Gembloux Agro-Bio Tech
Université de Liège

2nd ICOS Science Conference
Helsinki, Finland, 27-29 September 2016

Climatic and management drivers of CO_2 exchanges by a production crop: Analysis over three successive 4-year crop rotation cycles

P. Buysse[1], T. Manise[2], A. De Ligne[1], C. Moureaux[2], B. Bodson[2], B. Heinesch[1], M. Aubinet[1]
(1) University of Liège - Gembloux Agro-Bio Tech, Unit TERRA, Ecosystems-Atmosphere Exchanges, Belgium
(2) University of Liège - Gembloux Agro-Bio Tech, Unit TERRA, Crop Science, Belgium

Objectives

- ❑ To determine climatic and crop management drivers for each crop.
- ❑ To establish the three crop rotation carbon (C) budgets and to analyze the different budget terms.
- ❑ To investigate the role of intercrops in the C budget.

Methods

- ❑ Eddy-covariance measurements over the crop (2.8 m): sonic anemometer (Solent Research Gill R3) + infrared gas analyzer (Li-COR Li-7200)
- ❑ Measurements active since 2004
- ❑ Crop biomass samplings
- ❑ Usual EC corrections applied
- ❑ Data gap-filling and flux partitioning based on air temperature with the online tool provided by the MPI-BGC Jena (www.bgc-jena.mpg.de/~MDIwork/eddyproc/)

Lonzée Terrestrial Observatory (LTO)

- ❑ Temperate climate (mean annual T and P: 10 °C, 800 mm)
- ❑ Land cultivated for more than 80 years
- ❑ Luvisol (FAO), SOC stock [0-60 cm]: 6.23 ± 0.16 kg C m^{-2}
- ❑ 4-year crop rotation: Sugar beet (SB) – Winter wheat (WW) – Seed Potatoes (SP) – Winter wheat (WW)

$$C\ budget = NEE + C_{imported} + C_{exported}$$

Results and Discussion

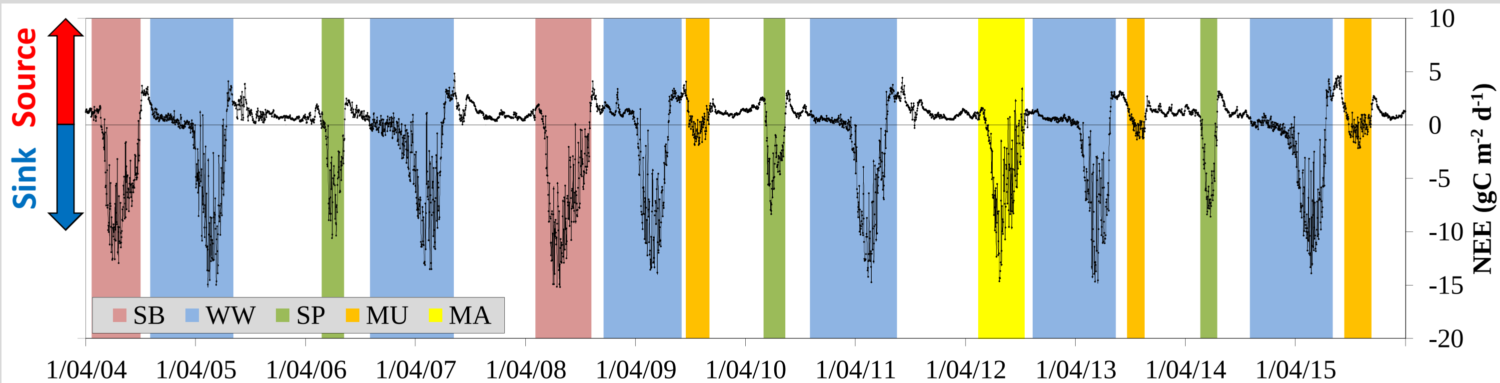

Fig. 1. Daily NEE fluxes over the studied period (1 April 2004 – 31 March 2016). Coloured areas indicate the cropping periods (SB: sugar beet, WW: winter wheat, SP: seed potato, MU: mustard catch crop, MA: silage maize) and white areas indicate the intercrop periods. Cropping periods were considered from emergence till harvest.

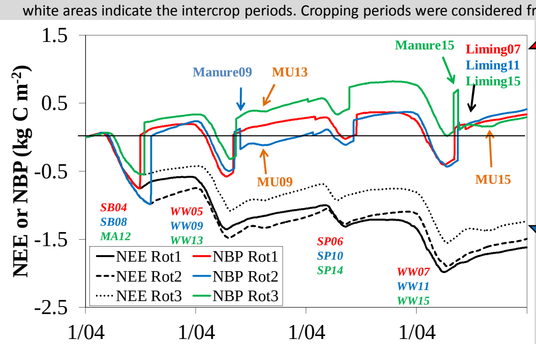

Fig. 2. Temporal courses of cumulated NEE and NBP fluxes over each of the three crop rotations . Each crop rotation was a net C source of about 350 ± 120 gC m^{-2}.

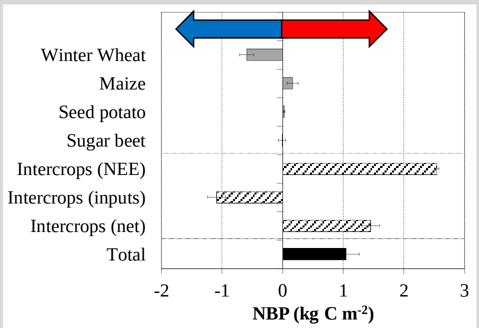

Fig. 3. Cumulated crop C budget over the 12 studied years. This particularly shows the large importance of intercrop periods in the C budget.

Role of intercrops: comparison of soil respiration during intercrops grown with and without mustard.

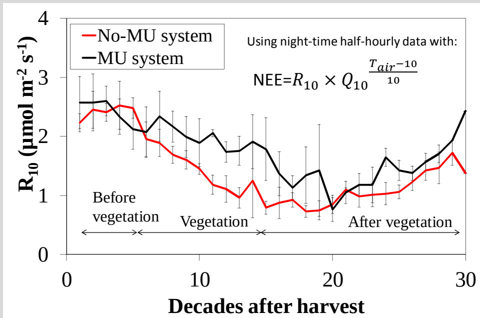

Fig. 4. Comparison of R_{10} values obtained after fitting NEE to air temperature night-time half-hourly data with a Q_{10} model for successive 10-day periods, for the data during intercrops after WW crops (3 intercrops where MU was grown (« MU » systems) and 3 intercrops where MU was not grown (« No-MU » systems). R_{10} values were significantly larger in the « MU » system during and after « vegetation » periods.

- **Inter-annual variability of NEE within a given crop type is a combination of climatic and management factors.**
- **Loss of 1.05 ± 0.22 kg C m^{-2} in 12 years (about 17% of the [0, 60]cm C stock).**
- **Intercrops play a large role in the C source effect.**
- **Mustard crops lead to more CO_2 uptake but enhanced residue decomposition occurs thereafter ➔ no impact on the C budget.**

Overall, our results show that, on average, LTO behaves as a C source of 87 ± 44 gC m^{-2} yr^{-1}, which agrees with what is found at other European crop sites, but represents a large proportion of the C stock at LTO. Validation by soil inventories is foreseen.

Contact person: Pauline Buysse, PhD (paulinebuysse@gmail.com)