Agriculture in the face of a changing climate: Adaptation and mitigation solutions

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Agriculture impacts the climate system by contributing to greenhouse gas emissions (GHGE) and the environment by using resources, such as water and fuels. At the same time, agricultural crops, their pests and natural enemies are severely impacted by the changing climate. Mitigation efforts aim at reducing GHGE from agriculture, while adaptation strategies focus at adjusting practices, processes and capital to the changing conditions. Here we present the results of a mitigation study on Mediterranean viticulture and an adaptation study on outdoor tomato cultivation.

In the first study, Life Cycle Assessment (LCA) was applied to determine the carbon footprint (CF) of grapes from wine and table grapes in Cyprus. The study covered three varieties: the indigenous white variety Xynisteri, the introduced red variety Cabernet Sauvignon and the table grape variety Soultanina (Thompson seedless). The study included 90 vineyards in the most important grape growing regions of the island. Results showed that table grapes had the highest CF (0.846 kg CO_2-eq/kg grapes), followed by the two wine varieties, the globally popular Cabernet Sauvignon at 0.556 and the indigenous white variety Xynisteri at 0.283 kg CO_2-eq/kg grapes. Fertilizers and field energy use were the carbon hot spots for grapes. The modelled scenario for footprint mitigation showed that the CF of all three varieties can decrease by 40-67% after applying locally produced animal manure and reducing tillage frequency. The CF of indigenous Xynisteri can get close to zero. Validation of mitigation practices through field-research is an essential step for the compliance of viticulture with global GHG emissions mitigation targets.

Tomato (*Solanum lycopersicum* L.), one of the most important vegetables in the world, is grown mostly outdoors. Farmers growing outdoor tomatoes need to adapt to the direct effects of CC on the crop. In addition, farmers must adjust their pest management practices to deal with changing pest pressure, especially by pests favored by warm and dry conditions, such as the two-spotted spider mite, *Tetranychus urticae* (Koch). The two-spotted spider mite attacks tomatoes among more than 200 crops and has developed resistance to more than 90 active ingredients of pesticides. Biological control of the pest with the predatory mite *Phytoseiulus persimilis* Athias-Henriot can be effective, but the impacts of CC on either pest or natural enemy have yet to be assessed. Here we modelled the suitability of areas equipped with irrigation facilities (AEI) in 2050 for the three species under the A1B scenario (CSIRO MK.3 model), which results in 1.6 °C warming by 2050, within the targets of the Paris agreement. Results suggest that by 2050 several top tomato producing countries loose from 30% to 100% of AEI suitable for tomato production. The potential for damage by the two-spotted spider mite would increase substantially in countries located in Europe, Africa and Asia, while disruption of control by the predatory mite would occur globally. Model predictions have a significant relationship with field validation experiments and farmer/expert perceptions on two-spotted spider mite infestation severity. Adaptation efforts need to focus on identifying suitable areas for AEI expansion, as well as on the development of tomato varieties resistant to heat and drought.