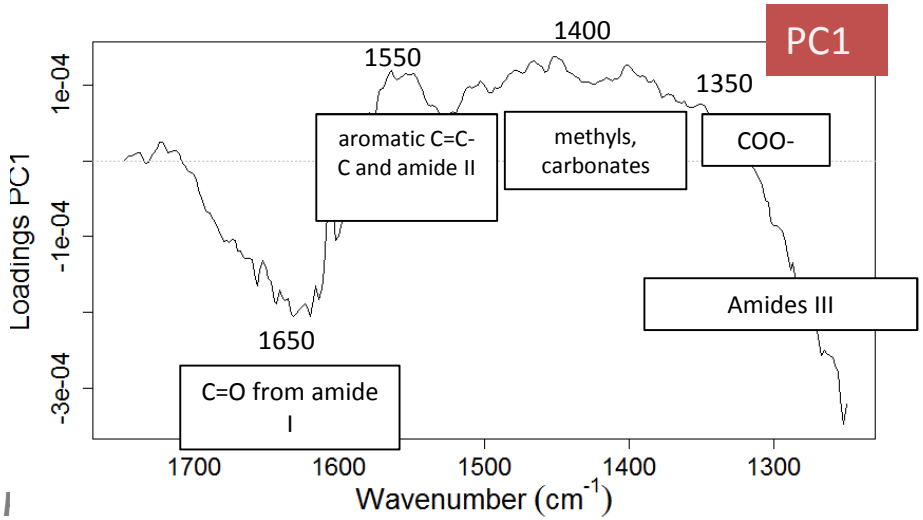
## FTIR-PAS



# The CRUCIAL experiment

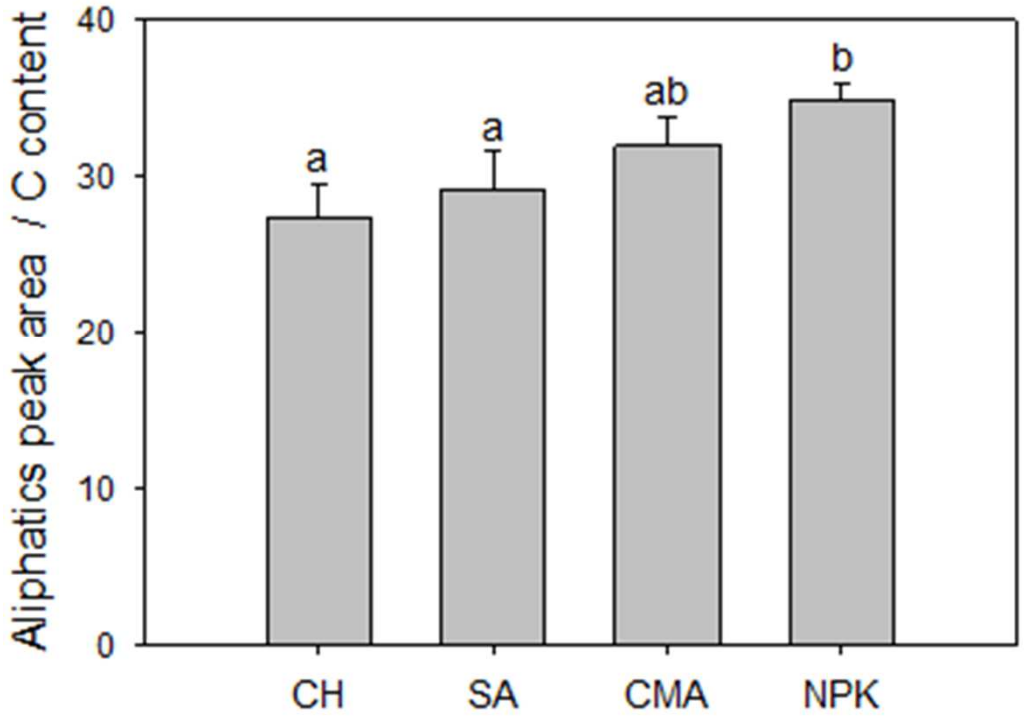
## FTIR-PAS: ACP



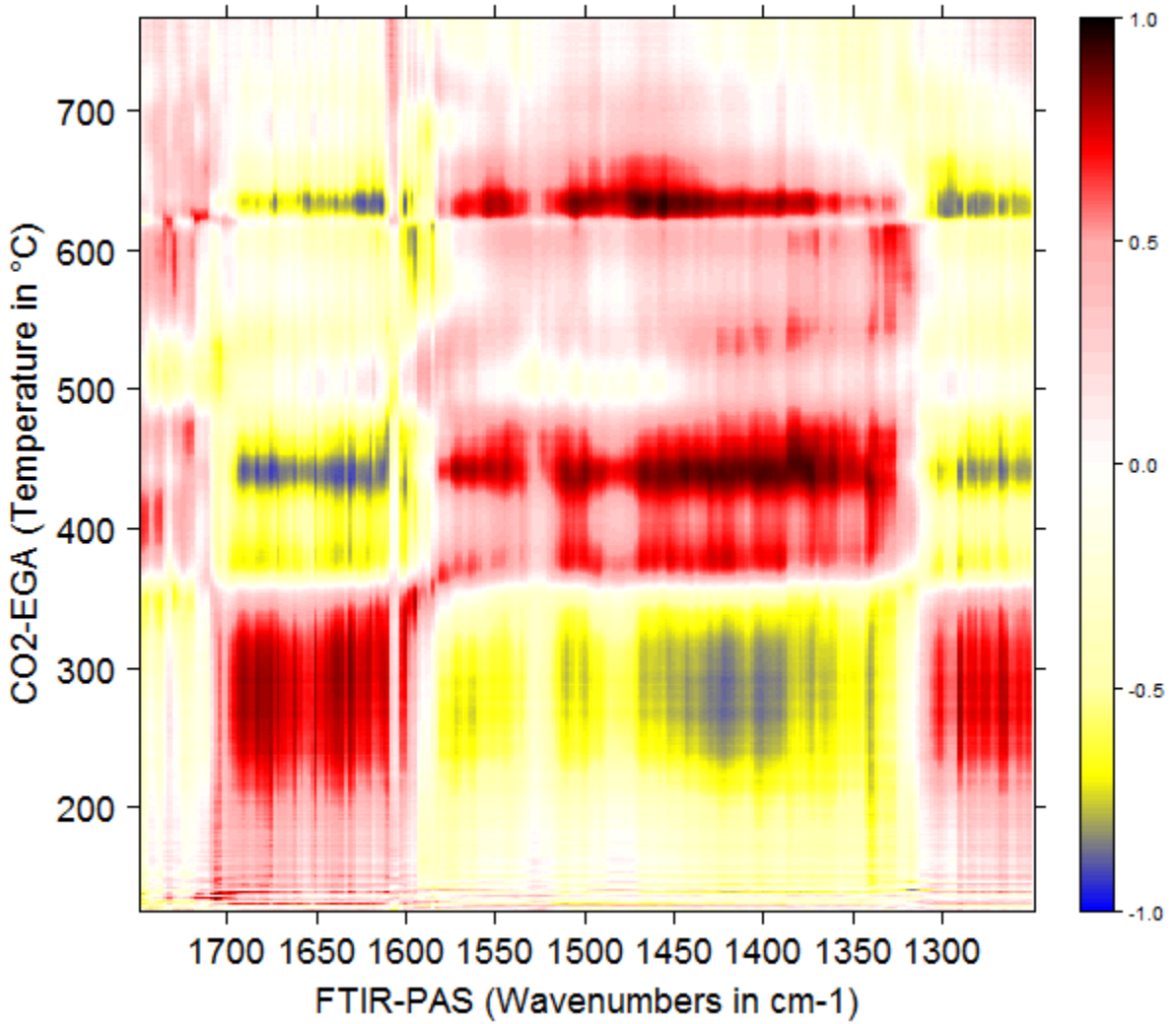
# The CRUCIAL experiment

## FTIR-PAS, integration du pic de composés aliphatiques à 3000 – 2800 cm-1



# The CRUCIAL experiment

## Matrice de correlation entre les données d'analyse thermique et de FTIR-PAS



# The CRUCIAL experiment

## Conclusions

- Large différences de teneurs en COS après 11 ans d'apport de PROs
- Energie nécessaire pour le labour fortement corrélée à la teneur en COS et argile
- Energie pour le labour liée à la quantité, plus qu'à la qualité de la MO accumulée
- Apport de PRO ➔ économie de carburant pouvant aller jusqu'à 14% (pour compost apporté à dose normale).
- Accumulation de MO thermiquement stable et enrichie en composés aromatiques (lignine), methyl et groupements carboxyliques dans les sols avec apport de compost OMR et de fumier
- MO accumulée après apport de boue: une composition similaire à celle du traitement de référence NPK
- Traitement NPK enrichi en composés aliphatiques, possiblement d'origine microbienne

# Merci pour votre attention!