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Towards virtual plant modelling as a tool in climate change impact research

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Abstract

A major issue of our today's research is to help meeting the challenges of future food security. One task is to assess and develop crop management strategies adapted to predicted future climatic conditions. Yet, both the variability of environmental conditions and the uncertainty of climate projections as well as the orchestra of multiple plant responses and their interaction with the environment make it difficult to predict plant behavior in the field. Recent studies have demonstrated the usefulness of classical crop models as a tool to investigate crop productivity under predicted climate conditions. These models use data on plant architecture only to a limited extent as they usually follow a systems approach by focusing on processes for predicting dry matter production. However, plant architecture is a major determinant of the crops' resource use efficiency. Moreover, plants show time dependent structural changes as they grow and develop, and these processes are affected by various environmental factors and stresses. Virtual plant models consider both the three-dimensional plant architecture and concepts of plant physiology. Here, we outline the way in which virtual plant modelling can further improve our understanding on the impact of climate change on food production. Greenhouse and growth chamber experiments may serve as data sources for model parameterization, in particular of response functions with respect to environmental stimuli. Data from field experiments in free air carbon enrichment (FACE) facilities, such as those obtained in the new Geisenheim FACE for special crops, may be used to evaluate virtual plant models with respect to future climatic conditions. A combination of field data and virtual plant model simulations may then allow us to assess the specific role of plant architecture in resource use efficiency and help to develop advanced strategies for future crop production.

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