EDITORIAL FORWARD

Integrating High-Intensity Horticulture research into Urban Spaces: A Practical Path for Food Security and Environmental Stability

As we move further into the mid-21st century, cities are expanding rapidly. While this growth supports economic development, it also reduces agricultural land and increases our dependence on distant food sources (Seto *et al*. 2012, Eigenbrod & Gruda 2015). This situation creates a serious concern for food security, especially in densely populated urban areas.

Today, buildings dominate cities. However, these structures can also become part of the solution. By converting rooftops, balconies, and unused urban spaces into green areas, cities can reduce heat, improve environmental quality, and support food production (Oke 1982, Santamouris 2014, Specht *et al*. 2014). Urban greenery is no longer just for beautification—it is becoming essential for sustainable living.

Urban horticulture is now gaining attention as a practical way to produce fresh food within cities. Vegetables, fruits, and ornamental plants not only improve the appearance of urban spaces but also contribute to nutrition and well-being (FAO 2019, Orsini *et al*. 2013).

However, growing crops in cities is not an easy task. Space is limited, soil is shallow, and resources such as water must be carefully managed. Because of this, there is a growing need for focused research on crops that can perform well under these restricted conditions.

Countries such as Japan have made significant progress in rooftop gardening and controlled environment agriculture. Technologies such as hydroponics and plant factories have shown how food can be produced efficiently in limited spaces (Harada & Whitlow 2020, Nakamura & Shimizu 2019).

These examples are valuable, but they cannot be directly applied everywhere. What works in a temperate, highly industrialized country may not suit tropical climates or the socio-economic conditions of developing nations, where environmental conditions and resource availability differ significantly (Orsini *et al*. 2013, Specht *et al*. 2014, Opitz *et al*. 2016).

One of the major challenges faced by developing countries is the reliance on agricultural technologies developed elsewhere. For many years, there has been a dependence on imported seeds, production systems, and research findings that are not always well adapted to local agro-climatic and socio-economic conditions (FAO 2019, Lal 2020, Altieri *et al*. 2015). This must change.

Developing countries need to invest in their own research systems. They need crop varieties that are adapted to their climates, their urban conditions, and their available resources. This includes developing plants that can grow in small containers, tolerate heat, and produce high yields in limited space (Lal 2020). Urban agriculture should not depend entirely on external knowledge. Instead, it should be built on local expertise and innovation. This shift is important not only for food security, but also for long-term independence and resilience (Opitz *et al*. 2016).

Urban agriculture must move beyond small-scale efforts and become a structured part of city life. To achieve this, research should focus on practical and applicable areas such as: Compact crop varieties that perform well in small spaces (Lal 2020, Orsini *et al*. 2013), Efficient growing systems such as hydroponics adapted for low-cost use (Resh 2013, Specht *et al*. 2014), Lightweight growing media suitable for rooftops (Grard *et al*. 2018, Sanyé-Mengual *et al*. 2015), Use of local organic waste to develop sustainable substrates (Grard *et al*. 2015, FAO 2019), Water management, including safe reuse of rainwater and greywater (FAO 2019, Lal 2020), These are not complex ideas, but they require strong scientific support and local testing.

Urbanization often brings environmental degradation, particularly through soil erosion on cut slopes during road construction. Horticulture offers biological solutions to these engineering problems. In this field, Japan has led the way in integrating botanical research with civil engineering to manage high-risk volcanic and urban terrains.

Studies on cut slopes at Mt. Sakurajima have demonstrated that the succession of exotic and native grasses is pivotal in stabilizing soil and preventing landslides (Kondo *et al*. 2016). More recent Japanese research has shifted focus toward “Artificial Soil” substrates and Plant Factories with Artificial Light (PFALs). Institutions like Chiba University and the Japan Plant Factory Association (JPFA) have pioneered the use of “Smart” phenotyping to monitor plant stress in real-time within urban modules (Kozai 2026). These Japanese models illustrate how research can be tailored to specific local geohazards and space constraints.

In a developing countries context, adapting these findings to urban road embankments using native horticultural species—rather than imported seeds—can provide both aesthetic value and physical stability while preserving local biodiversity.

The future of agriculture is not limited to rural areas. It is increasingly linked with urban planning, engineering, and environmental management. Cities must be designed to include green and productive spaces as a normal feature, not an exception.

For developing countries, this is a critical moment. We must move from being users of imported technologies to creators of their own solutions. This requires investment in research, collaboration among disciplines, and a clear focus on local needs.

It is my hope that this understanding will encourage researchers, students, and policymakers to explore urban spaces as new areas for agricultural innovation. Rooftops, balconies, and even roadside areas can become productive if supported by proper research and planning.

REFERENCES

Altieri MA, Nicholls CI, Henao A, Lana MA (2015) Agroecology and the design of climate change-resilient farming systems. *Agronomy for Sustainable Development*, 35, 869–890. https://doi.org/10.1007/s13593-015-0285-2.

Grard BJP, Chenu C, Manouchehri N, Houot S, Frascaria-Lacoste N, Aubry C (2015) Rooftop farming on urban waste provides many ecosystem services. *Agronomy for Sustainable Development,* 38(2), https://doi.org/10.1007/s13593-017-0474-2 .

Eigenbrod C, Gruda N (2015) Urban vegetable for food security. *Cities*, 49, 6-17. https://doi.org/10.1007/s13593-014-0273-y.

FAO (2019) The State of Food and Agriculture 2019. Moving forward on food loss and waste reduction. Food and Agriculture Organization of the United Nations Rome.

Harada Y, Whitlow TH (2020) Urban rooftop agriculture: challenges to science and practice. *Frontiers in Sustainable Food Systems*, 4, 76. https://doi.org/10.3389/fsufs.2020.00076.

Kondo K, Uchida T, Hayasaka D, Tanaka J, Sato A, Arase T (2016) Vegetation succession on cut slopes for erosion control at Mt. Sakurajima. *International Journal of GEOMATE*, 11(23), 2136–2142.

Kozai T (2018) Current status of plant factories with artificial lighting (PFALs) and smart PFALs. In: Smart Plant Factory (Kozai T Ed.). Springer, Singapore. 3-13. https://doi.org/10.1007/978-981-13-1065-2_1.

Lal R (2020) Home gardening and urban agriculture for advancing food and nutritional security in response to the COVID-19 pandemic. *Food Security,* 12(4), 871–876. https://doi.org/10.1007/s12571-020-01058-3.

Nakamura K, Shimizu H (2019) Plant factories in Japan. In: Plant Factory Using Artificial Light (Kozai T, Niu G, Takagaki M Eds.). Elsevier, 319–325. https://doi.org/10.1016/B978-0-12-813973-8.00028-2.

Orsini F, Kahane R, Nono-Womdim R, Gianquinto G (2013) Urban agriculture in developing countries. *Agronomy for Sustainable Development*, 33, 695–720. https://doi.org/10.1007/s13593-013-0143-z.

Oke TR (1982) The energetic basis of the urban heat island. *Quarterly Journal of the Royal Meteorological Society,* 108, 1–24. https://doi.org/10.1002/qj.49710845502.

Opitz I, Berges R, Piorr A, Krikser T (2016) Contributing to food security in urban areas: differences between urban agriculture and peri-urban agriculture in the Global North. *Agriculture and Human Values*, 33, 341–358. https://doi.org/10.1007/s10460-015-9610-2.

Resh, H. M. (2013). Hydroponic Food Production (7th ed.). CRC Press.

Santamouris M (2014) Cooling cities through green infrastructure. *Solar Energy*, 103, 682–703. https://doi.org/10.1016/j.solener.2012.07.003.

Sanyé-Mengual E, Oliver-Solà J, Montero JI, Rieradevall J (2015) 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. *International Journal of Life Cycle Assessment*, 20, 350–366. https://doi.org/10.1007/s11367-014-0836-9.

Seto KC, Güneralp B, Hutyra LR (2012) Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proceedings of the National Academy of Sciences*, 109(40), 16083–16088. https://doi.org/10.1073/pnas.1211658109.

Specht K, Siebert R, Hartmann I, Freisinger U, Sawicka M, Werner A, Thomaier S, Henckel D, Walk H, Dierich A (2014) Urban agriculture on buildings. *Agriculture and Human Values*, 31, 33–51. https://doi.org/10.1007/s10460-013-9448-4.

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1st May 2026

https://doi.org/10.4038/jas.v21i2.12340