Geophysical Research Abstracts
Vol. 19, EGU2017-17114, 2017
EGU General Assembly 2017

Production versus environmental impact trade-offs for Swiss cropping systems: a model-based approach

Magdalena Necpalova, Juhwan Lee, and Johan Six
Sustainable Agroecosystems Group, Department of Environmental Systems Science, Swiss Federal Institute of Technology, Zurich, Switzerland

There is a growing need to improve sustainability of agricultural systems. The key focus remains on optimizing current production systems in order to deliver food security at low environmental costs. It is therefore essential to identify and evaluate agricultural management practices for their potential to maintain or increase productivity and mitigate climate change and N pollution. Previous research on Swiss cropping systems has been concentrated on increasing crop productivity and soil fertility. Thus, relatively little is known about management effects on net soil greenhouse gas (GHG) emissions and environmental N losses in the long-term. The aim of this study was to extrapolate findings from Swiss long-term field experiments and to evaluate the system-level sustainability of a wide range of cropping systems under conditions beyond field experimentation by comparing their crop productivity and impacts on soil carbon, net soil GHG emissions, NO_3 leaching and soil N balance over 30 years. The DayCent model was previously parameterized for common Swiss crops and crop-specific management practices and evaluated for productivity, soil carbon dynamics and N2O emissions from Swiss cropping systems. Based on a prediction uncertainty criterion for crop productivity and soil carbon (rRMSE<0.3), in total 39 cropping systems were selected. Each system was evaluated under soil and climate conditions representative of Therwil, Frick, Reckenholz and Changins sites with four replications. Soil inputs were sampled from normal probability distributions defined by available site-specific data using the Latin hypercube sampling method. Net soil GHG emissions were derived from changes in soil carbon, N2O emissions and CH4 oxidation and the annual net global warming potential (GWP) was calculated using IPCC (2014). For statistical analyses, the systems were grouped into the following categories: (a) farming system: organic (ORG), integrated (IN) and mineral (MIN); (b) tillage: conventional (CT), reduced (RT) and no-till (NT); (c) cover cropping: no cover cropping (NCC), winter cover cropping (CC) and winter green manuring (GM). The productivity of Swiss cropping systems was mainly driven by total N inputs to the systems. The GWP of systems ranged from -450 to 1309 kg CO_2 eq ha-1 yr-1. All studied systems, except for ORG-RT-GM systems, acted as a source of net soil GHG emissions with the relative contribution of soil N2O emissions to GWP of more than 60%. The GWP of systems with CT decreased consistently with increasing use of organic manures (MIN>IN>ORG). NT relative to RT management showed to be more effective in reducing GWP from MIN systems due to reduced soil N2O emissions and positive effects on soil C sequestration. GM relative to CC management was shown to be more effective in mitigating NO_3 leaching and overall N losses from MIN systems; particularly in combination with NT management. GM management also increased soil N balance of MIN and ORG systems relative to CC management, which caused an additional N removal through CC harvest. Our results suggest that there is a substantial potential for improvement and optimizing the sustainability of Swiss cropping systems across sites especially in the context of climate change mitigation and adaptation.