Potential crop yields can be dozens of percentage points higher than estimated

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Food security policies implemented by governments, businesses and organizations such as the UN rely partly on global models that assess current and potential crop yields. Scientists at Wageningen University & Research (WUR) and the University of Nebraska-Lincoln warn that these global top-down models have certain shortcomings.

They argue that the models rely too much on coarse data regarding weather, soils and crops, and that there is too little input and validation using local data. In an article in *Nature Food*, they call for these estimates to be improved through the structural application of locally collected data and by testing the models more regularly with local experiments.

In their article, the researchers compared the performance of two commonly used top-down models (Global Agro-ecological Zones and the Agricultural Model Intercomparison and Improvement Project) with the performance of their own bottom-up approach, the Global Yield Gap Atlas.

Systematically low estimates

"The estimates provided by global top-down models for a large country such as the United States or a whole continent are often—though certainly not always—reasonably accurate, but when you look at specific regions or smaller countries, the results become unreliable. In fact, the estimated potential agricultural production for a country is often lower than the actual production achieved in preceding years," says co-author Professor Martin van Ittersum of WUR's Plant Production Systems chair group.

By way of example, he points to the results from the global models for rice in Asia and maize in sub-Saharan Africa: "For rice in Asia, the potential yield estimates made by the top-down models are systematically much too low, while the models fail to sufficiently distinguish between countries with demonstrably high and low potential yields for maize in sub-Saharan Africa."

Rough data and a lack of testing

Shortcomings in the top-down models are caused by the tendency of the databases to take a broad-brush approach, and the fact that they are based on generated weather data or assumptions about crop calendars. For example, they don't always correctly estimate when a crop in a particularly region will be sown and harvested. Global studies also use a single model for a wide range of crops and for the entire world, even though the models have not been tested locally with well-executed experiments.

"Potential crop yields in a particular area can therefore actually be dozens of percentage points higher than the assumptions made in the top-down models," says Van Ittersum. Investors, seed producers and other stakeholders make decisions based partly on these models, so there can be far-reaching consequences. "We cannot afford to make poorly substantiated decisions in our efforts to improve food security in Africa or other parts of the world, and in the way we use scarce resources such as land and water as part of those efforts."

Integrating local data

According to the authors, the problem could be solved by making structural use of local data in global studies. This local data (with regard to weather, soils, and crop management) and simulations are already available, having been systematically recorded since 2011 in the Global Yield Gap Atlas project (GYGA) which is co-managed by Van Ittersum.

"We started this project jointly with the University of Nebraska-Lincoln because we had found that the global models were often significantly inaccurate for specific countries and regions. We've now been able to compile high-quality and locally relevant data for about 70 countries, with the help of local experts. Because of this, we now know what the yield gap is for some of the major agricultural crops on 80% of the world's surface area. This bottom-up approach is very demanding, but it

does generate highly valuable information for policymakers and researchers working on the issue of how various countries and continents will be able to feed themselves in the future, and where the greatest opportunities might be found."

More information: Juan I. Rattalino Edreira et al, Spatial frameworks for robust estimation of yield gaps, *Nature Food* (2021). DOI: 10.1038/s43016-021-00365-y

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