

# SUSTAINABLE URBAN FARMING THROUGH COMMUNITY BASED AQUAPONICS Case: Kandri Village, Semarang

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## Abstract

Aquaponic is a combination of aquaculture and farming method without using soil. This farming system utilizes fish feces as a source of nutrition for plants and the use of plants to control water quality for fish. The local residents in Kandri Village tried to build aquaponics farm in their settlement. Initially, there were some problems of aquaponics development. The aquaponics materials and tools used still limited and many residents have not been interested in supporting aquaponics. However, they realized to gain knowledge and improve the conditions of the aquaponics system in their settlement with the community development. This study aims to explain the process of developing and utilizing aquaponics that they have been done. Discussion of research results refers to the concept of sustainable urban farming. The results of the analysis have seen that a movement in the community to be involved in developing aquaponics system continuously and establish cooperation with various parties. The indications show starting one aquaponic, then it developing into more than seventy aquaponics in their private houses and the public areas. The characteristic of community-based is working together to mutual gain in aquaponics.

**Keywords:** *Sustainable urban farming, aquaponics, community development*

## 1. INTRODUCTION

Urban farming is a dynamic concept that consists of various livelihood systems ranging from production and processing at the household level to more commercial agriculture. It can be explained that urban farming is not only in the form of agriculture but also in other forms such as stockbreeding, food production and others (Nordahl, 2009; Veenhuizen, 2007). The variety of farms includes small-intensive agriculture and livestock, food production in housing, land sharing, rooftop gardens, greenhouses in schools, restaurants that are integrated with gardens, food production in public spaces, and vegetables production in vertical space (Hou, Johnson, & Lawson, 2009; Mougeot, 2005; Redwood, 2009). Urban farming has become a common practice in many cities by involving communities in a variety of ways (Tornaghi, 2014).

The history of urban farming development has been going on for a long time with various backgrounds. At first, due to war and natural disasters in the Middle Ages, people made a way to get food supplies, one of them was making plantations in empty spaces. They began to grow fruits, vegetables, medicinal plants and flowers for themselves. In the 1890s, the Detroit, Michigan government created a program known as Potato Patch to encourage its citizens to plant on urban land (DiDomenica & Gordon, 2016). The industrial revolution also caused the rise of urban farming in the UK. The government provides a garden for workers. The goal is that they can grow their own food ingredients. Urban farming introduced to the public during the food and economic crisis in the United States during the world war. In the second world war, the United States made a Victory Garden program that is the activity of building a park in the city space (Belinda & Rahmawati, 2017). Through these activities school, children and families plant crops so they can eat fresh food.

Kaethler (2006) has classified urban farming into two types based on the extent of agricultural land. The two types of urban agriculture in question are small-scale urban agriculture and large-scale urban agriculture. Small-scale urban agriculture is the urban agricultural activity which has an area of less than 1,000 m<sup>2</sup>. Large-scale urban agriculture can be used for livestock, horticulture, and nurseries.

**Table 1. Urban Agriculture Categories of Use**

	Primary Parcel Category		Subset Category	
<b>Category</b>	Large-Scale Growing Operations	Small-Scale Growing Operations	Community Gardens	Growing on Impervious Surfaces or Poor Soil
<b>Size</b>	>1000 m <sup>2</sup>	92-1000 m <sup>2</sup>	150-14000 m <sup>2</sup>	465 m <sup>2</sup>
<b>Use</b>	CSAs, urban farms, community orchards, animal husbandry, horticulture, nursery, beekeeping	Farm stands, educational gardening programs, composting, vermiculture, food bank gardening, herb growing, beekeeping, market gardens, edible landscaping, fruit trees	Gardens with individual or communal plots; gardens with shared space and resources	Vertical gardening, indoor growing (sprouts, mushrooms, aquaculture, vermiculture), greenhouses, farm stands, processing facilities, farmers markets, container gardening, hydroponics

Source: Adapted from Kaethler (2006)

In the Table 1, there are two types of urban farming, namely community gardens and planting on surface land. Community gardens are urban agriculture that is carried out in groups by a community. Land area for community gardens activities of at least 150 m<sup>2</sup>. In this activity, the role of individuals and communities is needed. Urban agriculture with community gardens can be used as communal plantations. Urban agriculture can also be done on a surface or bad land and is not resistant to water. The area of land used for agricultural activities is 465 m<sup>2</sup>. Examples of urban agriculture with these types are vertical gardens, hydroponics, indoor plantations such as mushroom plantations, sprouts, aquaculture and vermiculture (Kaethler, 2006). In addition, to optimizing urban land and utilizing available resources, urban agriculture also maintains environmental sustainability with green open spaces. Continuing community participation is a factor in the sustainability of urban agriculture. There is a difference between conventional versus sustainable urban agriculture (Steele, 2017). Therefore, sustainable urban farming is very possible for small groups of people who care about healthy food production. As illustrated in Table 2.

**Table 2. Conventional versus Sustainable Urban Agriculture**

Conventional Agriculture	Sustainable Urban Agriculture
National/international production, processing and marketing	More local/regional production, processing and marketing
Concentrated with fewer farmers	Dispersed with more farmers
Large, capital-intensive production	Smaller, low-capital production
Impersonal and consumerism	More personal, community self-sufficiency
Competition focused-farming as business only	Community focused-farming as rewarding, a way of life
Domination of nature	Harmony with nature
Production maintained by agricultural chemical-synthetic fertilizers, pesticides, herbicides fungicides	Production maintained by development of healthy soil, use of integrated pest management techniques
Specilization: monoculture crops with single-cropping in succession	Diversity: poly-cultures with multiple crops grown in complementary rotations
Separation of crops and livestock	Integration of crops and livestock
Standardized production systems	Locally adapted production systems
Exploitation: reliant on nonrenewable resources, focus on short-term benefits over long-term consequences, external costs often ignored	Restraint: consideration of all external costs, concern with short-term and long-term outcomes, focus on renewable resources and conservation of non renewable resources

Source: Adapted from Beus, C.E. and Dunlap. R.E (1990) in Steele (2017)

Urban farming is also attractive to the government and society because it supports the concept of food security, where the conceptual focus on these activities can meet the four pillars, there are: availability, access, utilization and stability, in accordance with the 1996 World Food Summit (WFS)

definition: "Food security is a time when everyone has physical and economic access to sufficient, safe and nutritious food to fulfill their food needs for an active and healthy life" (Pemberton, Mgonja, De Sormeaux, Patterson-Andrews, & Mwaisango, 2016).

Besides the urban farming system, one of the most important issue in a meeting the basic needs of the community is the result of quality and sustainable food. Therefore, many food products that do not encounter health requirements are found on the market. Vegetables and fruits contain a lot of toxic ingredients that are not good for health, even though both types of food are highly recommended for regular consumption, because it is good for health. Health experts from the Environmental Working Group (EWG) explained the results of their research on vegetables and fruits, from the results of 68% of the research trials recorded containing pesticides. Pesticide content even remains attached after washing or peeling the skin. Various types of pesticides used have the potential to be carcinogens or can cause cancer, interfere with the production of endocrine hormones, and can disrupt with children's growth and development (Congleton, 2012).

In such situations, it is not surprising that many communities group appear to avoid these hazards, one of which is farming through the aquaponics. This system is a combination of aquaculture methods with farming methods without using plants media in the form of soil (hydroponic) which can be placed on limited land (Duarte et al., 2015; Hart, Webb, & Danylchuk, 2013; Somerville, Cohen, Pantanella, Stankus, & Lovatelli, 2014). The aquaponics is an agricultural system that utilizes fish manure as a source of nutrition for plants and the utilization of plants as a controller of water quality for fish, hence it is said that aquaponics is a method of sustainable aquaculture and agriculture, both of which form mutualism dependency (Bernstein, 2011; Somerville et al., 2014). The results of aquaponic are organic fish and vegetables that are very good for human consumption. The existence of this farming is expected as an alternative to sustain sustainable urban agriculture that can be seen in the context of its influence on the economy, social and environment.

Awareness of the fulfillment of healthy food is developing in aquaponics farming communities in various places, one of which is the aquaponics community in RW IV of Kandri Village, in the District of Gunungpati Semarang. The residents who attempted to develop an aquaponic in their private house in 2016. Initially, there was one aquaponic cultivation system, and even then there were still many problems faced. First, the aquaponic materials and tools used still limited. Second, the cultivation system of fish farming and raising is still simple. Third, many residents have not been interested in making aquaponics in their settlement. These various constraints and shortcomings did not dampen the process of aquaponics development in RW IV of Kandri Village. For this reason, the research question is about the process of sustainability of urban farming through community-based aquaponics in Kandri Village. Why do people support the realization of this aquaponic village?

## **2. METHOD**

This research applied qualitative method, this is in accordance to the aim to explore deeply the contemporary phenomena in the form of community activities for urban agriculture through the aquaponics system in RW IV Kandri Village, Semarang. The descriptive qualitative research approach is a case study and qualitative analysis tool carried out by collecting data in the form of data other than numbers, namely words or images. Qualitative models are used to examine a condition of a natural object not an experiment, where the position of the constituent is as a key instrument, sampling the data source. Data collection in this study was conducted both primary and secondary such as literature review, documents, interviews, and observations. This study applied semi-structured interviews where interviews

of this type were also included in the category of in-depth interviews (Merriam, 2002; Nasution, 1988). The participants are key persons who know and involve in Aquaponic Kandri activities. Then according to the rules of the case study research, the researcher will be open to all data that can explain the case so that here the data will be combined with triangulation. Tools and techniques such as observation, in-depth interview, preliminary meetings, inter-group meetings and workshops were used to gain stakeholders' participation (Auesriwong, Nilnoppakum, & Parawech, 2015). The sample of participants was determined purposively by people based on the specific characteristics of the sample (Bungin, 2003).

### 3. RESULT

Kandri Village with four RWs (*Rukun Warga*/community unit) has been designated as a tourism village because the potential of the local economic development carried out by the local community. Each RW in Kandri Village is expected to have its own tourism potential and characteristics, namely: RW I is developed as an educational and natural education tourism. RW II is a natural tourist destination, such as outbound, camping, and village exploring. RW III is one of main destination in Semarang as located nearby the Jatibarang Reservoir and Kreo Cave. Only RW IV itself does not have an identity as a tourist destination, so the idea appears to form a thematic village.

Apparently without realizing it, this aquaponics system became one of the leading tourism potential concepts in the village development in RW IV. The government always hopes that RW IV will soon have the unique-characteristics that can support the status of a tourist village as well as 3 other RWs. Of course, this is not easy, People who really understand this system are still few. Hence, the community have tried to develop community and inter-social learning to change this condition. The support of the college accelerates the development of community-based aquaponics by taking into account the aesthetic aspects, functions and systems of agricultural and fisheries cultivation optimally and sustainably. Most people feel that this new idea is good and beneficial their environment, so they want to try to make it happen.

As in the theory that thematic village ideas generally come from below, where residents decide on a topic and prepare unique tourist attractions based on local potential. The identity of a village can produce a unique characteristic and increase the sale value of their own village and can create additional sources of income (Kloczko-Gajewska, 2014; Kłoczko-Gajewska, 2013). This situation has caused the community to be enthusiastically involved in further developing their settlements with certain characteristics, one of which is considered capable of improving the quality of settlements is aquaponics.

#### **The process of aquaponics development**

The local resident who initiated the beginning of aquaponics as urban farming in a small area. The role of this figure is to experiment with various types of plants and fish that are suitable for development by the community. Initially, there was one aquaponic cultivation system, and even then there were still many problems faced. First, the materials and tools were still limited as it was used materials. Second, the cultivation system of fish farming and raising was still simple. Third, there was no social support or other citizens to make an aquaponics system in the village.

Therefore, community development is an issue of aquaponics system in this society. It contains components such as goals, media, makers of social change, targets, principles of compliance and techniques. The purpose of community development efforts can be financial or other benefits. The medium is a way of communicating like face to face, training, discussion and so on. The actors can be a person or group, while the target can be an individual, household or community group. The principle of compliance refers to the reason why the target receives the request of the social engineer, which raises the

principle of compliance generally due to: 1) Friendship, people are more willing to comply with requests from friends; 2) Consistency, people are more willing to comply with consistent requests; 3) Scarcity, people are more willing to comply with rare or rare requests in availability; 4) Reciprocity, people are more willing to comply with requests if the applicant has treated them well in the past; 5) Social validation, people are more willing to comply if seen as socially correct things to do; 6) Authority, people easily obey the requests of others with more authority (Mouton, Leenen, & Venter, 2016).



**Figure 1. The first aquaponic in 2016 and it’s modification in 2108**

*Source: Field observation, 2016 and 2018*

To create an educational tourist destination by developing of an aquaponics tourism village in Kandri Village, community development efforts have been carried out through community empowerment which broadly cover various activities, while the chronology of community development can be seen from RW IV aquaponics that has been done with various activities, as seen in the figure below:

**Table 3. Chronology of Aquaponics Village Development**

2016	2017	2018	Expectations
Social Learning, Community Development, Aquaponic development in many places.	Networking strengthening Aquaponics system training and manufacturing Replication in private houses	Replication elsewhere Marketing for aquaponic farmers' production Social learning and training	<b>The Aquaponics Village</b> , as an educational tour and training that is able to meet basic needs, especially healthy food

*Source: Analysis, 2018*

There are two groups for aquaponic tourism development community empowerment. The first group had a role as a social engineer, in this case, aquaponic activists then received government support through the head of RW IV. Indeed, the support of aquaponic activists from the national level and university played an important role in the development of the correct aquaponic technology system. This was realized by the activists because the various results of research related to aquaponics were the difficulties of regulating natural nutrients produced in this system, even they use sophisticated tools to measure water quality at any time (Duarte et al., 2015; Hart et al., 2013; Kyaw. & Ng., 2017). However, the first group convinced the ordinary people who can apply simple technology of aquaponics, but still used the principles of physical and micro biology system to get good nutrition for organism in aquaponics system. The first group conducts regular discussions and training activities for making aquaponics in households with personal awareness.

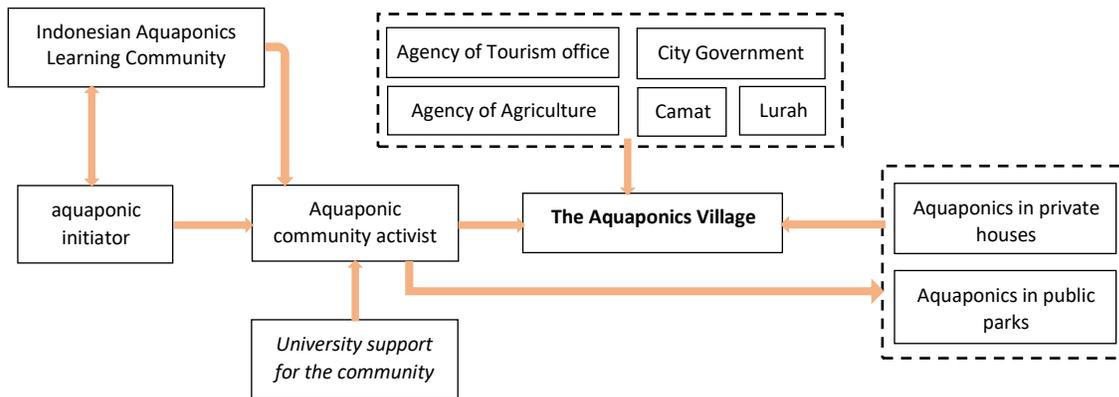


**Figure 2. Training on making aquaponics in the private house**

*Source: Field observation, 2016*

The second is the community, which at first were not interested in farming with an aquaponics system. The first group realized the importance of having a unique village or known as a thematic village, as expected by the city government. The second group tried to follow the activities of the first group, because they felt the acceleration of development and more government attention to their village. As in Community Based Tourism is a concept of tourism village development by involving and placing local communities who have the authority to manage and develop their own regions to improve the welfare of local communities and the sustainability of local culture and natural resources (Syafi'i & Suwandono, 2015).

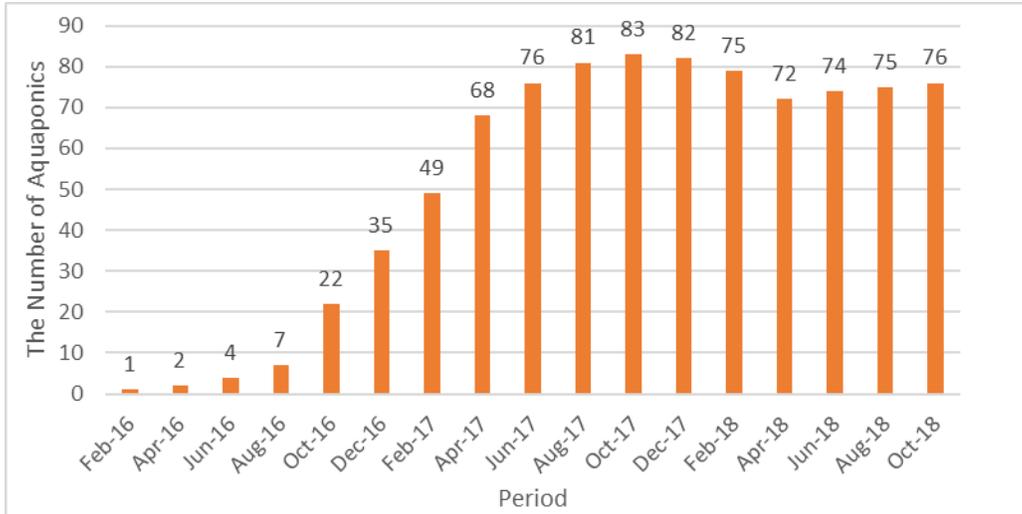
The community empowerment process goes through training, discussion, information that is quite massive from the aquaponics community activist or first group. They have many networks with outside parties to support the establishment of the Aquaponics Village. The lines of coordination of the development are as follows:



**Figure 3. Stakeholder relations in The Aquaponics Development**

*Source: Analysis, 2018*

As in the previous information, the aquaponics development in private houses are based on the willingness of the residents themselves, after they know the benefits of aquaponics. Whereas the aquaponics building system in the public park is assistance from the aquaponic activist, the government and other parties that support the development of the aquaponics Village. As for, the trend of the aquaponics developments in RW IV can be seen as follows:



**Figure 4. Trend of aquaponics in public parks and private houses**

*Source: Analysis, 2018*



**Figure 5. Map and figures of aquaponics in private houses**

*Source: Field observation, 2018*

#### 4. DISCUSSION

From the study of the aquaponics program in this village, it was seen the community has done agriculture with a very limited area. They believe urban farming with aquaponics is one of the solutions to meet healthy food needs. The activity shows that the current form of urban agriculture has very diverse systems. In the past, people planted the media using soil in pots in their home yards. At present, people are doing urban agriculture without using soil media, as seen in this system.

This condition shows that the community knows the benefits of urban agriculture programs. It can be used as a way to optimize the land and natural resources in urban areas. According to Kaethler (2006), the benefits of urban agriculture are in various aspects, namely: a. Food security; b. Safe environment; c. Education; d. Culture; e. Community improvement; f. Recreation; g. Economy; h. Health; i. Sustainability; and j. Food supply. In order to understand the sustainability of urban agriculture in the aquaponics village, every aquaponics actor must pay attention to the success factors of urban agriculture.

The success of urban agriculture is influenced by several factors. The attention and responsibility of each individual, community and government are important factors in the course of urban agriculture programs. Socialization and communication between the government and the community and individuals who run urban agricultural programs also need attention. There are three key factors to the success of sustainable urban farming programs. The three factors are production, processing and distribution (Steele, 2017). Argument of each key factor in the success of urban farming is as follows:

#### *Production factor*

Production factors are important factors because the purpose of farming with aquaponics systems will be determined at this stage. Production activities refer to what will be used as agricultural objects, whether they are plants or animals. It is also necessary to determine whether the results from agriculture can be consumed by humans such as vegetables, fruit, meat or even cannot be consumed such as fertilizer and animal feed. In the production activities also need to be prepared urban design that will be carried out. The land for aquaponics system does not need to be extensive, but to get optimal results, more land is needed, so production activities can run well. At this time, fish and vegetables production of Kandri Village are used for the community itself and its neighbors, the amount of its are too little to be sold out of the residential area.

However, some people have realized the need for communal aquaponics in a wider area than their private houses. Moreover, they have been able to breed fish and vegetables, which will be maintained in the aquaponic system on a larger scale. The community hopes to have conditions for sustainability production, especially for additional income.

#### *Processing*

Another factor that influences the success or failure of urban farming is the processing of agricultural products. Urban agricultural products can be directly utilized by the community as food ingredients or can be sold even reprocessed to add to the sale value. In the Kandri Village case, aquaponic products are mostly to meet their own needs, so that financial benefit as a part of sustainability cannot be achieved. The packaging process was only the first step taken by the community, but the results were not yet marketed, still for their own consumption. Actually, agricultural products in the form of food such as fruits and vegetables can be reprocessed into jams, juices, syrups, cakes and so on. Fish cultivation can be packaged as organic products, even fish fillets can be processed into nuggets. Processing agricultural products into new products can increase value of sales, so that the income of urban communities can also increase as well.

#### *Distribution*

The last success factor of urban farming is distribution. Distribution activities are related to marketing or marketing activities. The distribution of agricultural products is very important for people who carry out large numbers of urban agricultural activities. Distribution is done to get more selling points and increase their income. Agricultural products carried out by urban communities can be distributed in various ways. First, it can be through direct distribution. Direct distribution is a distribution activity that directly connects between farmers and consumers. Through this method consumers can directly choose existing agricultural products. Farmers can also market agricultural products to the community. In addition farmers can sell to restaurants, schools or cooperatives. The government can also take part in the distribution and marketing process. One way that can be done is to form a market that is specifically for urban agricultural products. In this way, the community will more easily sell their agricultural produce.

If referring to processing and distribution as the main factors for sustainability, Kandri Village still takes a long time to become sustainable. The current stage is the community's efforts to develop aquaponics that are more economically profitable, with the developing of an aquaponics that is shared together in a wider place.

#### *Sustainability of urban farming*

The stages that occur in aquaponic villages are social learning in aquaponic development. The development of aquaponic aquaculture systems is due to a large number of people who make aquaponics in their private houses by aquaponic activists training. Sometimes they don't know the correct system of how to do aquaponics system, the technology of mechanical filters, biological filters and sump tank containers circulated to plant media. They often conduct to try and error to produce quality fish and vegetables. The results of the cultivation are mostly used for daily food additions, they cannot yet sell to the market. If the community does not immediately improve the process of making the aquaponics correctly, then they can become bored, because the quality of their cultivation is lacking. As the facts happened in the aquaponics village, there has been a decrease in the number of people who have aquaponics. Although, currently there is an increase in the number of people who have aquaponics.

However, there are some people who realize the importance of production, processing, and marketing. This can be indicated by the willingness of the community to use the properly of aquaponics technology, in a wider area and they make it on an optimal scale of production. Entrepreneurial awareness is very important to maintain urban agriculture, this is an important part of sustainability. The principle of management through entrepreneurship can further enhance the role of the aquaponics village (AdrianaTisca, Istrat, Dumitrescu, & Cornu, 2016; Yogatama, 2017). The aquaponics village is a part of educational tourism, be aware that sustainable tourism development is built to understand the relationships between tourism impacts and community identity. If the community is able to develop sustainability through an economic approach, hopefully the results will be better (Hwang, Stewart, & Ko, 2011).

## **5. CONCLUSION**

Regarding the sustainability of urban farming, the conclusions from the discussion above are as follows:

The principles in aquaponics technology strongly support the quality and sustainable urban farming, especially to produce organic food. To get good aquaponic results, cooperation between community members is needed, because their land is small-scale.

Aquaponics on small-scale requires collaboration between community members, so that aquaponic products can be more optimal and varied. Community-based aquaponics plays a role in supporting the sustainability of urban farming activities. The members collaborate based on ability and capacity in aquaponic development. Starting from a simple aquaponics, then they develop a lot of aquaculture and plants continuously through filtering technology in simple water circulation.

Aquaponics activist groups explain the benefits of making aquaponics in their settlements so people can feel the benefits when they participate in the aquaponic development, especially the results of vegetables and organic fish products for their own needs. In addition, the enthusiasm of the community emerged in realizing this village because they hoped to become an aquaponic thematic village.

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