PUBLIC SPACES THROUGH URBAN FARMING

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ABSTRACT

Urban farming can help in many ways in creating public spaces with an engaging environment. Restaurants and shops can be opened that sell the locally grown crops, tours and workshops can be given through the urban farms and Other products like compost, DIY kits and biodegradable materials can also be sold. To enhance the individual urban farming functions, in- and outputs from each farm can be connected to create circular flows within the system. These flows ensure that less outside materials are needed in the farm, and improve efficiency and cost effectiveness in certain circumstances. Table 6.2 in the appendix gives a rough estimation on how big the flows need to be in order to sustain the urban farm. Based on the findings we can conclude that different function clusters like, a production centred function, a social interactivity centred function and a public farming centred function can be created and that existing restaurants and canteens can be integrated within the system.

KEYWORDS

Urban farming, public spaces, local food, health, transformation

1. INTRODUCTION

1.1 What is urban farming

Urban farming is a broad categorization for all the different kinds of farming that happen in an urban setting. This means that the different farming methods that fall under this category can be incredibly diverse and serve completely different functions. Urban farming can generally be divided into two further subcategories, private urban farming, and public urban farming. Private urban farming has a focus on crop production and monetary gains, whereas public urban farming usually focuses on alternative benefits like social cohesion and the public health. Examples of private urban farming are: Vertical farming, hydroponics, aeroponics and hydroculture. Examples of public urban farms are: small greenhouses, raised beds and allotment gardens. Some of these private farms could also be used in a public setting on a smaller scale, like aquaponics and hydroponics, but this is relatively rare and seen to a lesser extend.

Private urban farming could help with providing an extra source of food for the country, this is relevant because it is estimated that the Dutch population will increase to roughly 19.5 million by the year 2050 (Statistics Netherlands, 2021). Which in turn also means that our current food production to feed the entire country needs to increase as well. The Netherlands already has a high density with an average population density of 508 people per km2 (Worldometer, 2022), this means that further expanding the agricultural sector by conventional means could prove difficult because 54% of all the land available in the Netherlands is already being used for agricultural means and there is barely any space left for expansion (CBS, 2021). These private urban farms are a lot more space efficient compared to conventional farming, as multiple layers of plants could be stacked on top of each other, and new innovative cultivation methods could be used in these controlled settings compared to conventional farming (Tasgal, 2021). As a trade-off these urban farms however have a considerably larger energy consumption and start-up costs compared to their conventional counterparts (Butturini and Marcelis, 2020).

Public urban farming on the other hand focusses on helping with societal problems like improving the mental health and well-being of people. The surrounded greenery helps with reducing stress (Bennett and Swasey, 1996), and therapeutic gardening can be used to improve mental health by lowering depression and anxiety (Yang et al., 2022). Public urban farming could also stimulate social interactions between people, and allows people to grow their own healthy food instead of needing to rely on stores.

1.2 Improving the TU Delft campus

The TU Delft wants to focus on creating more liveliness on the campus and wants to create a larger connection with the rest of the city (TU Delft, 2019), currently if you are not a student, teacher or researcher there is little reason to go to the campus, with most of the facilities focussing on research and education. This focus on research and education also means that there is little to no reason to stay on the campus after dusk, as most of these facilities close around that time, leading to the campus feeling abandoned at night. Besides these social focusses the TU Delft also wants to create a CO_2-neutral and circular campus by 2030, through renovating old buildings and creating new ones with these factors in mind. In 2019 the TU had a carbon footprint of 49.165 tones of CO_2 with the largest contributor being gas for warming and electricity with 20.273 tones, and second largest being food consumption with 14.225 tones (TU Delft, 2021).

The thematic research question will look into how urban farming can help with creating public spaces to improve social activity and liveliness throughout the campus. Researching this part specifically has a large impact on the design of the selected spaces and on the campus as a whole, as the campus currently mostly consists of private and semi-public buildings. Here we can also look into the different forms of urban farming, how these could be used to strengthen these public spaces and how these urban farming functions can be combined into clusters to strengthen each other. The thematics research question is then also:

In which ways can urban farming help with creating public spaces on the TU Delft campus, and stimulate an engaging environment?

Sub questions that could help with answering the thematic research question:

- Which different urban farming functions could help with creating a desirable public space with healthy food options, social participation and an identity, and what are these functions characteristics?

- Which variations of urban farming can benefit from each other's flows and could therefore best be clustered together, and which can be placed independently?

- How big do the urban farming functions need to be to sustain these public spaces, and how does this translate to the consumption of energy and supplies of these spaces?

2. METHOD

The thematic research question and sub questions can all be researched through different methodologies. The sub question: 'Which different urban farming functions could help with creating a desirable public space with healthy food options, social participation and an identity, and what are these functions characteristics?' Will be looked at through a combination of a literary study and case studies. After studying various examples of all the different farming methods we create a comprehensive list of all these different methods, how they could be used for a public space, and include findings on how their characteristics like area, efficiency, accessibility to people and benefits on health.

The sub question: 'Which variations of urban farming can benefit from each other's flows and could therefore best be clustered together, and which can be placed independently?' Is researched through a literature study and case studies, and helps with creating a better understanding on the flows that happen in these facilities. By constructing individual smaller flow charts for each function with all the inputs and outputs of all the different urban farming methods we can assess where, for example, the by-product of one farm could benefit the other.

The sub question: ‘How big do the urban farming functions need to be to sustain these public spaces, and how does this translate to the consumption of energy and supplies of these spaces?’ Will be researched through a location analyses and literary study. Through the location analyses we can roughly estimate how many people will make use of the area, and through the literary study we can then define the required area, the produced amount of food, energy consumption and plan of requirements for each function.

The main question: ‘In which ways can urban farming help with creating a public space on the TU Delft campus, and stimulate an engaging environment?’ Will be researched through a literary study, case studies and experimentation. Also, by combining the findings from the previous sub questions a coherent flowchart that combines all the different urban farming functions can be made which describes which functions are best placed close together, and statements can be made about which functions can be clustered and to be placed into the social spaces.

3. RESULTS

3.1 How is urban farming used in public settings?

Urban farming is usually divided into solely private or public functions, examples of this are large vertical farms that do not allow any visitors inside to combat contamination on the private side, and small public gardens or greenhouses for the surrounding inhabitants on the public side. Urban farms that fall somewhere in between are usually comparatively rare however as they try to merge the productivity of the large scale private farm with the social interaction of the small scale public farm. These in between farms are quite rare in the Netherlands, but on a global scale there are still quite a few that can be analysed through case studies. A larger list of urban farms can be found in the appendix of this paper.

Through the case studies given in the appendix 6.4 we can see that this kind of in between urban farming can still be used in many diverse ways to strengthen public spaces. The most prevalent example is through selling the produce in local restaurants and shops to create public engagement. Examples of this are shown at the Space 10 pop-up farm in London (Appendix 6.4.1) and the ATT&T Park in San Francisco (Appendix 6.4.2). Besides selling the produce these locations also show aspects of urban farming to the customers by placing hydroponic and aeroponic systems in the restaurants respectively. By allowing people to look at and interact with urban farming in these settings it is possible to educate them on all the benefits and drawbacks of these various farming methods (Gibson, 2022). The produce that is sold can also be advertised as a more healthy, local and organic alternative to your usual store-bought greens to garner more interest (Kushwah et al., 2019). By using a diverse range of urban farming methods it is also possible to diversify the produce that is sold at the restaurants and shops, allowing for a broader range of urban grown meals on the menus (Bartok, 2019).

Besides selling the produce it is also possible to create tours and workshops within the urban farming space to attract more people to the area. The tours could help with creating interest into urban farming for the visitors, while the workshops teach them about all the different ins and outs of urban farming. Examples of urban farms that allow for tours and workshops are PermaFungi in Brussels (Appendix 6.4.3) and De Ceuvel in Amsterdam (Appendix 6.4.4). However, this usually does not happen in larger urban farms, as letting people walk through the farm increases the risk of diseases spreading to the plants. Normally vertical farms do not use pesticides, as the plants grow in a controlled sterile location where the chance of diseases spreading is low (Gopinath, Vethamoni and Gomathi, 2017), as the risk of infection increases due to tours and workshops it is possible to reintroduce a small amount of pesticides to prevent these diseases from popping up. Urban farming also makes it feasible to check on the plants and remove the diseased ones that start showing symptoms in the early stages to prevent further spreading (Zinnen, 1988). The farm can also be divided into a larger private section and a smaller public section that allows for the tours and workshops to happen. Dividing the functions makes it possible to contain the outbreak to a small portion of the farm, and allow the rest of the farm to continue as usual (PermaFungi, 2018).

Other non-edible goods that come from the urban farm can also be sold at the shops to create more diversity in the available products. Perma Fungi uses biodegradable materials from their mushroom farm to create furniture like lamp shades. And companies like the Rotterzwam and Life Cykel (Appendix 6.4.3) sell mushroom substrate with spawn in them that allows for people to create their own miniature DIY mushroom farming setups at home. It is also possible to sell goods like the leftover solid compost produced in vermiculture facilities and animal feed that is created by combining leftovers from the fish farms and vertical farms. All in all these goods can create more diversity in the goods sold at urban farming centred shops and show the people the diverse applications of urban farming besides producing food. A drawback of producing these alternative goods is however that they can take away some of the efficiency of the urban farm, space that is used to produce these goods could normally be used as more urban farming space, and goods like the biodegradable furniture from Perma Fungi is made from mycelium, which is usually harvested before the mushrooms are fully grown (Haneef et al., 2017).

3.2 Which functions benefit from interacting with one another?

Individual urban farming methods are inefficient compared to their conventional counterparts, they are considerably more efficient in reducing certain aspects like the amount of necessary space and water used (Swain e.a., 2021), but they counteract this with other variables such as a considerable higher energy usage compared to conventional farming (Barbosa e.a., 2015). By combining different functions it is however possible to reduce some of the drawbacks that urban farming brings with it and bring it more in line with conventional farming on those aspects (Goddek e.a., 2015). This is achieved by analysing the various flows that happen to and from the different functions and by connecting inputs and outputs that could benefit from each other. Placed in the appendix (6.1) you can find the individual flows going to and from the various functions and how they interact with other functions. A common example of this would be turning the ammonia waste produced from fish in an aquaculture into an useful nutrient solution for plants in your hydroponics system.

This form of using waste material from your aquaculture system to feed your hydroponic system is usually called aquaponics (Goddek e.a., 2015), it uses nitrifying bacteria within the water which break down the waste ammonia the fishes excrete and turn it into nitrate that can be used as a liquid fertilizer for your plants (Joyce e.a., 2019). The nitrate can also be combined with other fertilizers to enhance them. One of the drawbacks of aquaponics is that the fish and crops need to be able to survive in the same water conditions, meaning that aspects like temperature, ph-level, and the quantity of certain chemicals need to be attuned to both the needs of the fish and the plants (Coursey, 2021). Another way to remedy this is by using a decoupled aquaponics system, as the name suggests, this decouples the aquaculture and hydroponics systems from each other and allows for the nutritious fluids to be further modified to better suit the crops after it is extracted from the fish tank (Sallenave and Shultz, 2019). Leftover water from the vertical farming system can then be reintegrated within the aquaponics system to fill the tanks and leftover biomass from the farms and worms from vermiculture could be fed to the fish to sustain them.

Vermiculture is the act of keeping worms and using them to turn organic waste materials into compost for your crops. Besides organic waste from restaurants and leftover biomass from the crops other waste materials like paper and cardboard from the faculties and spent mushroom substrate from mushroom farms can also be composted through this method (Munroe, 2007). By digging holes through the organic waste the worms aerate it and allow for aerobic decomposition to take place. The worms excrement also helps enriching the compost (Rodale Institute, 2019). The worm population grows at an exponential rate, doubling in size roughly every 60 days if optimal conditions are met (Vodounnou et al., 2016), this means that alongside producing compost for the other farming functions, the excess worms can also be fed to other animals like fish.

Farming methods like mushroom farming and vertical farming can also benefit from one another. Unlike vegetables and fruits, mushrooms actually respire and take oxygen and turn it into CO_2 (CO_2 meter, 2022). This allows for a symbiosis to be created between vertical farming and mushroom where excess oxygen from the vertical farm is regulated towards the mushrooms and excess CO_2 from the mushrooms is send back to the plants. Besides CO_2 excess heat from the processes at the mushroom farm can be send to the vertical farm to help with heating and to cool the mushroom farm in turn (Grimm and Wösten, 2018).

Besides the farming functions benefiting from other farming functions it is also possible for them to benefit from other functions within the system like the restaurants and shops. As mentioned before the leftover organic waste from the restaurants could be turned into compost using vermiculture, but besides this it could also be used as a mushroom substrate to grow mushrooms, or be directly fed to animals (Luciano et al., 2020).

3.3 Speculated flow sizes and numbers

By estimating the various flow sizes of all the urban farming functions, and placing them into a table (appendix 6.2), we are able to attune all these functions to work together as efficiently as possible, estimating these various flow sizes can be quite difficult however, as various sources mention vastly differing quantities for the same flows. This is likely because various urban farms of the same function, like aeroponics for example, could have different configurations, have different cultivation methods or harvest different crops which hugely affects the given flow sizes. These differences can be accounted for by giving estimates and ranges instead of concrete numbers, but they still lead to slight uncertainties. The farming methods in the table are also compared to conventional farming methods such as outdoor farming and greenhouse farming to see where urban farming can be more efficient, and where it still falls short.

With the provided table we can create a feedback loop between all the different functions and public spaces so they can all sustain each other as efficiently as possible. From the numbers we can see that the largest bottlenecks lie in the energy department (McDonald, 2022), and the most gains lie in the water-, fertilizer- and space usage departments (Alshrouf, 2017). These numbers which can’t be sustained from other flows within the spaces themselves could instead be supplemented from other outside sources (McDonald, 2022), like solar panels, which could be added to help with a part of the power deficiency. Furthermore natural lighting can also be integrated within the urban farm to further reduce energy usage specifically, as up to 55% of the energy needed for urban farming comes from LED lighting (iFarm, 2020).

3.4 Creating public spaces through urban farming

As seen in the flowcharts, many of the functions could heavily benefit from each other and would therefore be best placed close together. As a general rule of thumb it is more important to place functions from the same department close together than functions from different departments, so two functions that focus on production, like an aeroponics system and vermiculture for example would benefit more than a production function and a social function, like an aeroponics system and a restaurant. But even then there are still some functions that are more crucial in each others flows than others. Based on these flows and their estimated sizes we can create an advanced flowchart that combines all the different smaller flowcharts of the various functions into one and placed it in the appendix (6.3). Functions that are crucial to each other can then be placed next to one another while functions that are less dependant on one another can be placed further away. The sustainability of flows can also be seen in the flowchart by the types of the arrows.

As seen in the combined flowchart certain functions are more important to be placed close together than others, for example: to transfer the excess heat, cold, O2 and CO2 between the mushroom farming and hydroponics farming it would be best to place them as close together as possible to ensure as little heat and cooling loss as possible, making it preferred to place these rooms next to each other (Grimm and Wösten, 2018). Other functions that need to be close together are the hydroponics system combined with the aquaculture and vermiculture setup, the nutrient rich fluids and liquid fertilizer that need to travel between the functions require a lot of piping infrastructure, and increasing the distance between them would also considerably increase costs. Other sources, like the leftovers from restaurants are less important to place close together to other functions, as placing them further apart has no real drawbacks and transporting the leftovers from place to place is relatively easy.

Through grouping the different functions together based on the combined flowchart we can also create clusters that fill different roles and serve to improve the public spaces. Some of these clusters can focus on roles like production while others look into fulfilling social roles. The most obvious cluster would be a large cluster that groups together all the production focussed functions, like vertical farming, aquaculture, vermiculture and mushroom farming on a large scale. This cluster could produce the largest bulk of all the produce made and would mainly serve a private function. As this function does not further interact with the public it is best to be placed somewhere where there is enough space available instead, like the southern part of the campus.

Another possibility for a cluster would be one where the social interactivity of restaurants and shops is merged with some small scale farming. Leftovers from the restaurants and shops could be recirculated into the farms, and the small scale nature of the farms would mean that it is also possible to hold tours and workshops to create further social interaction within the area. This cluster would best be placed in a central location in the campus, to ensure that enough people will be able to use the functions, and to help the campus with strengthening the liveliness of the campus for both non-students and during the nights and weekends.

Clusters that solely focus on public farming could also be spread through the campus and close to housing to promote a healthy life style and to get people farming. Multiple smaller scale clusters can be spread throughout the campus as they do not necessarily depend on other functions to work properly. These clusters can sell their produce to the restaurants and shops through community supported agriculture (CSA) (Woods, Ernst and Tropp, 2017), but this does not require them to be placed close by, allowing for more locational freedom and for them to be placed close to the current housing which is present on the campus.

Existing infrastructure like restaurants and canteens can also be integrated within the system to further expand the urban farming influence over the campus. The urban grown produce can be distributed to the restaurants and canteens to promote healthy, local and organic food and in turn those restaurants and canteens can provide the farms with leftovers to turn into compost with vermiculture (Munroe, 2007), and coffee grounds for the mushroom farms to use as a base for their mushroom substrate (Grimm and Wösten, 2018).

4. CONCLUSION

Based on the findings we can conclude that functions that fall under the same department, e.g. production, social interactivity and social farming are best placed close together to other similar functions in the same department, whilst it is not as important to place functions from different departments close together. Functions like aquaponics, vertical farming and mushroom farming for example are all best clustered together, as they provide many benefits for each other, like heating, co2, liquid fertilizer and biomass. Social functions like restaurants also produce leftovers and coffee grounds, which can be used in vermiculture and mushroom farming respectively to create circular systems, but these are more easily transported over larger distances compared to other flows like heat and liquids.

Within the production focussed functions it is also possible to separate smaller portions of the farms and dedicate them to tours and workshops for interested visitors. Not only can these sections help with cultivating more interest in urban farming among the visitors, but they can also help with teaching them about the ins and outs of urban farming. These parts are best to be separated from the rest of the farm to help prevent the spreading of disease through the other parts, as the other crops grow in a controlled sterile environment, and constant visitors would bring in a considerable amount of contaminants.

By creating circular flows between the functions it is also possible to improve the self sustainability and cost efficiency of the farms and roughly estimate the required sizes for all the various functions. The production of fertilizers for the vertical farms can almost be made completely self sustainable through the use of an aquaculture and vermiculture for example. The necessary sizes of all the functions can also be calculated by going through all the in- and outputs of the flowchart (Appendix 6.3) and comparing it to the given figures in the table (Appendix 6.2). To produce 100 kg of Vegetables and fruits for example, you would need to produce 15.4 kg of fish for the nutrient rich fluids and a combination of up to 20kg of mushrooms to turn all the leftover biomass into mushroom substrate, or 3.3kg of worms to turn the biomass into compost, keeping everything circular, resulting in areas of 6 m2, 129 m2 and 3 m2 respectively for the different functions. Other aspects, like energy usage, cannot be made circular and need to be added from the outside. To sustain the same 100kg of vegetables, 15.4 kg of fish and 20kg of mushrooms 8457 KWh of electricity is needed, which is comparable to the average yearly energy consumption of 3 Dutch households. This need for electricity can however be significantly reduced by allowing for the use of natural light, and by using solar panels.

Through grouping the different functions together based on the combined flowchart we can also create clusters that fill different roles and serve to improve the public spaces. A cluster that groups together all the different production centred functions and aims to grow as much produce as possible; a cluster that combines some small scale farms with restaurants and shops and fosters social activity by allowing for tours and workshops; a cluster that puts the focus on public farming and promotes a healthy lifestyle to people; and integrating existing restaurants and canteens within the system by supplying them with locally grown urban produce and by redirecting their waste leftovers and coffee grounds back into the system are all examples of integrating urban farming and creating an engaging environment within the campus.

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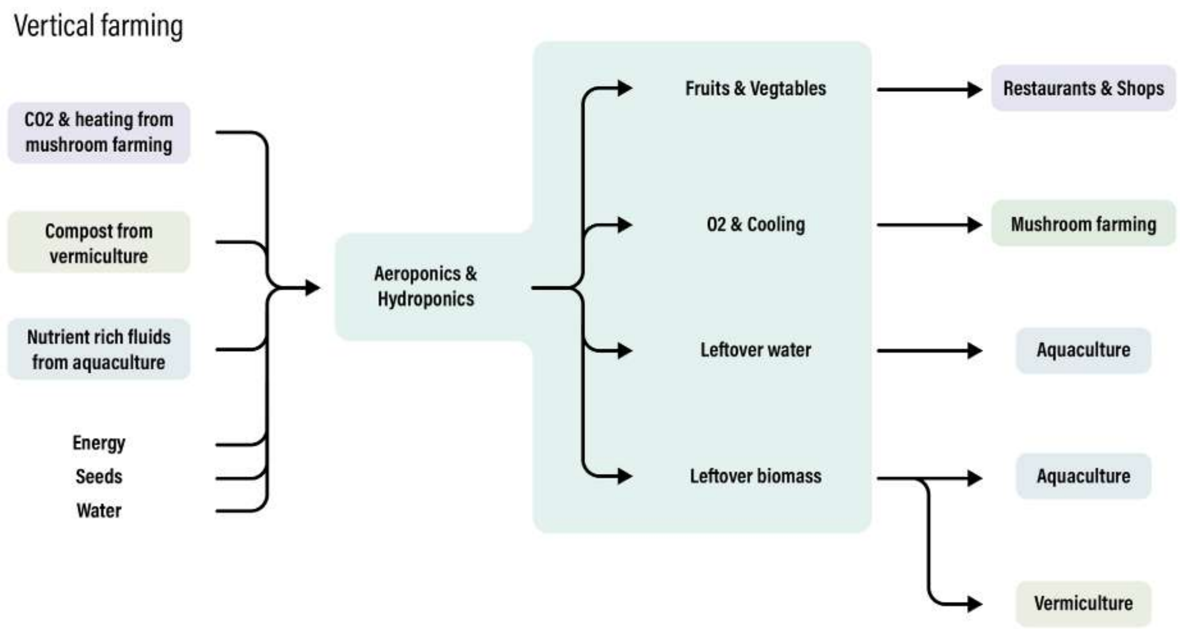
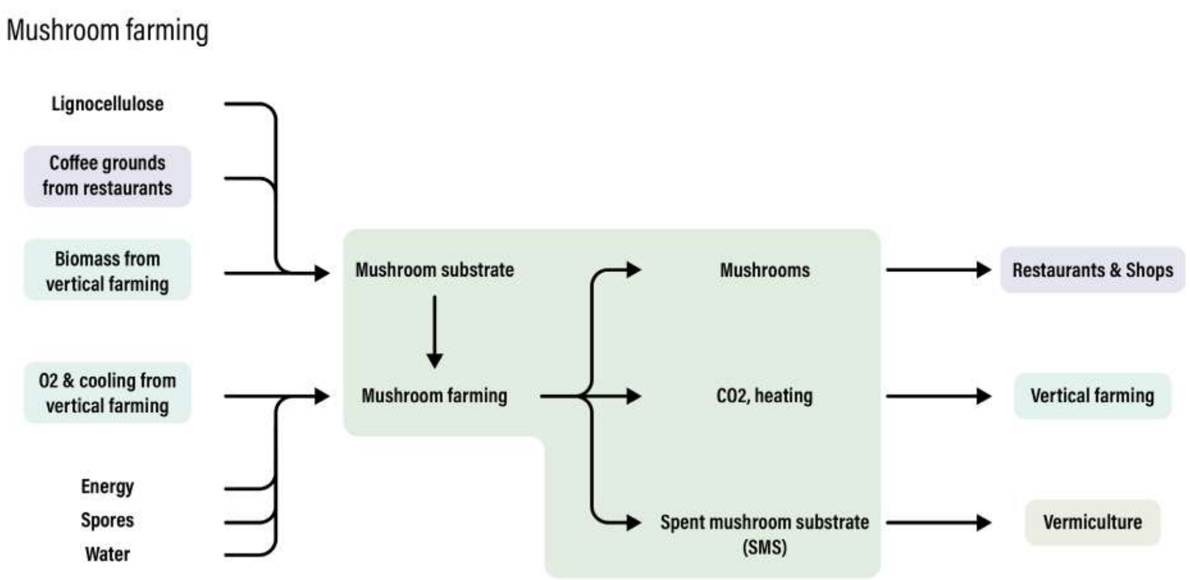
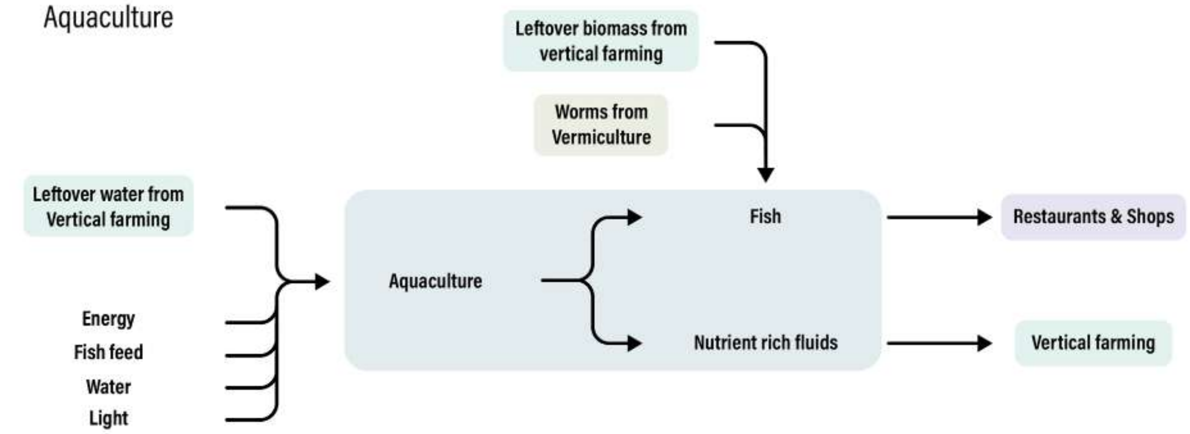
6. APPENDIX

6.1 Flowcharts per individual functions

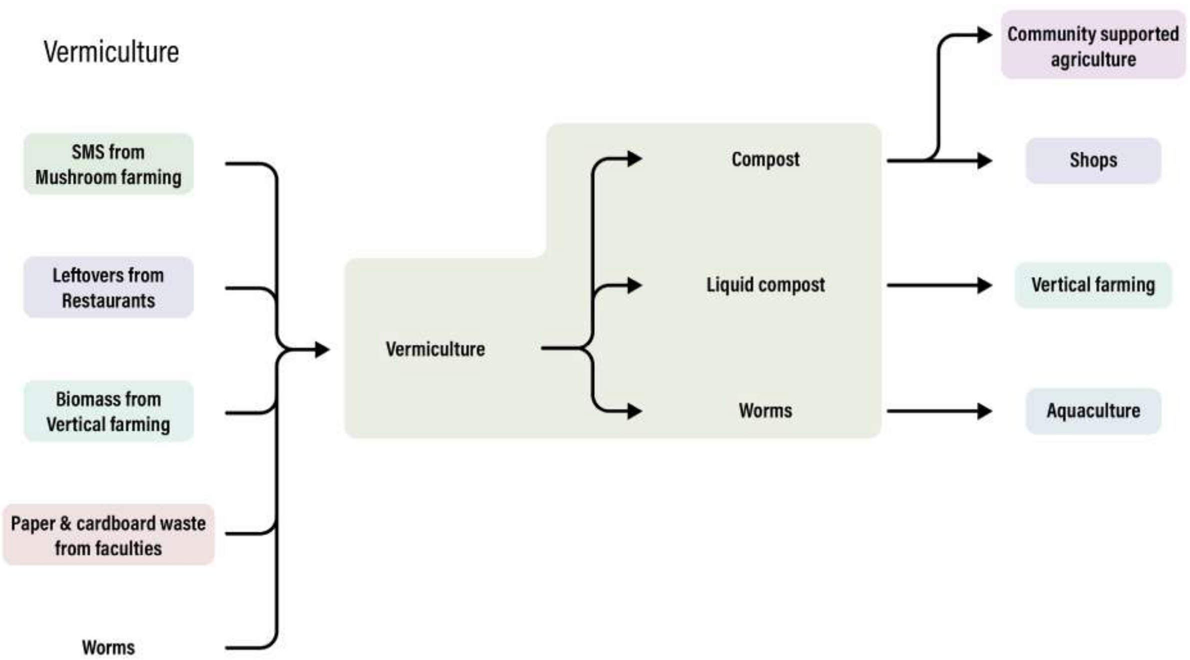




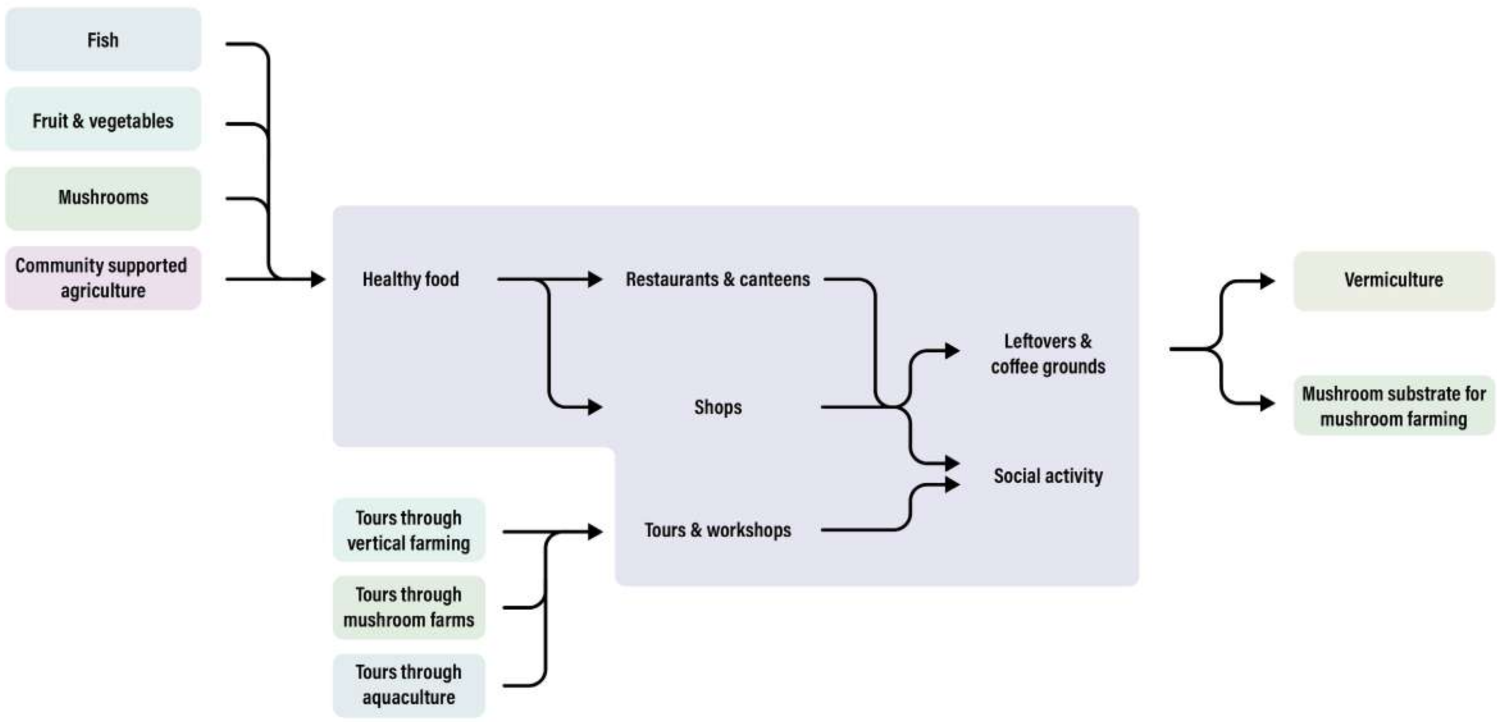
Aquaculture



Vermiculture



Social settings



6.2 Table with estimated input and output sizes

Normal farming	1 kg	+- 1 kg ?	0.21 kg	0%	214 L	0.3 kWh

Hydroponics	Crops grown	Biomass production	Oxygen production	Compost reduction*	Water usage*	Energy usage	Notes
Water culture	1 kg	+- 1 kg ?	0.21 kg	55% to 80%	21.4 L to 13.3 L	60 to 180 kWh/year	The roots are directly placed in the water
Ebb & Flow technique	1 kg	+- 1 kg ?	0.21 kg	55% to 80%	21.4 L to 13.3 L	60 to 180 kWh/year	The plants are placed in a medium which floods and drains in intervalls
Aeroponics	1 kg	+- 1 kg ?	0.21 kg	85%	2.6 L	250 kWh/year	Uses mist to spray onto the plants instead of water
Nutrient film technique	1 kg	+- 1 kg ?	0.21 kg	55% to 80%	21.4 L to 13.3 L	60 to 180 kWh/year	The nutrient solution flows along the plants and excess is recirculated
Drip	1 kg	+- 1 kg ?	0.21 kg	68% to 85%	10.7 L to 6.1 L	60 to 180 kWh/year	A tube drips exact measurements of nutrients solution onto the plants

* The lower number is used when the water is recirculated

- Hydroponics, Aeroponic and Aquaponic as Compared with Conventional Farming
- https://cubicfarms.com/how-cubicfarms-uses-54-62-less-energy-than-typical-vertical-farms/
- https://www.madsci.org/posts/archives/1999-02/917906305.Bt.r.html

	Mushrooms grown	SMS production	CO_2 production	Necessary substrate	Water usage	Energy usage	Notes
Mushroom farming	1 kg	2 kg	5 kg	5 kg	2.9 L	1.9 kWh	Mushroom colonies can be grown on substrates from other leftovers

- https://link.springer.com/article/10.1007/s00253-018-9226-8
- https://www.sciencedirect.com/science/article/pii/S0960852408004823?via%3Dihub
- https://www.co2meter.com/blogs/news/co2-mushroom-farming
- The Mushroom Sustainability Story: Water, Energy, and Climate Environmental Metrics

	Fish grown	Can sustain how many crops	Necessary fish feed	(Rain) water usage	Energy usage	Notes
Aquaponics	1 kg	6.5 kg	1.3 kg	292 L	159 kWh*	Amonia waste from the fish is turned into nutrients for the plants

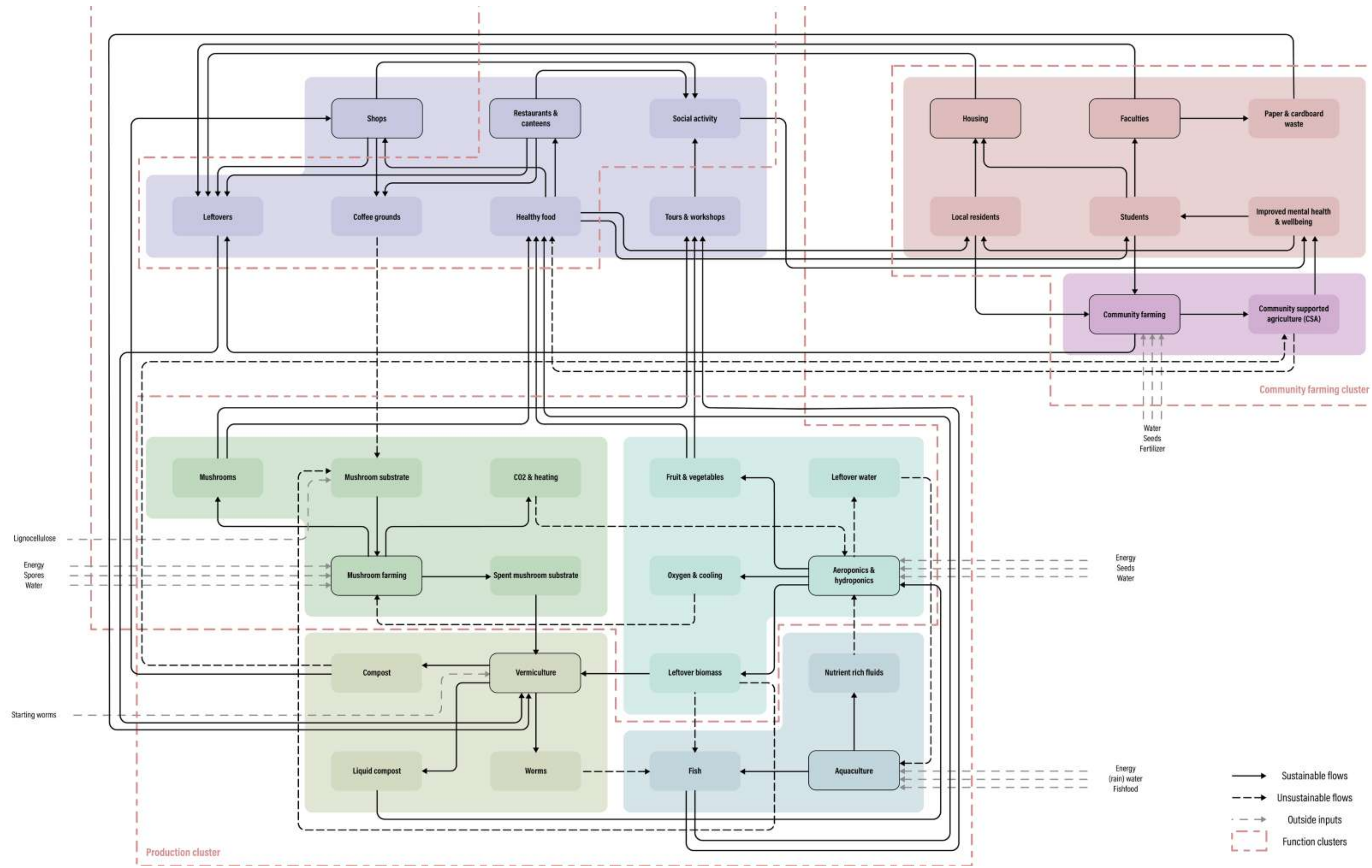
* Most was for heating the water

- https://www.theaquaponicsource.com/what-is-aquaponics/
- https://www.sciencedirect.com/science/article/pii/S0144860915000643
- Commercial aquaponics production and profitability: findings from an international survey

	Worms grown	Compost production	Necessary leftover biomass	Water usage	Energy usage	Notes
Vermiculture	1 kg	15 kg	30 kg	21 L	-	The worms turn waste organic matter into compost

- Manual of On-Farm Vermicomposting and Vermiculture

6.3 Combined flowcharts of the different functions



6.4 Case studies

6.4.1 HYDROPONICS

Hydroponics is the act of growing crops in nutrient rich solvents without the use of soil. Some of the crops could grow with their roots directly submerged in the solvent, but others can make use of other medium such as gravel for support.

The controlled environment also allows for specific measurements of nutrients and minerals within the solution, allowing for solutions that are specifically tuned to optimally grow a crop.

Using hydroponics costs a lot less water compared to conventional farming. It uses a lot of water to get started, but after that all the leftover water can be recycled and be brought back into the system to create this feedback loop. Growing 1 kilogram of tomatoes usually takes about 214 litres with conventional farming methods, but with hydroponics this is lowered to 70 litres.

Hydroponics can also be combined with other farming methods such as aquacultures (fish farming) to create aquaponics, which uses the excrement of the fish as a fertilizer for the plants.

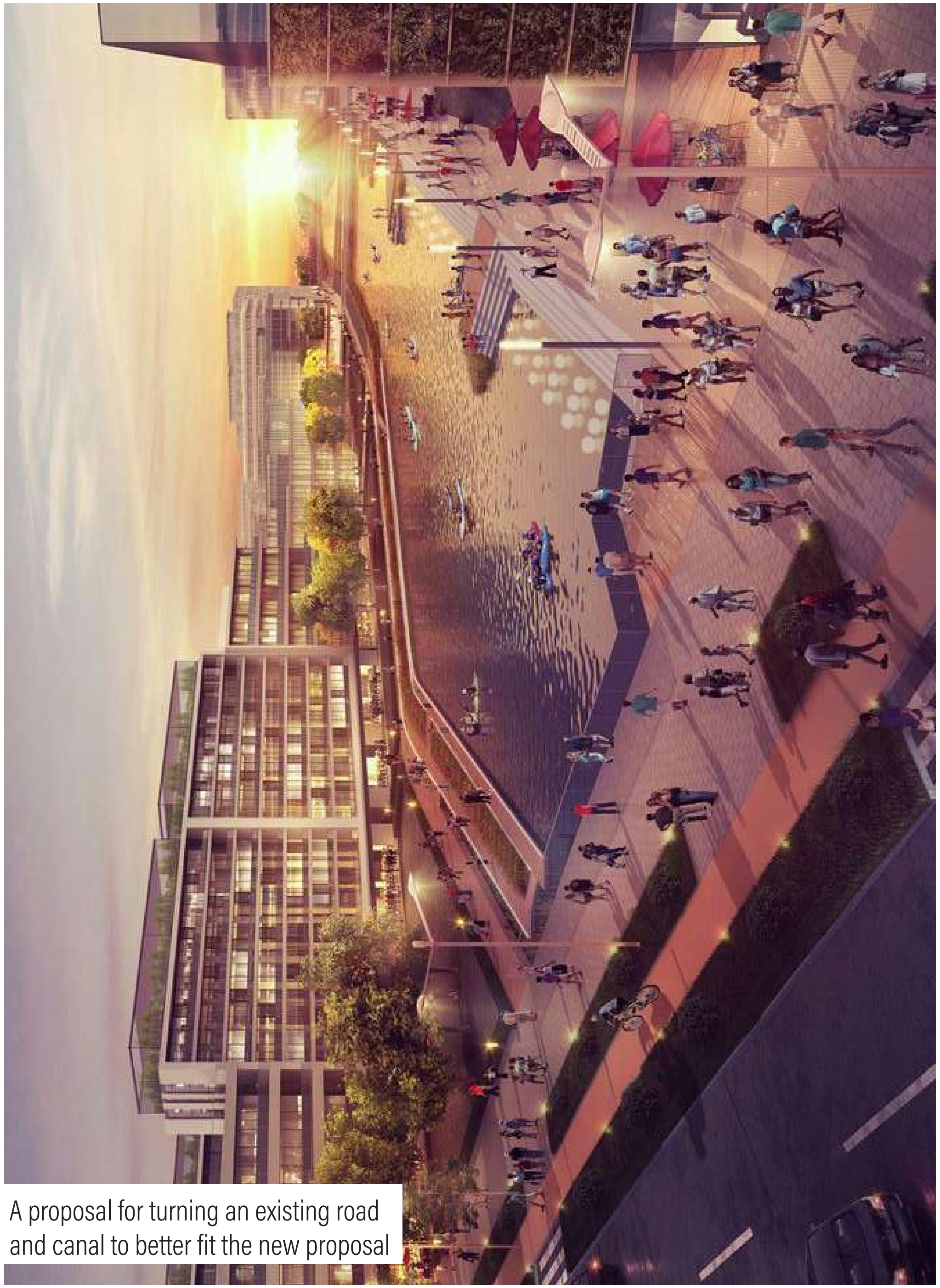
SUNQIAO URBAN AGRICULTURE

Shanghai, China

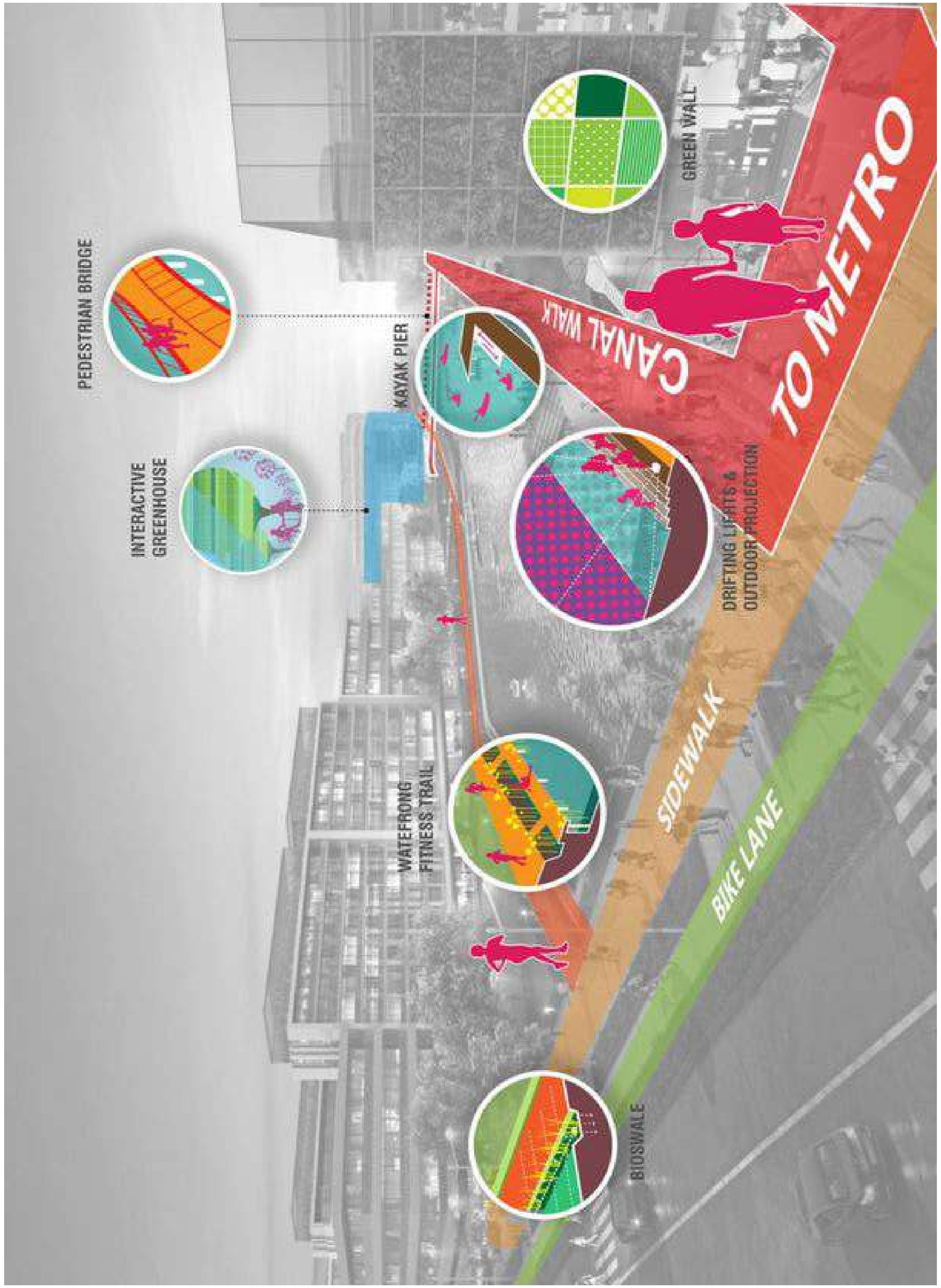
A proposal to turn Sunqiao into a space for urban farming

The old plans were to replace the local farms with housing

Besides the indoor farms it is also proposed to move farming elements into the public space

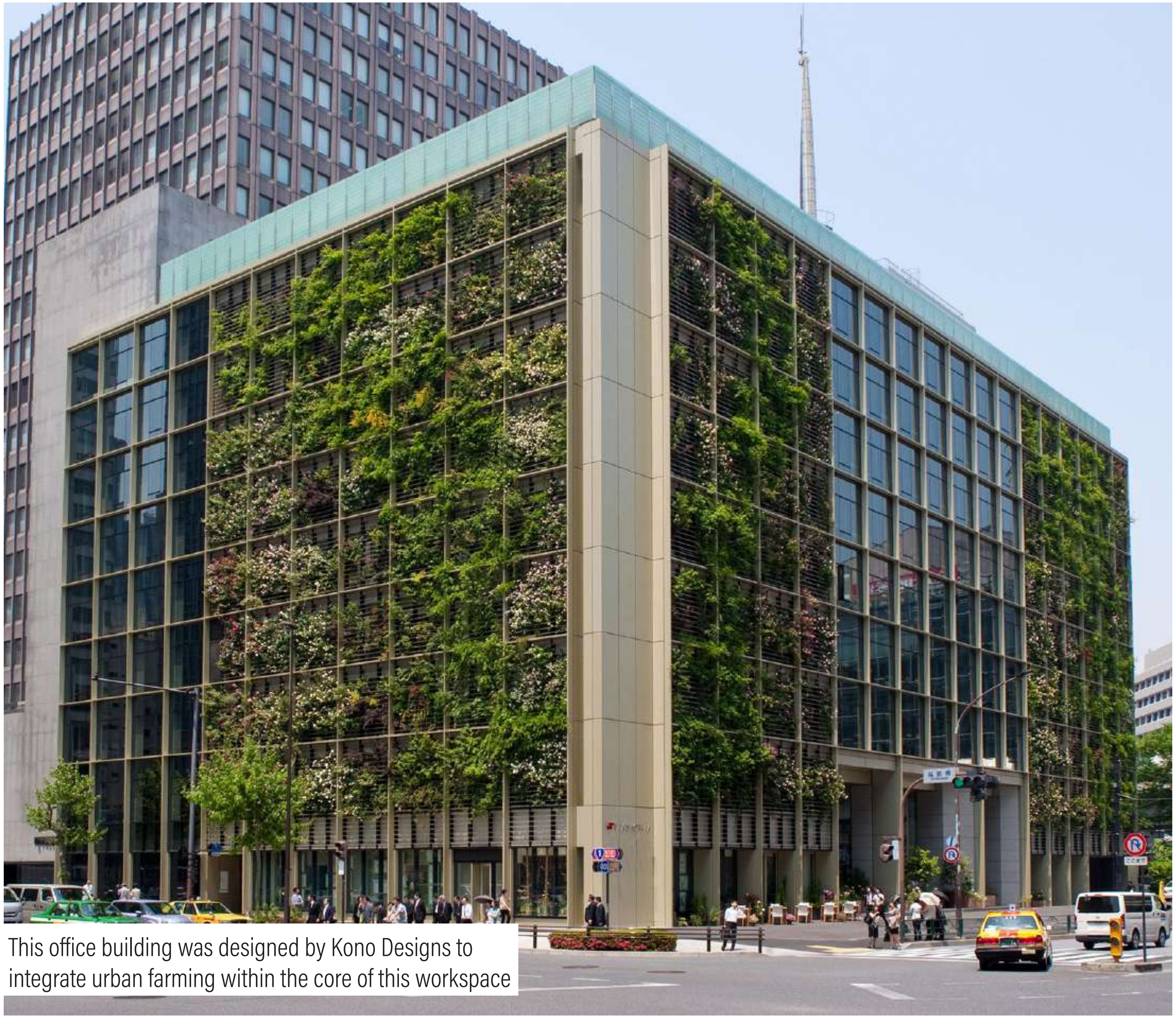


A proposal for turning an existing road and canal to better fit the new proposal



PASONA URBAN FARM

Tokyo, Japan



This office building was designed by Kono Designs to integrate urban farming within the core of this workspace

The walls are adorned with a variety of crops that are regularly harvested

In this 20,000 square metre office building, 4,000 square metre is dedicated to urban farming

The office workers are also responsible for planting and harvesting of the crops, and are allowed to bring the produce home

SPACE 10 POP-UP FARM

London, England

A pop-up store in London that promotes hydroponics

The hydroponic farm was placed in the middle of the venue

A salad bar was at the location, that allowed for people to create their own salads with the grown microgreens

The space teaches people about hydroponics, with bits of information on the walls, and by allowing people to walk inbetween the structure

HERBIVORE

Mumbai, India

The largest hydroponics farm in india, allows you to order the food online, and have it freshly harvested and delivered within 3 hours

They also have a subscription system where the farm delivers multiple vegetable boxes per week

6.4.2 AEROPONICS

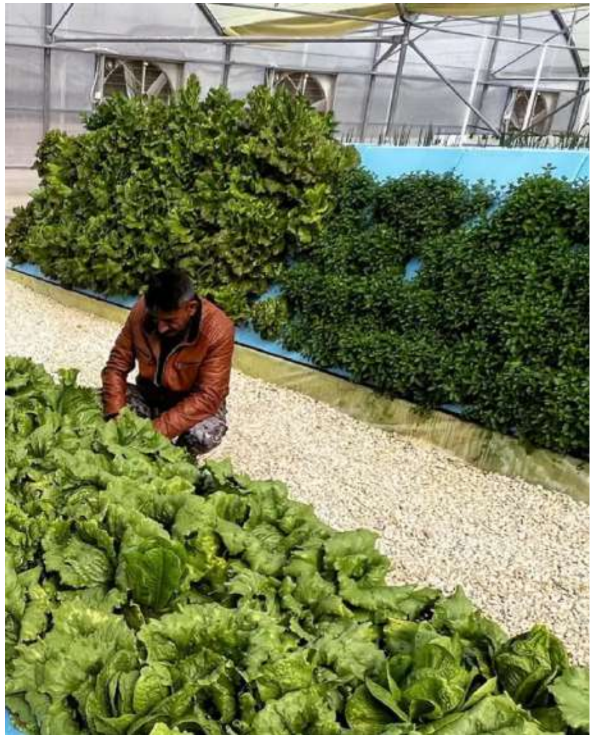
In an aeroponic farming system the plants are cultivated without the incorporation of any soil or substrate, instead they grow in the air with the help of supports. This allows for a nutrient rich spray to be used, as opposed to using conventional watering methods.

These sprays allow for precise amounts of water and nutrients to be delivered to the plant, resulting in an average 90% reduction in water use, and 60% reduction in nutrient use. These precise sprays also make it possible to precisely calibrate the amount of nutrients

Because these sprays can be calibrated to these precise specifications they can also be used to create optimal growing environments for the plants, this along with the minimal contact between the support structure and the plant, leading to unconstrained growth, means that larger, faster growing, optimized harvests per crop are possible.

By offsetting the planting times between parts of the farm it is also possible to create a steady source of crops throughout the year, instead of the usual peaks and lows.

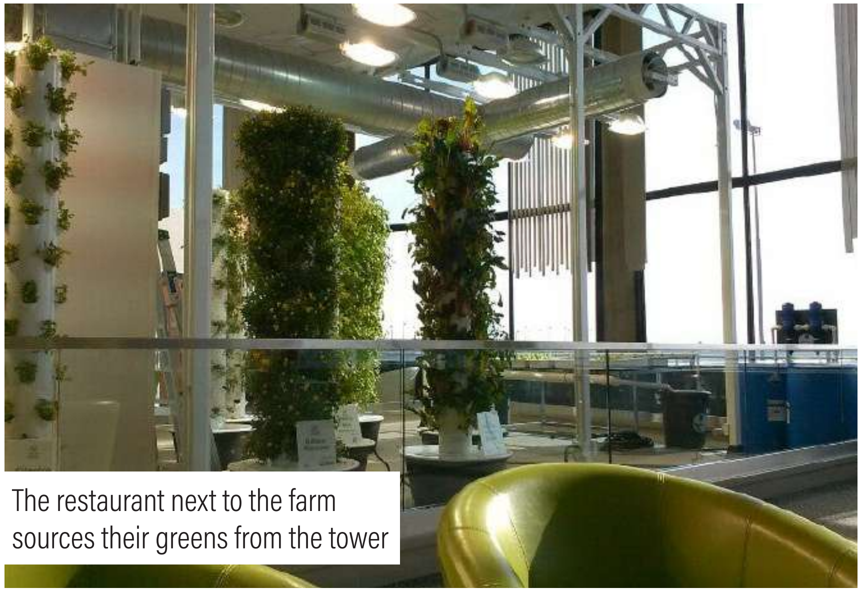
Aeroponic farming usually focusses on growing leafy greens, micro greens, herbs and seed tubers as these plants are optimal for these conditions.



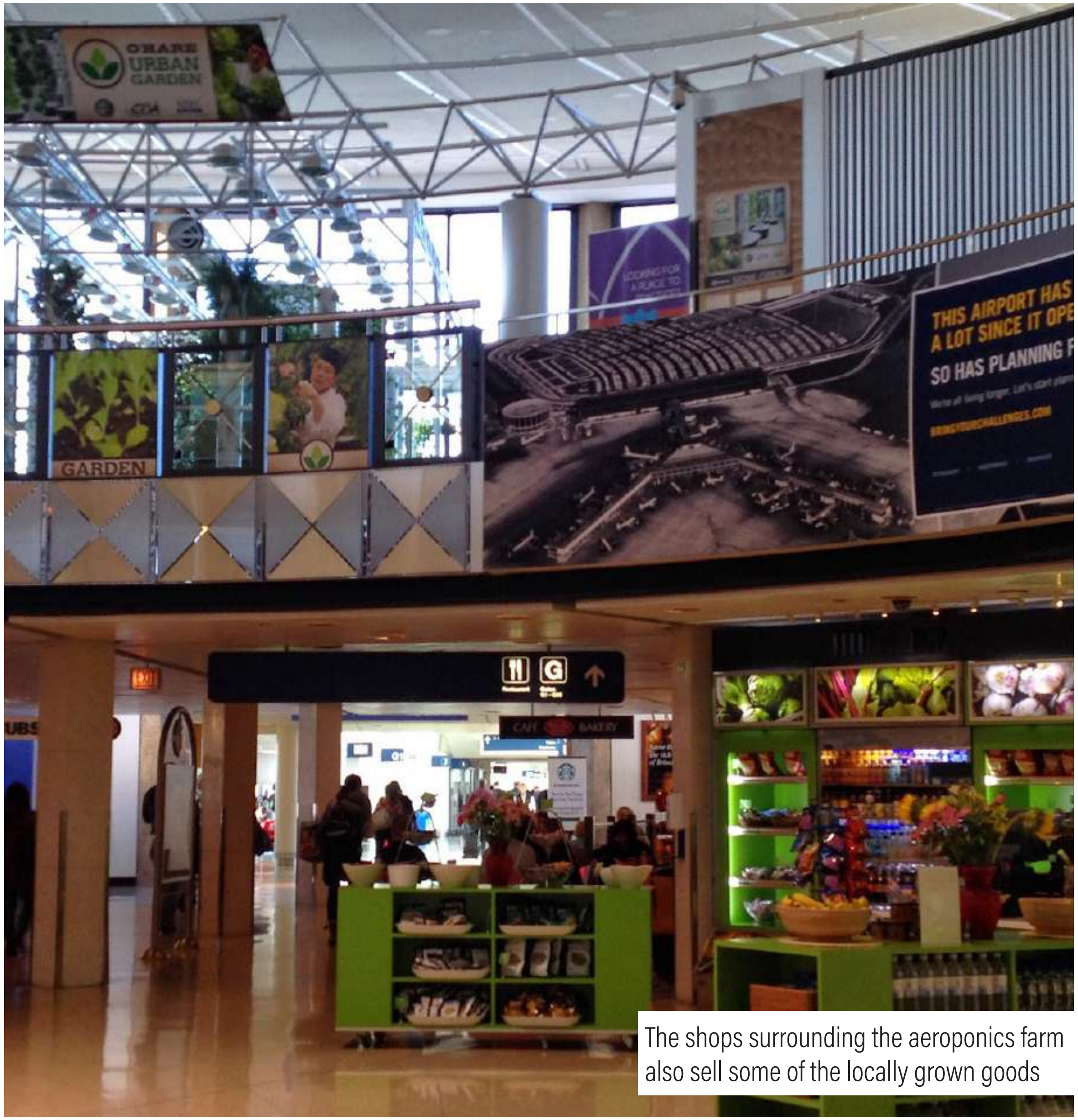
O' HARE INTERNATIONAL AIRPORT

Chicago, USA

An aeroponic farm in the middle of an airport



The restaurant next to the farm sources their greens from the tower

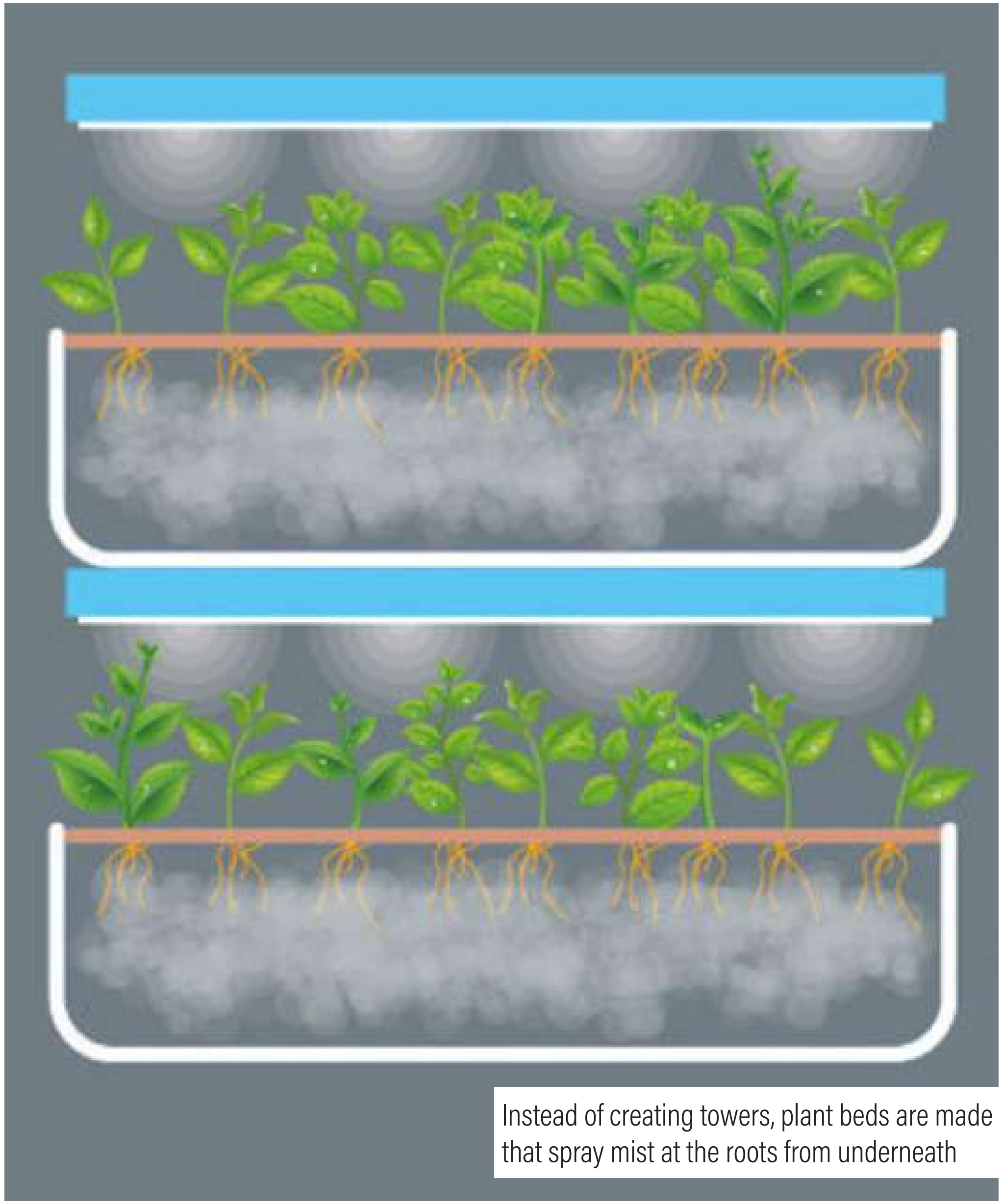


The shops surrounding the aeroponics farm also sell some of the locally grown goods

FAISAL FARM

Mastaba, Jordan

Aeroponics lets the farmers safe up to 90% of their water in one of the driest countries



Instead of creating towers, plant beds are made that spray mist at the roots from underneath

ATT&T PARK

San Fransisco, USA

This restaurant inside of a baseball stadium sources their greens locally from aeroponic towers

The people are able to dine
between the aeroponic towers

Workshops are held for kids to
teach them about healthy living

HAMILTON FARMS
St. Louis, USA

The aeroponic farms inside the greenhouse source all the greens for 5 of the local Hamilton restaurants

Events are also held at the venue where people can eat food directly sourced from the towers around them

USA PAVILION
Milan, Italy

A pavilion at the 2015 Milano expo, one of the façades consists completely out of an aeroponic system, allowing for crops to be grown on them

The panels holding the aeroponic systems could be rotated to beter face the sun

ALTIUS FARM

Denver, USA

The farm produces crops on the first floor with a restaurant on the ground floor

Through upscaling the farm also produces crops for most of the local restaurants

AEROPONIC POTATOES

It is also possible to grow tubers like potatoes in an aeroponic system

The roots hang in the air from a film, with the potatoes growing in between them

Normally the platforms are lowered, to allow for nutrient rich mist to be sprayed on the roots

6.4.3 MUSHROOM FARM-

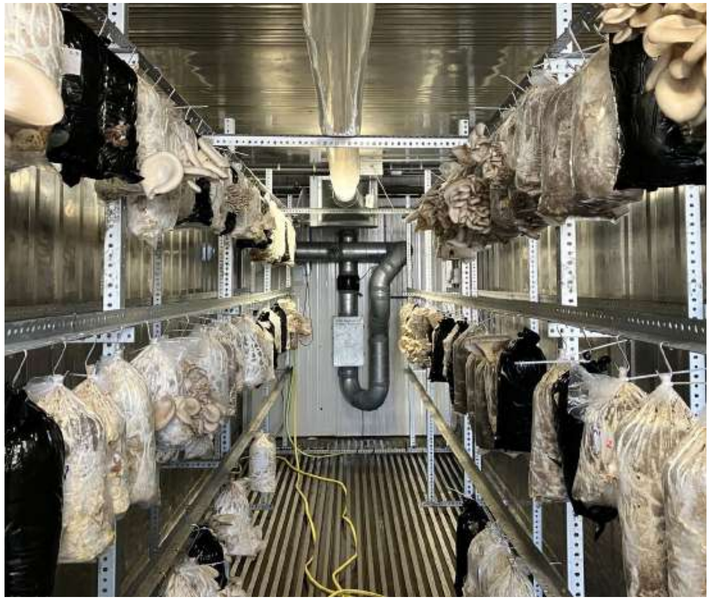
Mushroom farming is another way of bringing farming into the city, these mushrooms can either be grown hanging from a substrate, like oyster mushrooms and shiitake or on beds like button mushrooms.

Growing mushrooms is different from growing other farming produce because it is a fungus instead of a plant. Unlike plants they don't need light, so they are perfect for indoor growing, and they require oxygen to grow and produce CO2 instead of the other way around.

Mushrooms are best grown on media such as coffee grounds, straw, saw dust and wood chips and a rule of thumb is that roughly 5kg of substrate leads to 1kg of mushrooms. The spent mushroom substrate (SMS) can then be used as either compost, animal feed, biofuels and construction materials, allowing for even more circularity within the process.

Instead of using SMS in a pure form as fertilizer it can also be mixed with pig manure-based compost to improve the quality.

The SMS is also sometimes used in fish meals, to reduce the amount of fish food necessary.



PERMA FUNGI

Brussels, Belgium

Biodegradable materials that could be turned into furniture

Tours are held through the farm for people that want to learn more

Biodegradable materials that could be turned into furniture

Leftover coffee grounds
are turned into compost

GROCYCLE

Exeter, England

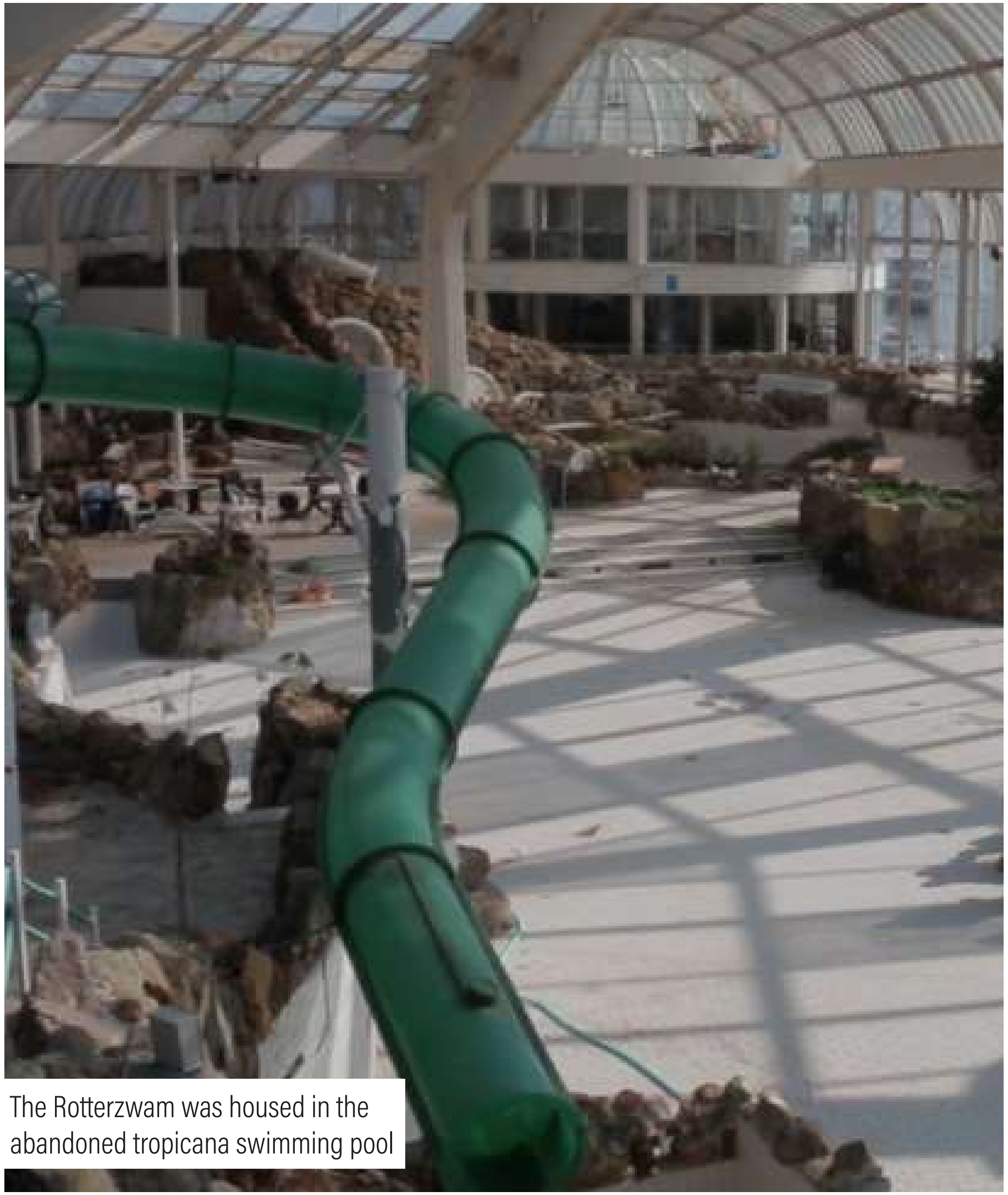
After they're done growing the oyster mushrooms are dried in racks

Low tech mixers are used to create the substrate on which the mushrooms grow

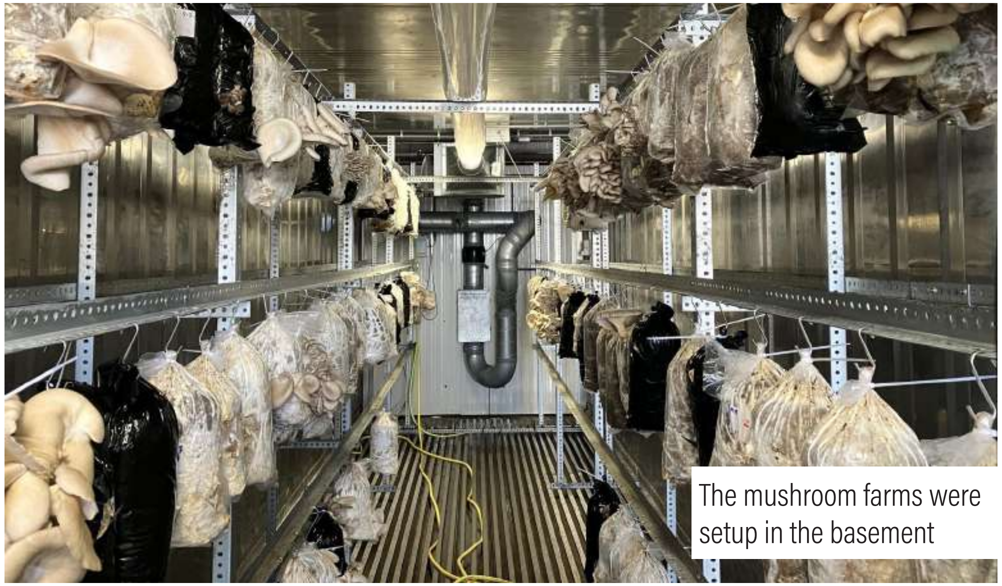
An oyster columns growing setup on coffee grounds

ROTTERZWAM

Rotterdam, Netherlands



The Rotterzwam was housed in the abandoned tropicana swimming pool



The mushroom farms were setup in the basement

They also sell do it yourself mushroom grow kits

The mushrooms where among others used
by the restaurant on the ground floor

LIFE CYKEL

Melbourne, Australia

The mushrooms can also be turned into extracs for in food

They also sell do it yourself mushroom grow kits

6.4.4 AQUAPONICS

When you combine fish farming with hydroponics you get aquaponics. The ammonia which is excreted by the fish can be turned into nitrate through bio-filtration and bacteria and then be used to feed the plants. Aquaponics can be combined with hydroponics or aeroponics to create a circular system. Usually it is done through a nutrient film technique (NFT), ebb and flow system, deep water culture, drip systems or aeroponics.

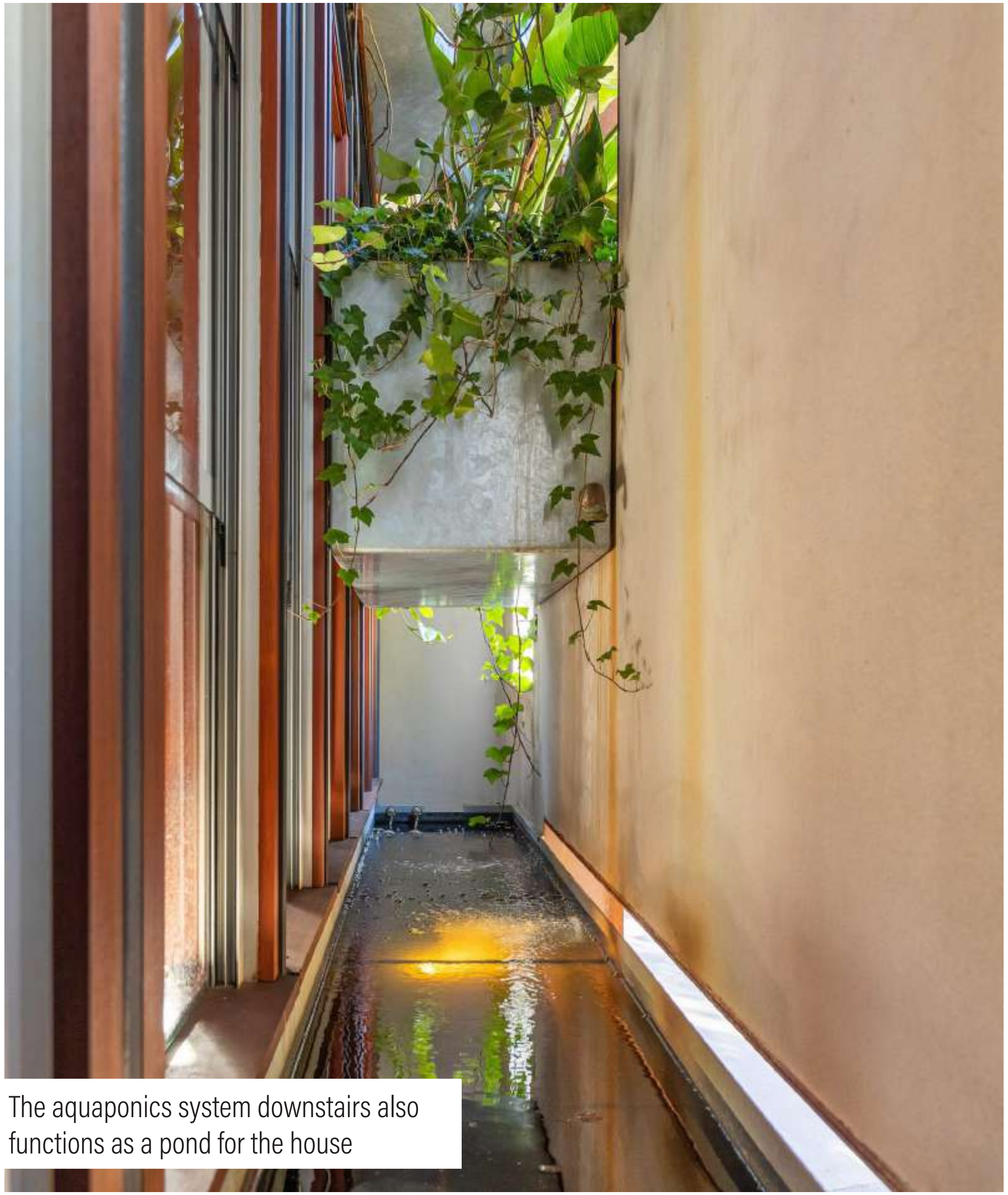
The system between the plants and fish can either be coupled or decoupled. A coupled system needs to farm fish and plants that have the same requirements for temperature, ph-levels etc., in order to ensure that both the fish and plants survive. A decoupled system can instead first treat the water before giving it to the plants, but this usually costs more and requires more technology.

Fish are also efficient at growing meat, an average fish needs 1.1kg of food to grow 1kg of meat, compared to 1.7kg of food for chicken, 2.9kg for pigs and 6.8kg for cows.

Aquaponics is more resistant to disease outbreaks in the fish colony compared to other methods of fish farming, because they're held in smaller divided tanks, which makes it easier to isolate the disease and tackle it before it spreads.

THE JUNGLE HOUSE

Darlington, England



The aquaponics system downstairs also functions as a pond for the house

The fish solution is pumped to the top of the building, from where it waters the plants

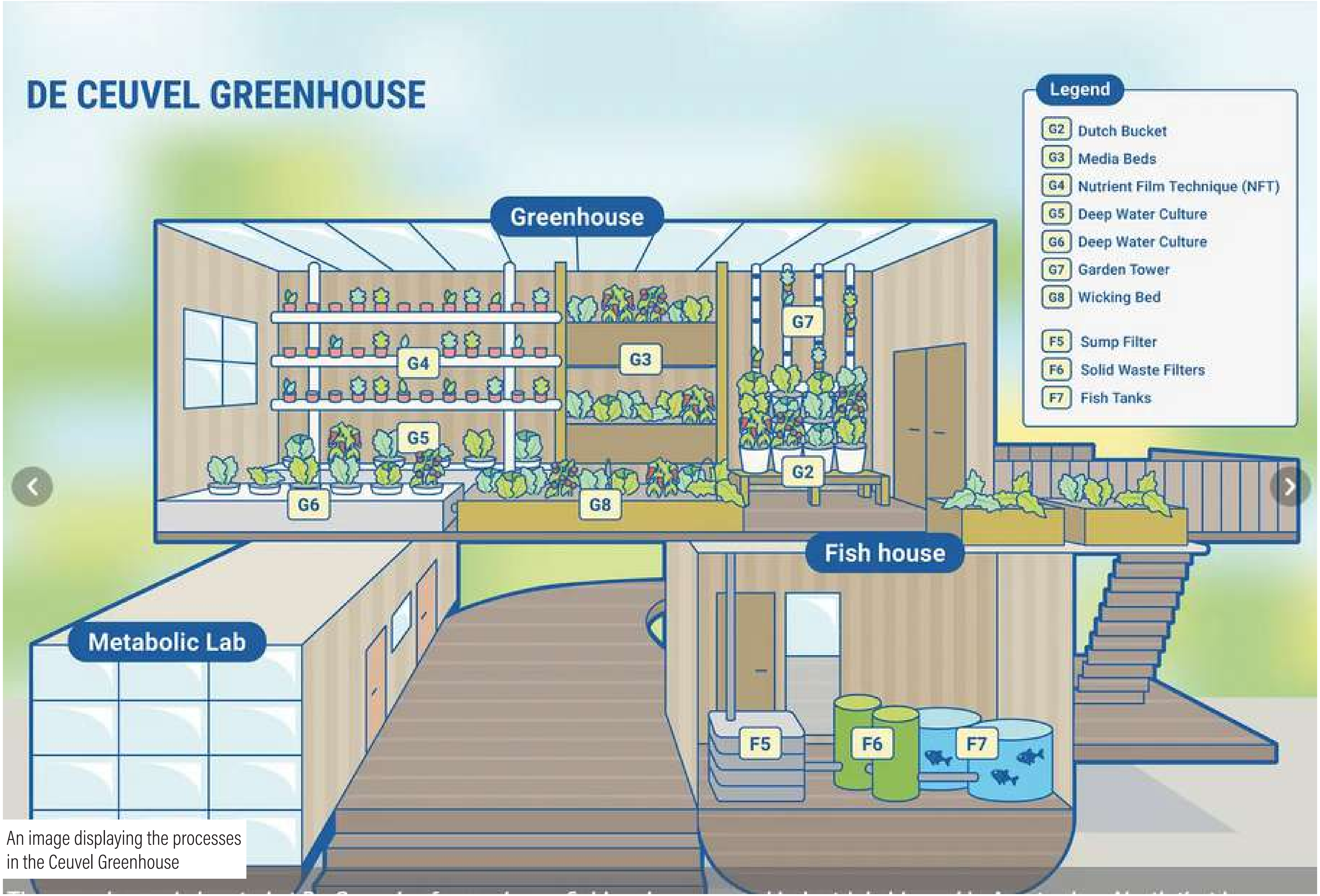
The rooftop garden provides the house with most vegetables

DE CEUVEL
Amsterdam, Netherlands

Workshops are held at the location to educate the people on aquaponics

The water is brought to the crops through a nutrient film technique

A restaurant at the location uses all the ecologically sourced foods



An image displaying the processes in the Ceuvel Greenhouse

GROWING POWER

Milwaukee, USA

An aquaponics system in the centre provides nutrient rich water for all the plants

Tours are given through the complex to teach about urban farming and aquaponics

An ebb and flow system is placed above the fish tank

KIKABONI FARM

Nairobi, Kenya

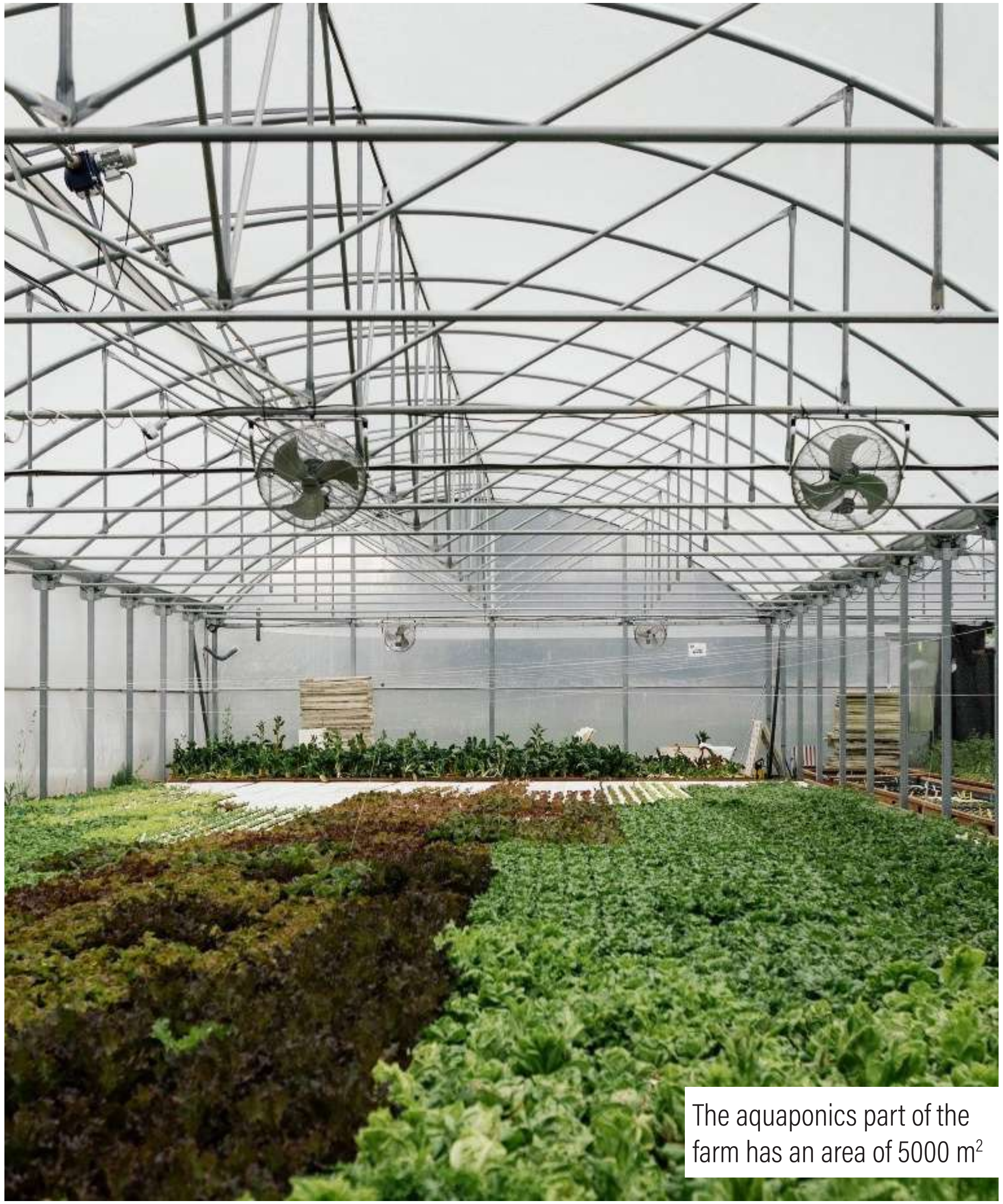
A low-tech decoupled system of aquaponics

The fish are cultivated indoors close to the site

LES NOUVELLES FERMES

Bordeaux, France

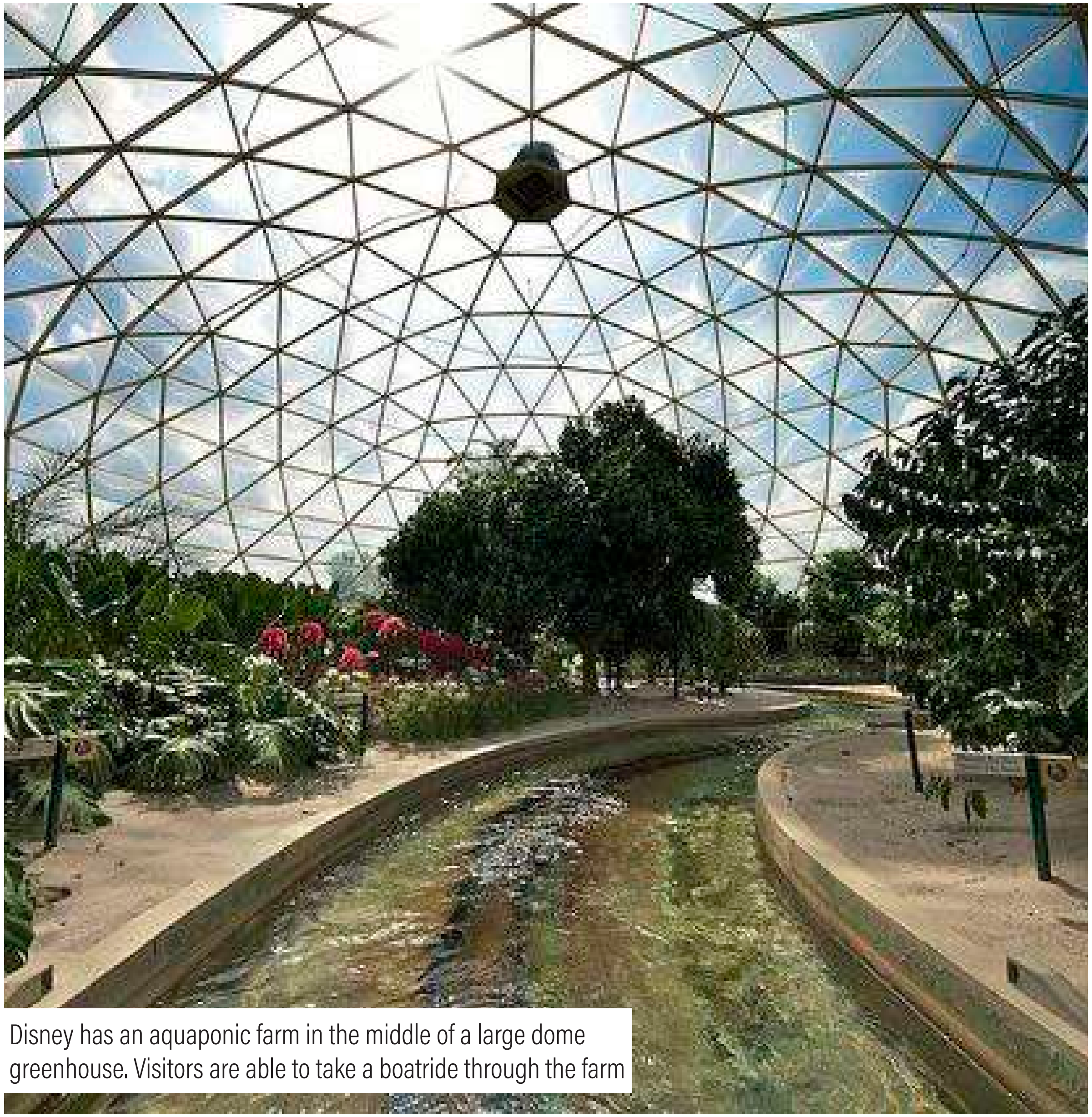
One of the largest European aquaponics farm



The aquaponics part of the farm has an area of 5000 m^2

WALT DISNEY WORLD'S FARM

Florida, USA



Disney has an aquaponic farm in the middle of a large dome greenhouse. Visitors are able to take a boatride through the farm

The boatride displays various farming methods like: aeroponics, aquaponics and hydroponics

Fish like Tilapa are also harvested at the farm, which help with fertilizing the crops

6.4.5 ROOFTOP FARMING

Rooftop farming is a kind of urban farming that has more of a focus on enhancing the community as opposed to being as profitable as possible. Other urban farming methods like aquaponics or aeroponics can be integrated within the design.

Because of the focus on the community, rooftop farming usually looks into improving aspects like mental and physical health, social interactions and an offering people an occupation. They are usually either completely open to the public, or focus on a specific target group and cater to their specific needs.

Because rooftop farming is such a broad definition there is also a large variety in kinds of rooftop farms. Larger scale farms could focus on improving the quality of life in an entire neighbourhood or community, while smaller scale farms could be used by single families.

TAINAN XINHUA MARKET

Tainan, Taiwan

A proposed rooftop farm on top of a market, each section will be tailored to a different crop

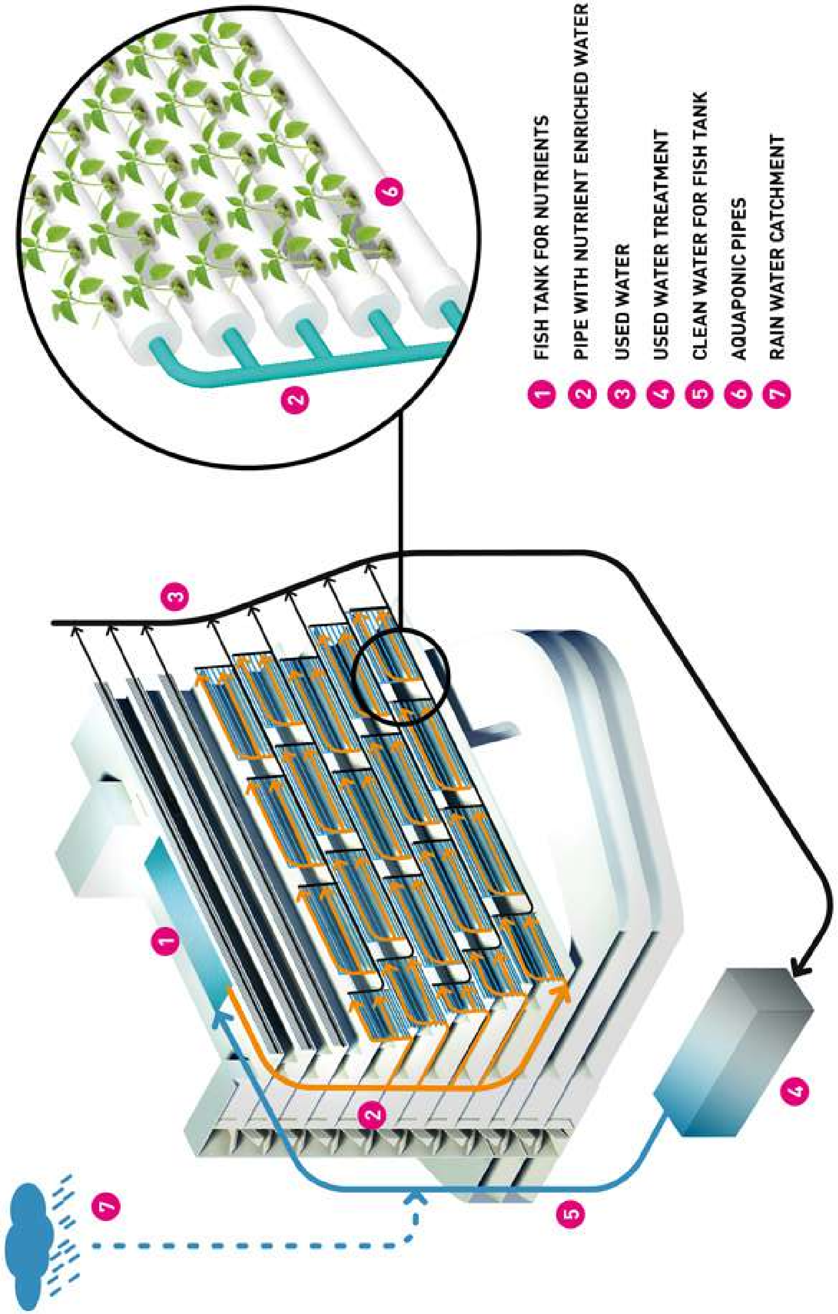
The produce will partially be sold underneath the farm at the market

The rooftop will be open to the public and allow for participation

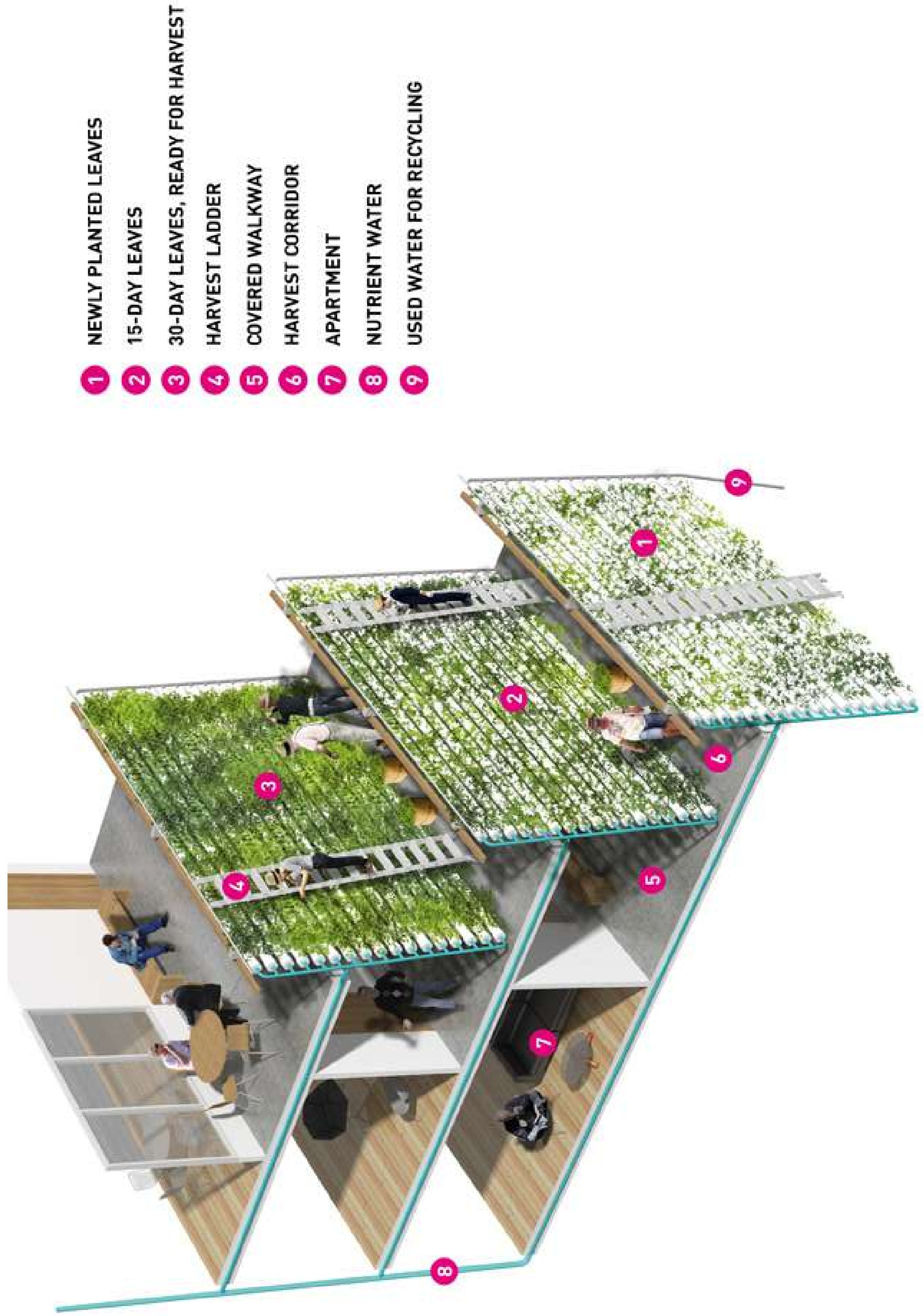
HOME FARM
Singapore


A retirement community that
also doubles as a city farm


The retirees are incentivized to participate, but
people from outside the community can also help



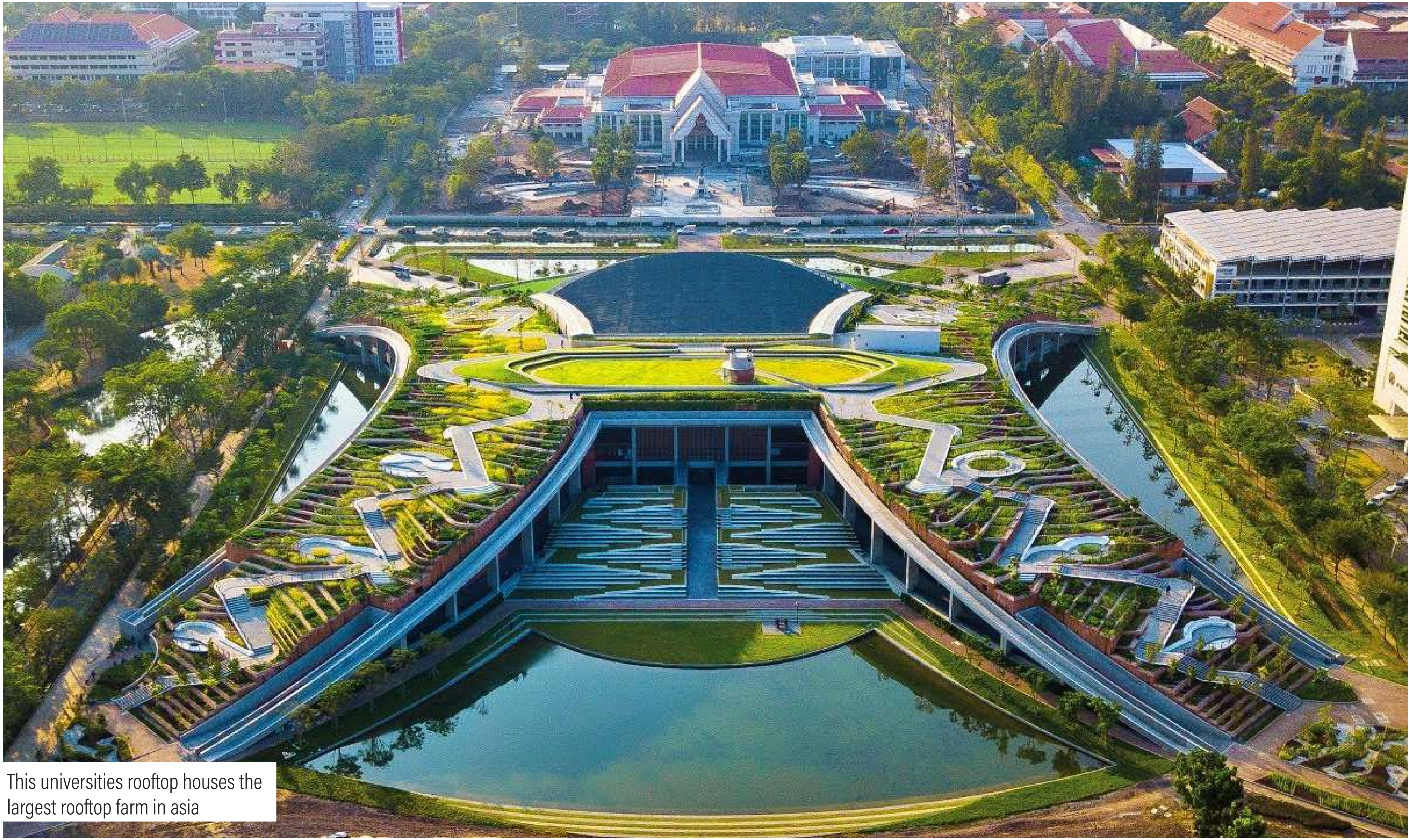
The community among others makes use of aquaponics to fertilize the walls



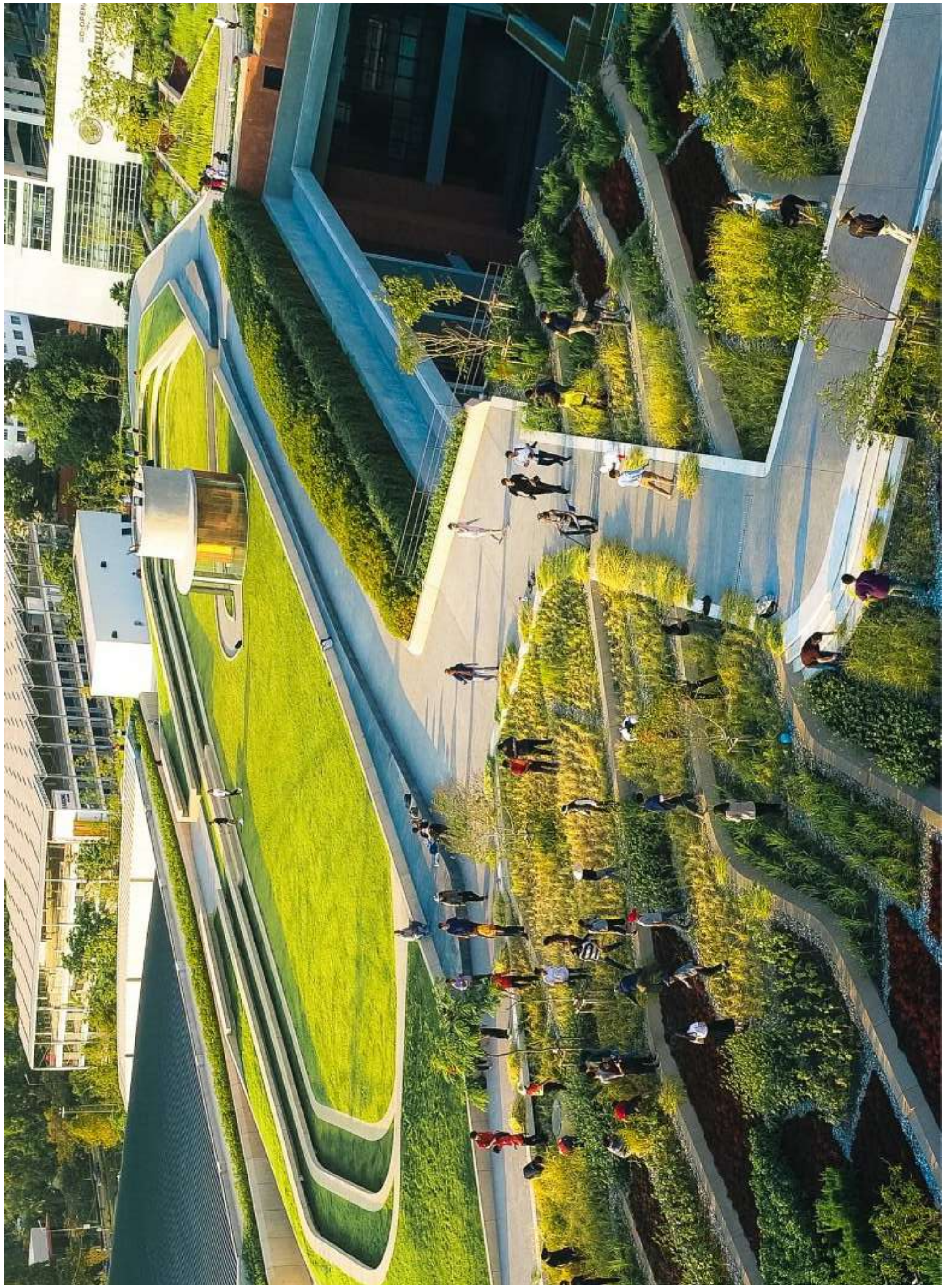
Each section will be planted in a separate period, ensuring constant harvesting

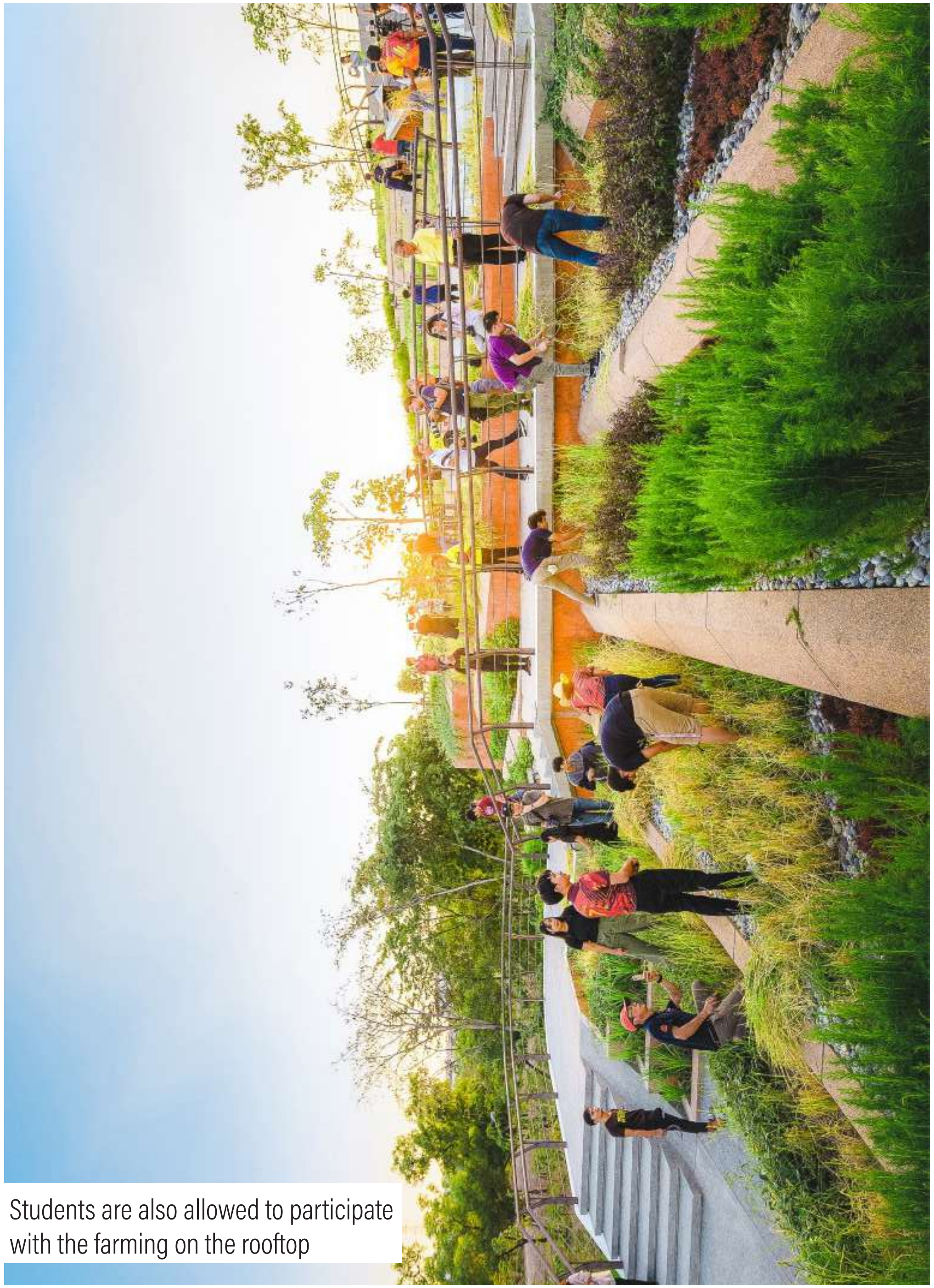
THAMMASAT UNIVERSITY

Bangkok, Taiwan



This universities rooftop houses the largest rooftop farm in asia





Students are also allowed to participate with the farming on the rooftop

UNCOMMON GROUND

Chicago, USA

The restaurant sources all their food organically and locally

The rooftop is used to produce all their leafy greens