



**Urban Agriculture, Food Security and Sustainable
Urban Food Systems in China**

Sriram Natrajan

© Institute of Chinese Studies, Delhi

Institute of Chinese Studies,
B-371 (3rd floor), Chittaranjan Park,
Kalkaji, New Delhi - 110 019
Landline Telephone: +91-11-4056 4823 Fax: +91-11-23830728
Email: info@icsin.org
Website: www.icsin.org

ABOUT THE AUTHOR

Sriram Natrajan is an Adjunct Fellow with the Institute of Chinese Studies, New Delhi and an independent researcher. He has engaged with China research for over two decades in the areas of agrarian change, rural transformation, food security, sustainable agriculture and more recently urban agriculture. He has worked as a consultant for the International Labour Office (ILO) on socio-economic security and as a lead consultant for the Food and Agricultural Organisation on improving food security statistics in Asia as part of the Zero-Hunger initiative. He has also guest lectured at Jawaharlal Nehru University and Delhi University besides designing and conducting a post-graduate course on India and the ASEAN at Chulalongkorn University, Bangkok. He is currently collaborating with the UN Urban Economy forum on research initiatives in the field of urban food systems and food security.

Contact: snatrajan@gmail.com

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Abstract

This is an exploratory paper on the re-emergence of urban farming/agriculture (UA) as an important priority in urban food systems and food policy in China. 'Re-emergence' because until about the early 1990s, cities/municipalities were able to meet most if not the entire requirement of fresh food and to some extent grain and livestock produce from within their boundaries. When rapid growth of urban centres in China began to manifest in the form of explosive population growth along with urban built up area, farmland within and around cities declined considerably and increasing amounts of urban food supplies were sourced from the hinterland or distant areas. In the recent decade, with rapid advances in technological capabilities aided by intensive research and development in the field of vertical farming, aquaponics and hydroponics, urban agriculture has become a priority in China's agriculture and food policy.

Keywords

Urban Agriculture, Food Security, China, Sustainable food system

Introduction

Globally, UA has become increasingly popular and assumed greater significance owing to the dire predictions of climate change and potential disruptions to food supplies. Closely related to the unpredictable consequences of climate change other potential factors such as severe soil degradation in large swathes of global farmland, water shortages, disastrous weather events together have increased the risks to sustainability of industrial food systems. The sudden and adverse disruptions to urban food supplies resulting from the ongoing COVID-19 pandemic has further enhanced the importance of local and guaranteed sources of food thereby elevating the status of UA in urban community movements and local planning and governance systems. China faces serious challenges to food security owing to the demographic pressures given limited and diminishing farmland on the one hand along with the adverse effects of climate change and other severe constraints to agricultural resources such as water depletion and soil degradation on the other. UA in China assumes greater significance given this adverse set of conditions than many other countries.

Though UA as a subject and object of research has a relatively short history beginning sometime in the 1990s, Mougeot (1999) traces the origins of UA studies to the 1960s in Central Africa by French geographical accounts. It is significant to note that currently, there are far more numerous UA studies on Africa than on other parts of the world. As regards China, there are just a handful of such studies in English and that seems to be also true in Chinese language (Horowitz and Liu, 2017). However, there is ample evidence of the practice of UA in various forms across many Chinese cities since the turn of the century— rooftop/balcony food gardens, vegetable farming in unused urban spaces, large scale peri-urban agriculture and technology intensive modern vertical farms.

This paper is organized in three parts besides this introduction and some concluding remarks at the end of the paper. The first part provides a background and international context to UA and briefly surveys global development policy on urbanization and UA. The focus in the second part is on the policy significance and practice of urban and peri-urban agriculture (UPA) in China. This includes findings from surveys and studies on intra-urban agriculture and peri-urban agriculture in some of China's large cities. The final part examines China's policy

emphasis on the emerging technology-intensive urban agriculture taking the form of vertical farms, hydroponics and aquaponics to ensure future food security.

1. Urban Agriculture: Background and International Context

Historically, urban agriculture (UA) was an integral part of urban centres wherever cities emerged, only to be displaced or diminished in modern times due to the very growth of cities. Bricas and Conaire (2019) note that until the industrial revolution of the 19th century there was a close link between cities and their food needs. The distance between agriculture (food supply) and the urban space that gradually widened with the advent of modern transportation (more markedly in the industrialized north) further intensified along with the process of globalization at the turn of the 20th century. Smit et. al. (2001) summarizes the historical character of urban agriculture succinctly:

Urban agriculture is a recent phenomenon in only a few places. Throughout the world, there are long traditions of farming intensively within and at the edge of cities. Each tradition is deeply rooted in local concepts of city and community, and in local societal and cultural practices (Chapter 2).

Smit et. al. (2001) is a revised edition of an earlier work¹ and constitutes one of the earliest and comprehensive examination of UA in developing countries from an international development policy perspective and engages with issues of urban food security, ecology, employment and the idea of sustainable cities long before the UN's New Urban Agenda of 2016. The work was an outcome of UNDP supported surveys in 18 countries of Asia, Africa and Latin America in the early 1990s and revealed that the growth of UA accelerated dramatically during the 1980s and the 1990s throughout the world and employing an estimated 800 million people directly or indirectly (urban farmers, figures for 1993 in Table 2.1 chapter 2). However, UA did not receive the attention it deserved then either in the media or in the international development community despite its significance in terms of employment, income generation, food supplies and enhancing the urban living environment.

¹ Jac Smit, Joe Nasr and Annu Ratta compiled the original UNDP (1996) report *Urban Agriculture: Food, Jobs and Sustainable Cities* which was expanded and revised in 2001.

Urban agriculture/farming has been described and defined in many different ways in varying contexts. Smit et. al. (2001, Chapter 1) describe UA as:

...an industry that produces, processes, and markets food, fuel, and other outputs, largely in response to the daily demand of consumers within a town, city, or metropolis, on many types of privately and publicly held land and water bodies found throughout intra-urban and peri-urban areas.

Elaborating further they note that,

Typically urban agriculture applies intensive production methods, frequently using and reusing natural resources and urban wastes, to yield a diverse array of land-, water-, and air-based fauna and flora, contributing to the food security, health, livelihood, and environment of the individual, household, and community.

A more recent volume dedicated to a survey of global urban agriculture uses a similar description as a generic guiding definition (Winkerprins, 2017):

Urban agriculture is the production, processing and marketing of food and related products in urban and peri-urban areas, usually through intensive cultivation and for consumption in the same urban or peri-urban area.

In China *Dongshi Nongye* is the commonly used term for UA and refers mostly to peri-urban farming and although by definition it also includes intra-urban agriculture (farming within the urban boundary) this is neither considered significant nor officially recognized or approved . The official policy focus is exclusively on peri-urban agriculture and technology intensive vertical, hydroponic and aquaponic farms organized in the form of ‘plant factories’. This is owing to their larger scale, higher productivity and value addition and therefore a potentially substantial source of future food supplies.

Besides many definitions and descriptions there are various forms and typologies of UA that are studied across multiple disciplines such as urban geography, urban landscape planning and architecture, demography and migration, economics, sociology, as well as environmental studies. It must also be added that technology intensive vertical farming by itself involves the expertise, research and development of innovative methods and processes by a whole range of scientific and engineering disciplines. While the broad and general description of UA noted here is a useful starting point, the economic, social and political contexts in which it is located along with the forms of practice in which it manifests are important parameters that frame any serious study. Mougeot (1999, page 1) draws attention to other important dimensions of UA -

“Key features of current definitions of UA generally have downplayed a critical trait that makes UA to be urban. UA is different from, and complementary to, rural agriculture in local food systems: urban agriculture is integrated into the local urban economic and ecological system. Unless this dimension is enhanced and made operational, the concept will remain little useful on the scientific, technology and policy fronts.”

There have been numerous studies of UA in the developing world following UNDP (1996) and it is important to note that African cities have received far more scholarly attention than those in Asia and Latin America. A comprehensive survey of urban agriculture studies in low-income countries (Poulsen et. al. 2015) reiterates that UA was/is widespread in several African and Asian countries noting that the factors sustaining this sector are largely the lack of alternative and remunerative employment as also the compulsion to meet household food demands – as a coping and survival strategy. In most cases, urban farming has also been employment and income generating. Despite the low share of UA relative to total food production, its importance in urban informal employment and food security was found to be significant though inadequately addressed in the realm of urban food policy. This study further found that household participation rates in urban agriculture ranged from 11-69 percent in low-income African and Eurasian transition economies.

Thus, in most developing countries of Africa, Asia and Latin America, UA is significant both in meeting food and nutritional requirements as well as a source of livelihood for migrant and

poor residents even though not receiving serious attention in urban development plans and policy. In most cases if not all, UA activities as well as most food distribution (retail) remain part of the informal sector outside the legal framework. Clearly there is a paucity of policy or regulatory support for UA activities in most developing countries.

In advanced industrialized countries, the convergence of awareness on issues raised by climate change challenges, environmental movements, the high costs of industrial agriculture both financially and in terms of carbon footprint, food safety and nutrition and other related factors explain the emergence of UA as an important component of urban landscape and economy. UA exists predominantly in the form of community gardens supported by local municipal governments within the city or in peri-urban areas and also practiced in home gardens, terraces and balconies. Community gardens have a long history in many European cities exploding originally during the wars in the early to mid 1900s but gradually subsiding and vanishing in many cities until reviving again in recent decades. More recently, modern urban agriculture involving a wide array of technological innovations in various engineering disciplines has converged into large scale commercial ventures in vertical indoor as well as hydroponic and aquaponic farming units (also referred to as ‘plant factories’) in many affluent cities with a substantial demand for high quality fresh and green food. These are rapidly evolving and are projected as a solution to the problem of land and environmental degradation that severely threaten future supplies of food in many countries.

As noted earlier, UA has been examined within and across many scholarly disciplines such as urban landscape planning and architecture, food security and environment besides urban geography. A small number of studies by economists mostly on African cities examine UA in the context of livelihoods in the informal sector, food insecurity and urban food systems. Numerous local, regional, national and global civil society initiatives promoting UA and related activities have emerged as important promoters of urban activism centred on fresh, safe and nutritious food supplies for the city and local regions.

Urbanization, Urban Agriculture and Resilient Urban Food Systems

According to the UN population data, in 2007, global population was estimated to be over 6.6 billion with the urban share crossing the 50 percent mark. Currently, this proportion is over 56 percent and expected to be reach over 2/3rds by 2050. Rapid urbanization in developing countries of Africa and Asia is projected to account for 90 percent of additional urban population by 2050. Between 2018 and 2050 China would add 255 million, India 416 million and Nigeria 189 million to their urban populations (UN, 2018). Rapid urbanization accompanying economic development in most developing countries has also given rise to increasing urban poverty and food insecurity. Following the declaration of the UN Sustainable Development Goals (SDGs) agenda in 2015, the New Urban Agenda was launched in 2016 in Quito, Ecuador which outlined the principles and policies to be adopted on a global scale towards promoting sustainable cities that included building resilient urban food systems.

We will promote the integration of food security and the nutritional needs of urban residents, particularly the urban poor, in urban and territorial planning, in order to end hunger and malnutrition. We will promote coordination of sustainable food security and agriculture policies across urban, peri-urban and rural areas to facilitate the production, storage, transport and marketing of food to consumers in adequate and affordable ways in order to reduce food losses and prevent and reuse food waste. We will further promote the coordination of food policies with energy, water, health, transport and waste policies, maintain the genetic diversity of seeds, reduce the use of hazardous chemicals and implement other policies in urban areas to maximize efficiencies and minimize waste.

The New Urban Agenda (NUA), 2016 Quito, Ecuador, (pp32)

While the NUA – recognized the Right to the City to promote building for current and future inhabitants, a non-discriminating urban space that ensures safety, health, accessibility, affordability, resilience and sustainability, the Milan Urban Food Policy Pact (MUFPP, 2015) emphasized and called for ensuring sustainability and resilience – enduring rural-urban inter-

relationships by recognizing an equitable exchange of resources goods, people and knowledge, healthy, and accessible food for all, protection of biodiversity and reduce food waste.

UA as a systematic, structured and integrated sector has considerable potential to promote the New Urban Agenda. The promotion of urban farming as part of a resilient urban food system is inevitable in order to meet the longer-term objective of urban food security and in the shorter term as a buffer during emergencies such as the COVID-19 pandemic. From a planning perspective, UA is now integrated as a part of Urban and peri-urban Food systems –or city region food systems. A systems based approach integrates the diverse forms, structures and practices that comprise the food economy of cities and urban areas around the world. This approach also enables a holistic perspective to comprehend complex but integrated structures of food production, procurement, processing, distribution, consumption and disposal of waste while also addressing the changing nature of externalities to the system such as the environment, climate, resource use. It also enables building up sustainability and resilience of such systems ensuring security to not only the present but to future generations.²

Though, urban food systems are systemically linked to rural food production, their share in food consumption exceeds the share in total population. They are also characterized by long supply chains that transcend not only national boundaries but are also trans-continental. UA emerges as an important element in expanding local food supply thereby shortening supply chains and ultimately reducing the carbon footprint of the urban food sector.

Since, by 2050, over 95 percent of global urbanization is projected to unfold in the developing world of Africa, Asia and Latin America. urban food security and food systems assume paramount importance in global food policy. Further, as most urban food is accessed through markets (retail trade), the means to purchasing food by low income households can only be assured by broader policy considerations of urban employment and remunerative livelihoods. In this regard, UA offers some scope in mitigating the effects of migration, falling employment brought about by technology as well as food insecurity.

² FAO (2013) and FAO (2019) elaborate on the role of FAO in approaching the sustainable development goals (SDGs) agenda in the areas of agriculture and food security.

FAO 2030 vision for Urban Food Agenda recommends a resilient, integrated, sustainable and inclusive food systems to achieve freedom from hunger and malnutrition for all through coordinated policy, plan and action by different levels of government, institutions and stakeholders. Accordingly, urban food systems must address the core components of productive resource use, efficient distribution services as well as food waste reduction and sustainable consumption. In the age of an information and knowledge society a free exchange of ideas and practices based on open networks is not only feasible but essential to building resilient systems³.

Urban farming including animal husbandry, has been a salient feature in many developing countries though not clearly visible or highlighted. Urbanization models so far have discouraged agricultural and animal husbandry activities within the bounds of the city for reasons of sanitation, safety and hygiene. The market for real estate in fast growing cities have in most cases eliminated urban farming altogether and shifted the same to peri-urban areas or beyond. But sustainable urban farming is rapidly evolving in varying urban contexts. Case studies on some of these reveal several potential models that can be replicated across both developing and developed countries as part of the New Urban Agenda. The Brighton & Hove experience in urban agriculture is an important illustration of how urban farming in Britain significantly contributed to sustainable development goals (case study and review by Nicholls et. al. (2020) by addressing issues of local unemployment, food poverty and access to livelihoods.

The demand for quality organic food, environmentally aware community networks and civil society initiatives are forging newer ways to produce, process and consume food in a responsible and sustainable manner as also to build greener and healthier cities. Local food systems shorten supply chains substantially diminishing the need for long distance transport and the pressures on cold storage thereby reducing the carbon footprint of urban food systems. Agro-ecological methods of food production that promote a holistic perspective on food production and consumption are being proposed as the inevitable alternative to industrial food production in the not so distant future. There are numerous initiatives to suitably design urban farming systems that can incorporate bio-diversity, soil and water conservation besides other

³ FAO (2019a) provides the framework for the urban food agenda from a policy perspective.

environmentally sound principles. Such systems to promote greener cities can be made sustainable with active community participation and municipal support.

As a signatory to the UN 2030 Agenda for Sustainable Development to realize the 17 SDGs, China's commitment and follow-up has been significant. China has actively participated in the lead up to the formulation of the UN Agenda 2030 and the SDGs. The National Action Plan on implementation of the 2030 Agenda (2016) has clear targets concerning SDGs with substantial achievements by 2020 itself. The goal of eliminating extreme poverty has already been proclaimed as achieved and the progress until 2020 with regard to other goals are expected to be revealed soon⁴. As regards SDG 11 too, which relates to sustainable and resilient cities, most of the targets for 2030 are listed to be achieved by 2020.

Urban agriculture as a sector of economic and social activity in China is quite distinct and in terms of policy it is treated under the domain of the Ministry of Agriculture (MoA) that provides guidelines for implementation by local/urban municipalities unlike in other countries where the local government designs, supports and promotes UA activities. The case of UA in China is discussed in greater detail in the section below.

2. Urban Agriculture with Chinese Characteristics

Urban agriculture in China in its nature, form and development differs considerably from that of other developing as well as the industrialized countries for reasons that are distinct to China in terms of political and administrative structure, agricultural resource endowments and the trajectory of economic development. Historically, city municipalities in China were organized not strictly as entirely urban but included rural counties surrounding the core urban space. This may have been by design to ensure food supplies closer to the city besides other considerations. As Horowitz & Liu (2017) note

“‘City’ (or Shi) in China refers to an administrative unit (over 600 of them) that includes prefectural-level cities, relatively small county-level cities and in many cases rural counties – therefore urban land (state owned) and rural land

⁴ This document can be accessed at :
https://www.fmprc.gov.cn/mfa_eng/zxxx_662805/W020161014332600482185.pdf

(collectively owned by the county/village) both comprise the city administrative unit in China.”

Therefore, what is conventionally referred to as UA in other parts of the world in discussions on farming or cultivating urban or peri-urban spaces to supplement local food supplies is not analytically identical to that in China. The core requirement for a sustainable urban food system -namely cultivable land around cities/towns exclusively under municipal jurisdiction - was historically built into the political and administrative boundaries of Chinese city municipalities.

As regards agricultural resources, China has historically had one of the lowest endowments of farmland per capita in the world. This continues to impose an enormous burden on the agrarian population to devise an increasingly productive outcome year after year, just to maintain the stability of national food and nutritional levels. Economic reforms in the late 1970s were initiated first in the rural and agricultural sectors precisely to relieve some of the pressures of underemployment of labour, promote diversity in agricultural production and initiate social and economic development in rural areas. The unabated and explosive urbanization and ultra-rapid industrialization that began in the 1990s along with unfettered urban economic growth intensified the pressures on valuable farmland and food production. Consistently high rates of rapid economic growth in the past three decades or more based on a diverse array of strategies such as rural industrialization, technological modernization of agriculture and industry, institutional innovations and integration with the global economy enabled China to effectively enhance living standards, stabilize food security and reduce poverty.

The enormous burden on agriculture and food production for a growing urban and rural population as well as expanded food demand arising out of economic growth and incomes did present a formidable challenge to China by the mid-1990s. Anticipating this and China's increasing economic capacity to divert these pressures on to the global food system, Lester Brown (1993) provoked the alarming prospect of “*Who will feed China?*” China's huge dependence on food trade in the following decade did prove to be the case but at the same time official state policy on re-configuring urban and peri-urban agriculture (UPA) began to take shape. The end-1990s was also the period when research and development in the area of technologically intensive vertical farming was launched. This form of agriculture was already

highly advanced in Japan which faced a similar challenge – limited farmland and high dependence on food trade.

The other challenges to food security in the Chinese case, are those arising from the risks to sustainability of industrial mode of food production with high input volumes and costs – water, energy and chemical inputs - as well as climate change challenge in all its ramifications. Additionally, serious problems such as soil degradation, water shortages and environmental costs have persuaded a re-evaluation of current development trajectory with a shift in emphasis on sustainability encapsulated by the term ‘ecological civilization’ in recent official policy pronouncements.

Besides these challenges to present and future food supplies two recent global developments also emerge as important factors that favour policies promoting a robust and resilient urban agriculture. One relates to the unfolding COVID-19 crisis and its after-effects highlighted earlier and the other to the current geopolitical situation of China being portrayed in the west as an adversary. The latter is likely to manifest in the extreme as a full-fledged conflict and in a less intense form of restricting China’s access to global markets, in particular food. The 13th five-year plan (FYP: 2016-2020) had already laid out two central objectives for the agricultural sector – self-sufficiency in food grains and absolute food security.

Urban and Peri-urban Agriculture in China

Urban agriculture in China appears to be extensively practiced across the country in all four forms – balcony/terrace gardens, farming on unused plots of urban land, peri-urban farming as well as technology intensive vertical farms. This is attested from newspaper reports spanning more than a decade and the small number of surveys and studies on urban agriculture in China, Horowitz & Liu (2017), Cui & Xia (2019), Yang et. Al (2016), Xie et. Al. (2020) etc.

As noted earlier *Dushi Nongye* is the guiding Chinese term used for UA and includes all the four forms of practice. However, the first two forms are rarely part of either official policy or scholarly attention (except in newspaper reports). Instead the focus is almost exclusively on peri-urban agriculture and/ or technology intensive vertical farms (Horwitz & Liu, 2017).

There are hardly any detailed studies within China examining UA practices of the first two forms. The earliest study (in English) is Cai and Zhang (1999) discussing the status and potential for UA in Shanghai. Following this is Kiminami & Kiminami (2007) based on a 2005 survey comparing UA in Tokyo and Shanghai. The most recent studies are on Wuhan (Horowitz & Liu (2017)) and on Nanjing (Si et. al. (2016)) both undertaken outside China. In these last three studies, local urban residents practicing some form of agriculture (mostly vegetable gardening) were surveyed to determine, their motivations, practical aspects of indulging in UA and the significance of their role in urban development, environment, livelihoods and food supplies. Just as UA studies elsewhere around the world, in China too these are conducted across intersecting disciplinary domains of urban planning, landscaping and architecture, urban geography, urban environment and sustainability.

The remaining part of this paper is a discussion on the studies mentioned above and on the emergence and active promotion by the government of high-tech vertical farms and smart agriculture that forms an important pillar of food security policy in China.

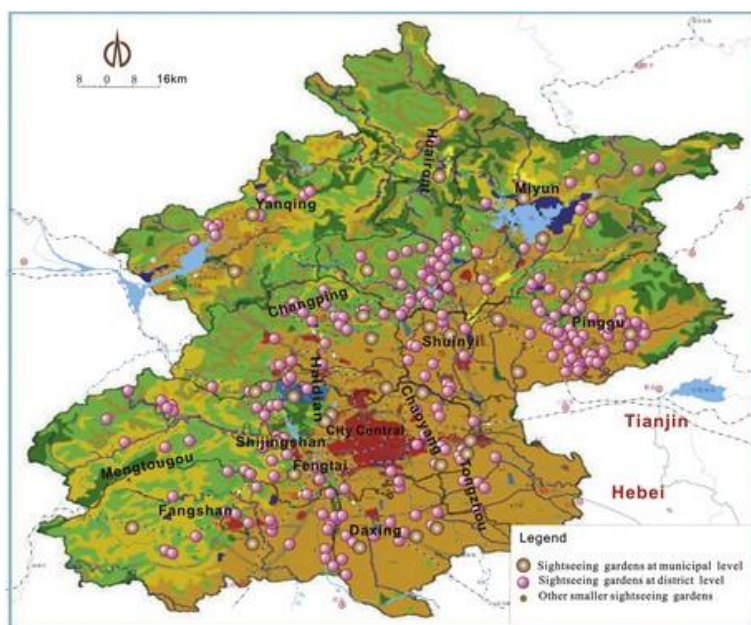
Beijing – Multi-functional Urban Agricultural Parks

Beijing is one of the pioneer municipalities (along with Shanghai) to formally initiate the UPA programme and develop the Urban Agricultural Park model. The UPA programme was officially launched in the late 1990s within the framework of sustainable urban development, and was essentially a drive to develop rural farms around Beijing metropolitan area into multi-functional agricultural parks that would cater to food production and horticulture besides agricultural tourism and serve as educational sites for school children. Thus, the term *Dushi Nongye* acquired a broader policy meaning in the early 2000s as a peri-urban project of modern agriculture with a multi-functional character addressing and promoting ecological, economic and social benefits. This modern urban agricultural park model is now prevalent in several cities across China. Within Beijing municipality there are at least 33 such parks effectively functioning. Cai (2014) elaborates on this multi-functionality thus:

“Beijing has created five zones that govern the type of agro-parks in the city. The “inner urban core” focuses on gardening, landscaping, and exhibition; the “inner suburban plain” specialises in recreational agriculture, which attracts

tourism, and precision agriculture, which utilises smart technologies such as moisture monitoring for automatic irrigation; the “outer suburban plain” emphasises large-scale, modern agricultural production and processing; the “mountainous” zone is devoted to special fruits and ecologic protection; and finally the “regional cooperation” zone helps bolster food security by facilitating relationships with nearby cooperatives and helping to ensure the quality of imports.”

Map 1. Farmer Household-based Sight Seeing Agriculture in Beijing

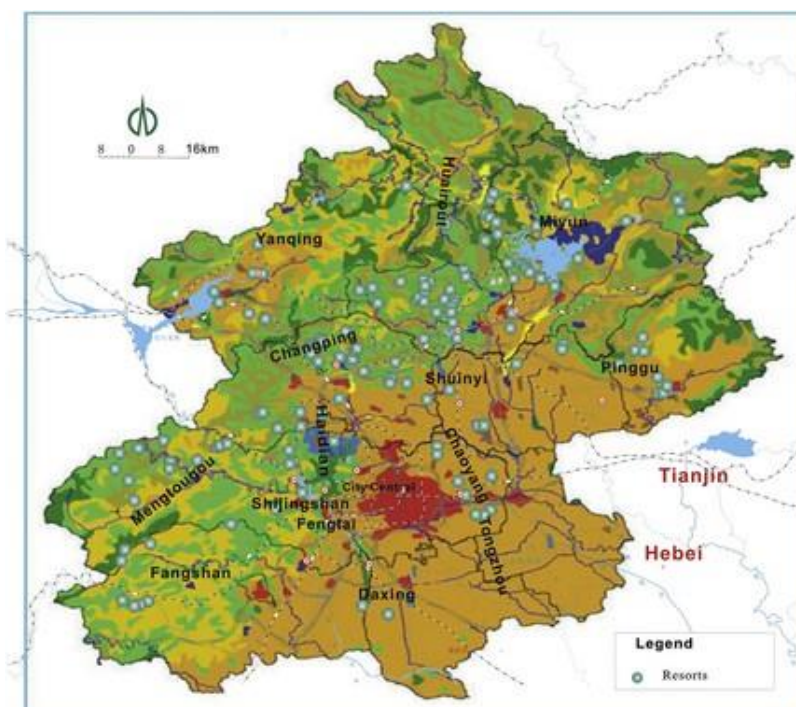


Source: Yang et. al. (2016)

Maps 1 and 2 reveal the density of multi-functional agricultural centres around Beijing urban area (within Beijing municipality). Yang et. al. (2016) examined issues on the rural-urban linkages underlying the approach to peri-urban agricultural initiatives and policies in Beijing. The policy driven agricultural transformation in peri-urban Beijing as a response to rapid urbanization has included high-tech precision agriculture, agro-processing and agro-tourism. The two major types/forms of agro-tourism in Beijing’s peri-urban agricultural initiatives are: Farmer household-based sight-seeing agriculture (FHSA, Map 1) and Enterprise based agricultural recreation parks (EARPs, Map 2). Under FHSA, urban residents can visit household managed farms in rural areas with or without homestay facilities and participate in some of the agricultural activities. EARPs are large commercial resorts providing higher

quality hospitality services (accommodation and dining) and recreational facilities including off-farm activities as well as observing and experiencing sophisticated agricultural and complex farming processes. The study also found that this model of peri-urban agricultural development besides being economically viable, is also socially inclusive and environmentally sustainable.

Map 2. Enterprise-based Agricultural Recreational Parks in Beijing



Source: Yang et. al. (2016)

A related strategic long-term program was launched in 2004 in the form of the “221 project” that outlined ‘comprehensive guidelines and concrete actions’ to enhance effectiveness in five aspects of agricultural economy. The deconstruction of “221 project is as follows; the first ‘2’ refers to agricultural resources and urban market demands, the second ‘2’ to technology and investment’ and the ‘1’ relates to a unified information platform linking agricultural production, exchange and marketing. The information links farmer cooperatives, organizations promoting UA and urban citizens through its knowledge base of best practices and disseminating new policies. In Beijing, the activities under this project included large investments in water and land conservation through rainfall harvesting and drip irrigation systems for large farms and greenhouses, pollution reduction by creating a forest area of about 6000 ha (Cai, 2014).

The other form of UA vigorously promoted by the Chinese government is the indoor and vertical farm model that employs an array of front line technologies, originally pioneered in Japan during the late 1970s and currently well developed and applied on an industrial scale.

There are no detailed surveys of urban citizens and households practicing vegetable gardening in balconies, rooftops or unused urban land in Beijing but several news reports attest to its widespread presence. Following the fallout from the milk adulteration scandal of 2008, issues of food safety especially chemical pollution in vegetables through pesticides encouraged the trend of intra-urban agriculture in Beijing as well as other cities all over China. A 2012 news story (in South China Morning Post) provides a good idea of the growing trend in this form of UA. It also reported that websites devoted to promoting UA were becoming popular with one site registering 60000 members and online sales of seeds for UA by another website turning over RMB 200 million in one year.⁵ The popular practice of vegetable gardening in balconies and rooftops besides farming in unused plots of land in urban areas – referred to as intra-urban agriculture/farming – in Shanghai and Wuhan are discussed in some detail in the following subsection.

3. Surveys of UA practice by urban households

Shanghai

Cai and Zhang (1999) is one of the earliest studies (in English) of UA in Shanghai published at a time when explosive urban development had just begun to take off in China. This study reported that Shanghai municipality (both the core urban area and surrounding rural areas/counties) had 41 percent of the workforce in agricultural production and interestingly of the 2.7 million farmers 80 percent worked part time. The regional self-sufficiency policy in cereals, vegetables and livestock produce was strictly adhered to until the mid-1990s. For instance, 80 percent of vegetables and fresh-water fish and the entire supply of chicken, eggs and milk were produced within a 10-km radius of the city.⁶ During the latter half of the 1990s,

⁵ Urban farming a growing trend in China by Zhuang Pinghui, 19 Aug, 2012 accessed 29 Nov. 2020 <https://www.scmp.com/business/china-business/article/1018114/urban-farming-growing-trend-china>

⁶ See, <https://wwf.panda.org/?204455/Shanghai-urban-farming>

much of the agricultural farmland within the city and suburbs were already making way for urban development. This paper documents the move towards specialized and capital-intensive agriculture farther away from the city.

While Cai and Zhang's (1999) study documents the end of one regime of urban food self-sufficiency that was planned and maintained for several decades another study of Shanghai by Kiminami & Kiminami (2007) surveys the emergence of another form in which urban agriculture was reinvented and revived in the informal urban space. This is also one of the earliest surveys of the motivations and perceptions of urban citizens and households indulging in intra-urban farming comparing Tokyo and Shanghai. Here, UA is examined from the perspective of sustainable urban development and urban residents' need for policies that can support UA activities. This study was also one of the earliest to use the internet to survey (over 800) residents in Shanghai during 2005. The authors clarify that the inclusion of only younger population who can access the internet did not significantly alter the results since the motivations and perceptions from the perspective of environmental and economic sustainability would not have large variations across age groups. The survey also found that Shanghai residents adopted UA mainly for three reasons; supply of fresh and safe food, to preserve the living environment and to create a healthy and affluent environment. Further, an overwhelming number of residents were in favour of maintaining green spaces, allotment spaces for gardening and practicing UA. Interestingly, the major reason for Shanghai as a preference for residence by those practicing UA was availability of urban farmland even though at that time the pressure of housing demand and therefore on urban farmland conversion was high and growing. Finally, the findings concluded that there was need for state policies to preserve urban farmland and support UA given their contribution to the environment and improvement in people's welfare.

Wuhan

Horowitz & Liu (2017) surveyed the various informal forms and practices of urban agriculture in Wuhan during 2010-14 applying a theoretical framework in critical urban studies called 'urban assemblage' -

“as an empirical orientation and methodological framework to help imagine how various stakeholders might reassemble various legal, physical and conceptual components of the city to leverage intra-urban agriculture as a tool for sustainable urban development.”

The main objective was to determine the modes and motivations of Wuhan urban residents or ‘cultivators’ (in the core urban area) to practice urban farming. The study observed that besides balconies & rooftops, sidewalks, road meridians, land under bridges and power lines as well as unfinished construction sites were used for farming vegetables and other fresh green produce. Larger multi-family cultivated plots were also in use for the same purpose alongside river Yangtze and a metro line running parallel to it. Recycled organic waste and water as well as human waste was well utilized. Cultivators belonged primarily to the age group of 50-75 years almost all with some experience of real farming with one third of them retired and drawing state pensions. There were also elderly who had migrated from rural areas to their younger generation family members in Wuhan and performed household and care work (with grand children). A sixth of the respondents were full-time urban farmers earning RMB 1000 -3000 per month (average farmer income in the municipality was around RMB 800 while the rest grew food for household use. Food safety concerns and health benefits from manual labour were the dominant motivation followed by ‘enjoyment’, ‘cost savings’ and ‘habit’. An interesting observation of this study is that

“..intra-urban agriculture in Wuhan prospers not because there are formal mechanisms to enable it, but because there are a lack of formal rules and regulations against it....The merit of the informal nature of intra-urban agriculture in China is that it grants dispossessed farmers-cum-urbanites welfare benefits and a ‘right to the city’ under a system that otherwise does not recognize private land ownership or citizen participation in the production of urban space.” (p 213)

Nanjing Urban Food System

The study of urban food systems is of recent origin in the Global North and increasingly put forth as an exclusive domain of policy significance in international discourse on food and

agriculture. For the Chinese state however, the long-standing policy of ensuring regional food sufficiency comprehensively covers both rural and urban food security issues. Si et. al. (2016) is a recent and rare study of the urban food system of Nanjing. The entire sequence of food from production to consumption is examined by closely looking at - cultivable land use, the flows of food from within the locality and from outside, the retail distribution of food through formal/modern and informal networks as well as including a brief discussion of intra-urban agriculture. Food security at the household level is also examined through a study of household food access, the dynamics of diets and patterns of food consumption, food safety issues as well as the role of food prices.

As in other Chinese cities, rooftop, balcony and front/back yard agriculture is widespread in Nanjing. The main motivation is also the same namely, vegetables from markets are not safe. As in Wuhan, the banks of the river Qinhuai are also cultivated even though enforcement of city regulations against growing food was found to be frequent. Relative to intra-urban peri-urban agriculture is more widely prevalent and prosperous providing about 23 percent in volume of the city's food requirements that includes 48 percent of rice and 30 percent of vegetables (Data for 2011, p 23). Interestingly, China's oldest organic certification agency – the Organic Food Development and Certification Centre of China - is located in Nanjing and over 80 percent of farmland was certified as hazard free, green or organic.

This study concluded that the informal economy in Nanjing's food system was a significant source of income and livelihood for the poor including migrant workers. As part of the food system, informal food retailing is a large sector with diverse functions and activities from trading in fresh, processed and cooked food. Besides informal food retailing, the city has thousands of supermarkets, small retail outlets and 100 wet and wholesale markets. As in the rest of China, in Nanjing too, food safety- free from chemical or biological contamination or adulteration - is a paramount issue and the most important dimension of food security is not so much as availability or affordability but access to safe food..

3. Vertical Farming, Smart Agriculture and Food Security in China

Urban agriculture policy in China falls under the purview of the MoA and the trajectory of

development of urban agriculture is guided largely by the overall framework of agricultural strategy. The form and nature of UPA during the early phase beginning around the mid-1990s (discussed earlier) underwent significant changes with the launch of the National Plan on Sustainable Agricultural Development (NPSAD) 2015-2030. NPSAD itself was part of a transformation in the national economic development strategy that coincided with China's commitment to the UN Agenda 2030 - the SDGs. Therefore, from 2015 onward all sectors of the economy were subject to the new overarching agenda of sustainability and environmental norms. In agriculture, the emphasis shifted away from high input agriculture (in terms of chemicals, water and energy) to technology driven, efficient and environmentally sustainable model of production. The policy emphasis on intensive application of new technologies in agriculture covers both conventional agricultural practice and in new forms of agriculture such as vertical farms, hydroponics and aquaponics that are easily adapted to urban environments. Smart agriculture involving information technology (IT) devices and applications have been deployed in parts of China to ensure efficient coordination of various phases and stages of farm production including calibrating and controlling input applications such as water, chemical fertilizers as well as monitoring plant growth through the use of drone technology.

The role of Chinese Academy of Agricultural Sciences (CAAS) became central in the new agricultural strategy, for research, innovation and development of new technologies. Technological solutions were recognized as the key to overcome in a sustainable manner, the limitations posed by land and water availability, soil degradation and pollution while at the same time enhance farm productivity to meet the challenges of food security for a growing population. In 2013, CAAS launched the Agricultural Science and Technology Innovation Program (ASTIP) with direct financial support from the central government⁷. This 13 year programme (2013-2025) covers the 12th, 13th and 14th five year plans which also laid out the following goals for China's mega cities by 2020 (Hosseinifarhangi, 2019)

1. Agricultural modernization and concentrated zones for high tech food production through multi-functional land use.
2. Coordinated development of urban-rural connections and increased agricultural production capacity.

⁷ http://caas.cn/en/research/research_program/index.shtml

3. Integrated development and modernization of industry, agriculture, defence, and science and technology (S&T) for enhancing agriculture's supporting role in industrialization and urbanization.

While these are broad objectives and goals, CAAS also has a specialized programme coordinating research and development on indoor and vertical agriculture. The Research Centre for Protected Agriculture and Environmental Engineering (CPAEE) manages 40 institutes all over China examining greenhouse engineering, plant factories, hydroponics and energy efficiency in indoor and vertical farms. It was reported that in 2013 there were 75 such high-tech 'commercial plant factories' (vertical farming factories) 25 of which used artificial lighting. Some of the achievements in this field are quite stunning such as indoor production of 150-500 kg pumpkins and hanging root vegetables such as soil-less sweet potato plant with hanging roots that can be repeatedly harvested without damaging the plant.⁸

Though comprehensive data or information on the scale and spread of high technology urban farming (vertical, hydroponic and aquaponic farms) in China is not easily accessible, news reports testify to a growing number of private companies both domestic and foreign investing in such ventures⁹. By some accounts, China has already emerged as the leader in indoor and vertical farming systems not only producing food on an industrial scale but also designing innovative indoor farms suitable for deployment at the level of the household. These systems as mentioned earlier offer a reliable promise of meeting increasing food demands in the near future and therefore form a crucial component of China's food security policy and strategy.

Concluding remarks

This paper was an attempt to put together issues, policies and forms of practice of urban agriculture in China in recent decades. Urban and peri-urban agriculture is a significant and growing sector in China having evolved from an earlier planned and self-sufficient urban food

⁸ See Daniel Thorpe, "How China leads the world in indoor farming", accessed on 29 Nov. 2020, <https://www.smartcitiesdive.com/ex/sustainablecitiescollective/chinas-indoor-farming-research-feed-cities-leads-world/409606/>

⁹ See <https://asia.nikkei.com/Business/Startups/Chinese-startup-gets-in-on-ground-floor-of-high-rise-farms>, <https://nextshark.com/chinese-high-tech-indoor-farm-vegetables/> & <https://www.boldbusiness.com/nutrition/vertical-farming-next-frontier-food-production/>

regime prior to the 1990s to acquiring a starkly different form and practice now. Of the various forms of UA, peri-urban and high-tech vertical farming are the main focus of government policy due to the greater potential in terms of scale, productivity and value added. But informal modes of UA practice appear to be widespread in most cities of China documented mainly in news media. As recently as November 2020¹⁰, the government has brought the agenda of food security and grain self-sufficiency back to the forefront following the COVID-19 pandemic. This is likely to be a positive impetus to urban agriculture in the near future. 2020 was the year for realizing many of the targets envisaged under the NPSAD as regards sustainable and urban agriculture. These are likely to be revealed soon in this year enabling a better evaluation of China's state policy and the efficiency of market for food. Given the lacuna in research on the urban food system and economy in China, there is considerable scope for comprehensive studies examining related issues of food security, food safety, informal economy, food policy and urban agriculture.

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¹⁰ Food security and grain self-sufficiency is back on the agenda post-coronavirus pandemic by Orange Wang, 18 Nov, 2020 <https://www.scmp.com/economy/article/3110399/china-food-security-beijing-tells-farmers-stick-grain-amid-global>

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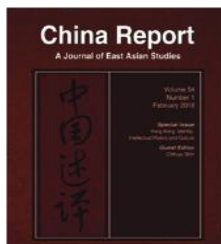


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B-371 (3rd floor), Chittaranjan Park,
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