

GREEN ROOF CONCEPT ANALYSIS: A COMPARATIVE STUDY OF URBAN FARMING PRACTICE IN CITIES

*Nur Hayati Hashim¹, Nur Huzeima Mohd Hussain² & Asmat Ismail³

^{1,2,3}Faculty of Architecture, Planning & Surveying,
University Technology MARA Perak,
32610 Bandar Seri Iskandar Perak

Email: nurhayatie.hashim@gmail.com

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ABSTRACT

The emergence of urban farming mainly for food production is one initiative in developing a sustainable environment. This paper presents a brief conceptual review of the ideas, issues and imperatives in implementing urban farming on the rooftop areas. The concern is to investigate an alternative way for urban dwellers to achieve resilience through urban farming — the review is based on the theoretical background and concepts of the relevant constraints taken from various established references. The method adopts comparatives analysis explicitly through established texts and secondary data taken from previous cases. The significant examples include; (i) green roof as rooftop farming in ensuring food security and reduce carbon footprint in Singapore; (ii) urban farming as a culture in emphasizing the domestic food production and consumption in Japan; (iii) rooftop urban farming in fresh urban food production in USA; and (iv) rooftop is effective as edible landscape and not only serve for visual purpose only in Thailand. These cases will lead to localize the concept of rooftop urban farming. There also will be a strategy for the greening of the cities by intensifying urban farming. This paper envisions to extend and establish the conceptual discourse for implementing urban farming on the rooftop areas in Malaysia.

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Keywords: Urban Rooftop, Green Roof, Urban Farming, Sustainability Urban Rooftop



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INTRODUCTION

It is a well-known fact that population growth increased the pressure on global food demand issues in urban areas (World Bank, 2013). Thus, the greening activities face a problematic situation due to the rapid urbanization and escalation in land prices. The increasing population and limited land created an alternative of high density and high rise strategy in the urban area. Therefore the establishments of the green roof in the urban area are widely increasing. According to Kortright (2001), the green roof can be defined as an open space with any planting that is separated from the ground by building or other structure. Thus, due to space constraints, the practice of green surfaces in ground areas is decreasing. Consequently, the green roof becomes the only choice for densely populated urban areas to create green space. In recent years, the applications of green roof urban farming are becoming more popular in many countries mainly in urban areas.

This paper will focus on the ideas, issues and imperatives of urban farming concepts on the rooftop. The significant and growing interest in rooftop farming is one way in which urban areas could attempt to be more balanced and sustainable in terms of resource consumption. The review enhances the concept of greening the cities through having the urban farming on rooftops. The discussion on urban farming is no longer about whether it can be implemented on the green roof or not, but the impact to utilize beyond the environmental values, social and economic aspect.

This paper would adopt a comparative analysis method using selected established references and studies across the world as a precedent study. All the significant cases will lead to an understanding of the rooftop urban farming concept around the world. This will eventually lead to the prospect of urban farming in the Malaysian context.

THE DEFINITIONS AND CONCEPT OF GREEN ROOF AS URBAN FARMING

The Definitions

The experiences of urban farming spread over the cities aiming for food production is contributing to urban food security and resilience. Thus, there are various versions in defining the meaning of urban farming. The main difference of the definition regards to the spatial, production, function and market specifications. According to Smit et al. (1996), urban farming can be explained as a localised food system wherein the production, consumption, recycling of food occurs in the city while FAO (2015) and RUAF (2016) stated that the definition of urban farming is growing plants and raising the animals within and around the cities. Similarly to Sanyé-Mengual (2015) described that urban farming is farming operations around the cities beyond food production and provides environmental and social services as well as support local economies by direct urban market orientation.

Urban farming is characterized by being multifunctional. The multifunctional concept deployed the benefits which are enhancing food, security, providing environmentally-friendly food, educating and promoting healthy habits, and building and empowering communities (Noseir, 2014). Urban farming also has been claimed to contribute to water efficiency, energy conservation, reduction of air pollution, community solidarity, improving economic wellbeing and revitalising low-income communities (Smit et al., 2015; Angotti, 2015). However, urban farming mostly has been practised by the low-income group but not the very poorest. (Zezza and Tasciotti, 2010).

So, this paper defines that urban farming is an activity of farming that happened in an urban area not only for food production but also for the other benefits towards environmental, economic and social aspect. The potential of urban farming also can be unfolded to unleash the multi-functionality in the Malaysian context.

The Concepts of Rooftop Urban Farming

The concept of rooftop urban farming arises after the distancing of a

consumer with food productions has consequences not only for social but also the environment and economic (Sanyé-Mengual, 2015). An attempt has been made to bridge the gap between the consumer and the output of foods in the urban area. This can be seen through the numerous urban greening and urban agriculture initiatives amidst the encroaching economic demands and the preservation of green spaces which are mostly urban area difficulties. Therefore the idea of a green roof to urban farming is emerging and gaining popularity. A green roof defined by Kortright (2001) is an open space with any planting separated from the ground by building or other structure.

Rooftop urban farming is part of the building base that has recently become essential in an urban area. According to Sanyé-Mengual (2015), shown in figure 1, urban farming can be divided into; (i) vertical farming and zero acreage farming (ZFarming) for new building and existing building as well, (ii) rooftop farming which is open-air farming and greenhouses.

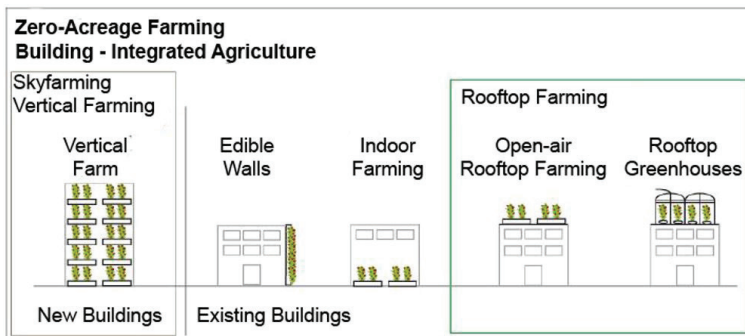


Figure 1: Types of Urban Farming on Building and Rooftop Farming.
(Source: Sanyé-Mengual, (2015)

According to Hui (2011) and Noseir (2014) shown in table 1, the benefits of urban farming, the multifunctional benefits of urban farming are divided into three major groups which are environmental, social and economic sustainability.

Table 1. Significant Benefits in Urban Farming

Environmental	Social	Economic
<ul style="list-style-type: none"> • Greener the environment • Recycle organic waste • Reduce ecological footprint • Mitigate urban heat island • Improve urban stormwater management 	<ul style="list-style-type: none"> • Strengthen the community relationship • Education • Community green space and amenity 	<ul style="list-style-type: none"> • Local food production • Increase food security • Generate profits • Local employment

(Source: Hui, (2011); Noseir, (2014))

The Typologies and Scales

The typologies of urban rooftop farming can be described based on multiple factors. According to Sanyé-Mengual (2015), the typology is simplified into two main variables which are (i) types of farming and (ii) the objectives of farming. The first variable is the type of farming which is referring to rooftop greenhouses or open-air farming and not including the details in the kinds of technology use. While the second variable; the objectives of urban farming can be divided into commercial or social activities. Sanyé-Mengual (2015) summarized the four urban rooftop farming typologies which are;

1. Commercial rooftop greenhouses
2. Socially oriented rooftop greenhouses
3. Rooftop farms
4. Socially oriented rooftop gardens

Meanwhile, the scale of rooftop urban farming has been classified by RUAF, (2016); Noseir, (2014) as shown in figure 3. The classification is divided into three main categories: subsistence; microscale; and medium to extensive urban farming.

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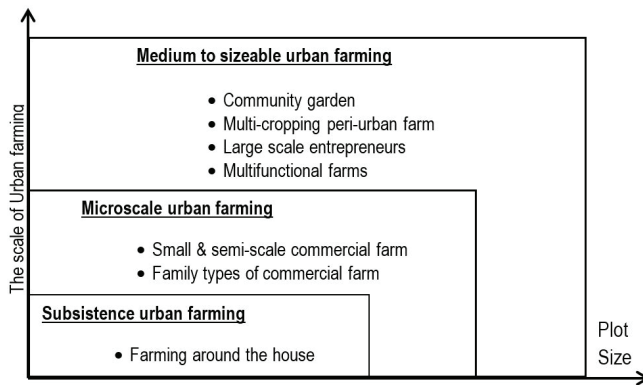


Figure 2. Scales of the Urban Farming Production System

(Source: RUAF, (2016); Noseir, (2014))

Figure 2 shows that urban subsistence farming is practised by locals that grow their garden at home. This scale of urban farming is the smallest and easiest that could be practised by the locals. Meanwhile, for microscale, urban farming includes commercialization to maximize economic benefits. This type also incorporates other recreational functions (RUAF, 2016). The most significant scale of urban farming is medium to large-scale urban farming. A larger plot is needed and more oriented towards market demand, technical knowledge and range (Noseir, 2014).

Rooftop Urban Farming: A Precedent Study

Rooftop urban farming has become a current necessity in most of the developing countries. Most of the countries with high population nowadays are practising urban farming to overcome the food security issue. There is much to be learned from precedent studies. From the management until the technologies used, all of these aspects can serve as examples for other places in a way to help tackle the food security issue. This paper has selected significant cases of rooftop urban farming applied in urban areas. This will facilitate a better understanding and impart knowledge as well as experience in the implementation of rooftop urban farming in other countries.

The selection of precedent studies in this paper is by taking into consideration the most established urban farming practice in each country. The selection of types of building used for urban farming is numerous so

that variation experience can be a useful reference in creating new urban farming, especially in the Malaysian context. Therefore, Singapore, Japan, Thailand and the USA are the countries that had been chosen as the focus of this paper. Each state will be represented by one successful and established urban farming. Most of the countries chosen are Asian except for the USA. The reason USA was selected is because it is the most prosperous farm in the urban area around the world. Therefore, the result from this comparative study will give some input on urban farming.

Singapore

In Singapore, the limitation of land for farming is limited due to the densely built upbuilding. The demands of food increase due to the rise of population. Therefore Singapore is trying to find a new solution in producing food around their city. The previous study from Hui (2011) indicated that 95% of all vegetables consumed in Singapore are imported, but through the rooftop urban farming, it can potentially produce 25% of the vegetables in Singapore.



Name	Khoo Teck Puat Hospital	 <p>The KPTH plot</p>  <p>The Green link bridges at KTPH</p>
Type	Intensive Urban Farm	
Location	Northern Singapore	
Area	2,200 m ²	
Year	2010	
Building Type	Hospital	
Produce	Vegetables & Fruits	

Figure 3. Details of Urban Farming in Singapore.

(Source: Donald (2011))

One of the recognized high-rise building in implementing urban farming is Khoo Teck Puat Hospital. This building has won the International Skyrise Greenery Award in 2010 and also Platinum in Green Mark. It is the first hospital that provides a living classroom and healing environment to help the patients enjoy the greenery. The unutilized rooftop space has been used for urban farming that produces a variety of fresh vegetables. All of the crops are served to the patients and the remaining vegetables will

be sold to the staff. The profit from this farm will be used to maintain the greenery and urban farm in this hospital. This farm has also provided job opportunities for the volunteers, including retirees and homemakers from the surrounding neighbourhoods that made this farm successful (Donald, 2011).

Thailand

The rapid growing metropolitan city in Thailand has turned the green spaces into urban structures (Suteethorn, 2011). The inspiration in turning the unutilized rooftop into urban farming is due to the loss of vegetable garden on land. Since Thailand is practising edible garden in their Thai garden, thus, the farming activity has been suggested to move to the rooftop. This is because of unutilized rooftop area which has the potential to replace the limited ground area for agriculture. Besides, in 2011, Thailand food resources are severely affected by the devastating flood in Bangkok. Therefore, the awareness of the importance of rooftop urban farm is widely spreading across the city.

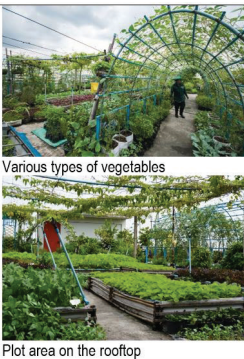
Name	Laksi District	 <p>Various types of vegetables</p> <p>Plot area on the rooftop</p>
Type	Intensive Urban Farm	
Location	Bangkok	
Area	4,000 m ²	
Year	2011	
Building Type	District Office	
Produce	Vegetables	

Figure 4. Details of Urban Farming in Thailand.

(Source: Thimmaiah (2013))

One of the good examples of rooftop urban farming in Thailand is in Laksi District office. This farm is located on the top of the seventh floor of the Laksi District office. The transformation of unutilized rooftop space into the farm comprises of 100 and more types of vegetables. In this farm, biodegradable wastes were used as resources for fertilizer and bio-pesticide (Thimmaiah, 2013). It is one excellent example for Malaysia in improving urban farming by turning the unutilized rooftop into rooftop farming in the

urban area. Most of the roofs in Malaysia are not utilized to the maximum.

Japan

In a way to transform the dense city into an urban forest, one of the ordinances in Tokyo requires each building to allocate 20% of its rooftop into a greenery area (Hui, 2011). Therefore, the establishment of a new kind of urban farming was the establishment of a rooftop farm to enable the growing of food in dense urban areas. One of the most important rooftop urban farming is known as 'Soradofarm Lumine' which has been created in Tokyo, Japan.

Soradofarm Lumine is an urban farming project which uses train station rooftops to facilitate the train passengers to train their skills, socialize and to have a relaxing place while waiting for their train. This farm is located at JR Ebisu Station, established by the East Japan Railway Co (JR East) with 535 sq. meters at the corner of the rooftop. This farm is opened to anyone to rent with the annual fee of 93,000 yen for a three square meter site and 117,000 yen for five square meters. The cost for each plot size covers the tools and gardening equipment for each member. People, including residents in the neighbourhood and commuters, are attracted to start farming here. As a result, the urban environment of the station is improved as well as able to produce some fresh, local vegetables. This type of urban farming which is rental farming will give income to the building owner. This is an excellent model to be implemented in the Malaysian context.

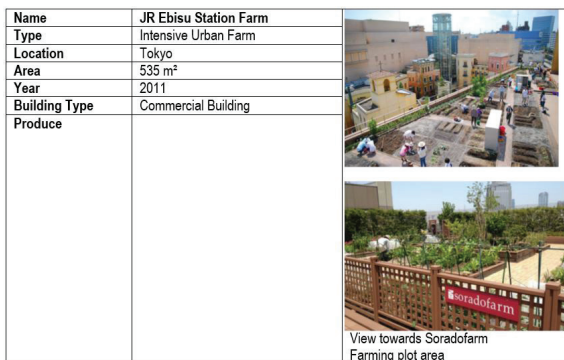


Figure 5. Details of Urban Farming in Japan.

(Source: Japan Sustainability, 2011)

USA

Food production in urban cities in the USA is excellent and demonstrated successfully (Nowak, 2004; Sanyé-Mengual, 2015). The growing demand for local fresh vegetables around the cities created the arena of the development of small business. This has created a new market for urban food production. The rooftop is the best place to create a farm in the urban area. The prominent and successful rooftop urban farming in urban cities in the USA is Brooklyn Grange. This farm was founded in 2010 and is one of the commercial-scale urban farming on the rooftop. Now the company owns two rooftop farms and a bee apiary on multiple roofs in New York. This type of urban farming gives benefits to the community and help the economy in the area too.

Other than food production on the rooftop, Brooklyn Grange also provides youth education programs through the City Grower association. This farm also provides a training program on urban farming and beekeeping (Sanyé-Mengual, 2015). Therefore, this will be implemented through the education program to educate the community to begin farming in the house compound in Malaysia.

Name	Brooklyn Grange	
Type	Commercial rooftop greenhouse	
Location	Long Island and Brooklyn, NY	
Area	4,000 m ² - 6,000m ²	
Year	2010 - 2012	
Building Type	Business building, Navy yard building	
Produce	Vegetables, honey, sauces	

Figure 6. Details of Urban Farming in the USA.

(Source: Brooklyn Grange (2011))

COMPARATIVE STUDY

The comparative study focuses on 4 countries which are Singapore, Thailand, Japan and the USA. The selection of the samples is based on the high population country that have successfully practised urban farming.

The comparison of all the case studies is in terms of the following criteria:

- a) **Types of urban farming**
All samples except the USA are private types of urban farming while the USA is more on the commercial kind. A learning centre is another role for all the examples.
- b) **Space utilization**
All of the urban farming are held on the rooftop, which were previously unutilized except for Singapore and Japan. The roof has been rejuvenated and converted for urban farming. While for Singapore and Japan, the rooftop is purposely planned for urban farming.
- c) **Climate**
The climate in Singapore and Thailand is similar to Malaysia, which is hot and humid. However there are four seasons in Japan and USA. Thus the selection of plants for Malaysian rooftops need to take these factors into consideration.
- d) **Design of urban farming**
The design of rooftop urban farming in Singapore and Japan is a combination of green roof and food production as well. While for Thailand and the USA, urban farming is entirely for food production only.
- e) **Users**
The users in Singapore are open to volunteers and patients since it is a hospital building. While for Thailand, the users are volunteers and gardening staff of the district office. On the other hand, there is a difference with Japan and the USA whereby the users are the owners and the workers. This is because urban farming has a private owner. The comparison between all the precedent studies are shown in table 1.

Table 2. Comparison between the Countries

Case study / Samples	Urban Farming				User
	Types of UF	Space	Climate	Design	
Singapore	Public & Private	Purposely create UF	Hot and humid	Farm & roof garden	Patients & volunteers
Thailand	Private	Utilized the rooftop	Hot and humid	Farm & roof garden	Volunteers & gardening staffs

Japan	Private	Purposely create UF	Four seasons	Farm & roof garden	The owner
USA	Commercial	Utilized the rooftop	Four seasons	Farm types	The owner & workers

(Source: Hui, (2011); Noseir,(2014)

The Rooftop Urban Farming: The Malaysian Context

According to the Department of Statistic Malaysia (2016), the urban population in Malaysia is projected to increase from 28.6million (2010) to 41.5 million (2040). The green area in the city is decreasing due to the projection of the building features resulting from the urban sprawling. Therefore, urban growth will increase the annual percentage of the cost of imported food and beverages. As a country importing food, Malaysia is highly exposed and vulnerable to external forces such as the rising of food prices. For instance, Malaysian food import has continued to increase each year (Zahari, 2011). Thus, to achieve national food security, it is crucial to find an alternative in producing and processing local food. Regardless of national food security, the farming sector also will provide rural employment and elevate rural incomes. Moreover, according to Nur Huzeima (2011), Malaysia has set the objective to make the country more self-sufficient with homegrown products in food production. Therefore the idea of homegrown food production will reduce the reliance on imported foods.

The issue creates the idea among the professionals in the construction industry to be innovative with the greening options not only on the ground but also on the building's rooftop which is a green roof and green wall (Nur Hayati, 2018). Moreover, the green roof can give a cooling sensation to buildings and better reduction of temperature than the white roof (Asmat et al., 2011).

Urban farming in Malaysia is not a new concept. The concept of farming was adopted a long time ago by rural folks within their residential area (Nur Huzeima and Byrd, 2011). This farming concept named as home gardening was practised and acted as a source of local foods for the households. The sharing basis of the harvested vegetables is a typical Malaysian culture (Muhammad and Rabu, 2015). As time passes, the farming activity changed its role by adapting with the socio-demographic changes and needs. The changing role is due to the issues of agricultural

land and urban poverty which emerged from the socioeconomic needs.

In contrast with the study by Rahman et al. (2013), green roof in Malaysia is increasingly common but most of the green roof are not for urban farming. In fact, the urban dwellers prefer aesthetical garden than urban farming. It is because, due to the high maintenance of urban farming on the rooftop. Therefore the purpose of having green roof should be considered in order to accelerate the benefits towards the environment, economic and social fabric.

Besides, regarding the policymaking process in Malaysia, there is always the forefront issue related to food security. There are a few policies used in Malaysia to promote urban farming. In the national Agro-food policy (NAP) 2011-2020, the primary policy measure is to pilot the development of the Malaysian agricultural sector. The policy is to address the domestic and global challenges to ensure sustainability in food security. Moreover, the policy is to tackle the issue of sustainable agriculture, land scarcity, the competitiveness of the agro-food industry and so forth. The policy also aims to modernize the agriculture system to be modern and dynamic. Modernization will enable the agriculture activity to be productive in an urban and rural area as well.

The Prospect of Rooftop Urban Farming in Malaysia

The study by Rahman et al. (2014) found that most of the urban dwellers are aware of the development of green roof in Malaysia. Thus the exploitation of green roof can be developed to be rooftop urban farming. These can be proven by the findings from a recent study by Muhammad and Suhaimee (2015) which revealed that most of the respondents are familiar with rooftop urban farming. This shows a good sign of the potential of rooftop urban farming in Malaysia. This is similar to the findings by Jafari et al. (2015) that mentioned the positive response among the urban dwellers is strong on the use of urban farming at the rooftop.

On the other hand, the study from Rezai (2014) found that urban farming in Malaysia provides several opportunities such as employment of locals, increase local income and health and food security as well. Thus, it can boost the economy not only for the urban dwellers but also for the

country.

The significance of the case studies from previous successful urban farming demonstrated that if it can be done in densely populated cities; surely it can be done in other countries. Thus, it shows that urban urban farming in Malaysia has the potential to be a success.

CONCLUSION

This paper presents the data from the previous study showing the success of rooftop urban farming. Urban farming is a new efficient concept for a sustainable and livable city. Although there are many constraints and limitations in creating rooftop urban farming in cities, the benefit is tremendous and not merely providing food supply to the city. Ensuring sustainable food security is an important task for governments all over the world. Most of the policies and strategies that have been planned and adopted aim to ensure food security in both the short and long term period.

Although urban farming in Malaysia is still in the early stages, strategic planning will be able to boost productivity. Therefore, the support from the society especially professionals in built environment is needed to reap the benefits of urban farming towards the environment, economy and society. However, the benefits could not be optimized if the citizens lack awareness and knowledge in urban farming. Thus the first stage to boost the rooftop urban farming is by introducing or educating the citizens about urban farming.

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