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2022

“Sustaining the
Resilient, Beautiful and Safe Cities
for a Better Quality of Life”

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**“ Sustaining the Resilient, Beautiful and Safe
Cities for a Better Quality of Life ”**

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AQUAPONICS FARMING METHOD AS A SOLUTION FOR SUSTAINABLE FOOD SECURITY

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Abstract

Aquaponics has quickly become a well-known solution for sustainable food production. The term "aquaponics" is made up of hydroponics and aquaculture and was first used in the 1970s. It is a production system that is innovative and intelligent, a method that integrates aquaculture (fish production) with hydroponics (plant production in water without soil). It plays a significant role in the future of environmental and socio-economic sustainability, especially in highly developed urban areas, by reducing city waste and improving urban biodiversity and air quality. In other words, it contributes to ensuring food security for the urban community through enabling local, fresh, pesticide-free, and healthy production with short supply chains in cities. Due to this fact, aquaponics meets several objectives of sustainable development, and it is the best option to apply as an urban farming method. Currently, Malaysia is emphasizing agriculture due to food insecurity as well as the traditional farming system, climate change, and environmental agenda. Since aquaponics can contribute to environmental and socio-economic sustainability, several objectives have been developed for this project. The first objective is to provide a workable and affordable aquaponics method of implementation in a small or confined place so that it can be used by residents in the apartments. The successful implementation of aquaponics can have a positive impact on the environment, economy, and society. It is also hoped to provide a circular economy that would sustain the business and make it profitable to the society in the long term. The second objective of this project is to enhance food security and ensure sustainable food production is applied when implementing the aquaponics system, as it can be used to improve the livelihoods of households and communities. To achieve the project objectives, firstly, there is a need to develop strategies focused on raising awareness of the aquaponics system among Malaysians. This can be materialized through collaborative governance that takes into consideration the contributions of government and the private sectors. Next, a continuous training and up-skilling program needs to be introduced to generate more knowledge and enhance the participants' skills. This training would be able to develop value-added marketing skills among the participants and increase their ability to apply circular economy principles to their projects. It is crucial for the participants to have knowledge of fish, bacteria, and plant production in order for the implementation to be successful. To conclude, the aquaponics system is very sustainable and environmentally friendly to be applied in urban areas. The urban community sees it as an economically oriented way to operate as their supplier of food, and the impact would reduce their household cost of living.

Keywords: *Aquaponics, Food Sustainability, Urban Poor, Circular Economy.*

INTRODUCTION

South-Eastern Asia has been expected to experience rapid population growth since the mid-twentieth century and is projected to meet its peak population size in the coming decades (United Nations, 2019). The rapid population migration (urbanisation) raises the rate of urban poverty and population in the developing regions (Rezai et al., 2016). This will cause a threat to food security, which is not a single global threat but rather the result of endless food supply chains that mostly extract food from rural regions.

Ensuring that human activities adhere to the principles of sustainable development is currently one of the biggest concerns in environmental management around the world (Xu et al., 2013). A system called the circular economy was developed to reduce the consumption of energy, natural resources, and waste production (Aleksić and Šušteršič, 2020). A circular economy for food deliberately impersonates natural regeneration processes so that waste does not really exist but rather serves as the feedstock for another cycle (Ellen MacArthur Foundation, 2020). The lack of arable land and the scarcity of water resources, particularly in emerging countries, have been recent issues in agriculture (Mateo-Sagasta et al., 2017).

Aquaponic systems were developed as a means of addressing these issues (Hochman et al., 2018). Aquaponics describes the combination of growing vegetables with keeping fish. Therefore, it is a closed-loop system in which animals living in water, mainly fish, and useful plants, such as herbs, fruits, or vegetables, are together. Whether the fish are also used for food production depends on personal preferences. The term "aquaponics" is made up of hydroponics and aquaculture and was first used in the 1970s (Goddeck et al., 2019).

Moreover, aquaponics is a sustainable food production system that reduces input and waste by incorporating circular economy principles and a biomimetic ecological system (Obirikorang et al., 2021). The system produces nutritious food naturally without the use of chemical fertilisers or pesticides and can be implemented anywhere there is a suitable water supply. In other words, it helps in ensuring food availability for the people and ultimately enhances food security. It demonstrates a hopeful future for the sustainable development of urban food production (Li et al., 2018), and offers better economic potential compared to traditional agriculture as well as fewer negative effects on the environment (Obirikorang et al., 2021).

In the new modern days, farming practitioners have evolved and adapted new technologies as well as new knowledge on the development of farming. It provided ecological benefits by reducing the city wastes and improving urban biodiversity and air quality. This great effort is working together with the SDG, Goal 11, that emphasizes sustainable cities and communities (Basar et al., 2022). Recently, the Covid-19 pandemic created a new and unanticipated global threat that posed a catastrophic international public health issue unparalleled in recent history. The disease, which was declared an intense and extreme concern by the World Health Organisation in January 2020, impacted the UN's Sustainable Development Goals (SDGs), with serious consequences for social and economic welfare (Su et al., 2022).

The effect of the Covid-19 pandemic may be prolonged and trickier compared to other financial crises. In Malaysia, at the household level, particularly among the B40 community especially in the urban areas, the Covid-19 pandemic's effects are increasingly crippling their ability to buy healthy and affordable food, particularly for households that spend up to 70% of their income on food (NSTP, 2021). Aquaponics might be the most sustainable solution to ease the economic burden of this group.

Aquaculture has benefited from technological advances made possible by the circular economy. Aquaponics use may be beneficial in countries with limited agricultural production capacity, rapid urbanisation, and exponential population growth (Mchunu et al., 2018). Since aquaponics appears to be able to maintain ecosystems and strengthen their resilience to climate

change, extreme weather, drought, flooding, and other disasters, it has gained popularity due to its advantages over traditional production methods (Yildiz et al., 2019).

As a result, aquaponics is receiving more and more attention as a critical component of achieving sustainable food production in the battle against poverty and food insecurity, both in urban and rural areas (FAO, 2015). Aquaponics is also regarded as one of the "ten technologies that could change human lives" because of its ability to supply the expanding urban population with nutritious food (Van Woensel, 2015). Aquaponics is also acknowledged as a sustainable food production method since it mimics a natural system and adheres to the circular economy principles by reusing nutrients and water (Goddek et al., 2015).

Aquaponics is in line with the Sustainable Development Goals (SDG) that were introduced by the United Nations (UN). It was a global action call to all participating countries to eradicate poverty, protect the environment, and secure peace and prosperity for all people. After years of consultations and negotiations with governments, civil society, businesses, and other stakeholders from all participating countries, the SDG was finally adopted with 17 goals and 169 targets on September 25, 2015 (United Nations, 2020). This is a major turning point in the pursuit of a more inclusive and sustainable future for all.

Therefore, the application of the aquaponics farming method in urban farming is the best option due to it being the most sustainable in nature. The circular economy concept that is incorporated into the aquaponics system would benefit the community in the future. It has the ability to boost economic development, improve food security and nutrition, and become a new way to address the global food supply challenge by maximising resource efficiency (Li et al., 2018).

Problem Statement

People have started to adopt urban farming as a hobby. They grew plants and raised animals/fish in their own backyard, apartment balconies, and a small corner of their house. There are various types of urban farming. The most sustainable in nature is aquaponics. It is a combination of conventional aquaculture (raising fish in tanks) and hydroponics (no soil plant cultivation technique). This means the food can be produced in a symbiotic environment while using less land (Molden, 2007). The nature of urban farming is always associated with food security. It grows plants and raises animals to improve food supply, health conditions, economic development, social networking, and environmental sustainability. Urban farming is farming activity in towns, cities, and/or urban environments. The plan is to sustain household food availability throughout the urban community.

Urban farming in Malaysia was first initiated in 1974 through "Program Bumi Hijau" and "Pembangunan Keluarga Tani". The program helped to mitigate the economic crisis and food security issues. It was found to be effective in reducing the rate of inflation by raising households' income through community involvement in agriculture. Today, the Malaysian government and its related agencies have contributed a lot to making urban farming gradually popular and highly adopted among urban communities (Othman et al., 2017). This reflects the vital role of the community in urban farming activities that are implemented within urbanised areas (Yusoff et al., 2017).

The problems that most aquaponics projects and service provider companies are facing are in disseminating the goodness of urban farming into the community, developing the strategy to sustain the implementation, and creating the courage to pursue farming continuously. This is due to little knowledge from the people in the community, small initial capital, and perceptions or sceptics about the success of urban farming. Moreover, aquaponics is a complicated system that encompasses three distinct concepts: fish, plants, and microorganisms. It needs to be thoroughly maintained, thus making it harder for the people to initiate the implementation.

Urban farming has shown its contribution to food security. However, there are possible drawbacks to every system that might limit or even erase its potential. Such problems are particularly common in developing countries and impoverished places where functional infrastructure, such as regulation, sanitation, and education, has yet to be developed or is in disarray (Catrina, 2018). The objectives of the paper are to provide a workable and affordable aquaponics method of implementation in a small or confined place; to enhance food security and ensure sustainable food production is applied when implementing the aquaponics system and to educate the community about aquaponics. To achieve these objectives, the following questions will be discussed:

1. What is the workable and affordable aquaponics method of implementation in a small or confined place?
2. How to enhance food security and ensure sustainable food production is applied when implementing the aquaponics system?
3. How to educate the community about aquaponics which should lead to them accepting it?

LITERATURE REVIEW

In order to approach the goal of this research work, the study defines aquaponics as a sustainable food production system implemented in urban areas. This includes a definition of sustainability as well as aquaponics. Subsequently, the implementation in urban areas is discussed, followed by issues and challenges that can occur. The section is concluded with a more detailed examination of the conceptual framework.

Sustainability

Sustainability - a word that has become increasingly prominent in almost all areas of life in recent years, but this is not a new concept. In everyday language, the term is associated with longevity and environmental protection, among other things, but "sustainable development" refers to the responsible use of the earth's finite resources. In short, sustainability is the ability to exist and develop without depleting natural resources for the future. The United Nations (2022) definition is "meeting the needs of the present without compromising the ability of future generations to meet their own needs".

The 2030 Agenda for Sustainable Development (UN, 2015) was adopted at the United Nation General Assembly that was held on September 25, 2015. There are 17 Sustainable Development Goals (SDGs) to be achieved by the member states over the next 15 years (until 2030). The 17 SDGs seek to ensure a sustainable, peaceful, prosperous, and equitable existence on Earth for all people now and in the future (the 5Ps of SDG; People, Planet, Prosperity, Peace, and Partnership). Therefore, in response to SDGs, there are six SDGs that were found to be incorporated into aquaponics (Goals 2, 6, 9, 12, 14 & 15). Goal 2 emphasises eliminating hunger, enhancing food security, boosting nutrition, and promoting sustainable agriculture. Aquaponics can efficiently provide food for everybody while also earning a living. It also encourages rural development and environmental conservation. Goal 6 is to ensure that everyone has access to clean water and sanitation, and that water resources are managed in a sustainable manner. Finally, conserving water by reusing it and treating it to make it safe for fish and plants allows for long-term water management.

Goal 9 focuses on building durable infrastructure, supporting long-term industrialization that benefits everyone, and fostering innovation. Goal 12 creates long-term consumption and manufacturing habits. Thus, aquaponics allows for sustainable consumption patterns of fish and vegetables. Goal 14 is to protect and develop oceans, seas, and marine resources in a sustainable way for the sake of long-term development. Goal 15 preserves and restores terrestrial ecosystems so that they can be used in a sustainable way. The goal is to

defend the environment from desertification, prevents and reverses land degradation, and stops biodiversity loss. Finally, aquaponics is also a fish-saving strategy.

Cooperation between the government, entrepreneurs, and the community is not always likely to be smooth. After all, the mindsets of all groups of people are quite different. As a result, the effective performance incentives are also quite different. When it comes to a situation dominated by such controversies, it is important for efficient progress that achievable goals are set for everyone, and that attention is paid to the sustained high motivation of those involved. The importance of mutual respect and careful communication must also be brought to the fore because one must always keep one's bearings and not lose one's bearings. All those involved speak quite a different language. But the results of the development process are valuable for all three parties. The following sections take a closer look at the three parties involved: the government, the company, and the community.

The Government Support

The history of urban farming in Malaysia started with “Program Bumi Hijau” and “Pembangunan Keluarga Tani” in 1974. These programs are the extensions of “Rancangan Buku Hijau”. The main objectives of “Rancangan Buku Hijau” are to maximise land development involving short-term crops, farming, and freshwater fish husbandry, to improve the marketing of agricultural products, to increase food production, to improve people’s incomes, and to reduce inflation.

Today, the foundation of urban farming in Malaysia has been evolved to meet the current situation. Urban farming is also a constituent program of Local Agenda 21 (LA21) Malaysia to promote sustainable development at the local level by creating and strengthening cooperation between local authorities, local communities, and the private sector. It encourages the urban community to actively participate in urban farming activities. The target is always the low-income group in the urban area due to the high cost of living.

Key stakeholders, either from the government or the non-government and private sectors, are the most relevant entities in sustaining urban farming projects (Ramaloo et al., 2018). The survey also discovered that key stakeholders had a "significant influence" in bringing together government and non-government organisations as supporters of the urban agriculture initiative. Based on the study's findings, it is suggested that key stakeholders sustain funding, start-up support for future community urban farming, enhance knowledge-sharing among urban growers, provide a wide range of activities in the gardens, attempt to involve young people, and promote ongoing community consultation and engagement.

It must therefore be involved in aquaponics urban farming projects, especially if the government is considered a funding institution in this context. Initiatives to integrate urban food production must therefore be publicised preferably by the government, as it has the most influence.

The Business Involvement

Another formal institution is represented by companies that have either knowledge about aquaponics or are generally willing to support the aquaponics project as well as the urban community in any way possible. Companies occupy an important place in today's society. Acting sustainably and assuming social responsibility are therefore part and parcel of modern entrepreneurship. There are now many ways for a company to become socially involved. What is the most suitable form in each case depends not only on the resources available, but also on the corporate philosophy.

A few of the possibilities to help include equipping and training the community with information, such as through training. Many companies manufacture products or sell services. One way of social engagement is to provide manpower or their products. Another way of

providing social support as a company is to give employees who want to be socially involved time off, for example, for a certain number of hours per week. In this way, social thinking among employees is being motivated, and society is being supported at the same time. Of course, a company can also simply donate money or goods. Probably the most classic form of social commitment is monetary donation. With monetary donations, the possibility is given to the receiver to choose freely what to do with the money. Donations in kind are, just like monetary donations, very diverse. The exciting thing about this form of donation is that the company can make a very concrete difference with its donation, which in many cases can then also be shown publicly. Overall, formal institutions play an important role in the planning, for the construction and commissioning, as well as for the operation of the aquaponics project.

The Community Acceptance

The concept of urban farming is not new to many cities in the world. Many cities have their own concept of urban farming. The cities create a better linkage between urban farming and food systems. Some examples of urban farming in the cities are Aero Farm (Newark, USA), Agricool (Paris, France), BIGH Farms (Brussels, Belgium), Bites (Phoenix, USA), Bowery Farming (New York Metro, USA), Fresh Direct, (Abuja, Nigeria), GrowUp Urban Farm (London, United Kingdom), Liv UP (Sao Paulo, Brazil), Pasona Urban Ranch (Tokyo, Japan), RotterZwam (Rotterdam, The Netherlands) and Sustenir Agriculture (Singapore).

The concept of the food systems in the cities has proven that urban farming could overcome the urban poor issues as well as increase the food in the crop production systems. However, the application of urban farming is relatively new in Malaysia (Norah et al. 2017). People in the high-rise condominiums, for example, plant food crops for self-consumption or potted plants for landscaping.

Making sustainable urban farming is a challenge to be faced. Urban farming can be successful when the urban community perceives urban farming positively and accepts urban farms in their community. In some other countries like England and China, urban farming is practised in diverse settings of space and time. The findings show that farmers make strong connections with the land and with other farmers as well as with members (Liu et al., 2017).

On the contrary, Malaysia is experiencing a lack of contribution and support among the public towards urban farming (Yusoff et al., 2017). Therefore, throughout the years from 2014 to 2016, the Malaysian government and its related agencies have contributed a lot to make urban farming gradually popular and highly adopted among urban communities (Othman et al., 2017). This reflects the vital role of the community in urban farming activities that are implemented within urbanised areas (Yusoff et al., 2017).

The influence of the urban community in its participation in urban farming projects is based on their motivations. The difference in their attitudes and lifestyle characteristics (Othman et al., 2019), level of cognitive, affective, and behavioural aspects (Zainal and Hamzah, 2017) are factors that influenced their acceptance towards urban farming in Malaysia.

Aquaponics

Cities have seen a significant growth in the population in recent decades. Urbanisation has become a major global trend, and supporting it demands provision systems for many aspects, such as infrastructure, commerce, tourism, and employment generation. This growth is accompanied by increased food demand from rural areas, which is linked to supply chains.

Agriculture has long been an essential aspect of human life and an economic pillar. Food security for a rapidly growing population, as well as climate change, are major concerns in this area. Climate change starts with a global rise in temperature, accompanied by droughts, floods, and other unpredictable events that are becoming more frequent. Production systems in urban areas have been developed to address food supply issues in cities (David et al., 2022).

Compared to rural agriculture, growing food in urban areas has a few crucial advantages, namely proximity to markets, fresh food provision, and decreased transportation costs (Artmann and Sartison, 2018). Additionally, local food production has fine consequences in lowering negative environmental effects because of its insertion in urban areas, advertising of the local economy, and strengthening social development (Goldstein et al., 2016).

Vegetable production in urban gardens, buildings and/or house roofs, and hydroponic systems are the most likely agricultural food production model in urban centres (Rufi-Salis et al., 2020). Aquaculture, the fastest developing livestock activity in recent years, has followed this trend and developed relatively effective technology for implantation in urban centres. Aquaponics is one of these technologies.

Aquaponics describes the combination of growing vegetables with keeping fish. Therefore, it is a closed-loop system in which animals living in water, mainly fish, and useful plants, such as herbs, fruits, or vegetables, are together. Whether the fish are also used for food production depends on personal preferences. The term "aquaponics" is made up of hydroponics and aquaculture and was first used in the 1970s (Goddeck et al., 2019).

In order to better understand aquaponics, first, the term "hydroponic" must be discussed in more detail. Hydroponics refers to the cultivation of plants in nutrient-rich water without using an organic growing medium such as soil or sand. The origins of this method of cultivation go back a long way. For example, the hanging gardens of Babylon already corresponded to an ancient hydroponic system (El-Ramady et al., 2014). Nowadays, these plants are increasingly used for commercial vegetable cultivation. The most common crops are tomatoes, cucumbers, and peppers.

When it comes to aquaculture, organisms living in water are bred for food production. Besides breeding fish, it is also possible to breed molluscs and crustaceans. As with the breeding of mammals, there are different variants of aquaculture. The operation of an aquaponics system is simply explained. Basically, the combination of aquaculture and hydroponics eliminates the main problems of both systems. Due to the lack of organic matter, nutrients, and minerals in hydroponics, these must be supplied manually. Water delivery is a problem in aquaculture, especially at high densities. The end effect of both is an increase in operating costs. In aquaponic systems, this cost factor does not exist. Here, the fish poop and urine serve as fertiliser for the plants, and the plants filter the water for the fish.

Aquaponics has quickly become a celebrity in sustainable food production. It has the potential to produce food, fish, and vegetables in a sustainable and pollution-free manner (Stickler, 2022). Adapting the arrangement to the landscape and available resources is also critical. To put it another way, aquaponics is a viable option in many situations, but not all of them. While aquaponics is an intriguing alternative to traditional fish farming, it is not without faults. While an aquaponic system is a much more sustainable way of producing food, humans must monitor and optimise it on a regular basis. At the same time, the fish may have improved living circumstances because of this. The guidelines include ample space, clean water, and high-quality feed.

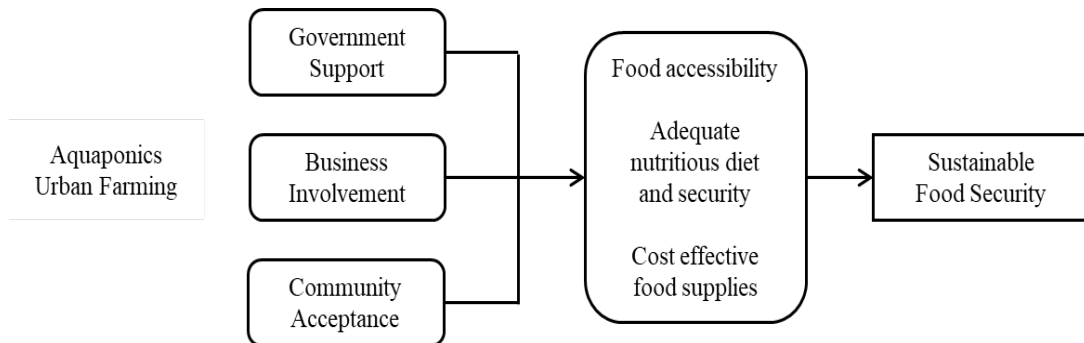
Aquaponics is also only partially accurate in terms of being a closed-loop system. Most systems rely on importing fish feed, which incurs ongoing costs as well as an increased risk of contamination. Water pollution is naturally more or less severe depending on the quality of the fish feed. The costs rise if you rely on ecological and consequently "clean" feed (Stickler, 2022). Plants, in addition to fish, play an important role in the aquaponics cycle. It also becomes clear that the term "closed system" cannot be fully realised at this point. An aquaponic system cannot provide this complexity because soil is full of trace elements, symbiotic relationships, and living things. While fish manure is an excellent base fertiliser, most plants, such as greens, tomatoes, or cucumbers, are not meant to grow in water alone. As a result, more nutrients are required to ensure flavour.

Conceptual Framework

Based on the discussion in the previous section, the study presented the following framework to achieve the objectives presented earlier.

Figure 1

Association between aquaponics urban farming and sustainable food security



The above framework, illustrated by Figure 1, incorporated the government support, business involvement, and community acceptance of the concepts as information independent variables that would determine the success of aquaponics as an urban farming method. The integration and commitment of the three parties would determine food accessibility, adequate nutrition, and security and ensure cost effective supplies for aquaponics farming. And ultimately, the aim of sustainable food security is achievable.

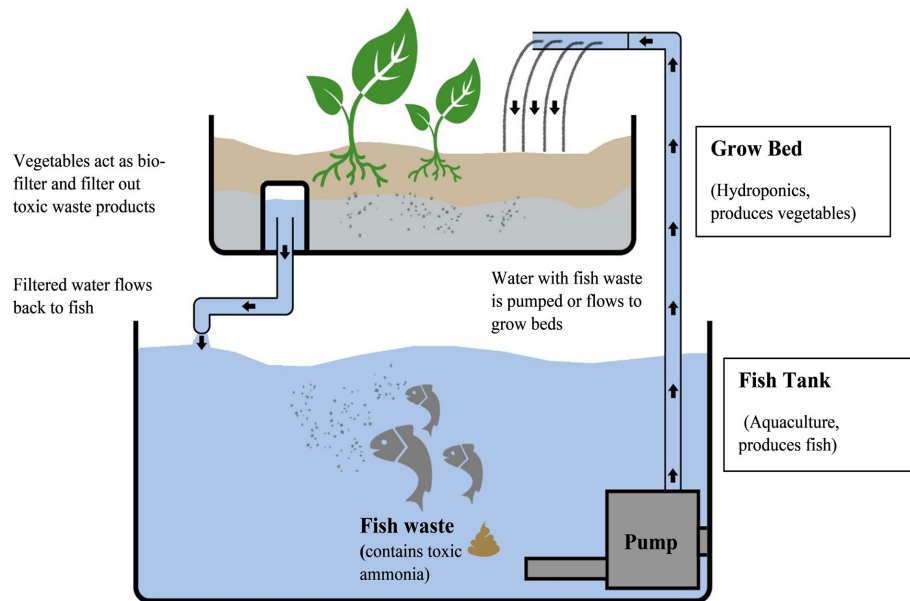
AQUAPONICS METHODS

There are two Aquaponics systems that can be set up by the businesses and community namely the DIY Aquaponics System and Vertical Aquaponics System.

1. DIY Aquaponics System



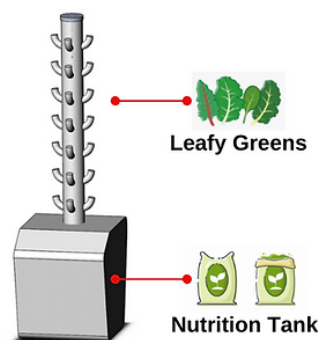
The system is credited to a DIY aquaponics inventor, Salak Tinggi Selangor.



This is the most common and cheapest version of the aquaponics system for household usage. It is a DIY version of an aquaponics system. The system is able to supply a small amount of vegetables and fish to cater to small families or newly wed couples. In one continuously recirculating unit, culture water that contains fish metabolic wastes is expelled from the fish tank. The water is filtered mechanically to remove solid waste, and then it is put through a biofilter to convert ammonia to nitrate. The water eventually returns, cleansed, to the fish tank after passing through plant grow beds where plants absorb nutrients. In the biofilter, bacteria can live and transform fish waste into readily available nutrients for plants. The plants then absorb these nutrients that have been dissolved in the water. By cleaning the water and eliminating harmful nitrogen compounds like ammonia and nitrite, this technique of nutrient removal supports the symbiotic growth of bacteria, plants, and fish. Thus, assuming the system is appropriately balanced, all the organisms work to provide a healthy growing environment for one another.

2. Vertical Aquaponics System

Vertical Aquaponics Hybrid AVF 101



The system was developed by Urban Farm Tech Sdn Bhd.

Growing plants in columns above a fish tank without the use of soil is one aquaponics technique called a vertical aquaponics. This technique is well-liked by aquaponics gardeners since it allows for both gardening and fish farming while using less water and space. In addition, by growing vertically, an aquaponics gardener can grow and produce twice as many plants as they could with a media-based aquaponics system in the same space. The nutrient film technique (NFT) aquaponics method is mostly used in vertical aquaponics. The plants are produced using the NFT aquaponics method in a long, narrow channel. Due to its simple yet efficient design that functions well in a variety of conditions, NFT is a hydroponic growing method that has been adapted to aquaponics. The grow channels in the NFT method are arranged horizontally, whereas they are arranged vertically in the vertical system.

The concept behind vertical aquaponics is to split the PVC pipe tubing into numerous tiny pockets where plants can grow. The vertical garden is placed above the fish tanks to maintain the system's simplicity. The water temperature, ammonia, nitrate, and pH levels must all be balanced and observed, and the fish must be in good health. The nutrient-rich water is transferred from the fish tank to the top of the vertical aquaponics towers using a small pump. Water flows back into the fish tank after passing through the roots of the plants and absorbing oxygen from the atmosphere. Since the tubes won't be filled with water, air will circulate around them, supplying plants' roots and leaves with the oxygen they require.

The cost of setting up this system is RM800-RM1,000. For vertical plant towers, leafy greens such as bok choy, kale, spinach, choy sum, amaranth, etc., and herbs such as sweet basil, mint, chives, cilantro, etc., can be planted in the system. For fish, the company recommends tilapia, patin, and catfish.

Implementation in Urban Areas

Feeding a growing world population, the resulting resource demands, environmental pressures, and increasing competition for land pose major challenges to food production. For sustainable, resource-efficient, and adaptable food production, modular bio-based production systems (MBBP) in urban areas represent a new approach. Among them, the aquaponics system. Forecasts predict that the world's population will continue to increase and, moreover, that most people will live in urban areas (Our World in Data, 2022). This leads to the question of how a growing, urbanised world population can be adequately supplied with high-quality food in the future. Not only that, but many people cannot afford to buy fresh vegetables or fish on a regular basis, for example. Here, the income gap also plays a crucial role. Therefore, it would be advantageous for those in particular need to have the option to grow their own food at home, preferably as a community. The goal is to implement an aquaponics system in an apartment complex for the community of that building to maintain it and share the harvest together.

As the literature points out, urban agriculture has received little attention. However, for an aquaponics farm to provide food, all that is needed is daylight, water, electricity, fish food, plants, and fish. This means that the implementation anywhere, even in urban areas as focused on in this assignment, should not be a big issue.

DISCUSSION

The concept of aquaponics is popular among communities in Australia and the USA, but the concept is yet to be known by most Malaysians. Nowadays, the aquaponics method of urban farming is slowly gaining attention among urban communities due to its benefits, and the method is the most sustainable (Rafee, 2015).

In Malaysia, there are 19 areas that are called urban. The areas include the Klang Valley, Penang, and Johor as the top three most urbanised areas in Malaysia, which comprise about 76% of the Malaysian population and experience 4% of annual growth (Department of

Statistics Malaysia, 2020). This is expected to result in the rise of a slew of urbanisation-related issues. The high cost of living, inadequate fresh food supplies, incapacity to buy quality and nutritious food, people focusing on job security, and so on are some of the most urbanisation-related issues that have been discussed recently.

This leads to the question of how a growing, urbanised population can be adequately supplied with fresh, quality food in the future? The majority of urbanites cannot afford to buy high quality fresh vegetables or protein on a regular basis, for example. Here, the income gap also plays a crucial role. Therefore, it would be advantageous for those in particular need to have the option to grow their own food at home, preferably as a community.

The main concept of urban farming is to cater to the increasing demand for fresh food in urban areas. In Malaysia, the foundation of urban farming has been evolved to meet the current situation. Urban farming is also a constituent program of Local Agenda 21 (LA21) Malaysia to promote sustainable development at the local level by creating and strengthening cooperation between local authorities, local communities, and the private sector. It encourages the urban community to actively participate in urban farming activities. The target is always the low-income group in the urban area due to the high cost of living. Therefore, the Malaysian government has to play its role to ensure the sustainability of aquaponics urban farming.

The government's efforts to encourage urban communities to participate in the greening program are well accepted (Mohd Rashid and Rasmuna, 2015). For all that, special attention needs to be given to urban farming, and it should be an outstanding part of the government policy towards sustainable development in line with current needs. Additionally, perhaps as a strategy to realise the policy leveraging agricultural investments is through education and training. They should be implemented to empower the knowledge, awareness, and attitude of younger generations towards urban farming. It is the most important element to improve the cities and provide better services according to the needs of the population.

In addition to formal institutions, informal institutions are also relevant for the development and implementation of MBBP in urban areas. The economic success of such novel innovations depends on how society accepts the new idea (Poulsen Spiker & Winch, 2014; Sanyé-Mengual et al., 2015; Specht et al., 2015). Various studies have concluded that high-tech forms of production (such as aquaponics or vertical farming) have low acceptance in society (De Wilt and Dobbelaar, 2005; Specht et al., 2016). The reasons for rejection often not only lie in the insufficient knowledge about these production types (Specht et al. 2016), but also in (a) negative affective attitudes (e.g., regarding the combination of fish excreta and crop production) (Milicic, Thorarinsdottir et al., 2017), (b) negative perceptions regarding animal welfare (Zander and Hamm, 2010; Milicic et al. 2017), and (c) personal attitudes (e.g., vegan lifestyle) (Milicic et al., 2017).

As already mentioned, one difficulty for aquaponics marketing is communicating the concept and its sustainability. This usually requires explaining the entire process to interested consumers and justifying why the plants are not kept in the ground and the fish are not kept in open water. It must therefore be achieved to convince most consumers of aquaponics after a detailed explanation of the advantages in terms of circular thinking and resource efficiency. Although the population indicates a high willingness to pay significantly more for food produced in an environmentally conscious and transparent manner, they seem rather reluctant to embrace aquaponics. One explanation could be that the complexity of the production system makes the processes and effects of aquaponic food production difficult to communicate. Among other things, they must also be prepared to accept the keeping of fish in tanks as animal-friendly after appropriate explanations. However, this high communication effort makes it difficult to market aquaponics and to implement it in urban areas.

Furthermore, multiple studies show a greater rejection towards the production of animal products (such as meat, milk, cheese, fish, or eggs) compared to plant-based production in

urban areas (Specht et al., 2015; Specht et al., 2016). Important motives are, on the one hand, the fear that one's quality of life could be affected by smell or noise, and on the other hand, that the urban environment is perceived as an unnatural space for animal production (Specht et al., 2016). Therefore, when marketing products from aquaponics systems, the personal needs of consumers should also be addressed. For example, even when buying organic products, selfish motives play a decisive role.

Finally, it can be said that there are three main issues and challenges, namely acceptance of aquaponics, knowledge transfer, and motivation (e.g., attitude, lifestyle) of users. Against the background of current discussions and societal trends towards more conscious nutrition and sustainability, it is necessary to investigate whether consumers or citizens would judge aquaponics production systems as sustainable and animal-friendly and value the products produced therein as high-quality (regional) products. To gain acceptance, aquaponics products and processes would have to be perceived as healthy.

SIGNIFICANCE OF THE STUDY

This study would be beneficial in an effort for aquaponics farming methods to be implemented as a solution for sustainable food security. The recommendation of this study would benefit many parties that are involved directly or indirectly, such as society, the government, and the aquaponics industry.

Firstly, this study is expected to develop several ways to raise awareness and educate the community about aquaponics, which should lead to them accepting it. Other than that, this study is expected to provide a workable and affordable aquaponics method of implementation in a small or confined place. The conceptual framework provided in this study may help society and companies in the aquaponics industry to sustain aquaponics implementation. The findings in this study are also expected to provide feasible ways to enhance food security and ensure sustainable food production is applied when implementing the aquaponics system. Further research is encouraged to be conducted to enhance the findings of this study.

From the study, it can be recommended that a change in agricultural methods can further improve the food security situation. The introduction of technology in agriculture brings opportunity to the urban community to venture in urban agriculture. Despite the advantages, there are several challenges in the planning and execution as well as the implementation of aquaponics urban farming among urban communities in Malaysia.

CONCLUSION

The purpose of this paper was to estimate the potential contribution of the aquaponics method as a solution to sustain food security, especially among the urban community. Studies that were conducted by various scholars provided a good sign of the potential development of urban farming technologies towards city communities in Malaysia. Urban farming is seen as supporting agriculture in a more economically oriented way and providing direct access to fresh produce close to urban communities. Besides, urban farming brings an affordable approach to minimise spending, especially for the low-income group, and enhance dietary quality and food diversity while addressing consumers' preference for local food. In addition, the key factors that encourage respondents to implement urban farming community programmes are the components of benefits, namely, reducing daily costs, improving the quality of fresh produce, and continuing programme existence and association. However, urban agriculture will only be successful if it is accepted and perceived positively by those living in proximity.

The application of urban farming technologies provides the opportunity to improve the quality of life, drive the economy of the community and provide a positive impact, as well as a good platform for community engagement. Consequently, this finding will be advantageous

in addition to promoting stronger community interdependence to create a sustainable urban farming community.

Looking ahead, aquaponics farming makes urban farming practices highly relevant and realistic to meet the needs of urban residents and should be reinforced in terms of government support and policy interventions to provide an even greater impact in the future. However, the success of establishing the urban farming community programmes is not a matter of a short time frame. It demands a comprehensive strategy from the government, the implementing agencies, and the community awareness to further enhance national food sovereignty, whether in the present or in the future.

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Tuan,

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Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

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Saya yang menjalankan amanah,

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