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Assessment of production risks for winter wheat in different German regions under climate change conditions

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The study shows climate change impacts on wheat production in selected regions across Germany. To estimate yield and economic effects the agro-ecosystem model HERMES was used. The model performed runs using 2 different releases of the model WETTREG providing statistically downscaled climate change scenarios for the weather station network of the German Weather Service. Simulations were done using intersected GIS information on soil types and land use identifying the most relevant sites for wheat production. The production risks for wheat yields at the middle of this century were compared to a reference of the present climate. The irrigation demand was determined by the model using an automatic irrigation mode. Production risks with and without irrigation were assessed and the economic feasibility to reduce production risks by irrigation was evaluated. Costs and benefits were compared. Additionally, environmental effects, e.g. groundwater recharge and nitrogen emissions were assessed for irrigated and rain fed systems. Results show that positive and negative effects of climate change occur within most regions depending on the site conditions. Water holding capacity and groundwater distance were the most important factors which determined the vulnerability of sites. Under climate change condition in the middle of the next century we can expect especially at sites with low water holding capacity decreasing average gross margins, higher production risks and a reduced nitrogen use efficiency under rainfed conditions. Irrigation seems to be profitable and risk reducing at those sites, provided that water for irrigation is available. Additionally, the use of irrigation can also increase nitrogen use efficiency which reduced emissions by leaching. Despite the site conditions results depend strongly on the used regional climate scenario and the model approach to consider the effect of elevated CO_2 in the atmosphere.