Greenhouse cultivation for more sustainable food systems

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FOOD SYTEMS

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Society must revisit the currently dominant agricultural model, based on agricultural expansion and intensification. Greenhouse cultivation represents a promising alternative, particularly in the Global South.

Greenhouse cultivation represents one of the most efficient agricultural models to ensure high yields and quality of locally-produced fresh produts with the possibility to extend crop growing seasons[1]. This high efficiency results from a partial or total control of adverse abiotic or biotic stresses, including excessive heat or cold conditions, optimized carbon dioxide and light levels, maximization of land space (e.g. vertical farming), limited biotic stresses (animal pests, diseases and weeds), and optimized irrigation or ferti-irrigation[1]. Greenhouse cultivation can therefore contribute to reduce food insecurity, especially across the Global South, thanks to the possibility of obtaining relatively high income by growing profitable crops to secure the livelihood of both rural and urban families. In addition, for many high-value field crops, greenhouse cultivation allows nursery raising to produce seedlings to be transplanted more later under open-field conditions with possibility for early field harvest, which brings an important added value for farmers who can sell off-season products at higher prices on the market. A wide range of technologies and materials can be employed for greenhouse construction, going from low-tech polyethylene films generally used for small-scale farming to high-tech glasshouses employed for precision farming. Likewise, depending on the greenhouse cultivation technique and species to be ciltivated, plants can be grown in soil or soilless substrates (making it possible to use unfertile, degraded, polluted or otherwise unsuitable land for open-field farming to grow food on an industrial scale).

Unlike relatively robust global statistics of open-field farming, no precise information exist to date on the global area for greenhouse cultivation. In particular, there is paucity of information as to whether the global extent and the expansion of greenhouse cultivation follow the same pace of global population with a particular emphasis on the Global South.

Now writing in Nature Food, Tong and colleagues[2] present a global assessment of greenhouse cultivation coverage in the 21st century. By coupling commercial nanosatellite imagery and artificial intelligence techniques, the authors mapped 1.3 million hectares of greenhouse infrastructures in 2019 across 119 countries, which is a much larger extent than the previously estimated one[3]. They found large and small-scale greenhouse infrastructures both in the Global North and the Global South with the latter having 2.7 times higher greenhouse coverage than the former. More specifically to the Global South, the authors found a striking expansion of greenhouse cultivation in China, which accounts for 60% of the global coverage, followed by Mexico and Morocco. For the Global North, Spain followed by Italy and Turkey are major countries in terms of the global greenhouse coverage. Their study also highlighted extensive greenhouse cultivation both across urban and rural areas of the Global South including China, with over 50% of greenhouse cultivations located across regions characterized by substantial resource constraints, including water scarcity that represents a key limiting factor for open-field cultivation. However, the study by Tong and colleagues did not differentiate between the types of covering materials used for greenhouse cultivation, a point which deserves further investigation.

Tong and colleagues[2] found knowledge gaps in spatiotemporal datasets of greenhouse cultivation including the duration of a given greenhouse cultivation coverage. For this reason, their analysis also included greenhouse cultivation that persisted only one year. The knowledge gap in the litearature on annual land use changes in terms of greenhouse cultivation raises concern on the stability of the mapped greenhouse cultivation coverage over time, especially for low-tech infrastructures that are widely present in the Global South.

While the work by Tong and colleagues[2] emphasizes the potential of greenhouse infrastructures to enhance global food security, their study also raises concern about potential negative socio-economic and environmental impacts of this greenhouse cultivation boom. The latter include reduced aesthetic values of the landscape due to greenhouse cultivation clusters, overexploitation of water resources in drylands, surface and groundwater contamination from excessive use synthetic pesticides and fertilizers, contamination of soil, aquatic and terrestrial environments by plastic debris, soil degradation due to more intensive and all year round farming practices, emissions of air pollutants and potential higher carbon, energy and water footprints, especially the grey water foorprint[4], compared to open-field cultivation[5–7].

The surge of greenhouse cultivation coverage in the Global South thus sounds an alarm bell and calls for proactive policies to mitigate potential negative effects of this cultivation system. Some of these drawbacks

can be reduced by using more efficient energy-saving techniques based on waste valorization and resourse renewal. Detailed multi-criteria assessment and life cycle analysis studies that evaluate economic, environmental and social cost-benefit analysis of greenhouse cultivation will be vital for decision-making in national and regional public policy.

Acknowledgements

JRL is partially supported by the CASDAR Fontes des semis project funded by the French Ministry of Agriculture.

Competing interests

The author declares no competing interests

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Greenhouse cultivation of valerian salad in Sabaudia, Latina province, central Italy (Photo credit: Massimiliano Natali)