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Diversity may save wines from climate change

by Ignacio Morales-Castilla[1] | Distinguished Researcher Beatriz Galindo; Elizabeth M. Wolkovich[2] | Professor

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[1]: Global Change Ecology and Evolution Group, Department of Life Sciences, Universidad de Alcalá, Madrid, Spain
[2]: Forest & Conservation Sciences, Faculty of Forestry, University of British Columbia, Vancouver, Canada

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Today's drastic global warming is threatening the agriculture of many valuable crops, including winegrapes. We propose a new approach to selecting winegrape varieties that are adapted to a future warmer environment and enhance the crop's diversity. This approach may, in turn, prevent losing our favorite vineyards across the world.

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Today's climate change is dramatically reshaping environments and threatening society, countless animal and plant species, and sustainable agriculture. Scientists foresee that global warming is going to bring unpleasant outcomes, such as reductions in crops' yield and quality. Today's farmers need a way to adapt to changing climate to save their farms, crops, livelihoods, and in turn, save the products consumers love, such as wine.

To this end, several approaches have been proposed. For example, farmers can change their local practices by improving microclimatic conditions (irrigation, shading, micro-misting, shifting sun exposure, etc.), or they can make much bigger changes by moving to a new spot with lower temperatures – usually at higher altitudes or latitudes – where future climate will be better suited to grow their crops.

However, these options are costly and unaffordable for many farmers. An alternative approach available to all is to exploit the already existing diversity within a crop and select the cultivar (a variety or race of a given plant) that will be best suited to grow under future climate in the same local environment. Cultivars (or varieties) represent diversity present within a crop – each cultivar is slightly genetically different, which can cause large differences in important attributes, such as how early or late they ripen. Many crops are rich in cultivar-diversity. Yet how much this diversity could help growers adapt to climate change has not been measured.

In this study, we asked how much agricultural diversity can help elevate crop resilience to climate change. To do so, we focused on the winegrape, one of the most essential crops in the food industry. Winegrapes are a well-known hyper-diverse crop, as you can perhaps guess based on how many wine labels exist in the world. Over 1,100 cultivars have been planted worldwide. Importantly, there exist comprehensive records on how these different cultivars responded to environmental changes in the past. Collectively, the winegrape serves as an ideal model crop to study the effects of climate change on agriculture.

To test if diversity within winegrapes may impact the future of winegrowing under climate change scenarios, we focused on phenology, the timing of key developmental stages such as flowering and fruit maturation, indicating when a given cultivar is mature. We modeled 11 of the most common winegrape cultivars, including Cabernet-Sauvignon, Chardonnay, Merlot, Pinot noir, and Syrah. This phenological modeling enabled us to predict when each variety will start to ripen under different climatic conditions. Using this model, we could identify which cultivars would be suitable based on their ripening time in a given area under two possible global warming scenarios: either 2 or 4°C higher global temperature.

Next, we assessed how effectively winegrape diversity can help future agriculture under these two global warming scenarios. The model allowed us to estimate gains and losses for current worldwide wine-growing regions if growers shift cultivars compared to if they do not. We found that if growers don't take any action and keep their current cultivars, we could lose up to 56% of current winegrowing areas under the milder warming scenario (2°C warming), and up to 85% in the more severe scenario (4°C warming). But, if growers change their cultivars to more climate-change-compatible ones as our model suggests, these losses would be reduced by a half with 2°C warming and by a third under 4°C warming. These results show how increasing agricultural diversity enhances crop resilience to global warming.

Collectively, our results provide a first major step in using cultivar diversity to adapt to climate change. The next goal should be answering the question of which cultivars will be best suited to grow where under different scenarios, and how to combine this approach with other strategies. Indeed, to put this strategy in place, growers will need models at the vineyard scale and information on more than just 11 of the 1,100 planted winegrape cultivars. Further, while opportunities for cultivar change increase with its diversity, there may be physical limits to its use – for instance, temperatures that are too high for any given cultivar. In such regions, growers may need to combine alternative adaptive methods.

While our study focused on winegrapes, similar analyses could be applied to other cultivar-rich crops – such as apples, stone fruits and berries – as long as we have information on the phenology of different cultivars across different temperatures to build models like ours. If we want to improve our forecasts of the effects of climate change on agriculture to make informed adaptation decisions, further efforts at collecting, assembling, standardizing and centralizing data on phenology – and additional agronomic features – will be critical.

The authors continue researching the potential of winegrape diversity to adapt winegrowing to climate change both in Europe and America.