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Urban agriculture in Asia to meet the food production challenges of urbanization: A review

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Abstract

Urban expansion in Asia is concentrated in metropolitan areas. This has adversely affected in-city food production by decreasing farmlands in and around urban centers. Asian countries have experienced fast disappearance of urban-fringe farmland which at some point provided 70% of the vegetables consumed by the city's population. Uneven distribution of incomes, along with an increase in urban poverty, has further exacerbated the already critical problems of low quantity and quality and high prices of wholesome food. In India, it is estimated that five out of every six urban families typically spend 70% of their income on food. The United Nations Development Program reports that some 200 million people are employed in urban farming and related enterprises, contributing to the food supply of 800 million urban dwellers. Also, over 85% of the vegetables consumed by the urban population in some Chinese cities are reportedly grown within the bounds of the municipality and an estimated ¥ 2.6 trillion worth of products is produced in "urban-like areas". These statistics show that depending solely on rural agriculture to supply the food needs of urban dwellers in Asia is inadequate. This paper highlights compelling evidence in available literature lending support to urban agriculture as a viable option to overcoming food production challenges and adverse effects of urbanization such as environmental pollution and "urban poverty" in Asia.

1 | URBANIZATION TRENDS IN ASIA

Although Asia is the largest and most populated continent in the world, it has and continues to experience massive population growth and urbanization (UNFPA, 2018) (Figures 1 and 2). Its population has quadrupled in the last century and is expected to continue to surge upwards (Table 1). Based on current trends, it is projected that by the year 2050, every country in Asia will have experienced significant population growth, even doubling in countries such as Afghanistan, Nepal and Pakistan (Asia population, 2019; State Statistical Bureau, 2014; Taylor-Hochberg, 2018).

Rural-urban migration is one key factor that has contributed to Asia's rapid urbanization (Hampwaye, 2013). Migration in Asia is mostly influenced by the need for better economic or social opportunities such as better standard of living, long-term employment, and the

availability of better business opportunities. Also, the search for better education, improved health care facilities, and better entertainment options may influence people's decision to migrate to urban areas (FAO-FCIT, 2011; Orsini, Kahane, Nono-Womdim, & Gianquinto, 2013).

2 | THE NEED FOR URBAN AGRICULTURE IN ASIA

The population increase in Asia has resulted in a decline in farmlands. This is due to the conversion of agricultural lands for other non-agricultural purposes such as construction of roads, residential, industrial or office complexes. The World Bank (2015) estimated that the growth of cities has led to the loss of some 2 million hectares annually, with about three-quarters of that been agricultural land. In addition to reduction in farmland, the loss of workers (both skilled and unskilled) in the agricultural sector due to migration of people who move to cities. The reduction in farmland and loss of workers in the agricultural sector has resulted in a decline in quantity of food available in urban centers and a rise in prices in urban centers with the poor been the most affected (Zezza & Tasciotti, 2010). Some studies estimate that five out of every six urban families in India typically spend 70% of their income on food, while in Kuala Lumpur, approximately 45–50% of total household expenditure goes to food (Zezza & Tasciotti, 2010). While high food prices in urban centers are mostly due to the high demand, other factors such as extra cost incurred in transportation and preservation (refrigeration) are also contributing factors.

The increasing urban population growth and its associated high food demand has revealed the inadequacies of traditional/rural farming methods to sufficiently supply the food needs of urban centers (Argañaraz & Gleiser, 2017), hence the urgent need for improved food production within urban centers. Urban agriculture involves the use of different techniques for the production, processing and distribution of agricultural products (agronomy, animal husbandry, horticulture, apiculture, aquaculture, etc.) in or around urban areas such as housing estates, schools and rooftops of office complexes (Van Tuijl et al., 2018). Urban agriculture can broadly be categorized into intra-urban and peri-urban agriculture (Opitz, Specht, Berges, Siebert, & Piorr, 2016). The former occurs in inner urban areas, usually on vacant public (parks, schools, or hospital) or private (household backyards) lands or plots, while peri-urban agriculture occurs in suburban or areas close to or surrounding urban centers (Van Tuijl et al., 2018). Kumar (2012) characterized urban agriculture in relation to rural agriculture as having higher productivity per unit of space, low capital per unit of production, low energy consumption, low marketing cost, freshness and higher quality of food produce. Increasing the contribution of urban agriculture would enhance the nutrition and health of urban population by providing them with fresh produce. In addition, urban agriculture improves the socio-economic standard and reduce urban poverty (as it provides a source of income for urban farmers, processors, and marketers). For example, the Ministry of Agriculture, Forestry and Fisheries (MAFF) estimates that farmland in "urban-like areas" are producing ¥ 2.6 trillion worth of products (City Farmer News, 2013).

Core Ideas

- Challenges of urbanization in dense Asia feeding a large number of people living in a limited space.
- Success stories of urban agriculture in Asian cities that have attained food self-sufficiency.
- Urban agriculture and impact on environment, food quality and waste recycling management.

Furthermore, urban agriculture mitigates deleterious environmental consequences of urbanization such as deforestation, air and water pollution, and poor drainage (Islam & Siwar, 2012; Kaur & Hitam, 2010; Orsini et al., 2013; Sahasranaman, 2016; Scott, 2015). This is because urban farming activity have been closely associated with protection and preservation of natural resources through the establishment of environmentally friendly 'green' spaces, increasing biodiversity, and the reducing pollution (Feng, 2013; Masi, Fiskio, & Shammin, 2014; Trutko, 2014; Yusoff, Hussain, & Tukiman, 2017).

Crops commonly grown in urban agriculture for personal consumption and/or for sale in the local markets in Asia include fruits and vegetables such as tomato (*Solanum lycopersicum*), pepper (*Capsicum annuum*), eggplant (*Solanum molengena*), squash (*Cucurbita pepo*), sweet potato (*Ipomea batatas*), broad beans (*Vicia faba*), peas (*Pisum sativum*), sugar cane (*Saccharum officinarum*), onion (*Alium cepa*), spinach (*Spinicia oleracea*), cauliflower (*Brassica oleracea* var. *botrytis*), broccoli (*Brassica oleraceae* var. *italica*), cucumbers (*Cucumis sativus*), bitter gourd (*Momordica charantia*), kale (*Brassica oleraceaen* var. *sabellica*) and radish (*Raphanus raphanistrum*) (Hill, 2016).

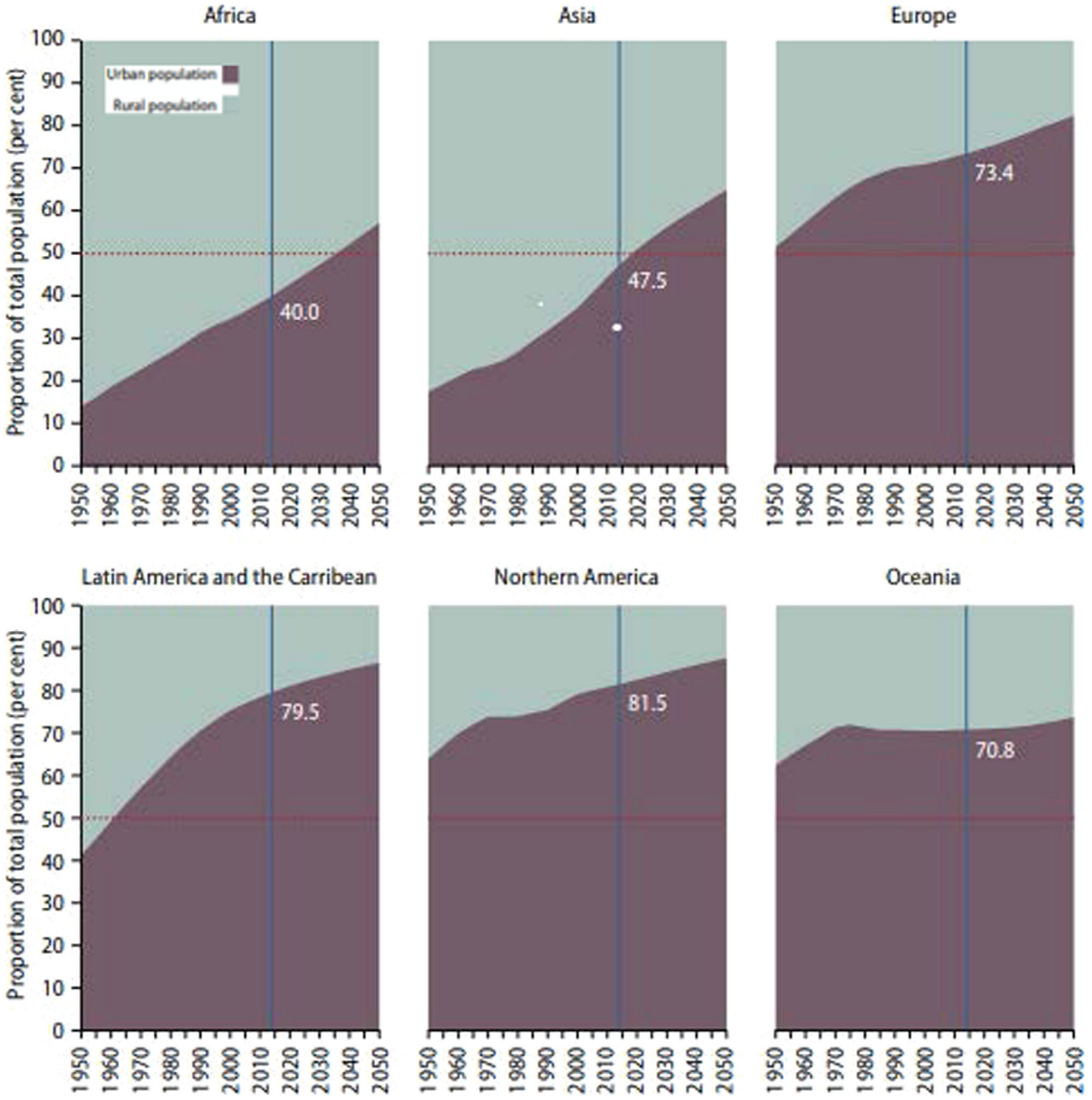

FIGURE 1 Urban and rural population as proportion of total population, by major areas, 1950–2050 (Source: UN World Urban Prospects, 2014; Statistics to the right side of the blue line represent predictions after 2014)

3 | CHALLENGES OF URBAN AGRICULTURE IN ASIA

Challenges particular to urban agriculture include a limitation in land area or spaces (Van Tuijl et al., 2018). This has resulted in higher prices to purchase, rent or lease urban spaces, thus forcing many prospective urban farmers to consider other options. When farmers rent or lease spaces in urban centers, they are often skeptical to make huge investments as there is always the threat of eviction by landlords in short notice. Other challenges of limited space in urban centers, especially for the small-holder farmers who subsist on patches of agriculture-zoned land that have gradually been enveloped by urban development is the constant threats of displacement by construction and a lack of clarity about land ownership and zoning.

Furthermore, there is also limitation of city plans or building codes which may prohibit the establishment of rooftop gardens at certain locations (Pfeiffer, Silva, & Colquhoun, 2015). Aside legal constraints to siting, other aspects of urban agriculture such as production, infrastructure, marketing and access to input may also be

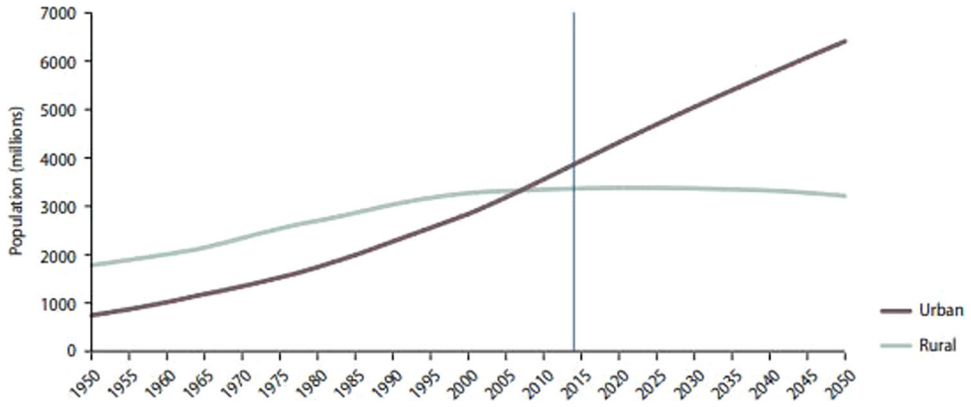

FIGURE 2 Urban and rural population of the world, 1950–2050
(Source: UN World Urban Prospects, 2014; Statistics to the right side of the blue line represent predictions after 2014)

negatively affected (Pfeiffer et al., 2015; Thomaier et al., 2015). Moreover, the high financial, technological and infrastructural requirements to setup, operate, manage and maintain urban agriculture (such as hydroponics, aquaponics, aeroponics etc.) is beyond what most local farmer can afford (Van Tuijl et al., 2018; Dimitri, Oberholtzer, & Pressman, 2016; Van der Valk, 2012).

Some question the 'safety' levels of 'urban vegetables'. They argue that there are high chances of heavy metal pollution since the air in urban centers are often heavily polluted (Vaneker, 2014). Yet others believe that the use of soilless growing technology (which is the principal medium of growth in urban agriculture) will only lead to 'artificial food' that lacks natural nutrients (Van Tuijl et al., 2018). Lawson (2016) reported air pollution (odor) and excess load on municipal energy grids especially in cases with livestock farms in urban centers.

4 | SUCCESSFUL URBAN AGRICULTURE PROGRAMS

Through deliberate efforts, some regions in Asia are now listed among parts of the world where urban self-sufficiency in food production has been attained (Chen et al., 2011; Zhenling et al., 2018). Despite been highly populated and industrialized, many Asian countries and cities set up urban agriculture programs that have helped maintain the presence of significant agricultural activities which sustains a robust local vegetable production system amidst intricate networks of railways, roads, and buildings (Moreno-Penaranda, 2011). Through intercropping and other high-density planting techniques, increased urban agriculture output has been achieved (Ladha et al., 2016).

Furthermore, many urban agriculture programs have been developed in India to increase the number of urban farmers. For example, the Pune City Corporation's City Farming Project was developed to encourage citizens to practice urban agriculture by growing vegetables and other crops on allocated land (Hallett, Hoagland, & Toner, 2016). Similar programs in cities like Mumbai, Delhi, Kolkata, Bengaluru, Chennai, and others have resulted in many individuals joining the ranks of urban farmers. Through these programs, farmers received assistance from the government, private agencies, and individuals. Additionally, the establishment of numerous host ventures that specializes in training and assisting farmers on urban agriculture techniques further contributed to increasing the number of urban farmers. Examples of such ventures include- The Living Greens, iKheti, Khetify, Homecrop, Greentechlife, Squarefoot Farms, Edible Routes, City Farming, Eartholics, Fresh and Local, and Urban Leaves etc. These organizations provide the needed guidance and directions to farmers who have chosen urban agriculture as a career or hobby. Similar ventures such as FutureFarms train urban farmers on hydroponic techniques to grow fresh vegetable produce (Roy et al., 2017). Furthermore, the Urban Horticulture Development Scheme introduced a "Do-It-Yourself" kit has enabled city dwellers to grow vegetables on open terraces of individual houses and apartment buildings. The kit contains basic materials needed to start a garden (Sahasrannaman, 2016). It was first implemented in the city of Chennai, but then also introduced to Madurai. The Sky Green vertical farm in Singapore is example of successful in city, all year-round vegetable (lettuces and cabbages) production. Sky Greens' vertical farming provides both an efficient and environmentally and low-carbon hydraulic water-driven urban vertical farm that reduces the amount of energy and land needed for traditional farming techniques. Within a greenhouse, the three story's-high vertical systems produce five to ten times more per unit area compared to conventional farms (Foodtank, 2013).

TABLE 1 Population history from 1950 and projections to 2090 for Asia

Population History				Population Projection			
Year	Population	Density (km2)	Growth Rate (%)	Year	Population	Density (km2)	Growth Rate (%)
1950	1,404,061,590	31.50	0.00	2020	4,623,454,191	103.71	0.84
1955	1,546,143,227	34.68	1.83	2025	4,799,909,855	107.67	0.69
1960	1,700,462,752	38.14	1.99	2030	4,946,586,362	110.96	0.55
1965	1,891,228,735	42.42	2.31	2035	5,064,479,825	113.61	0.42
1970	2,137,828,395	47.96	2.47	2040	5,154,419,096	115.62	0.31
1975	2,394,338,004	53.71	2.16	2045	5,218,558,306	117.06	0.21
1980	2,642,488,969	59.28	1.96	2050	5,256,927,499	117.92	0.11
1985	2,915,953,444	65.41	2.03	2055	5,269,931,516	118.22	0.01
1990	3,221,341,719	72.26	1.88	2060	5,259,717,370	117.99	-0.07
1995	3,489,306,253	78.27	1.48	2065	5,230,800,359	117.34	-0.13
2000	3,730,370,625	83.68	1.28	2070	5,187,459,467	116.37	-0.19
2005	3,964,342,662	88.93	1.19	2075	5,133,008,396	115.14	-0.23
2010	4,194,425,212	94.09	1.11	2080	5,069,807,932	113.73	-0.26
2015	4,419,897,601	99.15	1.00	2085	5,000,931,899	112.18	-0.28
2018	4,545,133,094	101.96	0.90	2090	4,929,164,111	110.57	-0.29

Source: Worldometers (www.Worldometers.info) and World Bank (https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS).

Successful implementation of urban agriculture policies depends on effective partnership between government and private institutions. The synergistic efforts of Department of Agriculture (DoA) and Universiti Putra Malaysia (UPM), and key players in the agriculture sector is reported to have encouraged more urban residents to participate in urban agricultural activities in open field plots, community farms, balconies, rooftops and garden pots in vertical stands (Hui, 2011; Shanshan & Ge, 2013).

5 | CONCLUSION

Regardless of geographical location, urban agriculture is driven by the need to provide fresh, wholesome, and affordable food for urban dwellers. Urban agriculture in Asia has become an important component of its economy and food ecosystem. It has been credited with numerous benefits such as improving in-city food and vegetable production, serving as a source of primary or secondary income for farmers, and as medium for mitigating environmental pollution through the provision of more 'green' cover etc. However, challenges commonly encountered by prospective or even already established farmers includes high financial and infrastructural requirements to start up, operate and maintain urban agriculture ventures. There is also the limitation of space in densely populated urban centers often resulting in zoning policies that may limit the operations of urban agriculture. Despite these challenges, urban agriculture has been successful in improving quantity of food and vegetables available to urban dwellers. The population of the world and Asia is increasing with most dwellers in urban centers. The reports of successful urban agriculture cases in Asia shows its potentials to supplement the conventional rural agriculture in meeting the increasing food demand of urban dwellers.

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