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# Is Local Food More Sustainable?
# Comparing Local Food Production to Conventional Centralized Agriculture in the Contiguous United States Through Life Cycle Assessment

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**Abstract.**
In recent years, local food production has seen growing interest as a pathway to sustainability. A variety of systems can enable local produce with varying sustainability impacts. Previous research indicates year-round Controlled Environment Agriculture (CEA) like greenhouses can have high environmental impacts due to significant energy intensity. Such studies focus on experimental performance or simulations in particular locations. Expanding beyond these case studies to capture regional variations would enable better stakeholder understanding of sustainability impacts and trade-offs.
Our research presents a geographically resolved cradle-to-store life cycle comparison of four lettuce production systems: indoor plant factories, greenhouses, local outdoor cultivation, and centralized cultivation. Combining U.S. DOE EnergyPlus modelling with geographic resolution in climate, grid generation mix, and water scarcity, we estimate the global warming and water impacts of CEA lettuce production across the contiguous United States. Further, utilizing the Food and Agriculture Organization's AquaCrop model, we simulate seasonal soil cultivation of lettuce in the same locations. We compare these results to conventional cultivation and transportation from California, where most US lettuce is grown.
Results indicate the average global warming impacts of CEA production are eight times higher than conventional systems. However, an 85% reduction in water footprints suggests energy-water tradeoffs. In contrast, local soil production reduces global warming impacts except where soil conditions greatly reduce yields. Variations in yields and precipitation lead to a range of water footprints for local outdoor cultivation, with most impacts lower than conventional usage.
The high climate impacts of CEA systems indicate conventional production is more sustainable; CEA systems would need to improve energy efficiency and decarbonize energy sources. Local seasonal cultivation, meanwhile, can be more sustainable than conventional systems with the right growing conditions. All local production results suggest trade-offs at the water-energy nexus, as the water intensity of the conventional system could incentivize technologies with lower water requirements and locations with less water scarcity. Our results provide geographically resolved comparisons of local vs. centralized food production and can facilitate food-energy-water decision-making on emerging food production systems.