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# Methodology for calculation of carbon balances for biofuel crops production

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Understanding the carbon balance implications for different biofuel crop production systems is important for the development of decision making tools and policies.

We present here a detailed methodology for assessing carbon balances in agricultural and natural ecosystems. We use 20 years of data from Long-term Ecological Research (LTER) experiments at the Kellogg Biological Station (KBS), combined with models to produce farm level $CO_2$ balances for different management practices. We compared four grain and one forage systems in the U.S. Midwest: corn (Zea mays) – soybean (Glycine max) – wheat (Triticum aestivum) rotations managed with (1) conventional tillage, (2) no till, (3) low chemical input, and (4) biologically-based (organic) practices; and (5) continuous alfalfa (Medicago sativa). In addition we use an abandoned agricultural field (successionnal ecosystem) as reference system.

Measurements include fluxes of N2O and CH4, soil organic carbon change, agricultural yields, and agricultural inputs (e.g. fertilization and farm fuel use). In addition to measurements, we model carbon offsets associated with the use of bioenergy from agriculturally produced crops. Our analysis shows the importance of establishing appropriate system boundaries for carbon balance calculations. We explore how different assumptions regarding production methods and emission factors affect overall conclusions on carbon balances of different agricultural systems. Our results show management practices that have major the most important effects on carbon balances.

Overall, agricultural management with conventional tillage was found to be a net $CO_2$ source to the atmosphere, while agricultural management under reduced tillage, low input, or organic management sequestered carbon at rates of 93, -23, -51, and -14 g $CO_2$e m-2 yr-1, respectively for conventionally tilled, no-till, low-input, and organically managed ecosystems. Perennial systems (alfalfa and the successionnal fields) showed net carbon sequestration of -44 and -382 g $CO_2$e m-2 yr-1, respectively. When studied systems were assumed to be used for bioenergy production, all system exhibited carbon sequestration – between -149 and -841 g $CO_2$e m-2 yr-1, for conventionally tilled and successionnal ecosystems, respectively.