Plant-internal variation of lipid composition and compound-specific isotopes of various crops

Guido L.B. Wiesenberg*

Jan Schwarzbauer**

Lorenz Schwark*

*Department for Geology and Mineralogy, University of Cologne

**LEK, RWTH Aachen

Part of the Priority Program (SPP) 1090 of the German Research Foundation

‘Soils as sources and sinks of CO_2‘

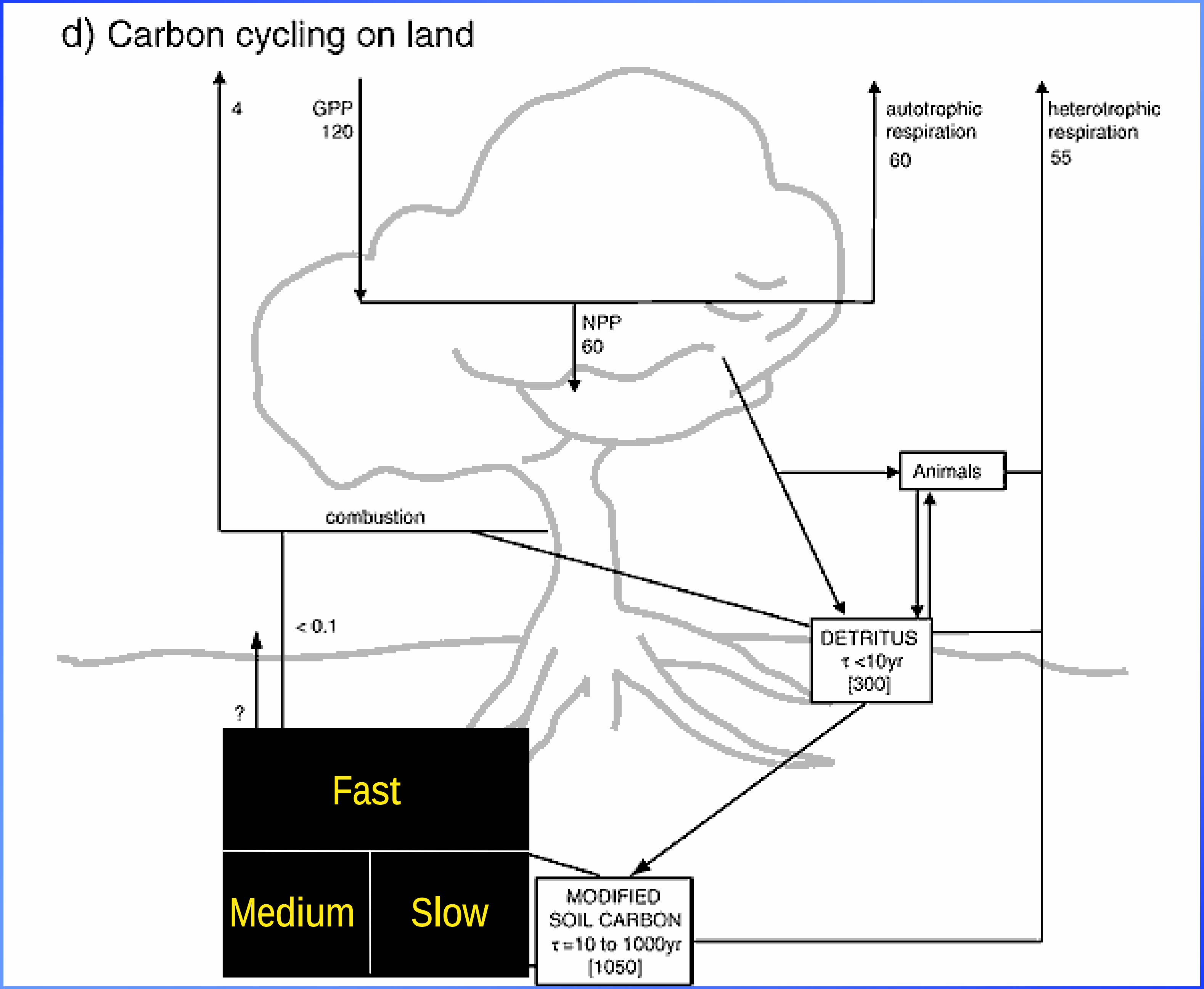
1. Why crop lipids?

2. Materials and methods

3. Molecular variation of
   a. alkanes
   b. carboxylic acids

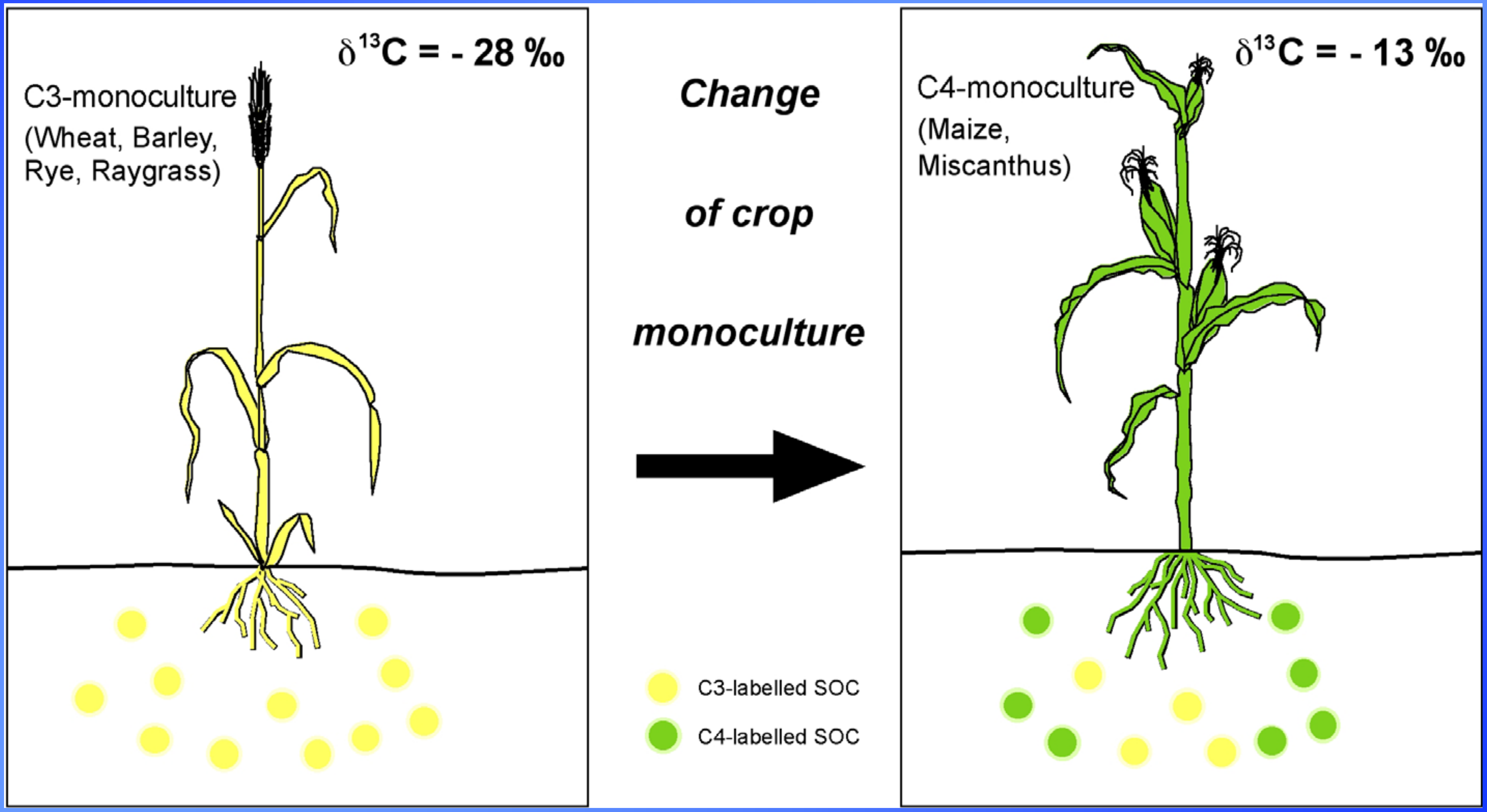
4. Compound-specific isotopy ($\delta^{13}C$) variation of long-chain
   a. alkanes
   b. carboxylic acids

5. Conclusions



IPCC 2001 WG 3. Technical Summary

Natural isotopic ($\delta^{13}C$) labelling: Bulk SOC



Wiesenberg (2004). Doctoral Dissertation. Cologne University

Aims

Lipids in agricultural environments

Development of plant lipids during growing season?

- **Evolution**
- **End member**
- **Differences between plant groups**

Translocation processes? (Plant-internal)

- **Molecular marker**
- **Stable isotopes ($\delta^{13}C$)**

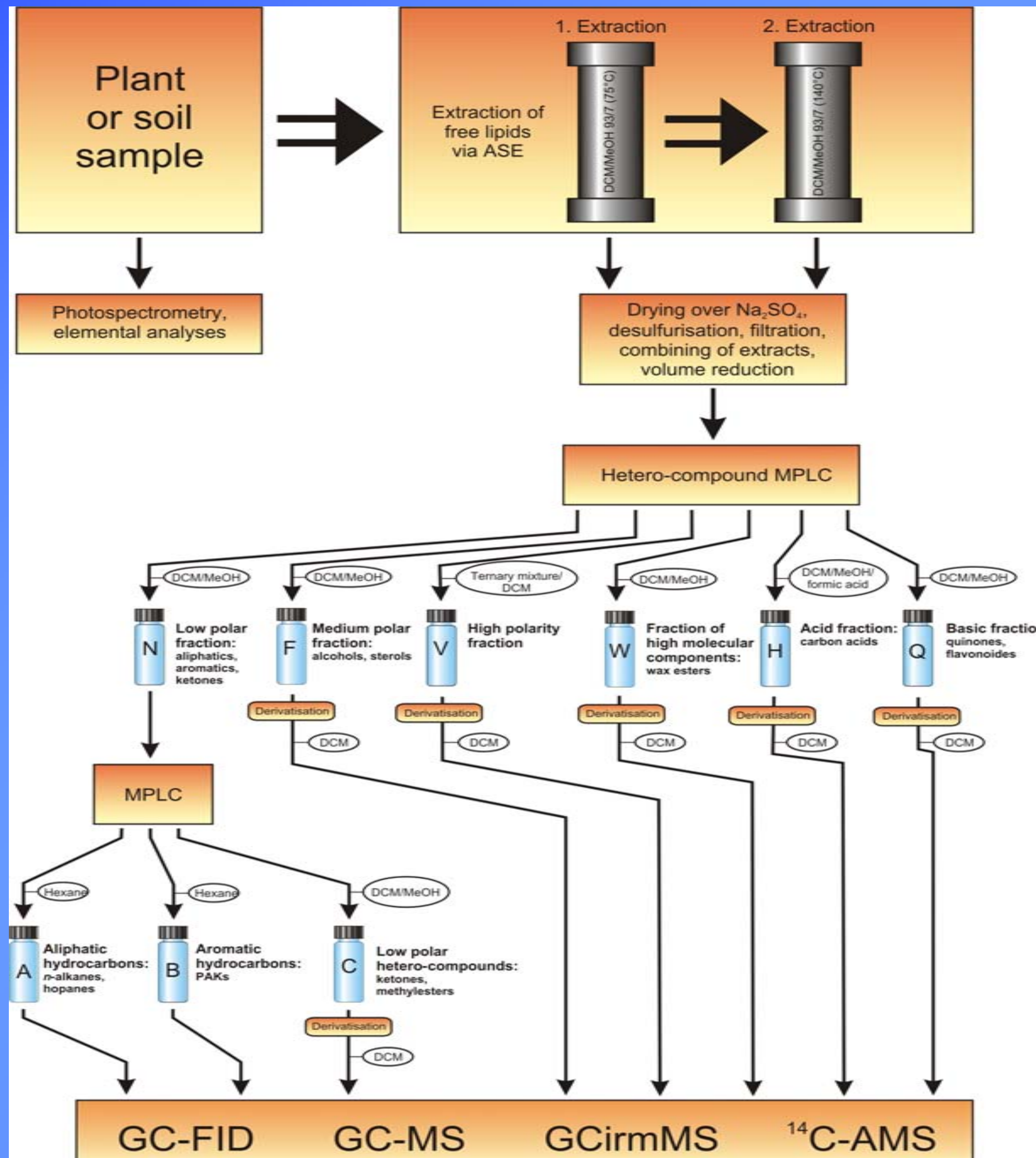
Materials

Crops of longterm trials with a change from C3- to C4-monoculture (with mineral fertilizer)

- **Halle/Saale** (Germany): rye ⇒ silage-maize
- **Rotthalmünster** (Germany): wheat ⇒ grain-maize

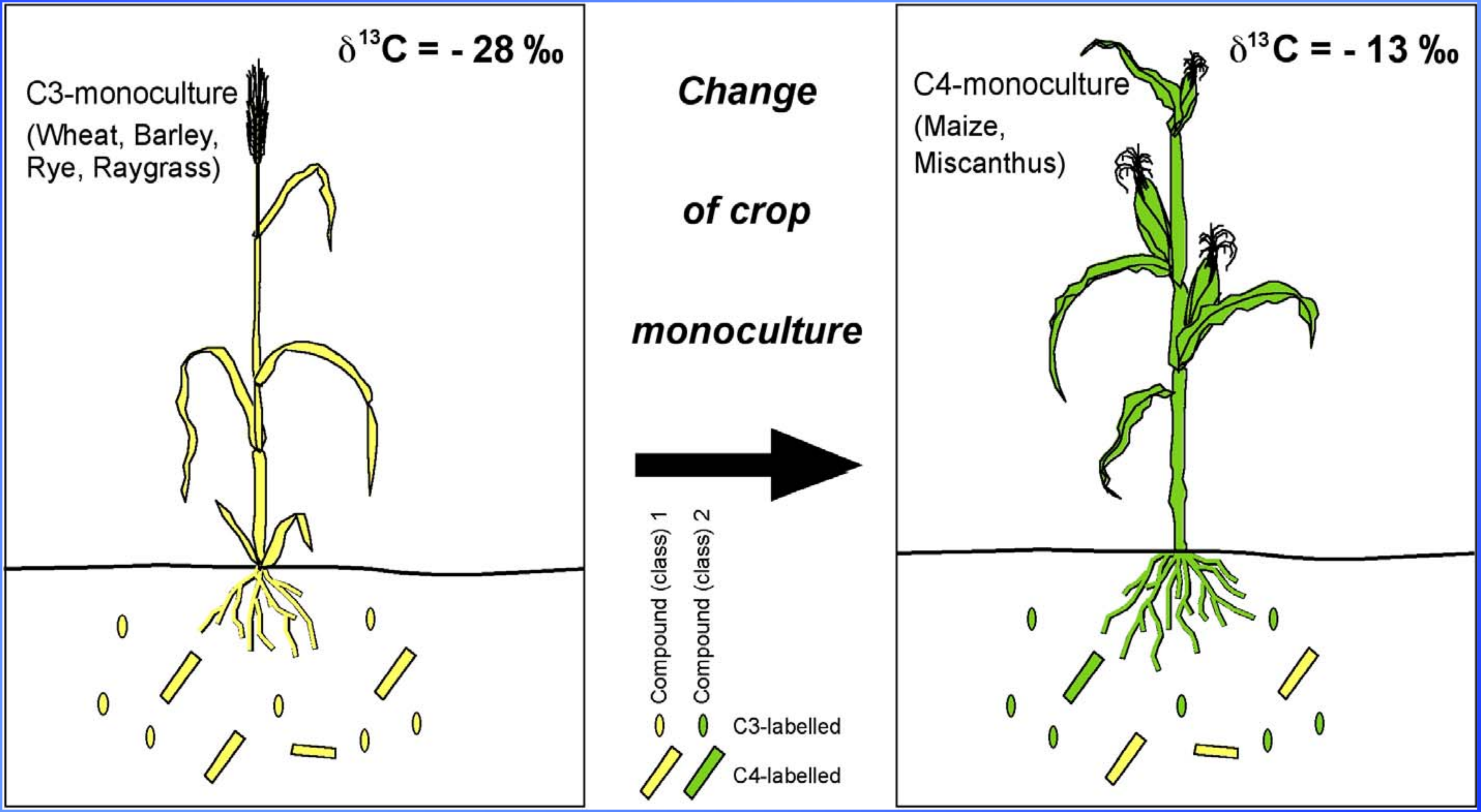
Monthly sampling: Roots, stems and leaves

Analytical flow-chart



Wiesenberg (2004). Doctoral Dissertation. Cologne University.

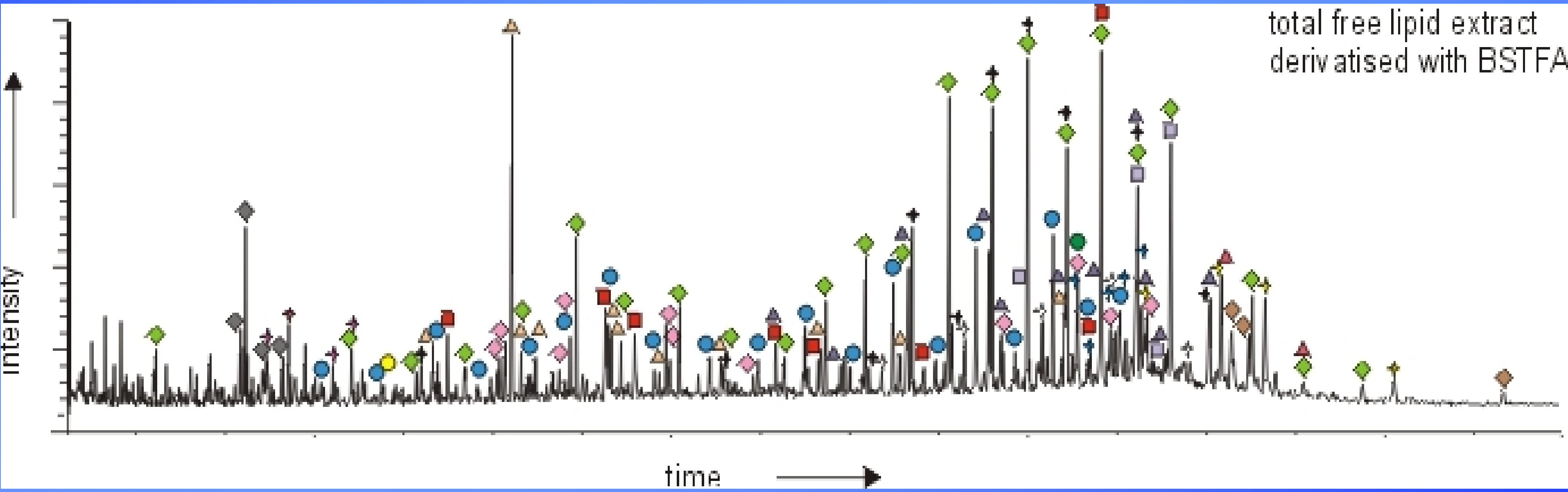
Natural isotopic ($\delta^{13}C$) labelling: Compound-specific



Wiesenberg (2004). Doctoral Dissertation. Cologne University

Free extractable lipids:

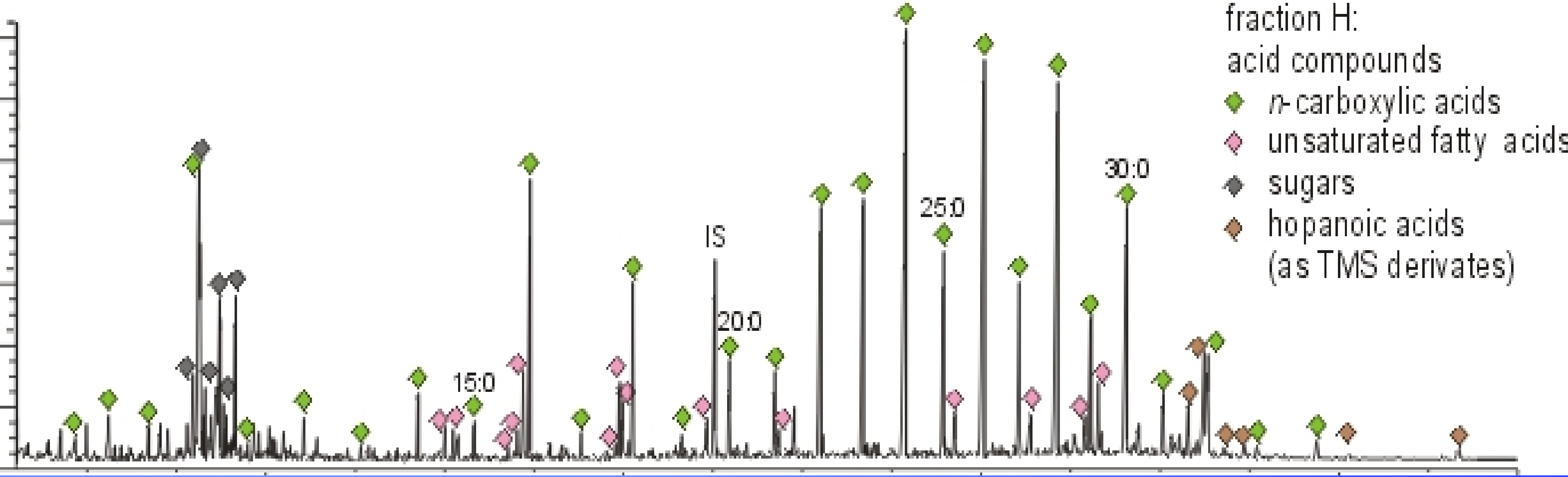
4-8% of soil organic carbon



Wiesenberg *et al.* (2004). Europ. J. Soil Sc.

Carboxylic acids

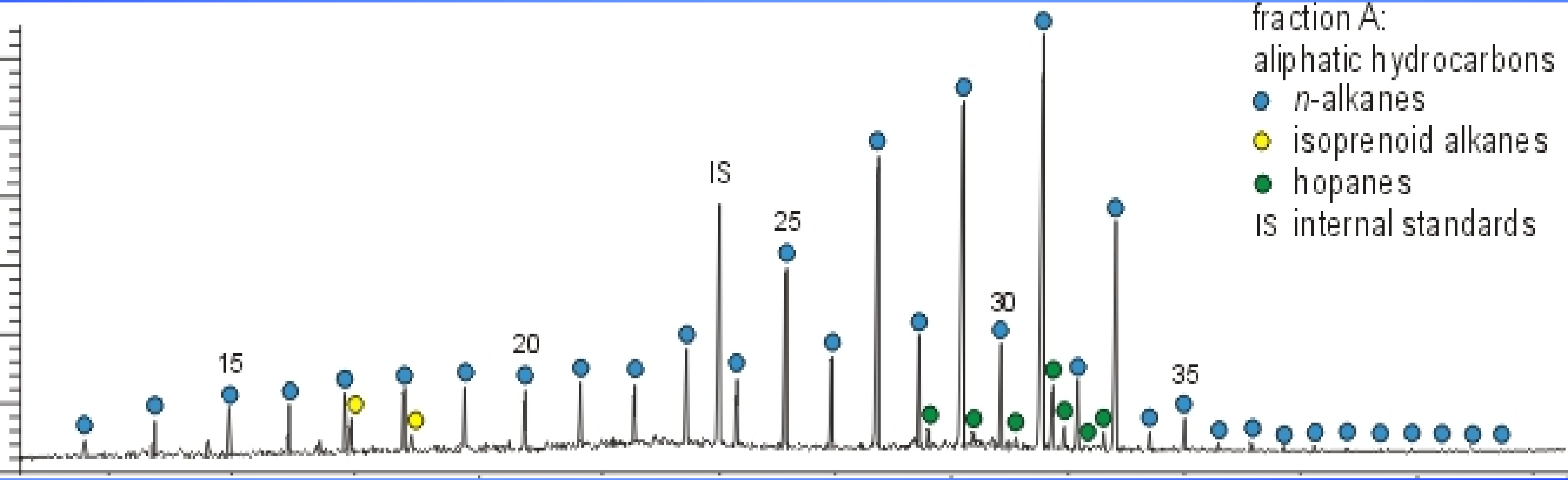
20-30% of total free extractable lipids



Wiesenberg *et al.* (2004). Europ. J. Soil Sc.

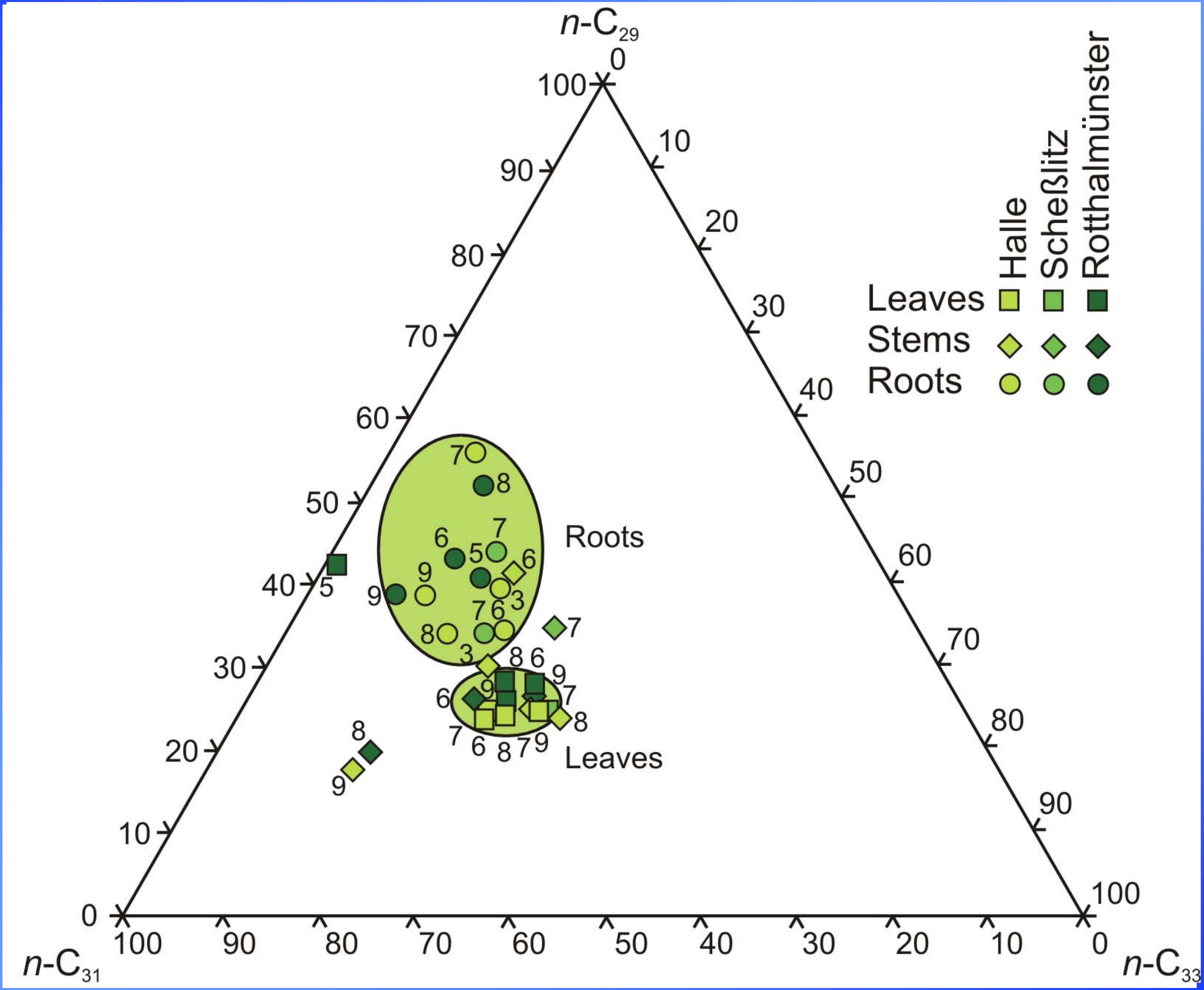
Aliphatic hydrocarbons

3% of total free extractable lipids



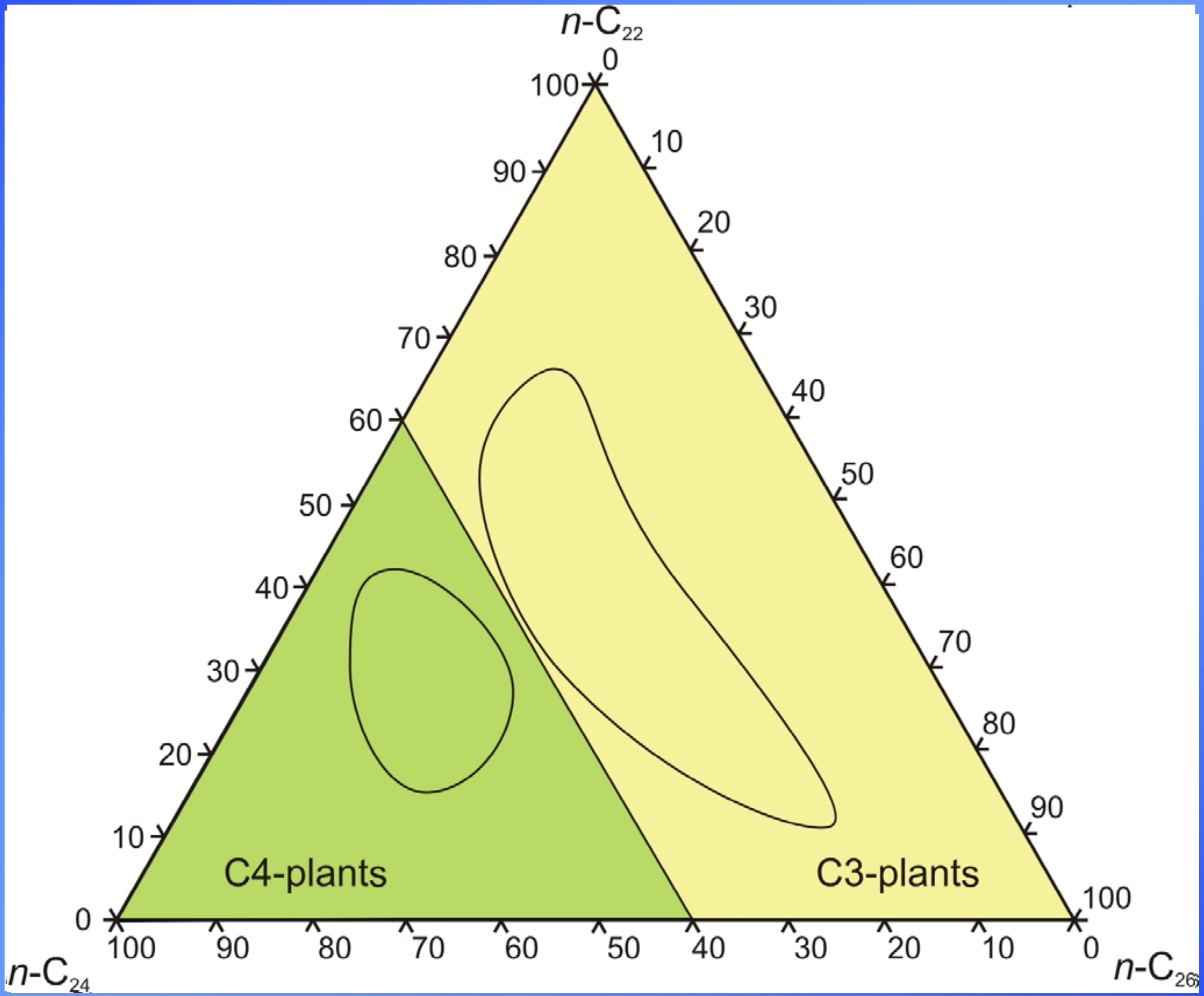
Wiesenberg *et al.* (2004). Europ. J. Soil Sc.

Long-chain alkanes



Wiesenberg *et al.* (2004). Org. Geochem.

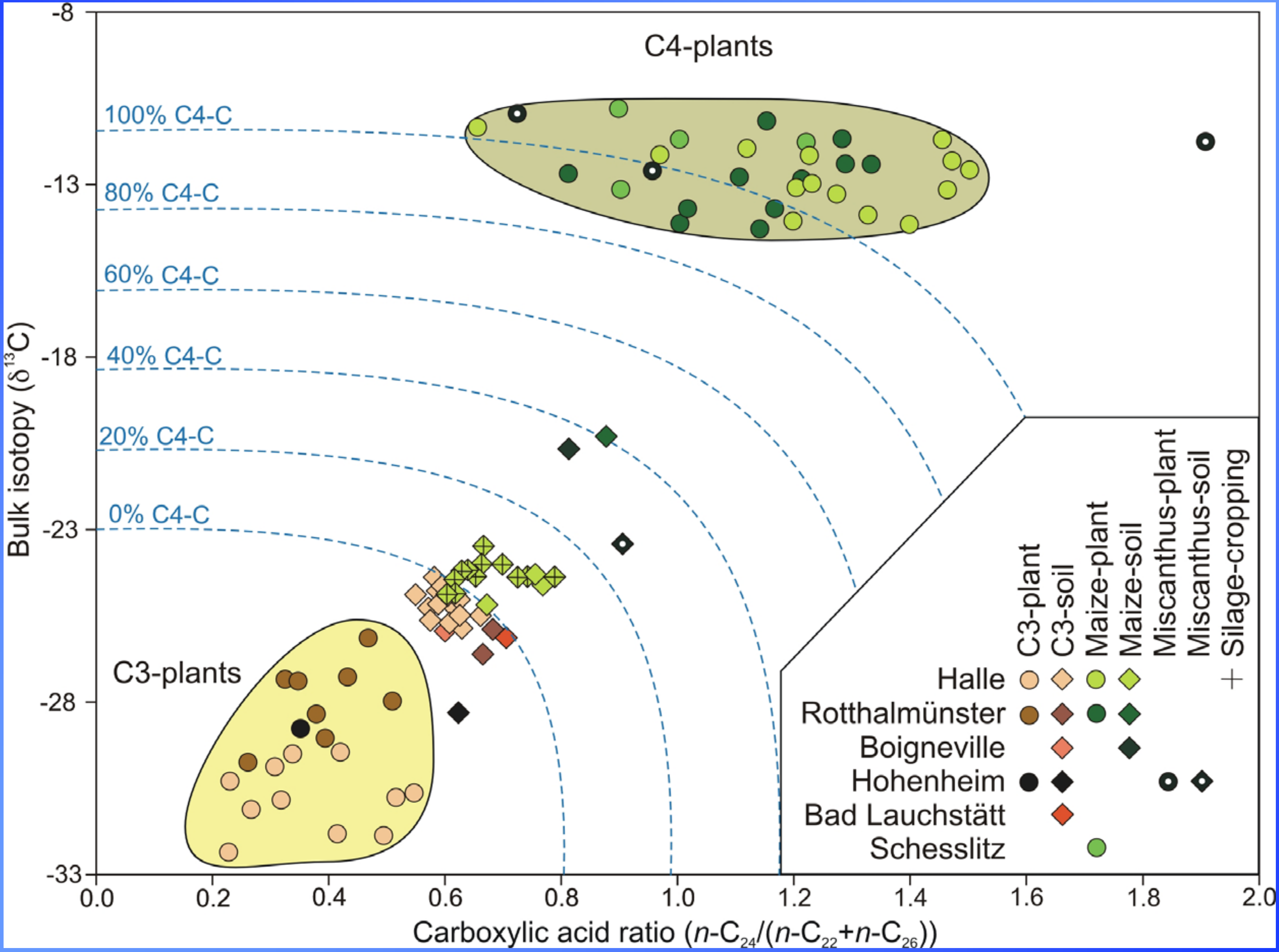
Long-chain carboxylic acids



Molecular differentiation of crops following different photosynthesis pathways

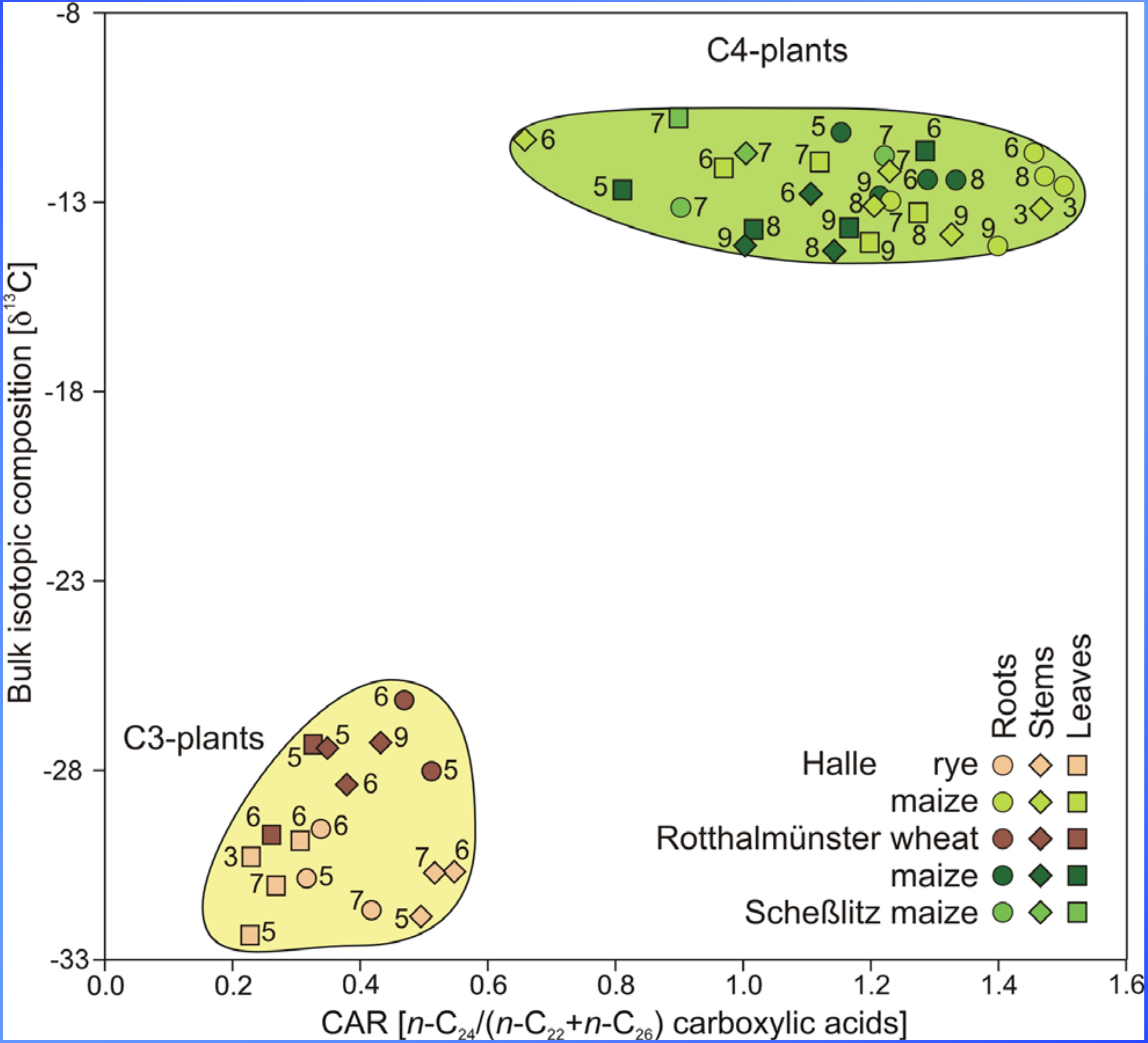
Wiesenberg *et al.* (2004). Org. Geochem.

Carboxylic acid ratio



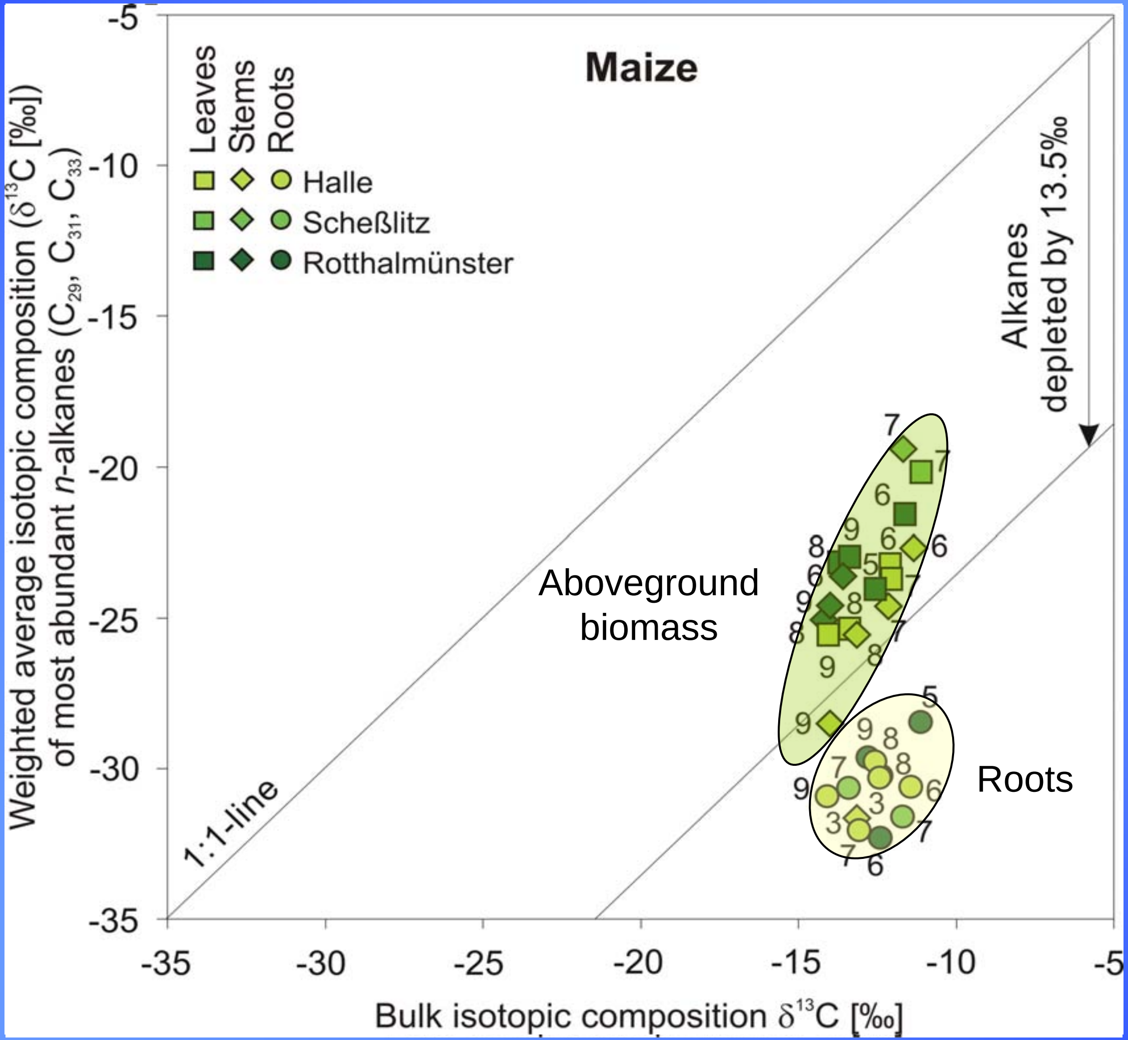
Wiesenberg (2004). Doctoral Dissertation. Cologne University

Carboxylic acid ratio (CAR)



Wiesenberg (2004). Doctoral Dissertation. Cologne University

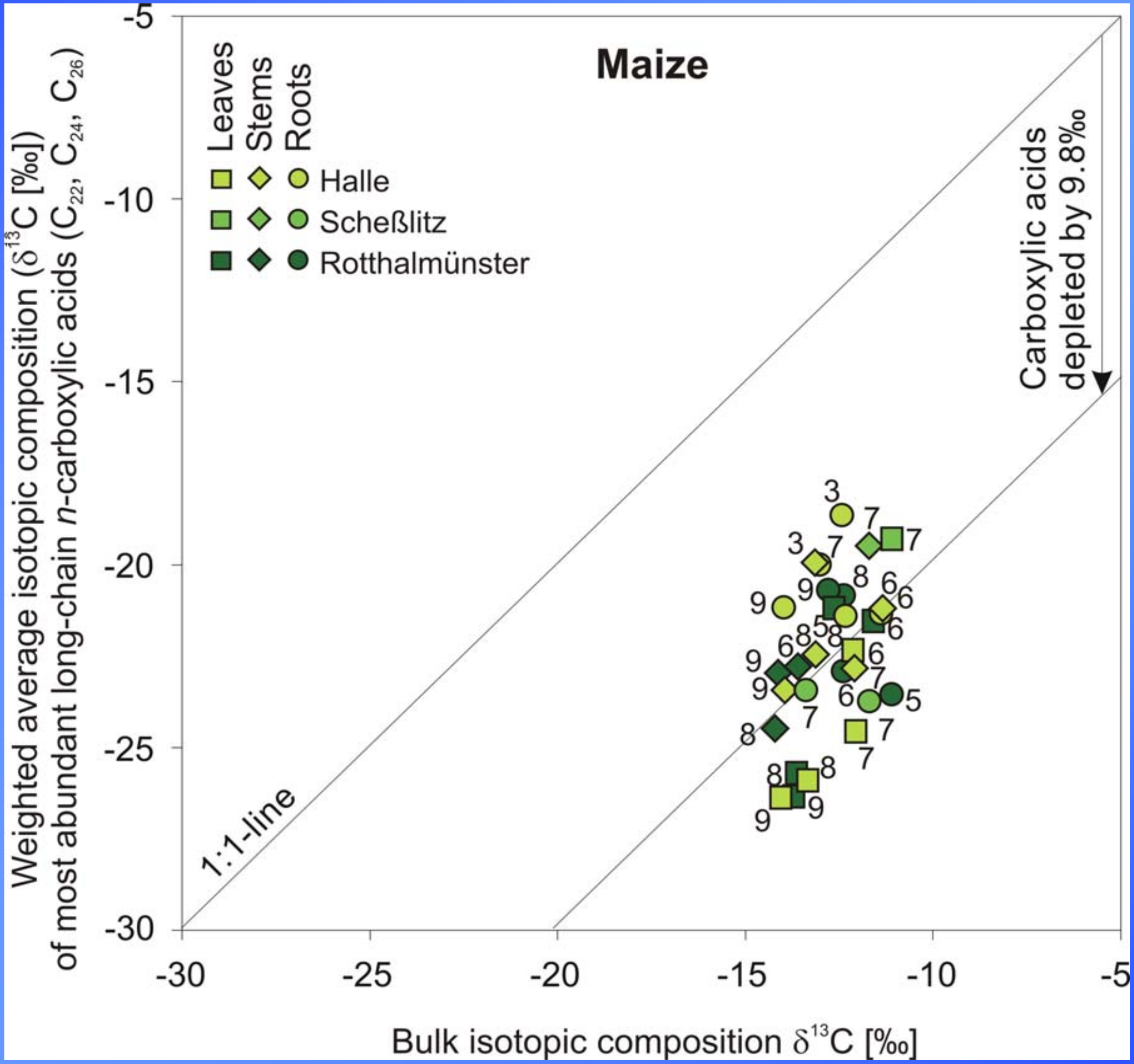
Long-chain alkanes vs. bulk isotopy



Isotopy of alkanes differs significantly between roots and aboveground biomass for maize.

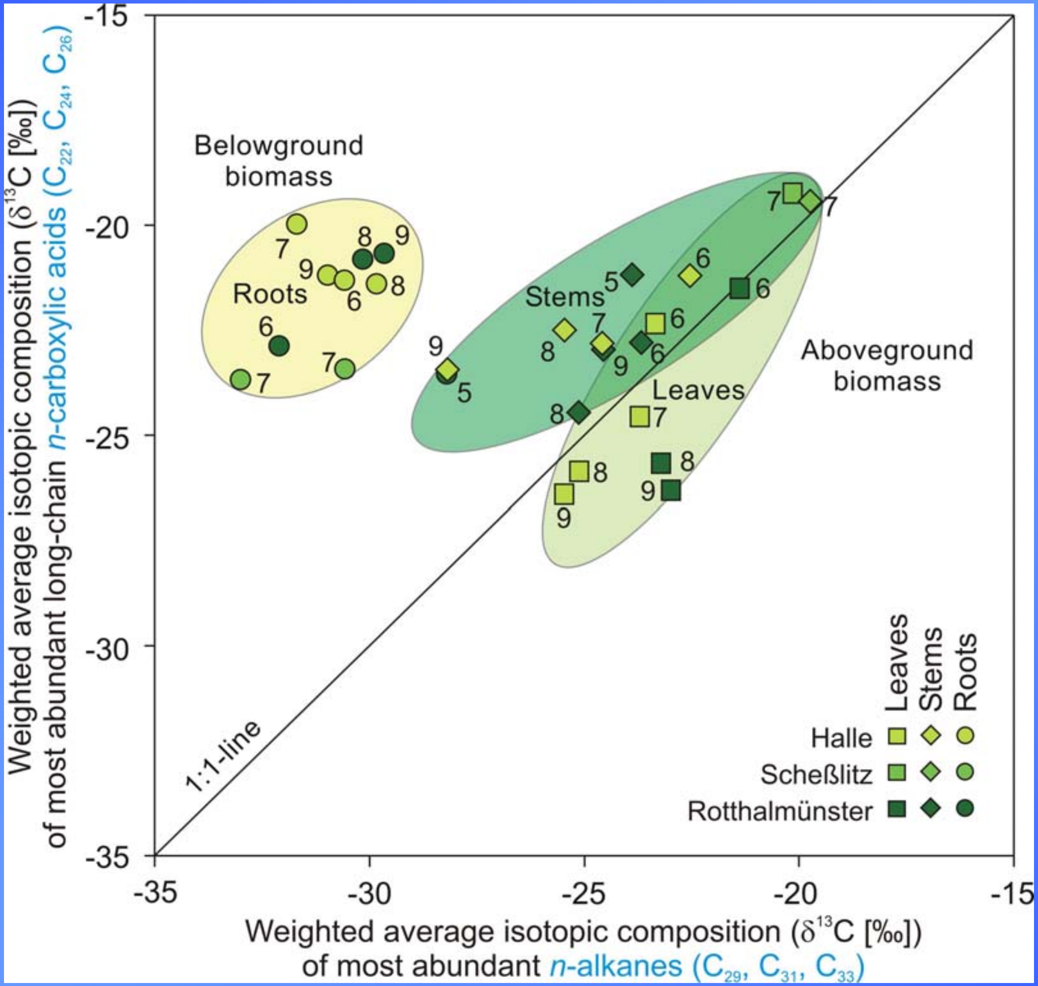
Wiesenberg *et al.* (2004). Doctoral Dissertation. Cologne University

Long-chain carboxylic acids vs. bulk isotopy



Wiesenberg *et al.* (2004). Doctoral Dissertation. Cologne University

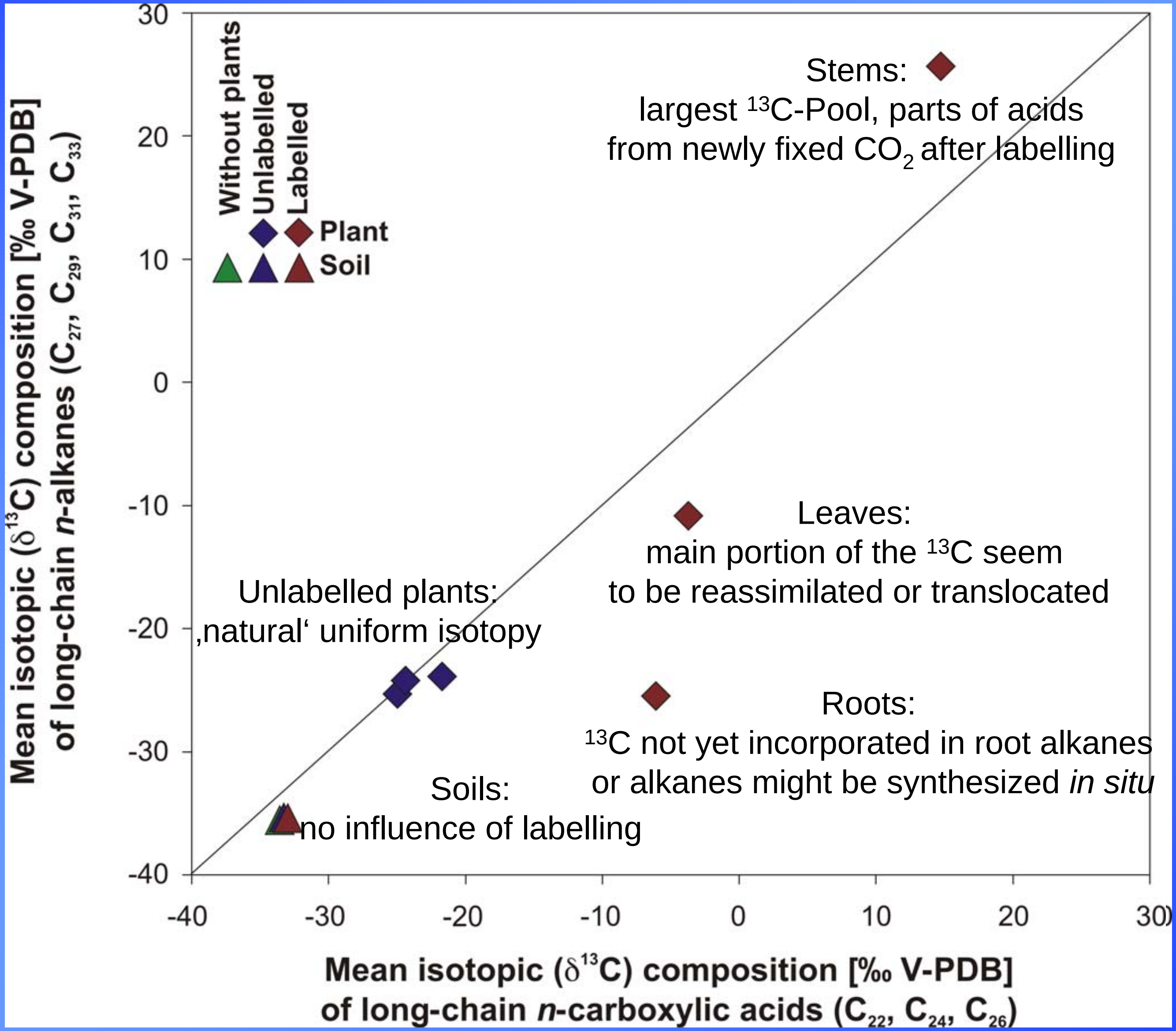
Carboxylc acids vs. alkanes



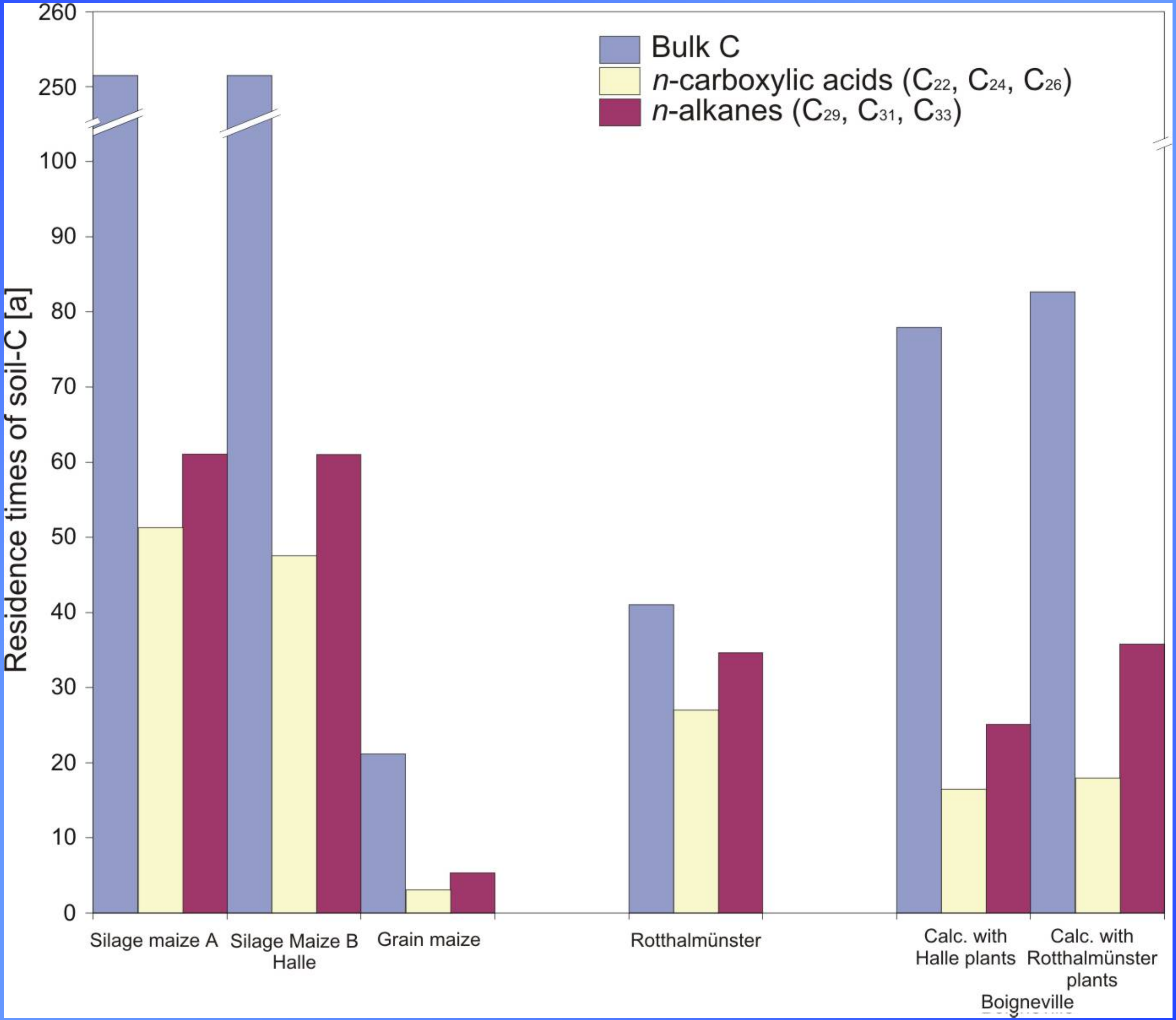
Diferent isotopy of maize (C4) root alkanes seems to be related to other biosynthetic precursors than in aboveground biomass or can be produced in the ‚microbial loop'.

Wiesenberg *et al.* (2004). Doctoral Dissertation. Cologne University

Carboxylc acids vs. alkanes of a labelling experiment



Turnover times



Wiesenberg *et al.* (2004). Org. Geochem.

Conclusions

- Long-chain *n*-carboxylic acids are best suitable for molecular differentiation between C3- and C4-crops (carboxylic acid ratio: CAR=n-C_{24}/(n-C_{22}+n-C_{26}))

- CSIA facilitates differentiation between i) C3/C4-crops, ii) above - and belowground biomass (C4-plants)

- ^{13}C-isotopic depletion of C4-plant root alkanes in comparison to carboxylic acids results from different biosynthetic precursers (e.g. suberin) or is a result of the ‚microbial loop‘

Thanks to ...

...you

and all people involved in this project!

Elemental analyses: Birgit Nabbefeld, Thorsten Bauersachs,
Birgit Keldenich, Oliver Paech

Lab: Hanna Cieszynski, Eva Lehndorff, Alexandra Richter

GC, GC/MS: Bianca Stapper, Yassin Hardi

Isotope analyses: Kay Scheffler (University Bonn)

Funding: DFG