



China's Adaptation to Urban Agriculture for Sustainable Food Supply: Case Studies and Policy Implications

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Abstract. China's large demand for agricultural produce has increasingly placed more pressure on its agricultural sector which is only exacerbated by the nation's limited arable land. Due to this, the nation has turned to unsustainable farming practices, specifically an overuse of fertilizers and pesticides, to meet its agricultural needs. A bulk of China's agriculture goes to the nation's cities and urban areas, which have increased due to rapid urbanization. urban agriculture is already present throughout Asian cities in two forms: Intra-urban agriculture is conducted within dense urban centers, in locations such as rooftops. peri-urban agriculture is farming done in the less populated regions surrounding urban centers often with more land. This paper conducts case analysis for four cities, each city presents a unique example of the conditions of success for urban agriculture. Shanghai demonstrates the impact and significance of sufficient funding in ensuring the success of urban agriculture. Tokyo provides an example of government policy supporting and fostering successful intra-urban agriculture. Robust peri-urban agriculture in Beijing shows that peri-urban agriculture can be used effectively to produce large amounts of produce around even the largest cities. Finally, Singapore shows that despite challenges with limited farmland innovative technology paired with effective utilization of vertical space can allow intra-urban agriculture to thrive even in the densest urban environments. To conclude, support from specific government policies, funding for technology advancement, and a robust combination of peri- and intra-urban agriculture should be used to allow urban agriculture to thrive within China's cities and combat its agricultural challenges.

Keywords: Urban agriculture, Sustainability, Agriculture, Public policy, Urban Studies, Case analysis

1 Introduction

China has held a strong tradition of agriculture which continues to today. Boasting the world's second largest population of a staggering 1.412 billion means lots of mouths to feed [1]. China accomplishes this by producing one fourth of the world's grain as well as leading the globe in the production of many other food products such as cereals and fruit. This feat is even more impressive when considering that China contains only

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L. Shi et al. (eds.), *Proceedings of the 4th International Conference on Public Administration, Health and Humanity Development (PAHHD 2024)*, Advances in Social Science, Education and Humanities Research 868, https://doi.org/10.2991/978-2-38476-295-8_10

around 9% of the globe's arable land [2]. Not only does China boast the world's largest population but the nation also contains some of the most populated cities in the world with 18 cities reaching populations of over 5 million [3]. China's urbanization reflects its rapid economic growth and urbanization. Currently, it is estimated that 45% of Chinese live in rural villages and engage in agriculturally based lifestyles, 40 years ago, it was 80% [4, p. 406-424]. This change illustrates China's shift from an agricultural society to an industrialized nation. Building on this change Chinese cities have grown at shocking rates which only leads to more demand for food. In addition to urbanization, China's industrialization has also caused numerous environmental challenges. Most notable is a sharp increase in air pollution from 35 micrograms of PM2.5 per cubic meter in the late 1990s to 50 in 2006 [5, p. 230-231].

The foremost issue with China's current agricultural practices is the abuse of pesticides and fertilizer, which causes a sustainability crisis. Studies have shown that China itself uses 30 percent of the world's pesticides and fertilizers on only 9 percent of the world's arable land [6]. This is a direct result of China's staggering population and the pressure to feed the nation. This practice along with over farming has led to a decrease in China's arable land through the form of desertification. Both factors have led to almost a 6% decrease in China's total arable land in the past decade [7]. This trend is projected to be more severe as China's continued economic and urban growth places even more pressure on the nation's agricultural sector. Apart from unsustainable agricultural practices China's ongoing environmental problems are also affecting the country's agriculture. Air pollution alone in China is estimated to have decreased crop yields by around 25% to 15 % [8].

1.1 Current Policies/Solutions for Sustainable Agriculture

China has attempted to set goals and regulations to combat the agricultural crisis. For example, the Green Wall project, dating back to 1978, seeks to stop the spread of desertification and preserve China's limited land [9]. The project aims to use the planting of trees to stabilize the soils and dunes, and the Green Wall is projected to be finished in 2050 [9]. The government has also set many goals regarding pesticide and fertilizer use. The farm ministry, for example, has set goals to decrease pesticide use by one tenth before 2025 [10]. These goals, however, fail to provide an actual solution to the ongoing issues. For example, China has also set plans to develop biopesticides by 2050 in hopes of replacing the harmful pesticides that are being used today [11]. This plan, although ambitious, does not help solve China's issues right now, nor will it effectively spread throughout rural China. The main issue remains that China has a population that is too large and only a small dwindling amount of farmland. The only way to combat this is to take pressure off of the current farms in China.

1.2 Urban Agriculture as an Effective/Feasible Solution

Unique problems call for unique solutions - this paper proposes that urban agriculture is the solution to this uniquely Chinese problem. For this paper, urban agriculture refers

to Intra-urban and peri-urban agriculture. Both forms of urban agriculture refer to agriculture in urban areas: Intra-urban agriculture is agriculture that happens within the heart of the city, the densely populated areas of rooftops, and even indoor areas. peri-urban agriculture logically refers to the agriculture that occurs in the suburban area around the city - where the urban city transits into rural land. Both forms of urban agriculture are crucial in this problem, each specifically addressing an aspect of China's agricultural challenge.

Urban agriculture can be an effective solution to China's agricultural struggles. On one hand, urban agriculture could help relieve significant pressure from China's traditional forms of agriculture. This allows less harmful pesticides and fertilizers to be used since some agricultural pressure will be alleviated as cities can produce their own food. Additionally, urban agriculture will create more job opportunities and supply food to cities in a more direct way, which is crucial in the post-pandemic era.

Urban agriculture is not a foreign concept to China. To understand how to implement urban agriculture, this paper first reviews the current application of urban agriculture in China through the two cities of Shanghai and Beijing. These cities can demonstrate the feasibility of urban agriculture throughout China, furthermore studies of foreign cities also provide useful information for urban agriculture in China. As show in figure 1.

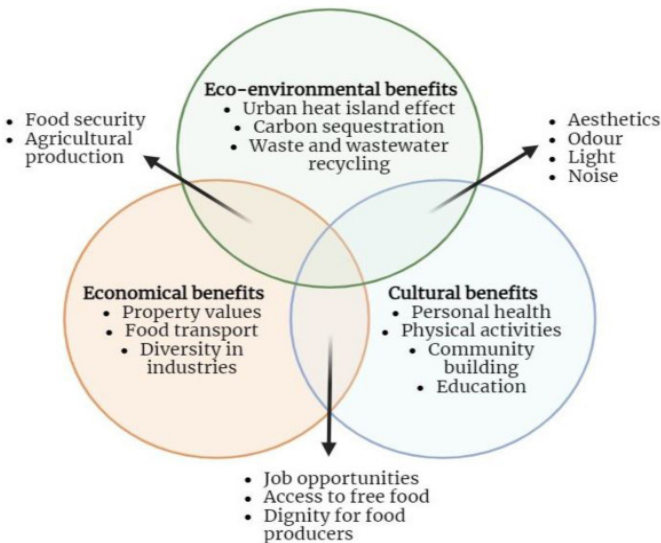


Fig. 1. Benefits of urban agriculture in China [12]

2 Research Question

The primary issue with China's current agriculture is centered around the abuse of fertilizers as well as pesticides. This is mainly attributed to the high demand for agriculture with limited amounts of arable land. Urban agriculture can be an effective solution for

this however in many cities Urban agriculture is not properly utilized or implemented. Therefore, this paper aims to answer the following research question: What are the necessary policies and steps that China needs to effectively implement urban agriculture into its cities to combat the nation's current agricultural issues?

3 Methodology

To answer the research question and learn how Urban agriculture can be successfully implemented into China, this paper examines four successful examples as case studies and compare these cases on implication of urban agriculture practices in most cities in China. Specifically, the four cities are: Shanghai, Tokyo, Beijing and Singapore.

Looking at each city as an example of urban agriculture, this paper then concludes the effective policies and practices that contribute to sustainable urban agriculture. Although the application of these policies and practices may be difficult and require significant effort from many stakeholders, the current examples of successful urban agriculture do provide references on its feasibility in most Chinese cities.

4 Case Analysis

This section focuses on the analysis of four cities with successful implementation of urban agriculture. For each case, I evaluate the process, policies and effectiveness that each city employs for urban agriculture. Table 1 compares the main differences between the four cities that the case study analysis were done on, focusing on their urban agriculture.

Table 1. Comparison of the Four Cities [13]

City	Population (millions)	Forms of UA	Advantages
Shanghai	29.87	Intra + Peri	Use of both forms of urban agriculture, economic investment into urban agriculture
Beijing	22.19	Peri	Strong example of Peri-Urban agriculture utilizing land around the city
Tokyo	37.12	Intra	Government policies that allow for successful farmland within cities for Intra-urban agriculture
Singapore	6.12	Intra	Use of technology and vertical farming strategies to have Intra-urban agriculture with limited space

4.1 Limitation and Delimitation

A limitation of this paper is that the comparison of the cities and analysis focus mainly on government policy and action. Urban agriculture can be much more complex and include many stakeholders. However, this paper considers government policy as a main factor in determining the success and implementation of urban agriculture. Thus, this

paper focusses mainly on the stakeholders of city governments in their actions in creating policy, some other factors are not considered throughout this research.

4.2 Shanghai

In Shanghai, China's most populous city, both Intra-urban and peri-urban agricultural practices exist. The municipal government of Shanghai reports that the city already produces more than 55% of its vegetables and 90% of its green leaf vegetables. This is primarily attributed to peri-urban agriculture, a green ring around the city that is used as an agricultural zone [14]. This is accomplished through a large increase in investment into agriculture over the past two decades [14]. This example of peri-urban agriculture's success in Shanghai can be a model for other large cities in China and shows the potential impact of investment into urban agriculture. At the same time as being an example of successful peri-urban agriculture, Shanghai also has many residents participating in Intra-urban agriculture. An important distinction to make in the case of Shanghai is that both forms of urban agriculture were used in conjunction to achieve such levels of success. This should prove as an example to other cities that it is not only feasible to use both forms of urban agriculture, but that it is also beneficial.

4.3 Beijing

A strong example of peri-urban agriculture already exists within China in the capital, Beijing. Beijing utilizes large amounts of land surrounding the urban city for agriculture. Currently, there are around 200 hectares of land around the city being used for peri-urban agriculture [15]. peri-urban agriculture has been implemented into the Chinese city through the government as well as private companies [16, p. 1-3].

The effectiveness of urban agriculture in Beijing is incredibly significant. For instance, a study demonstrated that even just 0.2 square meters of urban gardening could yield 100 kg of vegetables annually [16, p.1-3]. This demonstrates that the peri-urban agriculture within Beijing can produce large amounts of produce from the city and in combination with the large amounts of farmland available around the large city peri-urban agriculture has proven to be very effective in Beijing.

Applying this to other Chinese cities, especially larger cities like Beijing peri-urban agriculture can be very effective when implemented correctly. Often peri-urban agriculture is neglected, and more focus is placed on Intra-urban agriculture, yet the example of Beijing illustrates the importance of also placing emphasis on peri-urban agriculture due to its potential in producing large amounts of produce for a city.

4.4 Tokyo

The urban agriculture of Japan, specifically in Tokyo, demonstrates the importance of government support. There are many similarities that can be found between Shanghai and China. To begin, both nations rely largely on rice being the staple crop and grow wheat and soybeans [17, p. 121-151]. Additionally, both nations have a limited amount of farmland in proportion to the countries' own respective population [17, p. 121-151].

Being in a similar geographical location both nations have similar climates to explain the common crops. This similarity allows for the urban agriculture of Japan to be easily applied in Chinese cities.

urban agriculture is also present and a major contributor to agricultural production in Japan. This is more directly shown through Tokyo's Urban Agricultural output can feed up to 700,000 thousand households [18]. This staggering statistic demonstrated the success of the implication of urban agriculture in Japan. Not only does urban agriculture generate food, it enhances urban areas within cities as well. In large cities such as Tokyo, urban agriculture serves as green space within the concrete jungle. This success of urban agriculture can largely be attributed to government support and policies passed to support such agricultural practices. In Tokyo for example the government passed the "Law on Productive Green Areas", which played a crucial role in preserving land within cities for urban agriculture [19].

While urban agriculture is also present in China its effectiveness is a stark contrast to Japan. Chinese cities, despite in many ways being similar to Japanese ones, have yet to fully embrace urban agriculture on a large enough scale. As mentioned before, a primary cause of this is the level of government support in China. City governments within China typically are not involved with passing policies or supporting urban agriculture efforts - instead most urban agriculture in China is performed privately.

Understanding the current situation and place that urban agriculture holds in China as well as the example of Tokyo, it is evident that Government support is essential to Urban Agriculture. The example of Tokyo suggests that Chinese city government should actively pass policies and legislature that facilitates urban agriculture such as Tokyo's "Law on Productive Green Areas". Support also comes in the form of setting aside land within the city in the urban centers that can be used for Intra-urban agriculture. Government support is the essential factor in ensuring the success and impact of Intra-urban agriculture. Governmental policies such as financial incentives or reforms that create the infrastructure for Intra-urban agriculture are keys.

4.5 Singapore

The final example of successful urban agriculture within a city is Singapore (which can be considered as a nation but also a city). Similarly, to many Chinese cities, Singapore is an incredibly densely populated city with a large demand for produce. Having very limited access to land for agriculture, Singapore has traditionally turned to importing most of its produce [20]. Recently however, there has been a shift towards urban agriculture done in a creative way for the urban city.

In Singapore, the government has already set the goal of producing 30% of its own agriculture by 2030 [20]. To achieve this goal, the city has taken innovative ways to implement Intra-urban agriculture, this is done through a vertical model choosing to expand upwards to create farmland [21]. In combination with the public government and private companies, Singapore is currently implementing vertical farms onto rooftops. There has already been 260 of small vertical farms installed in Singapore, they are able to provide for restaurants and be shipped to local households as well.

Singapore's use of innovative technology to support urban agriculture as well as government collaboration by incorporating the vertical farms into the city's infrastructure provides an example for China. Urban agriculture, specifically Intra-urban agriculture can be especially effective if integrated into a cityscape. This can most easily be done in developing cities but as Singapore demonstrate can also be incorporated into established large cities.

5 Discussion

The four case studies done on Shanghai, Tokyo, Beijing and Singapore support urban agriculture as an effective and applicable solution to China's agricultural issues. Centering around governmental policy in multiple ways, all four cities' individual success lay out an example for how urban agriculture can be implemented throughout Chinese urban areas. Primarily all four cities solidify one key point: the national and city governments must take an active stance to pass policies that support urban agriculture for it to be conducted at a significant scale. Most directly this can be seen through Tokyo, in which one key piece of legislation allows urban agriculture to thrive within the city. Government support also needs to include monetary support and investment into urban agriculture. Shanghai can contribute much of its agricultural success to recent investments made towards urban agriculture.

Some other key points of government support concluded from the case studies include: Investment into new technologies such as aquaponics and vertical farming techniques as outlined by Singapore. Use of both forms of Intra and Peri-urban agriculture in conjunction as combining both have significant results and success. Following these steps, many cities in China can successfully implement urban agriculture.

The case studies conducted also serve as evidence that urban agriculture will be an effective solution to help alleviate China's food sustainability issues. Especially through the two Chinese cities, Beijing and Shanghai, urban agriculture produces a significant portion of a city's food demand. Paired with other strategies outlined such as better policies, the city governments will only increase the efficiency and output of urban agriculture, allowing them to become more self-sufficient. Utilizing urban land that was previously untapped lessens the amount of produce needed to be made by China's more traditional farms that previously relied on overusing fertilizers.

6 Conclusion

The four case studies done on Shanghai, Tokyo, Beijing and Singapore provide insight to how urban agriculture should be implemented in China. The success of Tokyo suggests that strong government involvement including new policies should be enacted to protect and facilitate urban agriculture. Meanwhile, Singapore shows the importance of technology to assist urban agriculture as well as possibility for successful Intra-urban agriculture even in cramped areas.

An example of a city that would benefit from the policy implications concluded through the case studies is Nanjing. In Nanjing, intra-urban agriculture is the most popular and is often carried out by older working-class individuals who mainly grow vegetables on rooftops and yards [22, p. 291-309]. These practices, however, could be improved to have a larger impact on China's agricultural challenges. The problem with the current practice of intra-urban agriculture in Nanjing is the scale at which it is carried out. Although the practice exists within the city, its scope is limited and fragmented within small communities. This limitation has prevented Intra-urban agriculture from having substantial agricultural production within Nanjing [22, p. 291-309]. Using the example taken from Tokyo's increased government support would allow intra-urban agriculture to be conducted on a larger scale with more land set aside from agriculture within the city. Nanjing is one example of how Chinese cities can begin to utilize urban agriculture more as they incorporate the solution proposed.

The effects of urban agriculture expand beyond combating China's unsustainable farming practices. Decreased use of fertilizers and pesticides will result in greater food security for cities as it decreases the risk of poisoning. The closer proximity of farmland also provides cities with higher quality fresh produce that is safe. Additionally, larger scale urban agriculture produces greater job opportunities in cities, particularly in larger agricultural areas around the cities in peri-urban agriculture. These jobs would also contribute to branching the divide between rural and urban China by allowing more rural farmers to migrate to farmland around cities.

One other significant effect will be on food safety in cities. A more direct food supply chain as well as less fertilizer and pesticide use will also increase the quality of food within cities, specifically increasing food safety with pesticide related issues. In Zhejiang alone there were 20097 pesticide poisoning cases between 2006 to 2010. Urban agriculture calls for farms to use less pesticides and emphasizes organic foods. It allows for fresh produce to be present in the market every day and greatly increases the quality of food that residents have in urban areas. This helps largely decrease the risk of pesticide related issues in urban cities. urban agriculture also creates more jobs in urban areas especially for rural migrants, as an example Beijing has already begun to see these effects [23, p.2-6].

As the demand for agriculture grows and arable land dwindles, innovative solutions to combat China's agricultural crisis are needed. Urban agriculture allows more sustainable agricultural practices by utilizing large amounts of untapped land in China's vast urban centers. Through implementation of government policy and new technologies, urban agriculture will be able to provide the fresh produce needed to supply China's cities.

6.1 Future Work

Considering the limitations of my work, future work would include analysis of more statistical information. This paper could benefit if there are publicly available statistical indicators for successful urban agriculture outside of factors such as government policies and monetary investment. For instance, if there are statistics of specific climate and environmental condition in which urban agriculture is most effective as well as specific

crops of effective urban agriculture of the cases, the study could be more comprehensive.

Further research on urban agriculture can also involve more general factors that lead to successful urban agriculture, such as analyzing more cities globally and of more diverse backgrounds including size, wealth, and climate. This would create solutions for other cities to implement urban agriculture outside of China.

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