Geophysical Research Abstracts
Vol. 14, EGU2012-5432, 2012
EGU General Assembly 2012

Assessment of the GHG budget mitigation potential of intercrops: analysis on several trials and intercrops species in the Southwest of France.

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To reduce organic carbon loss from the soil and nitrate leaching to groundwater, the European directives have promoted Good Agricultural Practices (GAP), such as the use of intercrops (IC). As shown by Béziat et al. 2009, Ceschia et al. 2010, the IC (or voluntary regrowth from the previous crop) limit net CO_2 release from the ecosystem or even contribute to carbon storage during their development. However, the seeding and destruction of IC can be difficult on soil with high clay content, especially when soil is wet, and they must be destroyed early enough so that the nitrogen they contain can be released in the soil and used by the following crops. For these reasons, the Midi-Pyrenees Agriculture Department obtained a 2-year temporary derogation to test the implementation of several nitrates catch crops (mustard, diploïd oat, black oat, oat/vetch, oat/phacelia) on clay soils in order to evaluate the best management practices for growing and destroying them. Their impact on the next crop development was also analysed. In this study, the CESBIO helped the Midi-Pyrénées Agriculture Department to 1) calculate a carbon budget for the different trials and 2) to estimate GHG budgets for those trials by using a life cycle analysis (LCA) approach. Emissions associated to Field Operations (FO) were estimated based on study by Ceschia et al. (2010).

During long periods of bare soil, the net CO_2 flux is reduced to heterotrophic respiration. Since this component of NEE is not measured on the IC sites, it has been estimated using data from a GHG-Europe instrumented site in the same region, the same year and on similar soils (Auradé site, Gers). Heterotrophic respiration was estimated to range between 96.4 and 131 g eq-C m-2 during the IC cycle that lasted between 65 and 89 days. At the end of the IC period, biomass was (in g eq-C) 0.77, 0.18, 9.89, 0.42, 0.48 for mustard, diploïd oat, black oat, oat/vetch, oat/phacelia respectively. The low amount of biomass is explained by a very dry summer in 2009.
FO ranged between 9.9 and 12.7 for the different trials. Compared to the other terms, they have a relative low impact on the GHG budget. They represented at most 13g eq-C during the IC period, 60% of those emissions are caused by the use of machinery. GHG budgets over the IC period are largely positive (source effect), due to low biomass production, mainly because of poor emergence and/or development. Still carbon fixation in the biomass mitigated the emissions.
To balance the GHG budget, biomass production should be doubled for mustard (1.5 ton biomass ha-1) which is realistic and increased by a factor 4 for oat/phacelia and oat/vetch associations. In general, we can conclude that except for the black oat (biomass production is too low), these intercrops improve the GHG budget. Nevertheless, to get real advantages from these intercrops, they need to produce more than 0.26 t/ ha to compensate technical operations and additional CO_2 emissions associated to IC decomposition will have to be assessed.