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Defining impacts of urban farming beyond catchy headlines

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Controversial figures on environmental impacts associated with urban agriculture are currently receiving attention from the media and the general public. For comparative analysis, however, methodologically sound evidence is needed, before conclusions can be drawn.

Over the need for consolidated and transparent evidence

In a recent manuscript (Hawes et al., 2024), Urban Agriculture (UA) was claimed to feature environmental impacts six-fold higher than conventional rural alternatives. However, such large gap was only visible when urban farming occurred in collectively managed social projects, whereas for commercial urban farms (and also in some cases of individual gardens) environmental impacts were comparable to those featured by rural commercial farms. Besides, the study adopted a potentially misleading and unconventional functional unit, e.g., the servings of a group of products (that on average accounted for about 80 g of a basket of fruits and vegetables that an individual should consume to align with USDA dietary guidelines). Though, the environmental performance (measured through LCA) of a specific crop may depend on many variables, including climate, location, available technologies, production practices or approaches and logistic chains, among others, and therefore, the comparison among the urban vs. conventional rural alternatives would be more rigorous if using a single product approach.

Indeed, the release of the manuscript caught major resonance in the media, where it was often translated into an alarming study where the functionality of UA was overall questioned (**Fig. 1**).

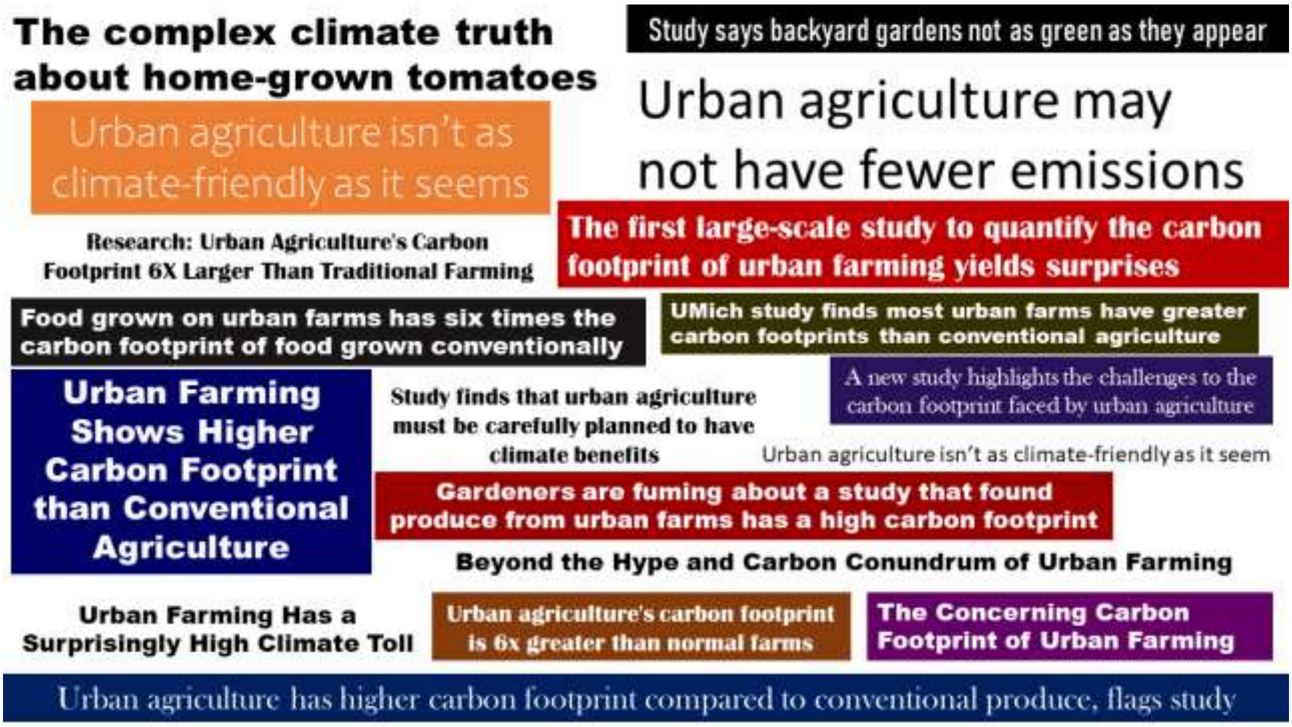

Fig. 1. *Headlines from 18 independent news outlets that referred to the study by Hawes et al. (2024), released in English language.*

It is not the first time that worrying claims are exaggerated by media on the possible adverse impacts of placing food production within urban settings. More than a decade ago, a scientific paper questioned the healthiness of UA in high-traffic areas, with reference to potential hazards associated with heavy metal pollution (Säumel et al., 2012). Despite the fact that contamination risks are associated with a number of factors occurring during cultivation (e.g., fertilization management, pest control strategies, or differential accumulation caused by genotypic variability within the same plant species), in the study, plants randomly harvested in potentially polluted areas of a city (Berlin, Germany) were compared with samples purchased in local groceries (whose origin or post-harvest processing and management were not specified). Still, news outlets released alarming claims about poisonings among urban farmers. Afterward, it took a few years for new contrasting evidence to emerge. Studies in Bologna (Italy), showed that by adopting the same genotypes and cultivation practices, similar contamination risks emerged in rural and urban settings (Vittori Antisari et al., 2015). Similarly, heavy metal concentrations were generally lower than risk threshold in studies performed in Madrid (Spain) (Izquierdo et al., 2015) or Vienna (Austria) (Ziss et al., 2021). Potential contamination in cities is generally associated with former industrial use of the land, and may therefore be easily predicted by historical data, and pollutant concentration may be further zoned by in situ spectrometry investigation through portable X-ray fluorescence methods, as commonly adopted in Nantes (France) (Bechet et al., 2018). In those, rare, cases where a contamination risk is eventually present, it may be eliminated by improved cultivation strategies (e.g., soilless culture) or post-harvest treatments (e.g., washing prior consumption) (Pennisi et al., 2016). While these discoveries confirmed that safe food can be produced in urban setting, it remains unclear why they received little echo in the media.

Comparing urban to conventional agriculture

When a comparative assessment is performed for environmental performances, it is crucial to standardize system boundaries and adopt reliable data for all crops under assessment. In the study by Hawes et al. (2024), the impact allocation differed between the urban farms and the conventional rural suppliers. More specifically, assessment of agriculture in cities was based on extensive participatory interviews (mostly providing qualitative information), that ultimately produced data for specific geographical regions. Conversely, impacts associated with conventional rural agriculture were estimated using average inventory data, applied on fewer crops (according to availability of figures) and combined with their usual provenance in selected locations (based on country statistics on imports). As such, the comparisons rely on different data quality and availability, with urban agriculture based on real production data, while the compared rural systems mostly relying on inventory data instead of real observations. Besides, differences in system boundaries of the literature feeding the data (sampled across only the most recent studies in the target location), may have altered the overall impact analysis. Furthermore, the study elaborated over a largely different sample size between rural farms (n=250) and urban projects (n=73, out of which only 9 belonged to the significantly higher impact category, the "urban collective gardens"). Accordingly, conclusions on comparative results may be misleading.

While it is not arguable that the generation of new data is beneficial to the overall understanding of impacts associated with UA, it should be considered that these recent groundbreaking results are also substantially higher from previous literature and should not be communicated as the new and only paradigm.

For instance, the study brings little reflection on previous literature on urban agriculture. Impacts of an individual garden have been previously estimated in the ranges of 0.10-0.40 kg CO_2 eq kg^{-1} of selected fruit and vegetables (Sanyé-Mengual et al., 2018). Similarly, when a number of fruit and vegetables were grown in a simplified soilless system for rooftop agriculture, emissions ranged 0.07-0.30 kg CO_2 eq kg^{-1} (Sanyé-Mengual et al., 2015a). Overall - even though comparison between diverse methodologies cannot be made - such figures do not support the suggested higher environmental impact of UA as compared to rural agriculture, which featured emissions of about 0.47 kg CO_2 eq kg^{-1} in the combined servings used in the study of Hawes et al. (2024). Consistently, for an integrated rooftop greenhouse in the peri-urban fringes of the city of Barcelona (Spain), a comparative assessment resulted in emissions of 0.79 kg CO_2 eq kg^{-1} of tomatoes, as compared with 0.87 kg CO_2 eq kg^{-1} observed in rural greenhouse production (Sanyé-Mengual et al., 2015b).

Among the most promising and debated systems for plant production in cities, vertical farms appear as a game changer that may largely transform our current food systems. Although some skepticism on the sustainability of the technology has been advanced (mainly due to the elevate energy consumption of the technology) (Stanghellini and Katzin, 2024), the environmental performances of vertical farming have proved viable in specific conditions, especially when fresh and perishable produce (e.g., leafy vegetables) are grown and environmental stresses hinder local cultivation. It is the case for instance of a commercial vertical farm in Sweden producing lettuce, with emissions as little as 0.75-0.77 kg CO_2 eq kg^{-1} when the most sustainable energy options were used, as compared to values ranging 1.31 to 1.62 kg CO_2 eq kg^{-1} when the production was coming from traditional rural farming, respectively in open field or greenhouses (Martin, Elnour and Siñol, 2023). In the same study it was also highlighted that comparative sustainability assessment favored controlled-environment UA in Sweden under different scenarios. Consistently, higher emissions were associated with products imported from rural farms in distant locations (as Italy or Spain, with average impacts of 1.72 and 1.84 kg CO_2 eq kg^{-1}, respectively) or energy-intense systems (as the Netherlands, featuring 2.33 kg CO_2 eq kg^{-1}). The gap between UA and rural agriculture was more limited when alternative national rural suppliers (0.86 kg CO_2 eq kg^{-1}) were considered, although this was only feasible under specific seasons of the year. The possibility for reducing environmental impacts (on a cradle to gate perspective) in urban farms thanks to high tech solutions was similarly confirmed in a recent study in Finland, where lettuce production in vertical farms (featuring GHG impacts of about 1 kg CO_2 eq kg^{-1}) was recently confirmed as a more sustainable option than greenhouse cultivation (that locally features 2 to 3.3. kg CO_2 eq kg^{-1}) (Joensuu et al., 2023).

Urban agriculture calls for diversified indicators

Urban agriculture embeds a number of associated ecosystem services that overall contribute to its sustainability. As recently proposed (also by authors of the study by Hawes et al., 2024), sustainability analyses of City/Region Food Systems initiatives need to combine environmental with economic and social indicators (Cirone et al., 2023). This is due to the fact that, across UA initiatives, financial viability may become secondary with regard to other social and environmental benefits. Accordingly, yields in community-based initiatives may be significantly lower than those experienced in commercial farms, thus resulting in increased environmental impacts per unit of food produced. When this is the case, relying only on greenhouse gas (GHG) emissions to evaluate sustainability may be misleading. It may be worth noticing that UA may play a crucial role in promoting urban symbiosis, extending beyond the utilization of local compost or reuse of vacant infrastructures outlined in Hawes et al. (2024). Indeed, urban farms can employ further residual streams from urban areas, tapping into the vast material and energy residual flows from urban environments. By only reviewing the carbon impacts, the functions of urban agriculture are also limited. Benefits can be observed across different LCA impact categories beyond GHG, as well as from ecosystem services quantification, e.g., in terms of biodiversity preservation, climate regulation, energy efficiency, among others (Orsini et al., 2020). Above all, the inclusiveness and social benefits of UA may be the main functions of these systems. A picture that was not fully drawn by a study that only considered a few farms in scattered cities across Europe and the USA, and that can therefore not be extended to the global UA sector. While the intrinsic value of figures provided by Hawes et al. (2024) toward a better definition of UA sustainability is unquestionable, it clearly emerges that further research is needed before a transferrable comparative analysis can be provided.

References

Bechet, B., S. Joimel, L. Jean-Soro, A. Hursthouse, A. Agboola, T.E. Leitão, H. Costa, M. do Rosário Cameira, C. Le Guern, C. Schwartz and T. Lebeau. 2018. Spatial variability of trace elements in allotment gardens of four European cities: assessments at city, garden, and plot scale. J Soils Sedim. 18:391-406. https://doi.org/10.1007/s11368-016-1515-1

Cirone, F., M. Petruzzelli, F. De Menna, A. Samoggia, E. Buscaroli, E. Durante, F. Orsini, M. Rufí-Salís, P. Tonini, X. Gabarrell Durany, et al. 2023. A sustainability scoring system to assess food initiatives in city regions. Sustain. Prod. Consumpt. 36:88-99. https://doi.org/10.1016/j.spc.2022.12.022

Hawes, J.K., B.P. Goldstein, J.P. Newell, E. Dorr, S. Caputo, R. Fox-Kämper, B. Grard, R.T. Ilieva, A. Fargue-Leliévre, L. Poniży, et al. 2024. Comparing the carbon footprints of urban and conventional agriculture. Nat. Cities 1:164–173. https://doi.org/10.1038/s44284-023-00023-3

Izquierdo, M., E. De Miguel, M.F. Ortega and J. Mingot. 2015. Bioaccessibility of metals and human health risk assessment in community urban gardens. Chemosphere 135:312-318. https://doi.org/10.1016/j.chemosphere.2015.04.079

Joensuu, K., T. Kotilainen, K. Räsänen, M. Rantanen, K. Usva and F. Silvenius. 2024. Assessment of climate change impact and resource-use efficiency of lettuce production in vertical farming and greenhouse production in Finland: a case study. Int. J. Life Cycle Assess. 1-13. https://doi.org/10.1007/s11367-024-02343-5

Martin, M., M. Elnour and A.C. Siñol. 2023. Environmental life cycle assessment of a large-scale commercial vertical farm. Sustain. Prod. Consump. 40:182-193. https://doi.org/10.1016/j.spc.2023.06.020

Orsini, F., G. Pennisi, N. Michelon, A. Minelli, G. Bazzocchi, E. Sanyé-Mengual and G. Gianquinto 2020. Features and functions of multifunctional urban agriculture in the global north: a review. Front. Sustain. Food Syst. 4:562513 (2020). https://doi.org/10.3389/fsufs.2020.562513

Pennisi, G., Orsini, F., Gasperi, D., S. Mancarella, R. Sanoubar, L. Vittori Antisari, G. Vianello and G. Gianquinto. 2016. Soilless system on peat reduce trace metals in urban-grown food: unexpected evidence for a soil origin of plant contamination. Agron. Sustain. Dev. 36:1-11. https://doi.org/10.1007/s13593-016-0391-9

Sanyé-Mengual, E., Orsini, F., Oliver-Solà, J., J. Rieradevall, J.I. Montero and G. Gianquinto. 2015a. Techniques and crops for efficient rooftop gardens in Bologna, Italy. Agron. Sustain. Dev. 35:1477–1488. https://doi.org/10.1007/s13593-015-0331-0

Sanyé-Mengual, E., J. Oliver-Solà, J.I. Montero and J. Rieradevall. 2015b. An environmental and economic life cycle assessment of rooftop greenhouse (RTG) implementation in Barcelona, Spain. Assessing new forms of urban agriculture from the greenhouse structure to the final product level. Int. J. Life Cycle Assess. 20, 350–366. https://doi.org/10.1007/s11367-014-0836-9

Sanyé-Mengual, E., D. Gasperi, N. Michelon, F. Orsini, G. Ponchia and G. Gianquinto. 2018. Eco-Efficiency Assessment and Food Security Potential of Home Gardening: A Case Study in Padua, Italy. Sustainability 10(7):2124 https://doi.org/10.3390/su10072124

Säumel, I., I. Kotsyuk, M. Hölscher, C. Lenkereit, F. Weber and I. Kowarik. 2012. How healthy is urban horticulture in high traffic areas? Trace metal concentrations in vegetable crops from plantings within inner city neighbourhoods in Berlin, Germany. Environ. Poll. 165:124-132. https://doi.org/10.1016/j.envpol.2012.02.019

Stanghellini, C. and D. Katzin. 2024. The dark side of lighting: a critical analysis of vertical farms' environmental impact. J. Clean. Prod. 142359. https://doi.org/10.1016/j.jclepro.2024.142359

Vittori Antisari, L., F. Orsini, L. Marchetti, G. Vianello and G. Gianquinto. 2015. Heavy metal accumulation in vegetables grown in urban gardens. Agron. Sustain. Dev. 35:1139-1147. https://doi.org/10.1007/s13593-015-0308-z

Ziss, E., W., Friesl-Hanl, S. Götzinger, C. Noller, M. Puschenreiter, A. Watzinger and R. Hood-Nowotny. 2021. Exploring the potential risk of heavy metal pollution of edible cultivated plants in urban gardening contexts using a citizen science approach in the project “heavy metal city-zen”. Sustainability, 13:8626. https://doi.org/10.3390/su13158626

Competing interests

The authors declare no competing interests.