In pursuit of more fruitful food systems

David Gustafson1 · Senthold Asseng2,8 · Clyde Fraisse2 · Kaiyu Guan3 · Gerrit Hoogenboom2 · Chad Kruger4 · John Kruse5 · Marty Matlock6 · Rachel Melnick1 · Ranjan Parajuli6,9 · Kirti Rajagopalan4 · Claudio Stöckle4 · Timothy B. Sulser7 · Layla Tarar1 · Greg Thoma6 · Keith Wiebe7

Received: 20 September 2022 / Accepted: 25 September 2022 © The Author(s) 2022

To the Editor

Recent analyses suggest that global fruit and vegetable (F&V) production will need to increase by 50–150% by 2050 to achieve sustainable and healthy diets for all 10 billion people expected to inhabit the world (Stratton et al. 2021). Meeting this increased demand will be very difficult due to numerous factors, including the scarcity of labor, dwindling water supplies for irrigation, and climate change. We have just completed a 5-year project (Agriculture and Food Systems Institute 2022) that began to tackle this daunting challenge: fruit and vegetable supply chains: climate adaptation and mitigation opportunities. We identified and tested climate adaptation and mitigation strategies in these supply chains through the development and application of a novel integrated methodology that included climate, crop, economic, and life cycle assessment (LCA) models, following protocols developed by the Agricultural Model Intercomparison and Improvement Project (AgMIP) (https://agmip.org/). Consistent with AgMIP standards, our modeling tools are for open use and are broadly applicable to other crops and regions, subject to normal input data requirements.

We found that these supply chains can be more resilient if growers change their planting strategies to avoid higher temperatures and shift production to areas with more favorable climates and available irrigation water (Gustafson et al. 2021). We projected that land and water footprints (per unit of consumed food) will decline over time due to higher yields and the positive impacts of increasing levels of carbon dioxide on plant growth and anticipated improvements in water use efficiency. Such systems now suffer major supply chain losses but will be increasingly mitigated through digital technologies and artificial intelligence. There is also a large potential to mitigate GHG emissions by waste reduction and process modification (Parajuli et al. 2021). Our integrated economic modeling results show that grower margins will continue to be squeezed, despite increases in demand (Kruse 2022). While these findings have important implications for the US, as discussed here, this type of analysis can be applied elsewhere across the planet in a global integrated framework such as IFPRI’s IMPACT (Robinson et al. 2015), making important contributions to larger-scale planetary health and sustainability goals.

In addition to these important findings, our results can facilitate participation in the ecosystem service markets now emerging for those interested in reducing the carbon footprint of food system supply chains. Shown in Fig. 1 are the on-farm GHG emissions in all eight crops that we studied (March 2022 F&V-CAMO webinar series 2002). Emissions can be reduced through climate-smart practices, such as cover crops, reduced tillage, and advanced nutrient management. Our integrated assessment methodology can be applied to other crops, health-based consumer scenarios (fresh vs. processed), and geographies, thereby informing decision-making throughout supply chains. Employing such methods for all important F&V crops will be essential as food systems are forced to adapt and transform to reduce...
carbon intensity due to the urgent imperatives imposed by climate change.

We have now released new digital tools to support F&V growers and the supply chain players who purchase these important crops. Our first tool (UF F&V-CAMO results webtool 2022) can be used to more accurately project future yield and determine where these crops might become more profitable or environmentally advantageous to produce, both in the near term and by mid-century. The tool can also assist with exploring multiple climate change impacts on F&V crops across the conterminous US, including the impact on yield, irrigation demand, and the environmental footprint.

We explained the use of this new tool in the public webinar series referenced above (March 2022 F&V-CAMO webinar series 2002), which also included a discussion of a second tool based on the concept of climate analogs. The climate analog enables the exchange of actionable information by answering the following question: “Is there another region whose current conditions resemble my future?” Through the use of this second new digital tool (WSU Climate Analog webtool 2022), paired groups of experts from such locations can meet to exchange insights. Our team has already assembled one such exchange between agricultural industry representatives in the southeastern USA (FL, GA, and SC) with those in TX, whose conditions are similar to the southeast’s future. Several actionable insights came from the first of these facilitated conversations, including the realization that pest management would soon need to become a year-round activity. Additional extension and outreach efforts have focused on sharing research results with F&V producers and industry personnel and providing broader public educational material from the project, such as through the Climate Friendly F&V blog series (Agriculture Climate Network 2022).

We must produce substantially greater amounts of F&V in more sustainable and affordable ways, meeting human nutritional needs while respecting planetary boundaries—all while adapting to both gradual climate change and the onslaught of extreme events (including those related to both weather and supply chain disruptions) that are making it even more challenging to affordably feed ourselves. This project indicates the potential of F&V systems to live up to this challenge if adequate public and private investments are made in prioritizing climate adaptation and mitigation opportunities.

**Funding** This project was supported by USDA NIFA award no. 2017-68002-26789.

**Declarations**

**Conflict of interest** The authors declare no competing interests.
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