

Conference Paper

Urban Agriculture Development: A Strategy to Support Food Security

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Abstract

The enhancement of rural-urban migration flows impacts on the enhancement of urban population. It takes more efforts to fulfill the food demand. Now, 80% food stock in urban area is fulfilled from rural area and imports. Urban agriculture development is a strategy to improve food availability, food access and also to support food security. Some of urban agriculture models that have implemented and developed in many country were metropolitan food cluster, rooftop garden, community garden, and vertical farming. This paper is a literature review from various study, research and document relates with urban agriculture. Based on this study, urban agriculture can increase urban community prosperity, environmental sustainability and quality of health. Urban agriculture productivity needs agricultural technology innovation to ensure sustainability of production. Urban agricultural models that is integrated with agricultural technology innovation able to create a resilient urban food systems to accelerate the realization of food security.

Keywords: urban agriculture; technological innovaton; food security.

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1. Introduction

The enhancement of migration flow from rural to urban impacts on the enhancement of urban population. The urban population in 2014 accounted for 54% of the total global population, up from 34% in 1960, and continues to grow. The urban population growth, in absolute numbers, is concentrated in the less developed regions of the world. It is estimated that by 2017, even in less developed countries, a majority of people will be living in urban areas [1].

Rural urban migration resulted both positive and negative impact to sosio-economy and environment. Migration problems relate to environment are groundwater extraction, less greenland for water absorption, and agriculture land. **The earth's lands are degraded 25 percent [2]**. Land subsidence in Bangkok, Mexico and Jakarta is 10-25 cm per year because of groundwater extraction [3]. Beside that, to satisfy food demand of the population, a lot land should be available to grow the foods. Now, 80% food stock

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in urban area is fulfilled from rural area and imports. Much of this urbanization will unfold in Africa and Asia, bringing huge social, economic and environmental transformations. Urbanization has the potential to usher in a new era of well-being, resource efficiency and economic growth. But cities are also home to high concentrations of poverty. Nowhere is the rise of inequality clearer than in urban areas, where wealthy communities coexist alongside, and separate from, slums and informal settlements [4].

Dickson [5] said that 109 million hectares of new land will be needed to feed the world population in 2050 by conventional farming. In contrast, urban agriculture need less land, for example in Havana over 26,000 popular gardens cover 2,438.7 hectares and produce 25,000 tons of food each year but 299 square kilometres of urban agriculture produces 113,525 tons/year [6]. It means urban agriculture need less land but produce 4.5 times food.

Urban agriculture (UA) development is a strategy to improve food availability, food access and also to support food security. Urban agriculture may provide a source of food or income for household. UA can be defined as "small areas within cities, such as vacant lots, gardens, verges, balconies and containers, that are used for growing crops and raising small livestock or milk cows for own-consumption or sale in neighborhood markets". Furthermore, commercial urban farming reportedly contributes a significant amount of the produce and poultry products consumed in some areas of Asia and Latin America [7]. Indonesia have a program "Sustainable Reserve Food Garden" in 2010. This program involves women in the family as the main actor to use home yard optimally to cultivate vegetable and potential fruits and/or poultry and small ruminant raising [8].

2. Urban Agriculture Model

Some of urban agriculture models have implemented and developed in many country were vertical farming, community garden, rooftop garden, and metropolitan food cluster, such as Argentina, Brazil, Ghana, Srilanka, Netherlands and Indonesia. Agroecosystems are ecological systems modified by human beings to produce food, fibre or other agricultural products [9]. If only refer to an household and its farm elements/activities, it can be called a farming system.

2.1. Vertical farming

Vertical farming is the smallest models can be implemented at own garden, but it can be biggest models implemented at the main building in the city. The Vertical Farming is the advanced level of agriculture technology where this has to be practiced when

there is unavailable of land and other requirements for the perfect structure of farming mode, this is the new way or approach in the advanced level and this paper deals the methodology, harvesting technique, water management and crop cultivation and yielding process [10].

Vertical farming includes three types of farming [11]:

1. Phrase vertical farming was used by Gilbert Ellis Bailey in his book "Vertical Farming" in 1915. He introduced the concept of underground vertical farming, presently followed in Netherlands.
2. In the second category, Vertical farming is done in open air or in mixed use sky scrapers for climate control and consumption. This is a sustainable type of farming for personal or community use and it may not be for commercial purposes. A modified form of this concept involves cultivation of crops in the periphery of sky scrapers to provide them ambient amount of light.
3. Third category involves cultivation of plant and animals in the sky scrapers in the closed system for large scale cultivation. These systems under trials at various locations (Singapore, Canada, London).

2.2. Community garden

Community gardens lead to a more livable environment, creating beauty and reducing crime [12, 13], increasing home values [14], and improving the image of the community [14]. Community gardening is different from allotment, backyard, or balcony gardening in its community focus: the people growing in the garden share ideas, resources, and experiences rather than working alone.

Community garden is developed to meet the needs of the participants who come together on common ground to grow fruits, vegetables, flowers, herbs, and ornamental plants (Figure 1). Community gardens can be found at such diverse locations as schools, parks, housing projects, places of worship, vacant lots, and private properties. While all these gardens serve as catalysts for bringing people together and improving community, some of them focus on growing food for the gardeners themselves. Others donate their produce to the hungry. Some focus on education, some on nutrition and exercise, still others on selling produce for income. Some simply provide a venue for sharing the love of gardening. All community gardens provide opportunities for neighborhood renewal and beautification. Types of Community Gardens:

- Plot Gardens (divide into individual plots)
- Cooperative Gardens (work as a team on one large garden)
- Youth Gardens



Figure 1: Community Garden in Cianjur-Indonesia (a) and Utrecht-Netherlands (b).

- Entrepreneurial Market Gardens (sell produce)
- Therapeutic Gardens

Community garden in Indonesia is known as Sustainable Reserve Food Garden Model (SRFG-M). This model is implemented by involving communities and relevant parties at central and regional level. The principle of SRFG-M are: (1) utilization of eco-friendly backyard for improving food security and food resilience, (2) food diversification based on local resources, (3) conservation of genetic resources (plant, poultry and fish), (4) sustainable of foundation seed field, (5) income generation and community welfare [15].

2.3. Rooftop garden [16]

Planting on roof top can make urban living more self sufficient and make fresh vegetables more accessible to urban people. There are two types of rooftop gardens and depending on the structural design of roof. One is the extensive rooftop garden, often inaccessible and the other is the intensive rooftop garden, which is accessible to people. The difference between extensive and intensive rooftop garden i.e:

2.3.1. Extensive rooftop gardens:

- Generally lightweight gardens
- Require little or no maintenance
- Vegetation acts like another layer of the roofing material and usually covers the entire roof
- Can be installed on both flat and sloped roofs

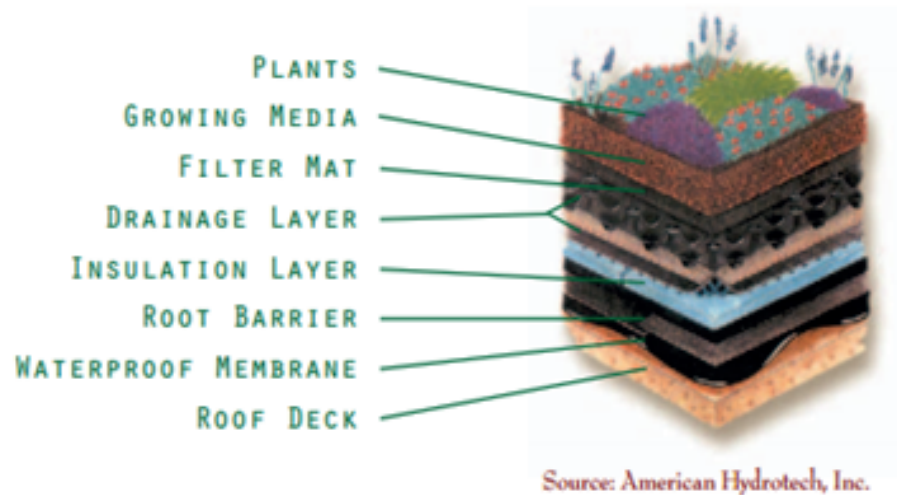


Figure 2: Green Roof Layers.

- Depending on climate and the amount of rainfall, can grow a variety of hardy grasses, wildflowers, mosses and sedums
- Use drought-tolerant plants that will go into hibernation if exposed to harsh conditions like wind and sun exposure and/or under-water.
- Since they are not generally walked upon, guard rails, exit requirements and access need not be a concern. If they will be walked on, these aspects need to be considered.

2.3.2. Intensive rooftop gardens:

- Allow for a more diverse plant selection such as perennial flowers, trees and shrubs (all of which can remain in containers over the winter) and the potential to grow food.
- Are subject to building and zoning codes, especially with respect to public safety issues, hence the need for proper exits, guard rails, and lighting.
- Generally installed on flat roofs with the vegetation either covering the entire area or in containers and raised beds.
- A stronger roof structure is required due to the added weight of people accessing the garden as well as higher soil and container weights, decking and trees all adding to the weight impact to the roof.
- More maintenance is required because of the greater variety of plants.
- Other considerations for an intensive rooftop garden include condition of roof, structural and weight capacity, access, cost, irrigation, and drainage.



Figure 3: Rooftop Garden Model in Netherlands.

Rooftop gardens (Figure 3) in cities could provide more than three quarters of the vegetables consumed in them, a case study from Bologna, Italy, suggests. If all suitable flat roof space was used for urban agriculture, rooftop gardens in the city could supply around 12,500 tons of vegetables a year whilst also providing a range of ecosystem services [17]. Planting on roofs and surrounding building can reduce heating in winter by 25 percent by protecting building from the wind, and they can cut air conditioning in the summer by 50 to 75 percent [18].

2.4. Metropolitan food cluster

Cofino (2015) said Metropolitan Food Cluster (Figure 4) is an innovative network of agrifood producers, processors, and service provider which is focused on the urban areas. It aims to optimize resource use efficiency, market connectivity and embeddedness in the wider social, spatial, and institutional frame work. The Metropolitan Food Clusters (MFC) concept aims to address these issues by transforming rural landscapes close to urbanised areas into climately robust, sustainable food production areas through optimisation of agro-logistics, linking food production areas to internal and external markets and positively affecting social and economic development [19].

In this model, Agro Park (AP) are spatial cluster of high productive plant and animal production and processing units in industrial mode combined with the input of high level of knowledge and technology. The application of industrial ecology reduce

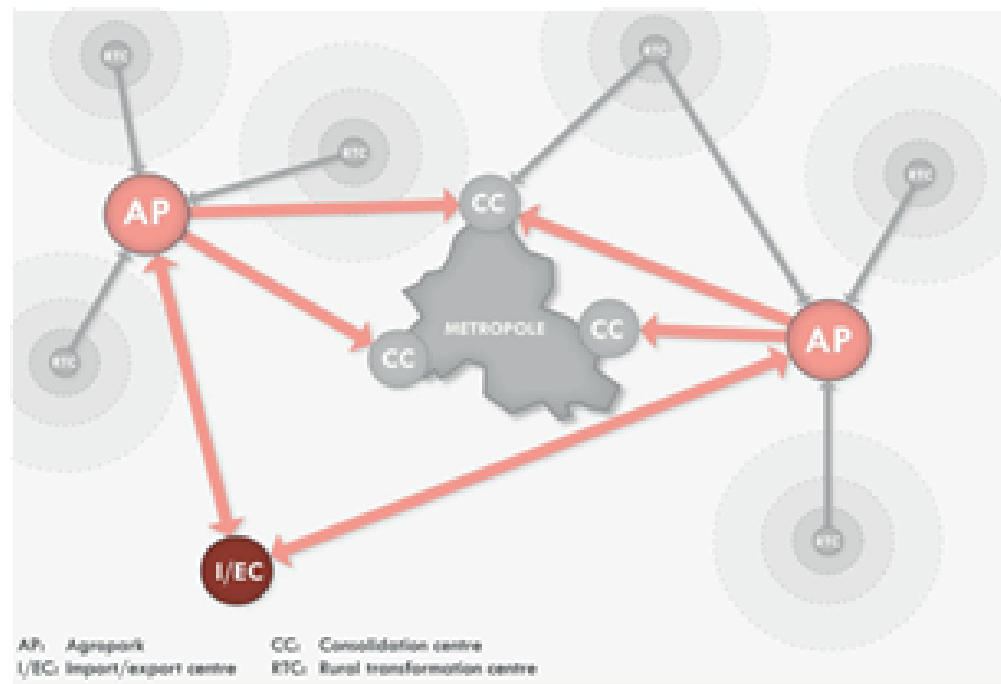


Figure 4: Metropolitan Food Cluster Model (Cofino, 2015).

costs and environmental emissions. Consolidation Centre (CC), products, both raw and processed coming from the rural environment or from specialized agroparks, are combined with import flows, if necessary be processed further, and then recombined and distributed into the metropole. Rural Transformation Center (RTCs) are satellites in rural areas where the inputs form land dependent production for the whole network are collected and/or processed. RTCs provide training and education to capacitate farmers to increase their productivity.

In Indonesia, this similar model is implemented by Agro Techno Park (ATP) in several provinces. Agro Techno Park is done through pilot area, counseling, training and business incubation for farmers and stakeholders in the area so that technological innovation can be adopted. Furthermore, surrounding communities can easily access their food because of more availability. Now, Agro Techno Park become agrotourism destination that we can find the information about agriculture start from farm to table. Figure 5 show Agro Techno Park (ATP) in several province in Indonesia.

3. Urban agriculture and food security

3.1. Urban communities prosperity

Food is a basic need that must be met for every people. People in rural areas can produce their own food while people in urban areas are dependent on purchased food. Most of the food in the cities must be purchased and the poor people can spend 60-80



Figure 5: Agro Techno Park (ATP) in Garut, West Java, Indonesia.

per cent of their income on food [7]. If the price of food is high, the food security of many urban households, particularly of the poorest sections of society, is undermined. In these circumstances, the quantity of food consumed reduces, and the diversity and nutritional quality of the food purchased also tend to decline. If they can produce the food from their backyard, automatically will reduce household expenses.

Urban agriculture may promote food security through income generation [21]. Study of Indonesian Agency for Agricultural Research and Development, noted that implemented urban farming or Sustainable Food Reserve Garden increased revenue for cayenne pepper IDR 80,000/month, for another vegetables IDR 50.000 /month, while saving household expenditure range IDR 195.000-715.000/month [22]. Implementation of Sustainable Food Reserve Garden in Kuta Baro District Aceh can increase household's income until IDR 400.000-750.000 for every harvest [23].

Urban agriculture contributes the food security of many major cities, both as an important component of the urban food system and as a means for vulnerable groups to minimize their food insecurity problems. City case studies indicate a considerable degree of self-sufficiency in fresh vegetable and poultry production. For example Dakar produces 60% of vegetable consumption while poultry production amounts to 65-70% of the national demand [24], Accra, 90% of the city's fresh vegetable consumption is from production within the city, Dar es Salaam, more than 90% of leafy vegetables come from home gardens [26].

3.2. Environmental sustainability

Urban agriculture can make environmental sustainability. Traditional farming need more 50% water and land resources than vertical farming. Environmental benefits of urban agriculture are often mentioned in the same breath as the potential environmental hazards (e.g., soil degradation, siltation of water courses). Urban agriculture conserve energy and water resources, and contributing to urban environmental sustainability. Waste from harvested agricultural and animal manure can be used for fertilizer, and waste water for crop irrigation. The reintegration of the waste stream with agricultural production has been recognized as a necessary precursor for environmentally sustainable urban communities [27, 28]. Urban agriculture can be a non-polluting land use [29, 30], reduce transportation energy needs, and packaging waste [31, 32]. Urban agriculture also can reduce green house gas emission (GHG) effect which is the main cause of the increasing temperature in urban cities.

3.3. Quality of health

According to data available from the World Health Organization (WHO) the growing problem of food-borne illness is global. The latest information from the WHO is from 2010 with initial findings showing that hundred of millions of people worldwide are getting sick from contaminated food (WHO, 2010).

Urban Agriculture can provide more nutritious food, which can result in better health. Higher quality food can benefit residents of low-income communities and has the potential to address chronic medical conditions. Improved access to fresh fruits and vegetables can be an effective way to combat chronic medical conditions such as diabetes, high blood pressure, heart disease and obesity. Proper nutrition can reduce chronic medical conditions among adults, which better prepares persons to acquire the skills and education needed to overcome poverty. In Java, home gardens provide for 18% of caloric consumption and 14% of proteins of the urban population [34].

3.4. Technology Innovation

Urban agriculture productivity needs agricultural technology innovation to ensure sustainability of production. Urban agricultural models that is integrated with agricultural technology innovation able to create a resilient urban food systems to accelerate realization of food security. This issue highlights innovations in urban agriculture. Innovation and the various forms of innovations are of particular importance because urban

agriculture is adapted to specific urban challenges and opportunities. Innovation is taking place continuously, exploring the multiple functions of urban agriculture, including food security, income generation and environmental management [35].

Besides technology innovation such as farming like vertical verticultur, cultivation of vegetables on seedbed, shelves gutters and polybag, Efficient fertilization technology and eradication of plant pests and diseases is needed for other innovative technologies. Urban agriculture can be implemented on backyard, buildings or city land. It needs less fertilizer, water, sunlight, etc. When every house in town apply urban agriculture models and agricultural produce are overflow, so it is need technology innovation. Technology innovation is postharvest technology, where is can be extend the shelf life and diversification product. For the next, urban agriculture have 2 division, 1) Fresh product divison and 2) Processing product division.

Postharvest technology is handling processing agricultural produce to get high quality vegetables and fruits. Minimize damage to crops, vegetables and fruits can be done through handling technology includes material washing vegetables and fruits are safely, waxing technology for fruits, shelf life and biodegradable packaging. Local product can be sell on local restaurants and retailers. It has developed more flexible contract conditions regarding dedicated time and price, as well as volume of products. For example, on Spain have method and brand emerged from a collaboration between local municipalities, restaurants, consumers, land owners and unemployed people in order to guarantee the preservation of rural territories and agrarian landscapes by enhancing agrobiodiversity and self-employment [36].

Processing technology includes further processing to be processed into food products. The process of changing agricultural products into food products can extend the shelf life and improve value-added. For example, when tomatoes or chilies are over-produced it is necessary to process them into jam, pasta and drinks. This can be done to other agricultural products, not only vegetables and fruit. Crops such as tubers are also able to be processed and used as a secondary food products to improve value-added.

4. Conclusion

Urban agriculture contribute positively and significantly to food security, where can reduce poverty level and hunger. Urban agriculture can reinforce every household to face food crisis through income generation and quality of food. Futhermore, it make a chance for every household to produce their own food, they have easier to access to quality diet. Food expenditures may also be reduced so they can fulfill the other needs. Therefore it is necessary have new breakthrough to develop urban agriculture in order to enhance the role and contribution, both in developed countries and even more in developing countries.

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