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Horticultural Trends and Urban Agriculture Resilience in Malang: A Five-Year Statistical Analysis

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Abstract

Urban horticulture plays a strategic role in strengthening sustainable food systems amid the rapid expansion of urban areas. In Indonesia, secondary cities like Malang are experiencing land-use transformations that marginalize agricultural activities, including horticulture. This study explores the dynamics of horticultural production in Malang Municipality from 2019 to 2023, utilizing primary data from the Horticulture Statistics Report published by the Malang City Statistics Agency (BPS). The analysis focuses on four major commodity groups: seasonal fruits and vegetables (SBS), annual fruits and vegetables (BST), biopharmaceutical crops (TBF), and decorative plants (TH). The findings indicate significant fluctuations in both harvested area and production levels, particularly in seasonal crops such as oyster mushrooms and chili peppers, which are highly sensitive to market prices and climate variability. Annual fruits like mango and rambutan consistently dominated the production volume, while biofarmaka crops such as turmeric and ginger showed a worrying downward trend. Notably, lemon production surged by over 1,100% between 2022 and 2023, suggesting new patterns of local market demand. Meanwhile, the decorative plant sector remained relatively stable, reflecting its niche role in urban aesthetic and cultural practices. These patterns reveal both the vulnerability and potential of urban horticulture within the broader framework of urban resilience and land governance. The study advocates for integrated urban agricultural planning, local value-chain strengthening, and policy support to ensure the viability of horticulture as part of sustainable urban development in Indonesian cities.

Article Info

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1. Introduction

Urbanization has become a major transformative force reshaping the social, economic, and ecological structure of cities across Southeast Asia. The region has experienced over a 22% increase in built-up land within just a decade, accompanied by a 31% rise in urban population—putting significant pressure on infrastructure, ecosystems, and land resources (Schneider et al., 2015). In Indonesia, mid-sized cities like Malang are undergoing rapid demographic expansion, land-use conversion, and economic diversification that increasingly strain traditional agricultural sectors such as horticulture (Vadrevu et al., 2020); (De Koninck & Rousseau, 2012).

This urban transformation has intensified competition over land, often pushing horticultural activities to the periphery, despite their critical role in ensuring urban food security and ecological balance (Morand et al., 2019); (Kamarajugedda et al., 2023). Urban horticulture—defined as the cultivation of food, medicinal, and ornamental plants within and around city areas—has been recognized as a key component of sustainable urban

development, contributing to biodiversity, health, climate resilience, and livelihoods (Xu et al., 2019); (Zeng et al., 2018). Yet, empirical data on the resilience, spatial distribution, and performance of horticulture in secondary cities like Malang remains scarce (Vadrevu et al., 2019).

This study addresses this knowledge gap by analyzing five-year data (2019–2023) from the official Horticultural Statistics of Malang Municipality compiled by Statistics Indonesia (BPS). It aims to examine the trends, fluctuations, and future implications of four key horticultural categories: seasonal fruits and vegetables (SBS), annual fruits and vegetables (BST), biopharmaceutical crops (TBF), and decorative plants (TH). The central research question is: How is urban horticulture in Malang evolving in the face of urban expansion, and what does this imply for sustainable city planning?

By positioning horticulture within the broader discourse of urban development, this research provides evidence-based insights to inform land use integration, urban food strategies, and climate-adaptive planning in Indonesian cities.

Urban Horticulture in the Context of Sustainable Urban Development

Urban horticulture is increasingly recognized as a key strategy to address food insecurity, reduce ecological footprints, and enhance the adaptive capacity of rapidly urbanizing cities. It contributes not only to food self-sufficiency but also to ecological restoration and climate resilience, especially in the Global South (Orsini et al., 2013); (Deelstra & Girardet, 2000). In developing contexts, where urban expansion frequently occurs at the expense of agricultural land, integrating horticulture into urban planning becomes both a practical necessity and a strategic approach to sustainable land management (Mougeot, 2005).

In cities like Malang, Indonesia, urbanization has intensified land competition and often marginalizes peri-urban and intra-urban farming systems. Population growth, real estate development, and infrastructure projects accelerate land-use conversion and displace agricultural activities, posing a serious threat to local food systems (Seto et al., 2012).

Dimensions of Urban Horticultural Systems

Urban horticulture comprises multiple domains that vary in their ecological roles, production cycles, and spatial requirements. This study categorizes them into four main dimensions:

1. Seasonal Horticulture (SBS): Refers to vegetables and fruits with short growth cycles, such as leafy greens and tomatoes. These crops are highly sensitive to seasonal climatic conditions and market price fluctuations, making their productivity unstable in times of urban or environmental stress (Lal, 2020).
2. Perennial Horticulture (BST): Encompasses fruit-bearing and long-lived vegetable plants like guava, avocado, or banana. These require secure tenure and long-term investment, but offer stability and resilience to market changes.
3. Biopharmaceutical Horticulture (TBF): Includes the cultivation of medicinal and herbal plants such as ginger, turmeric, and aloe vera. These species are gaining prominence as urban populations seek natural health solutions and as cities promote green wellness economies (Hodgson et al., 2019)
4. Aesthetic Horticulture (TH): Covers ornamental plants and landscaping vegetation used in urban greening, parks, and vertical gardens. These not only beautify cities but also support biodiversity, mental well-being, and climate moderation (Goddard et al., 2010).

Each domain interacts differently with urban development dynamics. Seasonal crops are most vulnerable to land-use conflicts and microclimatic variations, while perennial and ornamental horticulture can be more easily integrated into long-term urban ecological planning.

Empirical Studies and Research Gap

Empirical research has demonstrated the multifaceted benefits of urban farming: improving local food access (Zezza & Tasciotti, 2010), conserving biodiversity (Lin et al., 2015), and providing economic opportunities in low-income communities (RUAF Foundation, 2014). Despite these insights, few studies have disaggregated how distinct types of horticultural crops respond to the pressures of urban development—particularly in secondary cities such as Malang. Most analyses remain generalized or cross-sectional, lacking longitudinal perspectives on crop category-specific dynamics over time. This results in a limited understanding of spatial

resilience, yield variability, and diversification trends across horticultural systems in urbanizing landscapes.

2. Methods

This study adopts a descriptive-statistical research design using a content-driven analytical approach based on longitudinal data from 2019 to 2023. The focus is to examine production trends, fluctuations, and land-use implications of horticultural development in Malang Municipality as a representative case of a secondary urban center in Indonesia. Rather than applying inferential statistical testing, the analysis explores observable variations and trajectories across different categories of urban horticultural crops, aiming to inform sustainable urban planning, food policy, and land governance.

The primary data source is the *Horticulture Statistics of Malang Municipality 2023*, compiled and published by Statistics Indonesia (Badan Pusat Statistik/BPS). Data were collected through a full enumeration method covering all sub-districts within the city, with monthly and quarterly frequency. The dataset includes quantitative records of harvested area, production volume, productivity (in tons per hectare), and crop-specific details across four major horticultural categories: seasonal fruits and vegetables (SBS), annual fruits and vegetables (BST), biopharmaceutical crops (TBF), and decorative plants (TH). Each group is further subdivided into numerous sub-commodities, enabling temporal and categorical comparisons across a five-year period.

The analysis employs time-series trend examination, descriptive comparisons of production and productivity levels, and cross-category synthesis to detect patterns of growth, decline, or stability. Data visualizations such as line charts, bar graphs, and percentage change tables are used to illustrate key patterns. All data were processed and aggregated using SIMSPH, a statistical platform developed by BPS to consolidate district-level figures into city-wide summaries. The unit of analysis in this study is each horticultural crop group per year, assessed through variables such as total harvested area, total output (tons or kilograms), productivity rates, and annual percentage change. Where relevant, comparisons are drawn between commodity types to highlight systemic vulnerabilities or resilience. However, as the study relies solely on aggregated reports, spatial patterns of land-use change and socio-economic factors influencing production cannot be directly assessed. As such, the findings serve as an evidence base for future explanatory and spatial modeling studies.

3. Results asnd Discussion

Result

Trend Analysis of Seasonal Crops (SBS)

The trend analysis of seasonal fruits and vegetables (SBS) in Malang Municipality from 2019 to 2023 reveals significant dynamics in both production volume and cultivated land area. Among the 26 SBS commodities monitored, four crops consistently stood out in terms of production in 2023: large chili (cabai besar), bird's eye chili (cabai rawit), oyster mushroom (jamur tiram), and petsai (sawi). These key commodities serve as leading indicators for assessing the direction of seasonal horticultural development in the city.

Production Trends of Leading Commodities

Large chili recorded a notable increase in production in 2023, reaching 130.8 tons—an increase of 25.9 tons compared to the previous year. Both bird's eye chili and petsai also maintained high production figures, reflecting farmer preferences and adaptability to these crops under local agroecological conditions. In contrast, oyster mushroom exhibited volatile behavior over the five-year period. After a successive decline of 45% (2019–2020), 17% (2020–2021), and 12% (2021–2022), production rebounded dramatically in 2023 by 71%, indicating a potential recovery in cultivation efficiency and market responsiveness.

Table 1. *Production Trends of Leading Commodities* (2019-2023)

Year	Large Chili	Cayenne Pepper	Oyster Mushroom	Chinese Cabbage
2019	104.9	25.9	40.5	13.25
2020	104.9	21.7	22.3	15.8
2021	104.9	18.0	18.5	14.6
2022	104.9	4.7	16.3	14.6
2023	130.8	5.3	27.9	14.6

***Fluctuations* in Harvested Area**

Harvested area is a direct reflection of land allocation and farmer prioritization. In 2023, oyster mushroom led with 600 hectares, followed by bird's eye chili (60 ha), large chili (41 ha), and petsai (30 ha). However, the cultivated area for oyster mushroom also showed volatility: a sharp 50% decline in 2020–2021, followed by a 42% increase in 2021–2022, and another 30% drop in 2022–2023. Other crops, such as water spinach (kangkung), also experienced a decline in land area in 2023, signaling shifting planting decisions likely influenced by profitability and input constraints.

Table 2. *Fluctuations* in Harvested Area (2019-2023)

Year	Oyster Mushroom	Cayenne Pepper	Large Chili	Chinese Cabbage
2019	952.38	60	41	30
2020	600.00	60	41	30
2021	300.00	60	41	30
2022	426.00	60	41	30
2023	600.00	60	41	30

***Productivity* Patterns**

In terms of productivity (tons per hectare), the average figures from 2019 to 2023 show that other mushroom varieties led with 6.43 tons/ha, followed by large chili (2.70 tons/ha), tomato (2.06 tons/ha), and bird's eye chili (1.79 tons/ha). These figures highlight that beyond total output, land-use efficiency is an important consideration for selecting priority crops in limited urban and peri-urban spaces

Table 3. *Productivity* Patterns

Commodity	Productivity (ton/ha)
Other Mushrooms	6.43
Large Chili	2.70
Tomato	2.06
Cayenne Pepper	1.79

Annual Fruits and Vegetables (BST)

The annual fruits and vegetables (BST) sector in Malang Municipality displays a pattern of concentrated productivity across a few dominant commodities. Among more than 20 perennial crops monitored in 2023, mango, rambutan, and citrus (particularly *jeruk siam/keprok* and lemon) emerged as the most productive. Mango stood as the most consistently produced fruit over the five-year span from 2019 to 2023, with a cumulative production of 2,556 tons. Despite experiencing a dramatic drop of 80.18% from 2021 to 2022, mango production rebounded in 2023 with an increase of 149.58%, reaching 471.7 tons from 150.2 tons the year before. Rambutan followed closely with a five-year cumulative production of 1,892.1 tons. It also experienced volatility but maintained a relatively high productivity level of 179.4 kg/tree in 2023, an increase from 85.37 kg/tree in 2022. Meanwhile, *jeruk siam/keprok* consistently contributed high production values, totaling 1,553.7 tons across five years, with productivity reaching 55.82 kg/tree in 2023. One of the most striking trends was

the 1,115.5% surge in lemon production from 2022 to 2023, making it the fastest-growing fruit crop in terms of year-on-year percentage growth. Lemon production jumped from only 4.5 tons in 2022 to 54.7 tons in 2023, while productivity improved drastically from 12.33 kg/tree to 155.84 kg/tree. This phenomenon suggests an adaptive shift in cultivation patterns, potentially driven by rising market demand, changes in dietary preferences, or increasing awareness of health-related consumption trends.

In terms of land-use efficiency, jackfruit and pamelo also demonstrated high average productivity levels, reaching 130.25 kg/tree and 307.01 kg/tree respectively in 2023. These crops offer promising potential for land-constrained urban agriculture systems. On the other hand, banana—despite a wide cultivation area—continued to show low productivity, averaging only 26.27 kg/clump, highlighting inefficiencies in its cultivation within urban or peri-urban conditions. Overall, the BST category reveals a dual trend: the stability and resilience of flagship fruits like mango and rambutan, and the emergence of niche commodities such as lemon as high-potential crops. These trends signal opportunities for policy intervention to optimize varietal selection, improve cultivation practices, and strengthen supply chain connections for urban horticulture in Malang.

Biopharmaceutical Crops (TBF)

Biopharmaceutical crops (TBF), or *tanaman biofarmaka*, constitute a small yet critical segment in the urban agricultural ecosystem of Malang. These crops serve not only as culinary ingredients but also as raw materials for traditional herbal medicine and wellness products. Between 2019 and 2023, the data recorded 15 types of biofarmaka crops, primarily dominated by rhizome-based plants such as turmeric (kunyit), ginger (jahe), galangal (lengkuas), and temulawak, along with fruit- and leaf-based varieties like noni (*mengkudu/pace*), *mahkota dewa*, and lemongrass (*serai*). Across the five-year period, turmeric consistently ranked as the highest-producing commodity, with a cumulative output of 162.2 tons. However, its production trend has been declining: down 10.51% in 2021, 72.33% in 2022, and 28.97% in 2023. Similarly, ginger experienced a production drop of 57.63% in 2023, while *mahkota dewa* and *mengkudu* also recorded sharp declines of over 80% in the same year. This steep regression suggests increasing challenges in maintaining the viability of TBF crops, possibly due to land competition, reduced farmer interest, or limited downstream market integration.

The harvested area also shrank substantially. In 2023, turmeric still held the largest cultivation area among biofarmaka crops at 0.42 hectares, followed distantly by *kencur* at 0.05 hectares. Productivity patterns reveal a similar concern: most crops experienced declining yields. For example, turmeric's productivity dropped to 2.90 kg/m^2 in 2023 from a previous high of 2.96 kg/m^2 in 2022. Only a few crops like lemongrass (4.69 kg/m^2) and aloe vera (5.28 kg/m^2) demonstrated relative stability and higher yield efficiency. The declining performance of biopharmaceutical crops raises important implications for urban agriculture planning. While these crops offer high medicinal value, their production is often deprioritized due to limited immediate economic return and lower familiarity among consumers. Enhancing public awareness of herbal health benefits, providing market incentives, and integrating biofarmaka into agro-tourism and wellness programs could revitalize this sector. Moreover, encouraging compact, high-yield cultivation systems such as vertical or hydroponic rhizome farming may improve land-use efficiency and resilience in urban settings.

Decorative Plants

Decorative plants play a unique yet essential role in the urban horticultural ecosystem of Malang Municipality. While their contribution to food security is indirect, their importance in urban aesthetics, cultural practices, and psychological well-being is increasingly acknowledged in sustainable city frameworks. In 2023, 20 decorative plant commodities were officially recorded, with potted orchids, aglaonema, puring (croton), sansevieria, and jasmine (melati) being the most prominent in terms of cultivated area and production volume. Potted orchids led the category with a harvested area of 1,266 m^2 and production of 1,941 units, although this reflected a notable drop from 4,475 units in 2022. The productivity also fell sharply by 67.97%, from 4.79 to 1.53 units/m^2, indicating potential setbacks in cultivation intensity or market saturation. In contrast, aglaonema remained a stable contributor, with 335 m^2 of area and a production of 828 units, even though this also represented a 43.60% decline from the previous year.

Several other plant types showed resilience or growth. For instance, puring experienced a sharp increase in production by 142.11%, and phylodendron grew by 93.33% in both area and production, suggesting renewed consumer interest or improved cultivation practices. Meanwhile, pakis (fern) and cordyline recorded a consistent productivity ratio of 1.00, signaling steady but modest performance. Despite the overall presence of decorative plants across urban landscapes—such as in parks, home gardens, offices, and religious settings—the sector exhibited signs of volatility. Plants like chrysanthemum, rose, and jasmine suffered severe drops in production (over 60% for jasmine and over 95% for rose), highlighting the vulnerability of floral-based ornamental crops to market fluctuations and input constraints. Decorative plant sector in Malang remains niche but culturally and economically significant. The mixed performance across commodities points to the need for improved nursery practices, expanded market channels, and creative integration into urban landscape planning. Strategic support from city planning agencies could unlock further potential by promoting decorative plants as part of urban sustainability and green infrastructure policies.

Discussion

Urban horticulture serves as a crucial interface between food systems, environmental sustainability, and urban planning. In the context of Malang Municipality—a mid-sized city undergoing rapid urbanization—horticultural development reflects a dynamic interplay between land use patterns, farmer behavior, market responsiveness, and local government intervention. The synthesis of the 2019–2023 data reveals not only intra-category disparities across the four horticultural clusters—Seasonal (SBS), Perennial (BST), Biopharmaceutical (TBF), and Decorative (TH)—but also distinctive implications for policy and practice.

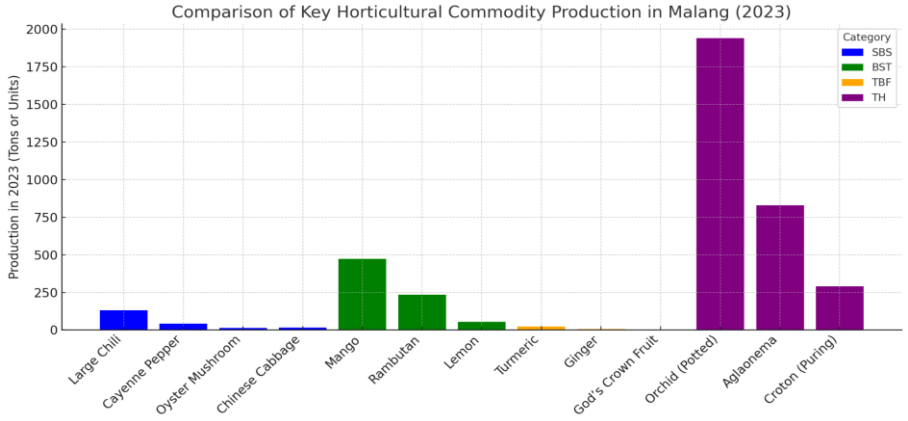

Figure 1. Comparison of Key Horticultura Commodity Production in Malang (2023)

Figure 1 (Comparison of Key Horticultural Commodity Production in Malang, 2023) clearly illustrates the heterogeneity of production values across commodities. Chili pepper (*cabai besar*), cayenne pepper (*cabai rawit*), and oyster mushrooms dominate the SBS group, while mango and rambutan lead the BST group. Turmeric continues to anchor the biopharmaceutical cluster, and orchids top the decorative segment in both production and area. These commodities collectively form the horticultural backbone of Malang's urban agriculture.

However, these apparent concentrations also mask vulnerabilities. In the SBS category, for instance, while chili pepper production rose to 130.8 tons in 2023—a 24.69% increase from the previous year—the crop's yield and stability are highly dependent on external factors such as rainfall patterns, pest infestations, and input availability. Similarly, cayenne pepper saw an impressive 60.23% increase, but this came after a steep drop in 2022. The most volatile case was oyster mushrooms: production plummeted by over 70% from 2020 to 2022, only to bounce back 71.32% in 2023. These extreme fluctuations indicate structural fragility and reinforce findings from studies on the precariousness of urban-periurban crop systems (Lwasa et al., 2014).

From a land-use perspective, oyster mushrooms held a disproportionately large harvested area (600 ha) compared to other SBS crops, suggesting a potential over-concentration of land use with questionable productivity efficiency. Although the average productivity of mushrooms is relatively high (6.43 tons/ha for other varieties), the annual volatility undermines long-term planning for producers and municipalities alike. This pattern

reflects broader regional challenges, where resource inefficiencies and poor spatial planning reduce agricultural resilience in fast-growing cities (Daudey & Matsumoto, 2017).

In the BST category, long-cycle fruit crops displayed mixed trajectories. Mango and rambutan remain staples with cumulative five-year productions of 2,556 tons and 1,892 tons respectively. These crops represent legacy cultivation patterns in peri-urban zones. Nevertheless, year-to-year shifts were dramatic. Mango production dropped by over 80% in 2022 before surging 149% in 2023. While part of this may be attributed to alternate bearing patterns typical in tropical fruit trees, it also points to inconsistent farm management or climatic stress. The lemon crop, however, stood out as a breakout case. Its production jumped from 4.5 tons in 2022 to 54.7 tons in 2023—a staggering 1,115% increase—possibly linked to post-pandemic health awareness. This suggests a shift in consumer preferences and highlights the potential of adaptive horticulture to respond to socio-behavioral change (Kamarajugedda et al., 2023).

Biopharmaceutical crops (TBF) constitute a high-value but underdeveloped segment. Key rhizome-based crops such as turmeric and ginger declined sharply, with turmeric falling by 28.97% in 2023 alone and its harvested area shrinking to just 0.42 ha. Despite turmeric's high medicinal and economic value, its marginalization reflects weak institutional support, inadequate market access, and declining farmer interest. This mirrors trends across Southeast Asia, where functional crops are often deprioritized despite their role in health resilience (Garschagen & Marks, 2019). Malang's TBF underperformance is a missed opportunity, given global interest in plant-based wellness products. Revitalizing this segment through urban wellness programs, school herbal gardens, and local pharma linkages could enhance both health outcomes and spatial productivity.

The TH category—decorative plants—presents a more nuanced picture. While orchids continued to lead in total production (1,941 units), their 67.97% drop in productivity from 2022 suggests instability in nursery practices or changing demand patterns. *Aglaonema* and *puring* showed greater resilience, with the latter experiencing a 142.11% production increase. These shifts reflect broader urban trends in indoor greening, lifestyle-driven consumption, and the influence of digital culture. However, declines in chrysanthemum and rose may be tied to reduced ceremonial functions or market saturation. Nevertheless, decorative plants offer unique co-benefits: they support urban aesthetics, contribute to biodiversity corridors, and enhance mental health—especially relevant under increasing urban stress and heat island effects (Lord, 2020).

From a systems perspective, these findings reinforce the multifunctional nature of urban horticulture. Each crop category serves distinct roles: SBS crops address short-term food supply; BST crops ensure long-term nutrition; TBF crops bolster preventive health; and TH crops enhance aesthetics and social cohesion. These categories also show varying degrees of resilience to urban pressures. SBS is highly climate-sensitive; BST is spatially demanding; TBF is under-leveraged; and TH remains undervalued in policy frameworks (Sahavacharin et al., 2024).

The policy implication is clear: tailored but integrated interventions are required. For SBS, early warning systems, irrigation infrastructure, and guaranteed input chains are essential. For BST crops, support for agroforestry and intercropping could stabilize yields while optimizing land use. The TBF segment needs focused awareness campaigns, herbal initiatives, and downstream SME linkages. TH crops could be mainstreamed via city landscaping codes and procurement policies. Figure 1 offers a vital insight: land area does not equate to productivity. Some crops with small areas (*e.g., aglaonema*) outperform larger ones in yield-per-unit terms, which is especially critical for land-constrained cities like Malang. Such data should guide planners toward more spatially efficient agricultural zoning and incentive schemes.

Finally, inter-sectoral coordination is imperative. Urban horticulture intersects agriculture, health, environment, and social equity. Building effective resilience requires coalitions of urban planners, cooperatives, innovators, and civil society organizations. This aligns with the New Urban Agenda and SDG targets for resilient, food-secure, and green cities (UN-Habitat, 2016). Malang's horticultural system reveals asymmetries and opportunities. With targeted interventions, participatory governance, and cross-sector collaboration, its crop

diversity can be transformed into a platform for inclusive, sustainable, and climate-resilient urban development.

4. Conclusion

This study examined the evolving dynamics of urban horticulture in Malang Municipality amidst rapid urban expansion, focusing on four key crop categories: seasonal (SBS), perennial (BST), biopharmaceutical (TBF), and decorative (TH). The five-year trend analysis (2019–2023) reveals a highly differentiated landscape of production, vulnerability, and policy relevance across these categories. Seasonal crops, while critical to short-term food security, displayed significant fluctuations in production and yield, underlining their sensitivity to environmental and input-based stressors. Perennial crops showed long-term potential but were undermined by inconsistent output and management practices. Biopharmaceutical crops, despite their high economic and medicinal value, remain marginalized due to weak institutional and market support. Decorative crops exhibited cultural and commercial resilience, though their performance varied sharply depending on species and consumer trends.

These findings affirm that urban horticulture is not a homogenous sector but a complex system where each category plays a distinct role—ranging from food provisioning and health promotion to ecological design and cultural expression. However, urban pressures such as land scarcity, climatic instability, and limited coordination among stakeholders pose significant barriers to sustained performance. To address these challenges, this study underscores the need for differentiated yet integrated strategies: enhancing climate and market resilience for SBS crops, incentivizing land-efficient models for BST crops, revitalizing the TBF segment through wellness and SME linkages, and institutionalizing decorative horticulture within urban landscape policy. Spatial efficiency, market diversification, and governance collaboration must guide these efforts. Ultimately, the horticultural diversity of Malang represents not only a productive asset but also a strategic lever for shaping a more sustainable, inclusive, and health-oriented urban future. Aligning horticultural development with climate-resilient urban planning will be critical in realizing this potential.

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