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Future scenarios of European agricultural land use: I. Estimating changes in crop productivity

F. Ewert ^a ... R. Leemans ^c

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Abstract

The future of agricultural land use in Europe is unknown but is likely to be influenced by the productivity of crops. Changes in crop productivity are difficult to predict but can be explored by scenarios that represent alternative economic and environmental pathways of future development. We developed a simple static approach to estimate future changes in the productivity of food crops in Europe (EU15 member countries, Norway and Switzerland) as part of a larger approach of land use change assessment for four scenarios of the IPCC Special Report on Emission Scenarios (SRES) representing alternative future developments of the world that may be global or regional, economic or environmental. Estimations were performed for wheat (*Triticum aestivum*) as a reference crop for the time period from 2000 until 2080 with particular emphasis on the time slices 2020, 2050 and 2080. Productivity changes were modelled depending on

changes in climatic conditions, atmospheric CO₂ concentration and technology development. Regional yield statistics were related to an environmental stratification (EnS) with 84 environmental strata for Europe to estimate productivity changes depending on climate change as projected by the global climate model HadCM3. A simple empirical relationship was used to estimate crop productivity as affected by increasing CO₂ concentration simulated by the global environment model IMAGE 2.2. Technology was modelled to affect potential yield and the gap between actual and potential yield. We estimated increases in crop productivity that ranged between 25 and 163% depending on the time slice and scenario compared to the baseline year (2000). The increases were the smallest for the regional environmental scenario and the largest for the global economic scenario. Technology development was identified as the most important driver but relationships that determine technology development remain unclear and deserve further attention. Estimated productivity changes beyond 2020 were consistent with changes in the world-wide demand for food crops projected by IMAGE. However, estimated increases in productivity exceeded expected demand changes in Europe for most scenarios, which is consistent with the observed present oversupply in Europe. The developed scenarios enable exploration of future land use changes within the IPCC SRES scenario framework.



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Keywords

Crop productivity; Modelling; Technology development; Climate change; Increasing CO₂; Land use change

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