A MICRO-AGRICULTURE SYSTEM
IN SAN FRANCISCO’S TENDERLOIN DISTRICT

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THESIS
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ABSTRACT

The purpose of this research was to establish a micro-agricultural networking system – a new extension of the traditional urban agriculture in the Tenderloin District of San Francisco, for which mapping and design of the prototypes of apparatus for the new system were provided. One of the aims of this thesis was to design new applications for urban agriculture as small-scale spaces in cities without affecting the original properties of the land use. Precedent mapping, metrics of green spaces, and municipal codes were provided to identify appropriate spaces for micro-agriculture. Networking systems that enable the combined implementation of several micro-agriculture types were established. The importance of micro-agriculture applications to local food diversity and availability, farm-to-restaurant networking systems, and the enjoyment of social participation are discussed in a contextual framework.
TABLE OF CONTENTS

CHAPTER 1 - INTRODUCTION ................................................................. 1
CHAPTER 2 - LITERATURE REVIEW ..................................................... 3
CHAPTER 3 - RESEARCH DESIGN ......................................................... 15
CHAPTER 4 - CONCLUSION ............................................................... 48
BIBLIOGRAPHY ..................................................................................... 52
CHAPTER 1 - INTRODUCTION

1.1 Background

During the 20th Century, urban agriculture has developed as a grass-roots community movement providing people with more access to local food, a sense of empowerment through contributions of labor, and rewards of produce grown. In many contemporary underserved communities, urban farming is developing steadily and rapidly. Meanwhile, in many developed and highly urbanized places, such as those found in Japan and Europe, many people organize to develop urban farming areas in communities where they grow their own food for fun and for self-sufficiency.

However, difficult issues impact the continued development of existing urban agriculture modes. One is the limited availability of high valued land. As populations grow, communities are pressed to develop parcels for the needs of human settlement. Land availability is reduced and land prices rise. As a result, the land for agriculture is pushed further away from central districts. While citizens all over the world continue to organize forming NGOs (non-governmental organization) to develop urban community farms, the land also continues to be developed for commercial purposes.

Another issue is the feasibility of urban farming. In many metropolitan areas, the government allows communities to develop local vacant lots or abandoned areas as farmland in order to improve the local food supply. Often the results turn out to be less than ideal for many reasons, including the low yields of community farming lands, the
capital investment problem, social participation, etc. However, there is still demand for urban agriculture to improve local food access and food diversity.

1.2 Strategy

This thesis focuses on discovering and finding capable spaces in cities that have not been considered for food production. The development of those spaces will not affect existing built environment and municipal decisions about land use. For this work, the application of those spaces for urban agriculture is called “Micro-agriculture”. Micro-agriculture is a new expansion of traditional urban agriculture. It consists of new applications of urban farming in small-scaled places and spaces somewhere in cities without affecting the original properties of land use. There are advantages of micro-agriculture, including the economization of urban spaces, the enjoyment of social participation, landscaping public spaces, enrichment of local food diversity, and improvement of local food access for under-served communities.

Strategies are developed that determine viable site and prototype designs for the establishment of micro-agriculture for the local food-table chains in the Tenderloin District of San Francisco. San Francisco is a leader in fresh, healthy, sustainable food. However, the Tenderloin District is underserved in the amount and diversity of vegetable production.
2.1 Background Study

Urban agriculture can be traced back to Mesopotamia in 3500BC where farmers set aside plots for that purpose. Urban agriculture in the United States developed in the early 20th Century (Jared 2012). In many cities, urban farming was a way to solve the food access problem and to provide self-sufficient production of food resources.

On April 12th 2011, the proposal and ordinance for supporting urban farming and food access were passed by San Francisco’s municipal government. The proposal, developed by Mayor Ed Lee and Supervisors David Chiu, mainly aimed to encourage the sale of produce from urban gardens and farms by modification of its zoning code (SFUAA 2011). The Mayor of San Francisco maintained that the Urban Agriculture Ordinance would help improve the production of fresh, locally grown produce. In addition, the allowance of local food production within City limits would also revitalize vacant arable space and create green jobs (SFUAA 2011).

2.2 Micro-agriculture’s Matrix Study

In order to better study urban agriculture and develop the innovative framework for micro-agriculture, a number of challenges and key resources should be taken into consideration. These include locating physically available urban spaces; potential construction materials; composition of soil; compost; types of vegetation; and modes of
financing. Much existing literature provided me with valuable information on materials, soil, compost, vegetation, and operating networks.

### 2.2.1 Study of Framework

Development of agriculture for urban areas must confront the problem of financial sustainability. There are various financial frameworks urban farmers have established to help diversify the market. The most common employs the urban agriculture project as a public service project that is operated by the neighborhood. The material, financial and labor needs of urban farm land is established and managed by the local community and the government. Many enterprises are willing to donate to the revitalizing green career. On the other hand, urban farmers themselves have found different and effective ways to maintain the sustainability of urban farming. Farmers sell food from the farm to small grocery stores, corner stores, and community co-ops. Small stores and co-ops benefit from direct sales from farmers as they cut out a middleman, which often makes for a less expensive product (Hagey et al. 2012). In this way, urban farmers can profit from selling vegetables and re-investing the money for the equipment and other operational expenses.

Thomas Lyson mentioned in commodity Agriculture and Civic Agriculture (2004) that in recent decades a number of farms have established commercial networks with farmers’ market, pick-your-own farms, and restaurants. The farm-to-table network provides citizens with a direct and sustainable means to consume vegetables and other fresh food. It is also a fast and promising way to channel food output from urban agriculture.
2.2.2 Precedent Models for Community-based Local Food Initiatives

a. Street Parks Program

The Street Parks program is a partnership between the Department of Public Works (DPW), the San Francisco Parks Alliance (SFPA) and the residents of San Francisco. Its purpose is to transform public spaces (vacant lots, trash and illegal dumping spots, hillsides, unaccepted streets, etc.) to sustainable landscape design works (gardens, greenery, parks, parklet, etc.) with aesthetic function (Department of Public Works 2012).

The site scope for projects is guided and provided by DPW. According to the project guidelines, residents select sites that they are interested in planting/developing and maintain for more than 3 years near their neighborhoods (less than 3 blocks). After the application is approved by SFPA and DPW, DPW will then confirm the community property owner/neighborhood corporation and ensure the safety of land and suitability of development. The residents or community who may be impacted by the sites will take charge of fundraising, site design and maintenance following approval. The cost of this program is supported by The Park Trust and the DPW and off-set by volunteer participation. The leading departments of this program- SFPA and DPW - encourage the neighborhood community to apply for funding of materials through public and private channels (Department of Public Works 2012).

The project is a precedent example of how the community-based project works in partnerships among residents, government and related departments and organizations,
and functions as a reference for the existing modes of operation for micro-agriculture programs.

b. Urban Gleaning Program

The Urban Gleaning Program DPW provides all residents and businesses in San Francisco access to healthy and nutritious food. It also reduces waste of locally grown food; and creates a food distribution system that targets communities that normally do not have access to fresh and healthy food. DPW will support residents and businesses with the help to gather, pick wash produce, and package it for distribution to food banks, shelters, soup kitchens, and hot-meal delivery programs. Buckets and other tools are also provided for harvesting and distributing produce (Department of Public Works 2013).

The program was started based on the existing fruit trees in public and community gardens, and it is open to all interested residents who register their fruit trees in the program. The volunteer program is a redevelopment community project for urban food production, which can serve as an example for the establishment of micro-agricultural systems.

c. Buijtenkitchen

The Buijtenkitchen is a mobile restaurant building by Studio Elmo Vermijs in the Netherlands. The innovative establishment is located in the community of farms, where cooks can get the freshest seasonal ingredients from the farms immediately (ArchDaily 2012). I will not point out the ones that follow but will assume you will correct them.
The Buijtenktchen is a new type of restaurant that integrates the farm-to-table system with food service.

Just as Buijtenkitchen is a mobile unit that locates next to the farm land where the food is produced, micro-agriculture can also be a mobile utility that locates near the restaurants or communities in demand of fresh fruits and vegetables.

2.2.3 Study of Technics

The installation of micro-agricultural systems will include the evaluation of construction material, tectonics, soil selection, irrigation systems and vegetation. The following examples are used in the design of proposed micro-agriculture applications.

a. Tectonics Study on Material and Composition

1. Attachment to the Partition Wall (Figure 2.1)

The Top Sider Planter offers four different ways to attach the micro-agricultural application to the existing surface of buildings. The rectangular planter can be supported by means of a bracket, or it can be self-supporting. The bracket design can be of the type made to fit on top of the partition wall (Helfman 1985).

The planter may be conventional material such as metal, plastic, synthetic resin or wood. The metal includes stainless steel, bronze, copper, aluminum or brass, with a brushed or satin texture being preferred (Helfman 1985). Suitable plastics include acrylonitrile butadiene styrene (ABS), acrylic, polystyrene, polyethylene, polyvinyl chloride (PVC), Teflon and so forth. Synthetic resins may include the kind as nylon, rayon, Dacron,
Formica, Fiberglas and so forth. The concept of this patent provides valuable guidance on the tectonics and material selection.

2. Vertical Farm (Figure 2.2)

The *Vertical Wall Garden* introduces an easy and efficient means to use certain materials and make them into a vertical planting’s apparatus. The frame of the planting spaces can be made of sustainable plastics. The material for the soil bag can be permeable geotextile. (Urriola 2011)

3. Hanging Planter (Figure 2.3)

The hanging planter provides an environment that can allow plants to grow in a substantially downward direction. (Oliver et al. 2009). The application can be used in micro-agriculture interior environments.

4. Bracket Device (Figure 2.4)

The bracket device invented by Yurkovitch (1937) provides this research with a reliable guide for attaching micro-agricultural systems to the existing pipe structures in urban areas.

5. Planter (Figure 2.5)

The *Planter* provides this research a way to install the planter into an existing hollow wall cavity. The model is appropriate for plants with short roots. (Richer 1991).
Besides the two example inventions, there are many useful products that can be applied to the new micro-agricultural model. Products, such as Junji Canada’s Planter Irrigation System (Shinda 1984), Garrick’s Automated Planter Box System (Garrick 1976) and so forth, provide this investigation with a variety of ways to create simple irrigation systems for plants.

b. Irrigation Study

1. Plant Irrigation System (Figure 2.6)

The irrigation apparatus provides ways to conduct water from a reservoir below the container to the soil. By use of a pump, water can easily flow from the reservoir to the container. The apparatus is generally useful for small micro-agriculture units.

2. Automated Planter Box System (Figure 2.7)

The Automated planter box system provides a reliable model for the freestanding planters and planters in the parklet. In this invention, the lower portion of the inner container is porous to the flow of liquid which is held in the intermediate space between the two containers. The water level within the intermediate space is regulated by a valve which is set to open when the water reaches a second high water level. The high water level is above the porous portion of the inner container and the low water level is below the porous portion. In this way, the planter itself can provide alternate wet and dry periods for plants growing in the inner container. (Garrick 1976).

c. Vegetation Study

The selection of vegetation for the micro-agriculture mainly requires determining root depth requirements of vegetables or herbs.
Information shown in Table 2.1 is provided by the Cornell Cooperative Extension Service (de Long n.d.). According to the container size recommendations, the clients can select their preferred vegetation based on its required container type.
Figure 2.1 – Drawings showing how planters are attached to the partition wall
Helfman et al. 1985

Figure 2.2 – Drawings showing the structure and composition of the vertical garden
Urriola 2011

Figure 2.3 – Drawings showing the inner structure of planters that can be hung, in which plants grow upsidedown
Oliver et al. 2009
Figure 2.4 – Different types of bracket device which can help to attach micro-agriculture planters to other structures
Yurkovitch 1937

Figure 2.5 – Drawings showing the patent of inserting planters into wall cavity
Richer 1991
Figure 2.6 – Plant Irrigation System - By the force use of a pump, the water can easily flow from the reservoir to the container
Shinada 1984

Figure 2.7 – Automated planter box systems enables steady irrigation
Garrick 1976
<table>
<thead>
<tr>
<th>Plants</th>
<th>Hanging Basket</th>
<th>Small 4'-6' pot</th>
<th>Medium 8'-12' pot</th>
<th>Large &gt;12' pot</th>
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<td>VEGETABLES</td>
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<td>Beans (bush)</td>
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<td>Beans (pole)</td>
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<td>Broccoli</td>
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<td>Swiss Chard</td>
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<td>Cherry Tomato</td>
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<td>Tumips</td>
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<td>Parsley</td>
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<td>Rosemary</td>
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<td>Sage</td>
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<td>Winter Savory</td>
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<tr>
<td>Thyme</td>
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<td>FLOWERS</td>
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<td>Annuals &lt;12' in height</td>
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<td>Annuals &gt;12' in height</td>
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<tr>
<td>Annual Vines</td>
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<td>Perennials</td>
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Note: recommended minimum container size is indicated by shaded areas on the table.

Table 2.1 – Recommended minimum container size for various plants based on the root depth
Long N.D.
CHAPTER 3 - RESEARCH DESIGN

3.1 Site Description

San Francisco is a leader in fresh, healthful, sustainable food. However, the Tenderloin District (Figure 3.1) is underserved in the amount and diversity of produce. The Tenderloin District, a neighborhood in downtown San Francisco, California, encompasses about fifty square blocks. There are over 30,000 residents (Figure 3.2), sixteen grocery stores (Figure 3.3), and two community gardens, but no supermarket there. The US 2010 population census in the Tenderloin District was 31,565 residents (City and County of San Francisco 2012). According to GIS data (City and County of San Francisco 2012), the population is very dense in the blocks including Turk Street, Eddy Street, Ellis Street, Hyde Street, Leavenworth Street, and Jones Street, where each block has 700-1700 people.

The US Department of Agriculture recommended average intake of vegetables and fruits should be five or more ½-cup servings per day per person. Americans need to consume more fruits and vegetables, especially dark green and orange vegetables, and legumes (Guenther, et.al. 2006).
Figure 3.1 – The Tenderloin District context
City and County of San Francisco 2012

Figure 3.2 – Map of population showing the distribution of population
City and County of San Francisco 2012
Figure 3.3 – There are 16 grocery stores in the Tenderloin selling a limited variety of fruits and vegetables

Figure 3.4 – Coverage conditions about fruit store and vegetable grocery stores showing that most areas in the Tenderloin are underserved zones
Though there are sixteen grocery stores in this region, the variety and amount of fruit and vegetables sold do not support the large population living there. According to a report published by San Francisco Study Center in 2007, there were only a few fresh items sold in these stores. While there are a few stores where people can purchase apples, bananas and potatoes there, the variety and diversity of food is not enough to provide the residents with abundant and balanced diets. What’s more, many vegetables and fruits in the groceries and stores are not fresh.

The Tenderloin District is the lowest income area in San Francisco, and many people living here are immigrants from Asia and South America. Incomes in the district are so low that residents often cannot afford to purchase cars or houses. Most residents rent houses or apartments. In addition, the steep topography of downtown San Francisco is more suitable to walking rather than driving cars. In the scope of the district map, the coverage of the sixteen groceries based on walking distance is mapped and illustrated, in order to provide the research with a macroscopic vision of the areas where provision of vegetables and fruits is underserved. The coverage map (Figure 3.4) shows that a considerable area in the Tenderloin District needs more fresh vegetable resources to increase the food diversity and coverage. These areas are the proposed places for the application of micro-agriculture.

The Micro-Agriculture project can function as an entrepreneurial endeavor that can help add food layers to underserved communities and provide residents with more food selection options.
3.2. Feasibility Analysis

To develop a new urban agricultural system that would provide people with a greater quantity and variety of fresh food, existing policies and zoning codes must be examined. (Figure 3.5) (San Francisco Municipal Code 2012). Through analyzing the planning code, the feasibility of spaces for micro-agriculture can be seen by mapping the spatial limits and allowance based on the spatial ordinance.

In the San Francisco Municipal Code, rules for traditional urban agriculture are as follows:

1. The site for urban agriculture should be less than 1 acre
2. The time schedule for the sales and donation of fresh food and/or horticultural products grown on site is limited.
3. The compost area for urban agriculture must be setback at least 3 feet away from the red line – the boundary of the site.
4. In the planning district (Figure 3.5), the site of urban agriculture land must be within ¼ mile of the lot.
5. The site in open space must be on the ground, not in the building.
6. The area for open urban agriculture must be within 2500 square ft. in public space which is owned by the City and County of San Francisco and the Neighborhood Development Cooperation.
7. Open urban farming land must be accessible to residents.
Figure 3.5 – Zoning of the Tenderloin District

Figure 3.6 – Available lots for urban agriculture as purple blocks show
According to the planning ordinance of City and County of San Francisco above, the available sites to apply urban agriculture are those areas in the purple blocks, which are decided based on the spatial aspect (Figure 3.6). However, there are two problems:

1. There are minimal purple areas in the Tenderloin.
2. Parking lots soils contain many lead contaminants, which would render the vegetables unsafe for consumption. As a result, it is not feasible to apply traditional on-ground urban agriculture to the Tenderloin District.

As for new micro-agriculture systems, the direct application of traditional urban agriculture may not be effective. While some concepts will apply, the new micro-agricultural applications will be included in the genre of commercial art works and mobile food facilities.

SEC. 102.2 of the Municipal Code indicates that art works, creative productions and small-scale material works and other crafts can be placed in areas designated as open space. SEC.184.80 defines “Mobile Food Facility” as any vehicle or pushcart used in conjunction with a commissary or other permanent food facility upon which food is sold or distributed at retail. For purposes of this thesis, a pushcart and a mobile caterer are both referred to as a Mobile Food Facility unless specifically stated otherwise (San Francisco Municipal Code 2012).
Micro-agriculture infrastructure can be in the form of sculptures, small-scale glass works, commercial arts, mobile food facilities and vending machines.

![Comparison between traditional urban agriculture and micro-agriculture](image)

**Figure 3.7** – Comparison between traditional urban agriculture and micro-agriculture which shows that micro-agriculture has more advantages over the traditional urban agriculture

Comparing traditional urban agriculture’s pros and cons with micro-agriculture’s, the advantages of micro-agriculture are obvious. Traditional urban agriculture can improve local food access and urban food diversity. However, traditional urban agriculture is less advantageous than micro-agriculture in terms of property values, prohibited uses, and the unstable capital investment and market revenue.

### 3.3 Design Strategy

There should be an urban ecosystem framework for the effective application of the micro-agriculture. The government uses tax revenues to fund these projects, and the
incremental income from the projects will in return improve the tax base. The San Francisco Redevelopment Agency obtains funding of its redevelopment projects through a financing method called "tax increment financing (TIF)."

In the TIF financing method (Figure 3.8), the assessed value of redevelopment projects becomes the Base Year Value when the projects were approved by City Council/San Francisco Redevelopment Board. The increase in taxable values of properties brought by the projects over the Base Year Value in last year will be the tax increment. The collections of tax increment are pledged to the payment of debts on obligations issued to finance redevelopment projects according to the California Redevelopment Law. (Successor Agency to the San Francisco Redevelopment Agency 2009)

![Figure 3.8 – A diagram showing how financing works in the micro-agriculture projects with the cooperation of different institutes](image-url)
Proposed Framework

As for the Micro-agriculture Program in the Tenderloin District, the existing financing circuit of redevelopment projects (Figure 3.9) serves as a base for the proposed framework. After the City’s approval of the Micro-agriculture Program the capital will be issued to the management of the project. The Tenderloin Neighborhood Development Corporation (TNDC) is the property owner and project manager of all the construction in the neighborhood. In the next stage, TNDC will set up a series of things, including the design of micro-agricultural sites and applications; the construction; the recruitment of workers or volunteers; the meetings among property owners, steward, government and residents; the maintenance and so forth. The assessed value of micro-agriculture will be regarded as the Base Year Value once the proposal is approved. The property or business impacted and appreciated because of the micro-agriculture should pay the taxes for it. The increment of tax will then be used as capital for the project in return. The proposed framework of micro-agriculture can be applied to two different realms: public and private.
Public Mode

In the public mode (Figure 3.10), the city government will authorize the neighborhood development institute to set up the Micro-Agriculture Project and also allocate funds to the project. People living in the neighborhood will pay more taxes and can enjoy the new kinds of vegetables from the installation. In this mode, the public organization plays a very important role in micro-agricultural projects. Once the project starts, the neighborhood development institute will be in charge of raising money for the construction, recruiting workers and overseeing the process of building the project. The public micro-agricultural project will operate with funding from the government.
The advantage of the public mode is that the project can function as a small-scale community garden system which can improve the residents’ participation and the vitality of the neighborhood. Based on the existing employment ratio and construction of the Tenderloin District, the Tenderloin Neighborhood Development Corporation (TNDC) can make flexible adjustments on the project’s construction and labor needs. The TNDC can arrange the location of the micro-agriculture application with reference to zoning limits, parking demand, safety needs, and other conditions of the district.

Figure 3.10 – A diagram showing a proposed framework for public mode, in which the government, foundations and neighborhood institute play the most important parts

In the Tenderloin, there are a considerable number of foundations that will donate to the development of the neighborhood. (Figure 3.11)
The foundations are listed as below:

1. Coalition on Homelessness
2. Curry Senior Center
3. Tenderloin Health
4. William Taylor Methodist Church
5. Saint Boniface Roman Catholic Church
6. Walk San Francisco
7. IOOF
8. St Boniface Church
9. Street Beats
10. Salvation Army Kroc Community Center
11. Aranda Residence
12. The Central City SRO Collaborative
13. Safwat Morsy
14. Gray Area Foundation For The Arts
15. International Art Museum of America
16. San Francisco Aids Foundation
17. San Francisco Drug Users' Union
18. Cadillac Hotel
19. Bay Area Women's & Children's Center
20. Indo Chinese Housing Dev Inc
21. SF Gospel Mission
22. Heart of the City Farmer's
23. SF Camerawork
24. Central Market Community Benefit Corporation
25. Tenderloin Neighborhood Corporation
26. Community Housing Partnership
27. Burnham Praise
28. Coast
29. Glide Memorial United Methodist Church
30. SF Bicycle Coalition
**Private Mode**

In the private mode (Figure 3.12), the vegetarian restaurant (Figure 3.13) will invest in the installation of the micro-agriculture system after governmental approval. The revenue made from the project will go back to the restaurant. In this mode, the operation of the projects largely depends on the condition of the vegetable and restaurant markets. The restaurant in charge of the micro-agricultural project can harvest the vegetable products from the project and directly use them in food service. Based on ingredients needed for its recipes, the restaurant can design and improve the micro-agricultural applications itself. The kinds of the vegetables grown will be determined by the private restaurant.

![Diagram](image.png)

*Figure 3.12 – A diagram showing a proposed framework for private mode, in which the private vegetable restaurants plays the leading role*
This mode is very convenient to operate once the restaurant decides to import the technology of micro-agriculture into their food service. Under the scenario, people can purchase food directly from the restaurants’ micro-agricultural applications. Under the other scenario, restaurants use vegetable from the applications and prepare vegetarian food for people and charge clients for the food service.

### 3.4 Data Collection and Design

A large part of the research emphasizes finding available and feasible spaces in urban areas. The mapping and metrics for this spatial study are mainly based on the analysis of statistical data and image data. Informational databases from the government, therefore, serve as an important key resource for the data collection work. The statistical data is mostly provided by the City and County of San Francisco, Google Maps and the
Tenderloin Neighborhood Development Corporation. The image data is mostly from the bird’s eye view of Google maps at different scales, and photographs taken from the aspect of streetscape in the Tenderloin District of San Francisco. To better determine those spaces that can be used as the new form of urban agriculture, there are two basic strategies that should be applied to the approach. One is geo-information collection and mapping, and the other is photography.

The research deploys a matrix that includes the financing framework, site selection, and the tectonics of the apparatus to better bridge relationships among all the important factors related to the Micro-agriculture Program.
Figure 3.14 – The Matrix of the Micro-agriculture showing the relationship among financing framework, site selection and major tectonics
3.4.1 Prototypes

Based on the feasible space for Micro-agriculture, the research proposes four types of tectonics for the micro-agricultural physical models (Figure 3.15): attached, thickened/layered, repurposed, and inserted.

Figure 3.15 – Four different major tectonics of micro-agricultural physical model, including the thickened, attached, inserted, and repurposed
1. Planters of Parklet

By using GIS Technology and photographic investigation, along with analysis of sunlight among buildings, a feasible form for a public mode-parklet may be determined (Figure 3.16). A parklet consists of two metered parking spaces, which are repurposed to a landscape use. The name “parklet” has been generally used since the Pavement to Park Program started in San Francisco in 2010 (Figure 3.17). The apparatus of micro-agriculture can be deployed in a parklet. Using a parklet as the site for micro-agriculture has several advantages. First, it is convenient and easy to encourage public participation and activity, as parklet is a new type or public space more implementable and accessible to pedestrians. Second, it will support the local neighborhood businesses and properties. As there are benches and chairs on the deck in the parklet, customers of the nearby cafes or other shops may relax there attracted by the beauty of the small landscape. People using the areas may treat the neighborhood as a wonderful destination and habitat. Third, because it is located on the street side of the neighborhood area, construction and maintenance can be implemented very quickly by workers or volunteers of the Tenderloin.
The sample design of the micro-agricultural application is located in the parklet near the corner of Jones Street and Ellis Street (Figure 3.18-3.19). In the parklet area, the application will open to the street and the pedestrian. The parklet is two parking spaces long and four feet wide. It is located in the store front of a liquor store where some fruit is
sold. There are two wood planters on the surface and plastic on the inner-faces. In order to reduce the impact of the environmental pollution by vehicles, the planter is covered with an acrylic material. The cover has five panels with hinges to connect each of them.

The irrigation system relies on a pump for irrigation (Figure 3.20).

![Figure 3.18 – Proposed view of micro-agriculture in the corner of Jones and Ellis Street](image)

![Figure 3.19 – Master Plan of Parklet in the corner of Jones and Ellis Street](image)
Figure 3.20 – Detailed Cross-section of Micro-agriculture in the Corner of Jones and Ellis
2. Urban Structure

Considering that there are twenty vegetarian restaurants in this area, the private mode’s micro-agricultural project can serve as a system that directly uses vegetables for food dishes, which is beneficial and convenient for the restaurants and clients. The private mode is primarily located in or attached to constructions in the district. The map of the ongoing construction and proposed construction in this area (Figure 3.21) can help to test the potential spaces for the realization of micro-agriculture. The new application can be attached, layered or inserted in the buildings. During the spatial investigation, there are many vertical spaces in the city area that have not been utilized. The implementation of new green agriculture in the buildings will provide a city with a new look of fantasy.

Figure 3.21 – Map of on-going and proposed construction showing the potential spaces in buildings for micro-agriculture
There are many tectonics for the restaurants to choose according to the properties and ownership of the buildings. There are different ways to install the application on the building to meet different conditions.

a) Attachment to handrails

The planter box can be attached to handrails or other pipe-like structures in urban scales (Figure 3.15). The planter box is attached to the handrail by a mounted arm bracket, on which the direction can be adjusted. The planter box itself consists of a big water box and a soil box inside. There is a water conduit that connects a hole between the soil box and the water box, so that the water can be conducted to the soil box until the moisture soil’s water level reaches the same level as in the big box (Figure 3.22).

![Diagram of micro-agriculture attached to handrails](image)

Figure 3.22 – Detail drawing of micro-agriculture attached to handrails showing the inner structure of attached micro-agricultural application and the system of irrigation

It is an appropriate way to use the vertical spaces surrounded poles and columns by attaching planters to them. However, not every space with handrails is available for the prototype. The fire escape space is unavailable for micro-agricultural attachment because the previous function of fire escape would be affected.
b) Attachment to partition wall

The way of attachment is derived from Helfman’s invention. In this invention, the planter is attached on the top of the partition wall or the façade of the wall.

The ways of attaching the box to the partition wall vary. The planter box can be fastened by hooks, slides and so forth. Besides attaching the planter box to the top of the partition wall, the planter can be also hung on the surface of the partition wall to function as both a decorative green box and a productive micro-agriculture application (Figure 3.23).

![Figure 3.23 – Two models of attachment to partition wall, including a hanging planter box and a sliding planter box](image)

c) Insert in the façade

Micro-agriculture can be employed into the construction project (Figure 3.24). The planter can be inserted into the wall layers. The rendering picture shows the relationship between the micro-agriculture application and the architecture (Figure 3.25). During the construction of the façade of the buildings, the planter box will be inserted into the
surface of the buildings. The structural material for the application is carbon fiber, which is strong enough to resist the force of bricks. The seams between buildings and micro-agricultural structure are filled with concrete. The soil used here is compressed plant growth medium which expands when contacted by water (Figure 3.26). (Melvold 1968) This soil is made of pressed peat moss by dehydration. The soil bag is a sleeve of water-resistant material which is collapsed against the briquette to a minimum volume to be easily transported (Melvold 1968). After watering it for planting, the soil bag will swell and become porous. Before adding soil, the soil bags are compacted into a briquette shape which is of very light weight. After people purchase and use it, the material in the bags can absorb water from the top hole of the bags. Then, seeds can be put on each bag from the top hole into the deep soil.

Figure 3.24 – Proposed view of vertical micro-agriculture inserted in the façade of a building
Figure 3.25 – Detailed rendering of a vertical micro-agricultural module showing the inner structure and composite materials of the application and how the application works with the architectural structure

Figure 3.26 – A patent providing a model of soil for the vertical micro-agriculture. In the patent, the soil material – pressed peat moss is filled in a water-resistant bag with two big holes. Before watering it, the soil in the bags is compressed into a briquette-like shape; after watering it, the peat moss can absorb water and dilate (Melvold 1968)
d) Freestanding on the street

The freestanding application of micro-agriculture can be supported by vegetarian restaurants in this area (Figure 3.27). The location of freestanding applications can be decided by each restaurant itself according to the preferred measured distance. The sample design of the freestanding micro-agriculture system is a reused vine curtain (Figure 3.28) and a repurposed mobile cart, in which small planters can be placed (Figure 3.29). There are many ways to design freestanding micro-agriculture systems. Neighborhood property owners can freely design and decide the types of freestanding application once their applications for joining the Micro-agricultural Program and the location preferences are approved by the city government.
Figure 3.27 – Map of Freestanding Micro-agricultural applications which are connected with vegetarian restaurants in the Tenderloin

Figure 3.28 – Freestanding Green Wall
Gsky N.D.

Figure 3.29 – Mobile Micro-agriculture
3.4.2 Vegetation

From the aspect of vegetation selection, there are many vegetables that are easy to grow in a garden. The following list identifies the potential spaces to grow various vegetables according to their root depth requirements (Long, n.d.).

1. Hanging units attached to hand rail:
   Beans, Cucumber, Peas, Cherry Tomatoes, Parsley, Thyme

2. Small Container in vertical façade
   Lettuce, Spinach, Basil, Chives, Lavender, Summer Savory

3. Medium container in freestanding units in street side

Clients using micro-agricultural applications can refer to the seasonality chart for the selection of plants in different seasons (Table 3.1). (Center for Urban Education about Sustainable Agriculture, n.d.) In order to better add food layers and improve the diversity of vegetables for the Tenderloin, vegetables like beans, cabbage, cucumbers, eggplant, squash, tomato, and cherry tomato should be planted more. Because the available planting and growing time for these plants is only one season, there may be additional demands that cannot be satisfied with those foods in other seasons. Herbs like basil, chives, thyme, sage, mint, lavender, etc., are suggested to be selected for two reasons. One is for the companion of vegetables, as planting different vegetables and herbs together can increase the crop production to some extent and have positive effect on pest
control. The other is for landscape aesthetics require those herbs and grass plants to ensure beauty. Because the texture of herbs is very different from the texture of vegetables, to combine different textural plants together can better improve the landscape view.
Table 3.1 – A chart showing the seasonality and the proposed locations for vegetables and herbs in the Tenderloin District.
CHAPTER 4 - CONCLUSION

This thesis establishes a new urban agriculture system: micro-agriculture. I propose that micro-agriculture systems could increase food diversity and increase available food layers for the people living in the Tenderloin District. Different from traditional urban agriculture, micro-agriculture establishes networks among small-scale farming applications, food services, and neighborhood participation.

This investigation and research of existing food markets, zoning codes, and spaces of the Tenderloin District considered a number of precedent micro-agriculture programs. These programs, developed in San Francisco over the last ten years, propose the creation of new landscapes, green industry, and design in the San Francisco area. Many landscape projects were designed to solve issues of the environment, community, and civic participation of the Tenderloin. Programs include the Tenderloin National Forest Project by the artists Darryl Smith and Laurie Lazer; Curran House’s green design by Andrea Cochran; the Urban Air project turning billboard space into a bamboo garden; the Public Toilet Project in the Tenderloin; and so forth. All these projects showed that the Tenderloin District, once the poorest area of San Francisco, is a place of opportunity waiting to be discovered and innovatively revitalized.

The available urban spaces in the Tenderloin District are too limited to be used for traditional urban agricultural. Therefore I used the thorough understanding of the city Municipal Code to explore the feasibility of an alternative production model referred to as micro-agriculture. While traditional urban agriculture is infeasible, there are many
potential spaces that can be used for micro-agricultural applications, such as the planters in the parklet, vertical spaces between buildings, and available spaces within constructions.

Any successful micro-agriculture application must face the feasibility of financing the operation. Based on the existing financing methods and the tax increment financing strategy, two modes for the micro-agriculture system were explored: the public mode for neighborhood development and foundation; and the private mode for restaurants. Several typologies were developed to address various public and private scenarios.

This physical design model for micro-agriculture focuses on tectonics, material and vegetation selection, soil, and irrigation. The tectonics include attaching (bracket planter), layering (parklet), asserting (planters inserted into the wall), and repurposing (mobile micro-agricultural cart). The materials for micro-agriculture planters vary, and can be light polymeric materials like PVC, metal, wood, and so forth. The water to irrigate the soil can be pumped up from the underground reservoirs or flow down from the top of buildings. The soil type for different tectonics also varies; it can be normal organic soil for planters in the direction of gravity and briquette soil (Melvold 1968). The vegetables selected should be from plants with shallow root systems, so that they can fit in the micro-agriculture applications.

In this thesis, the most important task is to find spaces to create new micro-agricultural prototypes for the new form of urban agriculture. The establishment of micro-agricultural
networking has the potential to improve food insecurity in metropolitan areas. The impact coverage of the vegetable industry in the districts changed to a better condition (Figure 4.1). Capital investment in micro-agriculture and the connection of networking farming systems and farming-to-table systems can promote circulation and development of fresh food business (Figure 4.2). Although the success of the prototypes in the networking industry still remains to be observed over the next few decades, research on micro-agriculture systems for the advanced green industry provided a view of the relationship among landscape, human environment, and resources.
Figure 4.1 – Propose coverage map (walking distance) of Micro-agriculture showing most areas in the Tenderloin can be served by the Micro-agriculture

Figure 4.2 – Proposed view of micro-agricultural landscape
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