Impacts of climate change on agro-ecosystems

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Climate change impacts on agro-ecosystems can be recognized at different spatial scales. At the leave plant scale increasing CO_2 leads to increased photosynthesis whereas C3 plants respond more than C4 plants. Additionally elevated CO_2 reduces the stomatal conductance with decreased transpiration and a up to 70 - 100 % higher water use efficiency (WUE). Although looking at the canopy / plant community scale the effect of raised CO_2 on WUE is much less pronounced. On the ecosystem level the effects of raised CO_2 level are much more complex. Yield, NPP, total C and N, photosynthesis and transpiration will increase, respiration reactions are unclear yet. Additionally feedbacks e.g. with the nitrogen cycle have to be considered. These feedbacks and their effects are difficult to predict and some impacts may be species / ecosystem specific.

Within the Kyoto Protocol, Article 3.4, activities to mitigate climatic change in the sectors forestry, cropland and grazing land are described. Possible cropland management options to sequester carbon are: More efficient use of animal manure, application of sewage sludge, return of surplus cereal straw to the soil, convert to no-till agriculture, use surplus arable land to de-intensify production (extensification), use surplus arable land to plant woodland and use surplus arable land to grow biofuels. Only with combined land management options for carbon sequestration, the European Kyoto 8% target will be reached. But it has to be mentioned that the proposed management options represent the biological potential carbon sequestration, not considering economic, social and political constraints. Additionally cropland ecosystems also produce other trace gases like N_2O and CH_4 which have to be taken into account in C sequestering options.

In respect to the global cropland C sequestration potential (45 Pg over 50 years) the European is considerably smaller (0.4 Pg over 50 years). The historic C losses from soils due to land use change could globally be reversed through the biological potential of C sequestration. Regarding the future increase of atmospheric C at a rate of 3.2 Pg C / y, the global soil C sequestration potential is estimated at 0.9 Pg C / y. Bearing in mind that soil C sequestration has a limited duration and considering a energy gap of up to 25 Pg C / y by 2100 (as a calculated difference of SRES A1FI scenario emissions and atmospheric CO_2 stabilization target of 550 ppm CO_2 for 2100), soil C sequestration will only play a minor role in controlling carbon emissions by 2100. Although for stabilizing CO_2 levels of 450-650 ppm in 2100 drastic reductions in C emissions are required during next 20-30 years. For that critical period soil C sequestration could help to reduce atmospheric CO_2 increase. But in the long-term, non-C emitting energy sources are the only solution for stabilising the atmospheric CO_2 concentration

Agro-ecosystems provide agricultural production and environmental quality as ecosystem service. These services are affected by climatic change (e.g. climatic warming), socio-economic and policy changes (e.g. CAP reforms). There are expected changes in crop yields and changing risks (e.g. yield variability) due to climate change. Environmental quality as for example air (trace gas emissions), soils (carbon storage, erosion, salinisation), water (nitrate pollution, pesticides) and biological resources are affected by global change.

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