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Evidence for negative carbon budgets for European croplands

Scientists have calculated carbon budgets for croplands in Europe, based on field measurements from nine sites across Europe. They found that significant soil carbon losses occurred from cropping even though some farmers used measures to enhance carbon-sequestration. These results may challenge findings from some other modelling studies if they turn out to be typical for all EU croplands.

The study was conducted under the EU CarboEurope project[1], which provides comprehensive data from seventeen sites across Europe with variable crop and climate patterns and farmland practices. The new results from this study used data from nine sites across Central, Southern and Western Europe over four years. Sites were chosen for the range of crops grown and to represent areas with differing carbon concentrations in the soil ranging between around 10g of carbon per kg (gC/kg) of soil to around 45gC/kg of soil.

Among its findings, the study found that cropping on the sites with higher carbon concentrations, i.e. the sites with carbon concentrations closer to the 45gC/kg mark, tended to result in hotspots of carbon loss. Therefore the researchers recommend that these soils should be a priority policy target, and management of the lower carbon soils should seek to increase soil organic matter. It is believed that climate change impacts may increase the carbon losses, due to increased mineralisation in warmer winters, and that increased cultivation of biofuel crops may reduce the amount of carbon-rich residues available.

The study distinguishes between two different types of carbon budget: Net Biome Production (NBP) and Net Ecosystem Production (NEP). The latter is estimated using standard models of carbon flux and storage at 30 minute intervals over four years. NBP is calculated by including carbon from fertiliser input and losses caused by fire and harvest to the NEP, but still ignores soil erosion and fluxes to groundwater and atmosphere. Greenhouse gas (GHG) balances were also calculated by adding emissions from farming operations to the NPD, such as from fuel and machinery.

The results indicate net carbon losses even from long-established croplands. These sites have used organic fertilisers and retained crop residues according to good-practice guidelines. Losses vary widely with region and crop - fallow years may result in carbon losses, as observed in temperate Belgium, or Avignon in France. However, some farmers plant crops specifically to improve soil quality (a form of cover-cropping) to improve the carbon budget. Crop rotation can sequester carbon, but land management, plus estimation of carbon and GHG budgets, must be site-specific.

Large carbon losses are generally associated with root crops, such as sugar beet. Continental averages suggest NBP of 2.4 tonnes of carbon per hectare per year (tC/ha/yr). Harvest losses were 3.82 tC/ha/yr, whilst carbon inputs averaged only 0.42 tC/ha/yr. The authors report a mean overall loss of 3.8 tC/ha, over 4 years, or 110 per cent of photosynthesised carbon. Only one site appeared to act as a carbon sink – a wetland rice monoculture at Sueca, Spain. The GHG balance suggested emissions represent 42 per cent of harvested carbon.

However, the authors caution that a larger network of 59 sites would be needed to determine whether the results from this study are likely to be typical for all EU croplands. These results are surprising as good practice had been largely applied to the nine croplands, so the carbon budget could be expected to be neutral. The researchers point to a range of other modelling studies which have suggested that European croplands store about as much carbon as they emit, but these studies had concentrated on long-established sites with limited crop, soil, yield and land-use data and ignored high-carbon soils.

1. CarboEurope is supported by the European Commission under the Sixth Framework Programme. See: www.carboeurope.org

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