

This is the AAM of the chapter Thi Q.V. and Juntti M. (2024) Urban resilience from agriculture: a case study of Ho Chi Minh City in Vietnam. In Cripps K. and Thondre S. (eds.) Higher Education and SDG2: Zero Hunger. Emerald Publishing. Available at: <https://bookstore.emerald.com/higher-education-and-sdg2-pb-9781836084617.html>

## **Urban resilience from agriculture: A case study of Ho Chi Minh City in Vietnam**

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6017 words with abstract, keywords, tables and figures

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## **Abstract**

This chapter focuses on the potential of urban agriculture to support progress in SDG targets 2.1, 2.2, 2.3 and 2.4 in Ho Chi Minh City, Vietnam. The chapter integrates findings from the British Council funded “Urban Resilience from Agriculture through Highly Automated Vertical Farming in the UK and Vietnam” -project undertaken in collaboration with Middlesex University, Van Lang University and local agricultural stakeholders in Ho Chi Minh City. Food security in the city faces multiple challenges ranging from significant in-migration, decreasing area of cultivated land, the impact of the Covid-19 pandemic that continues to depress the economy and disrupt food supply chains, and climate change impacts affecting the environment and people throughout the city. Ho Chi Minh City accommodates a substantial agricultural sector, which is evolving from traditional to modern production practices. The city’s leaders have established numerous policies that place emphasis on green, circular economies, climate change resilience and low carbon emissions. There is therefore a growing demand for agricultural solutions that integrate traditional and modern technologies and that are embedded in the local topography, soil types, architectural space and native culture. Findings from greenhouse trials, community awareness surveys and stakeholder led workshops point to a range of high-technology supported agriculture models that, if applied flexibly throughout the varying context of the urban area, have good scope to help Ho Chi Minh city meet its growing need for food as well as its sustainability aspirations.

## **Keywords:**

1. Vietnam
2. Ho Chi Minh City
3. Urban agriculture
4. Vertical farming
5. High-technology production systems
6. Urbanization
7. Urban food security

## 1. Introduction

Vietnam is a fast developing lower middle-income country. In 2019, it ranked 117th out of 189 countries for the Human Development Index (UNDP 2022). Three decades of economic and social progress render it well poised to address the UN Sustainable Development Goals (SDGs). Among its Asian peers, Vietnam's progress on the SDGs is second only to Thailand. Globally, Vietnam was 49th out of 166 countries in 2020, rising by four places from 2019 (Ministry of Planning and Investment 2021). While Goal 2: Zero Hunger, is one of the five SDGs that Vietnam is on track to complete by 2030, the following targets are posing a challenge: access to safe nutritious and adequate food for all, especially the poor and vulnerable, including the elderly and infants (Target 2.1); reducing all forms of malnutrition, in specific, meeting the nutritional needs of children, adolescent girls, pregnant and lactating women, and the elderly (Target 2.2); increasing labor productivity in agriculture and income of agricultural workers (Target 2.3); and ensuring sustainable food production and applying resilient agricultural production methods that increase productivity and output, maintain ecosystems, and enhance resilience to climate change and other disasters and gradually improve land quality (Target 2.4) (Ministry of Planning and Investment 2021: 12; Ministry of Vietnam Politics 2020). These challenges implicate both urban and rural territories and many are felt particularly keenly in the context of rapidly growing cities, such as Ho Chi Minh City (HCMC). This chapter discusses the scope for high-technology supported urban agriculture to aid progress in meeting the above SDG targets in the context of HCMC. We report on the findings from the Urban Resilience from Agriculture project undertaken in collaboration with Middlesex University in the UK, Van Lang University in Vietnam and agricultural stakeholders in HCMC.

HCMC is one of the five largest cities in Vietnam. It is situated in a tropical climatic region, on the Saigon river above the Mekong River Delta, about 50 miles from the coast of the South China Sea. The city's territory spans highly urbanized areas as well as forests and beaches, and integrates a diverse river system. It has a total land area of 209,523 hectares (or 2,061 km<sup>2</sup>) with 21 districts and one urban center. According to the preliminary census results in 2022, the city's permanent population is 9,166,800 people, and with temporary population included, rises to about 14 million (HCMC Statistics Dept., 2023). According to a report by the Department of Agriculture and Rural Development of Ho Chi Minh City (2022), the entire city has 113,634 hectares of agricultural land, accounting for 54.23% of the total land area. The main crops encompass vegetables, flowers and ornamental plants (accounting for about 5.6% - 6,317 hectares).

HCMC is a prospering city. The average income per capita increased from 58.1 million VND/year in 2014 to 53.6 million VND/year in 2022, making the city one of the wealthiest in Vietnam (HCMC Statistics Dept. 2023). According to census data, in 2022, there were 39,381 poor and near-poor households, accounting for 1.55% of the total households (HCMC Statistics Department 2023). The city constitutes a center of economic activity, culture, training and education, and science and technology, and is the largest focal point for international exchange and integration in the country. Benefitting from burgeoning and diverse business and education sectors (six academies and 50 universities) the city has great potential in technology, management, and international cooperation. The city's leaders are determined to exploit this potential to achieve sustainable development and have affirmed a commitment to developing a green economy, decreasing waste, and reducing greenhouse gas emissions by encouraging low carbon solutions and the development of circular economic models for integrated and efficient use of outputs from production processes.

Despite economic growth and technological potential, HCMC is not immune to the challenges to food security. A rapidly growing population and the constant influx of rural migrants together with climate change impacts place multiple pressures on agricultural land area and productivity. The city is committed to supporting urban agriculture to enhance food security and food safety, integrate lessons from the Covid-19 pandemic into supply chain management, and respond to climate change, while contributing to a circular and low carbon economy (HCMC People's Committee, 2021a). According to the leader of the Department of Agriculture and Rural Development in HCMC, by 2030, at least 70% of the city's agricultural production area will apply high-technology solutions to increase value, and efficiency of land use, while creating the premise for building a modern, sustainable urban agriculture sector (Xu 2021).

## **2. The transition from traditional to modern agriculture and responding to food security needs in Vietnam and Ho Chi Minh City**

### **2.1 Urban agriculture in Vietnam**

Consequences from the COVID-19 pandemic along with the negative impact of climate change have highlighted the benefits of maintaining a dynamic and creative agriculture sector in the urban context (Langemeyer et al. 2021). In Vietnam, there is a range of popular urban agriculture models to build on. Vu (2022) summarizes the most common types as follows:

(i) Subsistence agriculture: developed due to the need to produce and consume fresh fruits and vegetables by households in most urban areas.

(ii) High technology agriculture: located in urban fringe areas or large cities, capable of producing large agricultural output with high quality and ability to serve large markets, including some capacity for export. Examples of high-technology agriculture that provides for urban consumption needs and contributes select agricultural products for export can be found in Hanoi, Ho Chi Minh City, Da Nang and Can Tho.

(iii) Protective agriculture: popular in industrial urban areas such as Bien Hoa, Viet Tri, and Dung Quat with a significant increase in tree cover for environmental protection.

(iv) Agriculture for tourism: transformed towards producing products to serve the needs of the tourism and hospitality sector (vegetables, flowers, ornamental plants, specialty aquaculture, etc.). This is prominent in cities such as Ha Long, Do Son, Da Lat, Nha Trang, Vung Tau that attract a lot of tourism.

(v) Ecological agriculture: this is a general trend for modern agricultural development that is environmentally friendly, aspiring to an ecological balance.

Having recently joined the group of middle-income countries, Vietnam remains focused on promoting economic growth while striving for synergies in technical, socio-economic, and ecological aspects of development. Policies such as Viet Nam's Socio-Economic Development Strategy (2021-2030) and Socio-Economic Development Plan (2021-2025) place emphasis on innovation, improved labor productivity, scientific and technological advances, improved quality of human resources, promotion of comparative advantages, and proactive international integration.

The 4th Industrial Revolution, with breakthroughs in technology, especially digital technology, responds directly to the above aspirations and has spurred a growing trend for high-technology agriculture engaging both digital and analogue solutions to optimize the production system (Hosseinifarhangi et al., 2019). Digital technology solutions aimed at optimization

of inputs and technology aided monitoring of risks can be environmentally sustainable and yield superior productivity compared to traditional production methods (Ibidem).

Vietnam is among the ten countries most impacted by climate change globally and agriculture constitutes its most vulnerable sector (UNDP, 2022). Solutions that contribute to resilience, adaptation and sustained and growing productivity and quality of agricultural products are seen as crucial and actively sought for in efforts to meet SDG 2 Targets. In fact, in the last five years, science and technology have contributed about 30–35% to the growth value of agriculture in Vietnam (Ngoc 2023). The adoption of high-technology solutions informed by scientific research is therefore considered a necessary step to ensure food security.

## **2.2 Lessons learned and motivations for expanding urban agriculture and high-technology farming in Ho Chi Minh City**

A key issue for urban food security in HCMC is the high in-migration and the attendant need for housing and infrastructure, which reduce the area of agricultural land while simultaneously growing demand. According to statistics from the United Nations Population Fund (UNFPA), rural migrants presently account for a third of the population of HCMC and there is no end in sight for this trend (Government of the Socialist Republic of Vietnam 2011). Between 2010 and 2015, productive agricultural area decreased by an average of 700 ha per year and this accelerated to 1,000 ha per year to 2020 (HCMC People's Committee 2021b; Department of Agriculture and Rural Development 2020). Presently, HCMC's agricultural production capacity falls significantly below demand (HCMC People's Committee 2022). Even its most productive sector of vegetables and flowers is only able to supply 28% of demand (Table 1; Xuan 2021). In addition to the reduced agricultural land fund, fragmentation of the current production scale and the prevalence of traditional farming practices contribute to this. The area presently under so-called high-technology farming accounts only for about 0.44% (500 hectares) of the total agricultural land area (Department of Agriculture and Rural Development of Ho Chi Minh City 2022). There is an evident need for consolidation of production areas, application of high-technology solutions that support large scale consistent production capacity and access to trained workers. In addition, there is a need to deal with epidemics and crop losses associated with climate change impacts.

TABLE 1 HERE

Accordingly, by 2030, the city aims to increase the supply capacity of all types of food by 15% from 2020 (Department of Agriculture and Rural Development of HCMC, 2021). By 2045, the agriculture should constitute a modern economic sector, characterized by technologically advanced processes at every stage of the supply chain from production, processing, and preservation to market connectivity (Department of Agriculture and Rural Development of HCMC, 2022). But realizing this aspiration requires a change in thinking in agricultural production, with transformation of the crop-animal structure in accordance with the circular economy model to promote local food and urban food self-sufficiency. There are signs that this change is already beginning as the rapid urbanization and climate change impacts are causing a reluctance to invest in traditional agricultural production. Moreover, the young, qualified workforce is attracted to the industry and services sectors, leading to increased labor shortages in agriculture. This provides a push for new solutions to develop urban agriculture to adapt to climate change and create jobs and a source of stable income for urban residents.

Research evidences high willingness to adopt technological solutions among urban food growers. A survey of urban growers in Ho Chi Minh City by To (2023) found that 97.63% of agricultural households agreed that biotechnology must be applied in breeding and seed

selection, 96.83% of households supported a stronger focus on farming and animal husbandry techniques, 97.10% of households agreed to promote the application of high-technology machinery in production in general. Besides, 95.25% of surveyed urban agricultural businesses requested the application of technology in work management, and 93.67% expressed need for technological improvements in harvesting and post-harvest preservation (Vu, 2022).

The above findings point to good potential in meeting SDG Target 2.3: increase labor productivity and income of agricultural sectors. An increase in high-technology production that is able to grow productivity and counter the loss of agricultural land can also help address Target 2.1: access to safe and nutritious food for all. But the shift towards high-technology solutions must not happen at the expense of food safety. To this end, the Ho Chi Minh City Food Safety Management Board was established in 2016, with the goal of establishing a uniform process for food safety management, improving coordination mechanisms, and enhancing the effectiveness of food safety standards through regular inspections and fines for non-compliance (Government, 2017; Food Safety Management Board of Ho Chi Minh city, 2020).

### **3. Community awareness and criteria for sustainable urban agriculture models for the context of Ho Chi Minh City**

This section reports on research findings from the Urban resilience from agriculture - project by Van Lang University. A key aim of the project was to engage university and school teachers and students, and local farmers and farming businesses to address gaps in awareness, knowledge and skills pertaining to urban agriculture within communities (Gulyas and Edmondson, 2021) and to develop workable urban agriculture models for HCMC.

During the project, a trial greenhouse was constructed on the University campus, containing a vertical agriculture model with a range of vegetable crops grown over a 2-year duration. The aim was to test productivity and sustainability criteria of selected crops in across a range of models (Table 3). Additionally, surveys, interviews and workshops were undertaken with residents and growers across both central and suburban districts of HCMC to gauge awareness of urban agriculture, uptake and attitudes towards high-technology solutions in agricultural production, and needs and expectations of growers and residents for a suitable urban agriculture model in the city (Table 2).

To further improve awareness and acceptance of automated urban agriculture, the project included an awareness raising and education program through which academics from Van Lang University shared project findings with agricultural business managers and employees of various administrative bodies such as the Vietnam Fatherland Front Central Committee, environmental resources department, women's organizations, and training and education department. In early 2023, an education program on vertical gardening and urban agriculture was also provided to thousands of students and teachers in a number of high and middle schools in the city and neighboring localities. The following subsections set out the key findings from this research and knowledge transfer.

#### **3.1 Community awareness of urban agriculture and implications for expansion**

Findings from the survey of 300 residents in HCMC demonstrate that city dwellers are increasingly concerned about food quality, their health, and their living environment. Surveys undertaken in the central Binh Thanh and Go Vap Districts in Ho Chi Minh City show that living in townhouses decorated with green plants, creates a feeling of closeness to nature and is favored by the majority of the surveyed urban residents. Here, "urban garden" refers to a type of growing system which urban residents can take advantage of to grow vegetables and

flowers in a range of possible locations within urban dwellings (see section 4.2). Survey results also evidence that there is high willingness among households to establish such urban gardens and that there is wide-spread willingness to apply technology to production. More than 90% of survey respondents expressed the wish to adopt urban gardens and more than 99% of perceived the application of "vertical garden technology" and "soilless culture" as an inevitable trend. Table 2. elaborates on survey findings among residents.

#### TABLES 2 AND 3 HERE

The findings from the trial greenhouse yielded positive results for both the productivity and CO<sub>2</sub> absorption capacity of vertical gardens (Table 3, Vu & at al., 2023). The tested model was designed to be suitable for urban gardens in city centers and for households with terraces, balconies or skylights. In addition to providing fresh vegetables, this garden model not only improves the look of urban dwellings but also benefits the ecological environment by the carbon fixation ability of the fresh vegetable cover (Vu, 2023).

Findings from a survey of farming businesses (cooperatives, cooperative alliances and individual farm enterprises) in suburban areas show that more than 90% of the surveyed businesses already apply technology to agricultural production, including large-scale high-tech agriculture systems. There is every reason to expect this investment in high-technology solutions in the urban fringe to expand as the Department of Agriculture and Rural Development has recently started collaborating with relevant urban districts to incentivize the restructuring of urban agriculture at local scale to address fragmentation and production capacity in the period 2022–2025 in line with the city's strategic vision for agriculture to 2050 (Department of Agriculture and Rural Development of HCMC, 2021; HCMC People's Committee 2021c; HCMC People's Committee 2021d).

### 3.2 Deriving criteria for viable urban agriculture models

The research findings together with evidence of the current situation in regard to urban agricultural capacity, technologies and demand were collated for discussion in workshops with experts, researchers, and business managers. The aim of the workshops was to identify and evaluate issues related to urban agricultural development based on three aspects: economics, society, and environment. The outcomes the discussions were used to construct a set of criteria for a sustainable urban agriculture model fit for Ho Chi Minh City to align with the HCMC People's Committee's vision for the development of urban agriculture in the city to 2050 (HCMC People's Committee 2021d). The following criteria were proposed:

(1) Ability to meet the consumption needs of urban residents for fresh food with better quality and price than products produced in other localities (green vegetables, meat, eggs, milk, fresh seafood, etc.).

(2) Suitability for urban architecture and includes green space, a modern and civilized urban and rural landscape, a reduction of greenhouse gas emissions, and activities associated with tourism.

(3) Maximization of the effective use of space, land, labor, and products suitable for small and medium-scale production, as well as the specific conditions of the region.

(4) Ability to contribute to preserving, restoring, and developing typical and indigenous plant and animal breeds and providing new high-quality varieties to the city market and other localities throughout the country.

(5) Alignment with a circular agricultural economic model (using raw materials, fuel, by-products, and organic waste on site to recycle products for environmentally friendly agriculture)

(6) Ability to create new sources of income, to help stabilize and improve the quality of life, and satisfy the increasing enjoyment needs of modern, civilized urban and rural populations.

(7) Product creation model applying advanced and modern techniques, technology and production processes, promoting the advantages and central role in science, technology and market of large urban areas, creating competitiveness.

(8) Ability to create linkage and cooperation in production, processing and connecting consumption markets in the city, domestically and for export.

(9) High capacity for adaptation to climate change and crops and livestock diseases.

#### **4. Recommendations for urban agriculture models in Ho Chi Minh City**

Based on the findings from the Urban resilience from agriculture -project, and what we learned from experiences from high-technology agricultural models from other countries (Israel, China, Japan, etc.), we propose two distinct types of urban agriculture for HCMC.

(1) In central regions (highly urbanized areas), small and medium-scale farming models serving mainly local needs for vegetables, flowers, ornamental plants, ornamental fish, and pets should be applied.

(2) In suburban areas, depending on the conditions of terrain, land, space, and building architecture in each area, the following agricultural production models that can be applied at larger scale and serve both local and export demand appear appropriate: (i) growing vegetables, mushrooms, and flowers, orchids, apricot trees, ornamental plants (ornamental leaves, bushes, etc.), and urban plants; (ii) growing fruit trees and perennial industrial trees; (iii) afforestation and agro-forestry production associated with eco-tourism; (iv) raising high-quality beef cattle and breeding cattle; (v) high-yield dairy cow farming (vi) farms raising high-quality pigs and breeding pigs; (vii) high-quality aquaculture model; (viii) ornamental fish farming; and (ix) clean salt production.

##### **4.1. Introducing high-tech agriculture in inner city areas**

The agricultural land-area of the inner-city districts of HCMC is modest and highly fragmented (2,526 hectares, accounting for about 11% of the total agricultural area of the city; HCMC Statistics Department 2019; 2023). Therefore, a feasible and advisable solution would be to supplement the existing mostly traditional urban agriculture (Fig.3) with vertical gardens (Fig1 and 2) to make the most of the available space (Vu, 2022-2023). Vertical growing systems are suited for growing most leafy vegetables, spices, and medicinal herbs to meet the growing demand for safe vegetables in the city, especially premium vegetables and high-quality vegetables for restaurants, hotels and other hospitality companies in the city. A broad adoption of vertical gardens in inner city areas could make a notable contribution to reaching the SDG2 targets that Vietnamese cities are presently struggling to meet.

FIGURE 1 HERE



## **4.2. Existing and new production models in suburban areas**

### **a. Vegetable farming**

Large-scale vegetable production is concentrated mainly in the three suburban districts of Cu Chi, Hoc Mon, and Binh Chanh and account for about 89% (18,624ha) of the entire city's vegetable growing area (HCMC Statistics Department 2019; 2023). This type of vegetable production has good potential to contribute to significantly to urban food security and the achievement of several SDG2 targets. The three suburban districts are able to accommodate a concentrated system of large-scale vegetable production in greenhouses or open air, depending on the plant species and output quality standards for each type of product. The common factor of these different production models should be the application of smart irrigation systems (Fig.3) and precision control of input materials (seeds, fertilizers, and pesticides) in accordance with Good Agricultural Practice (GAP), organic production standards, Good Manufacturing Practice (GMP) or equivalent, depending on the registration of the relevant cooperative or farming business. All enterprises participating in this large-scale production model should apply advanced technological solutions at every stage of the supply chain from production, processing, and preservation to market connectivity, and should function in a coordinated manner to ensure stability of supply.

FIGURES 2a and 2b HERE

### **b. Production of flowers, ornamental plants and urban trees**

While this type of urban agriculture does not have relevance for urban food security, it has good potential to enhance agricultural income (SDG Target 2.2). Tree cover and the production of flowers and ornamental plants also aligns with the HCMC's efforts to improve the urban environment, provide ecological benefits (for biodiversity and climate mitigation and adaptation) and to improve the attractiveness of the city to tourists. Therefore, taking advantage of land and market potential and scientific and technological potential, especially in biotechnology, to promote the production of flower varieties (orchids, apricot flowers), ornamental plants, and urban trees is highly advisable. This is a sector that can achieve significant economic value from meeting the demand from the city's urban landscape development as well as export markets. Presently, the production area of flowers, ornamental plants is concentrated in Cu Chi, Binh Chanh, and Hoc Mon, and is estimated to cover about 2,250 ha (HCMC Statistics Department 2019; 2023). Of this, orchid production accounts for 300 hectares, ornamental plants for 850 ha and apricot and other urban trees 550 ha each. Much of the orchid production already relies on high-technology solutions in breeding and production (Fig4) and has brought in an average revenue of \$800 million to \$1.2 billion per year (Government 2018).

FIGURE 3 HERE

### **c. Fruit trees and long-term industrial trees**

HCMC has well-established fruit tree production spanning approximately 8,000 hectares (HCMC Statistics Department 2019; 2023). The key tree species are rambutan, longan, mangosteen, and durian, concentrated along the Saigon River in Cu Chi district and Thu Duc city. Mangoes are concentrated in Giong Cat in Can Gio district on alluvial soils along rivers

and canals. Citrus trees (grapefruit, lemon, orange, tangerine), guava, Siamese coconut are concentrated in the alum soil area in Binh Chanh district. An example of the application of high-technology solutions in this sector is the development of tissue culture bananas is concentrated in large-scale planting areas in Cu Chi district (HCMC Party Committee, 2020). Developing and maintaining this type of agricultural production supports both the food security, income and environmental targets of SDG 2.

#### **d. Models of afforestation and combined agro-forestry production associated with eco-tourism**

HCMC is determined to maintain the existing 33,372.44 ha of woodland as this supports the city's aspiration of functioning as an eco-tourism center for the country (HCMC Statistics Department 2019; 2023). Due to the varied landscape of the city integrating a river system, there is scope industrial timber production, agro-forestry and aquatic production such as fisheries. Digitally aided aquatic production has good potential to aid progress in access to safe and nutritious food for all (SDG2.1) and increasing income for farmers (SDG2.3), and can also contribute to the establishment of a circular agricultural economy in urban areas.

#### **e. Animal husbandry**

HCMC is home to the Dairy Cow Company and industrial-scale pig and chicken companies (HCMC Statistics Department 2019; 2023). Although it is not a particular strength, the livestock sector is nevertheless important for all of the SDG 2 targets in urban areas. The production of high-quality animals, meat, eggs, and milk, should be coupled with the establishment of local slaughterhouses and the provision of insurance cover to ensure biosecurity and food hygiene. Here, international collaborations should support the gradual modernization of production technologies and the supply chain. HCMC should maintain its role as a center providing high-yield dairy and beef cattle breeds, and high-quality pork breeds. It should develop poultry herds on an industrial scale, especially egg-laying chickens and nurture cooperation across all sectors of livestock production to ensure safe and stable supply of fresh meat, eggs and dairy products.

### **5. Conclusions**

This chapter evidences the broad scope of urban agriculture present in Ho Chi Minh City and the city's strong position in applying high-technology solutions to urban agricultural production. With the potential vested in the city's natural conditions and human resources, along with favorable credit policies, access to scientific research, and international trade connections, we are confident that the city will be able to further develop urban agriculture that meets the need for nutrition among the growing population. Adopting and enhancing the range of high-technology supported urban agriculture models can improve food self-sufficiency and food security, increasing access to fresh foods among poor and marginalized households and augmenting agricultural productivity and incomes, thereby responding to the targets of SDG 2 that Vietnam is still struggling to meet. Moreover, nurturing existing non-food related agricultural production is not to be overlooked as it has important potential to enhance and diversify agricultural income, and aligns with the city's aspirations pertaining to urban greening and eco-tourism.

The Urban resilience from agriculture -project demonstrated the scope for collaboration between growers, schools and universities in furthering the adoption of high-technology

agricultural solutions in the urban context. Research findings and stakeholder perspectives were brought together in workshops to derive criteria for viable and sustainable production models to align with existing policy goals. The criteria emphasize the importance of considering local conditions, both the nature and architecture of the area when expanding production. In the urban center, vertical garden solutions can be applied for either small scale subsistence production or at larger scale to support access to safe and nutritious food for all (SDG Target 2.1 and 2.2) and to serve the needs of the hospitality sector. In suburban areas, larger scale high-technology reliant models have potential to raise both productivity and income (Target 2.3) and increase sustainable food production that helps maintain ecosystems, and enhances resilience to climate change and other disasters (Target 2.4).

To sum up, agricultural production models should be encouraged to develop according to the principle of circular agricultural economy, applying appropriate types of technology to make the most of urban space as well as creating safe and high-quality agricultural products, ensuring food security, and positively impacting the ecological and socio-economic environment. Van Lang University, in collaboration with local growers, has demonstrated that there is good scope for augmenting the uptake of high-technology solutions in all agricultural production sectors in HCMC and that the general attitude towards urban agriculture among residents is positive.

### **Acknowledgements:**

This work was supported by the British Council's Going Global Partnerships grant from the call for UK-Viet Nam Partnerships for Quality and Internationalization (Grant ID GGPVN 3.6) led by Middlesex University (UK) and Van Lang University (VN). Quyen Vu Thi, would like to thank Van Lang University, Vietnam for funding this work and to give many thanks to my lovely students: Le Minh Hieu, Nguyen Vu Huong Giang, Le Hoang Khoi and Doan HuyenTrang for help with surveys for urban residents and for taking care of plants in the trial greenhouse.

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**Tables:**

<b>Sector</b>	<b>Capacity to meet demand (%)</b>
Vegetables	28%
Live pigs	11%
Live cattle	19.7%
Seafood	14%
Poultry	1.2%

**Table 1:** Ability of urban agriculture to meet demand in HCMC (data from Xuan 2021)

<b>Summary of questions/answers</b>	<b>Percentage of households answering that agree with the statement of the given question (%)</b>		
	<b>2020</b>	<b>2022</b>	<b>2023</b>
Gardening helps connect people with nature and helps family members become closer	65	89	93
The vertical street garden model (wall garden) is suitable for most housing types in urban areas	71	96	95
Urban gardening should apply automatic irrigation technology to help reduce labor and save irrigation water	89	92	93
Gardening helps improve health and connect neighbors emotionally (thanks to exchanging vegetables and fresh food).	60	87	91
Gardening helps beautify the house, increase real estate value and minimize the negative effects of climate change	80	98	100
Urban residents have easy access to technology and gardening techniques thanks to the media and the attention of educational institutions.	50	89	91
Vertical gardens and walled garden technology have been known and applied by urban people	27	69	90

**Table 2.** Urban residents' perceptions regarding urban gardens (data from Vu & et al. 2023)

<b>Species</b>	<b>Vegetable biomass (kg/m<sup>2</sup>)</b>	<b>CO<sub>2</sub> absorption capacity of the plant (kg/m<sup>2</sup>)</b>
Green mustard	27.9 - 30.4	48.0 - 52.4
Bok choy	33.0 - 34.2	56.7 - 59.0
Brassica juncea	30.1 - 35.4	51.9 - 61.1
Butterhead lettuce	22.3 - 22.7	38.47 - 39.1
Purple lettuce	21.4 - 23.6	36.8 - 40.7

**Table 3.** Biomass productivity and CO<sub>2</sub> absorption capacity of produce grown in the trial greenhouse (data from Vu & et al. 2023)

**Figures:**



**Figure 1.** Vegetable plants grown on the terrace/ rooftop garden (copyright: Q. Vu Thi)





**Figure 2a.** High-technology supported urban agriculture in the suburbs (copyright: M. Juntti)



**Figure 2b.** Traditional urban agriculture in the suburbs (copyright: Q. Vu Thi)



**Figure 3.** Orchid farming (copyright: Q. Vu Thi)