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# Global crop production: adaptation options to temperature increase

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Climate change is already and will continue affecting the productivity of agricultural systems, therefore demanding for adaptation strategies to avoid production losses. Due to the complexity and heterogeneity of crop-climate-soil systems, adaptation options are mostly implemented and evaluated locally. Nevertheless, global-scale estimates are needed because e.g. the efficiency of adaptation measures needs to be discussed in the context of costs and opportunities elsewhere. Global gridded crop models (GGCMs) can be informative at both local and larger scales by consistently simulating the entire global crop-land while accounting at the same time for local conditions.
Here we present the first systematic study on cropping systems adaptation to temperature increase based on a GGCMs ensemble sensitivity analysis. The models consistently implemented two management options that can alleviate impacts of temperature increase on major grain crops: first an adoption of new cultivars to maintain the original growing period (a measure to counteract accelerated crop phenology) and then a full irrigation (with the aim of avoiding increased water stress due to increased atmospheric vapor pressure deficit (VPD) under warming). We assess the effectiveness of these two options, as well as their combination, in avoiding yield losses of four major crops (maize, wheat, rice and soybean).
First results show that, at the global aggregation, irrigation and the unaltered growing period both allow for increasing yields under most warming scenarios, and that the most positive effects occur when these strategies are combined. We also study how adaptation effectiveness varies across regions of the global crop land. In temperate regions a cultivar shift typically has positive effects by reducing yield losses and often even leads to fully maintaining or exceeding the baseline yield levels across various levels of warming. On the other hand, in warmer areas, such as the tropics, this strategy only shows limited effects, even when combined with irrigation and already at moderate warming levels. This suggests that in such environment temperature is already a strong limiting factor that cannot be alleviated by altered crop phenology. This poses a challenge to identify and model alternative adaptation strategies. Irrigation typically helps to increase yields in water-scarce growing environments, but this is also true for most baseline conditions. Irrigation becomes a true adaptation measure only if the yield increase is larger under warming than under baseline conditions. This can e.g. occur in regions where the additional warming leads to substantial increases in VPD.