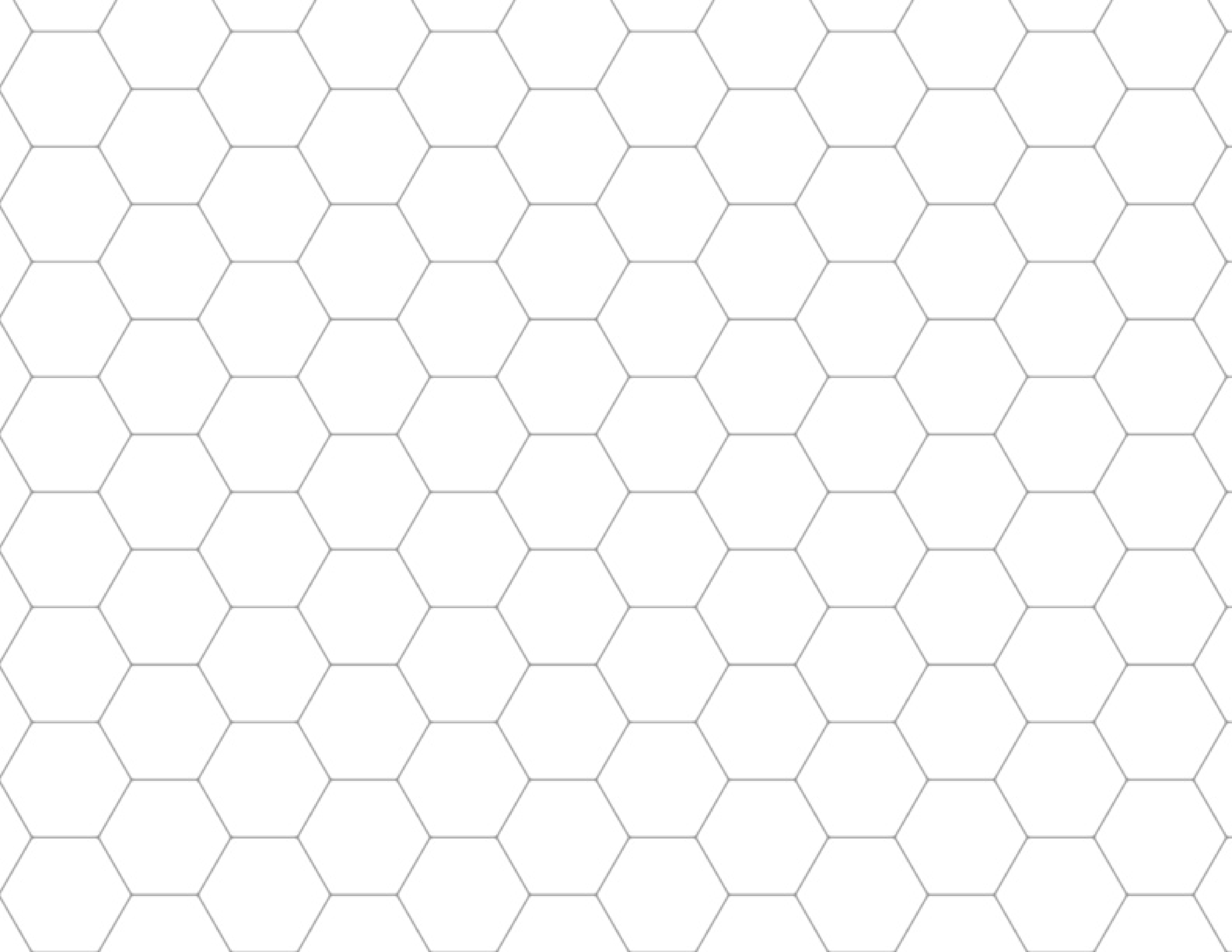
growing a foodshed

biointensive urban agriculture transforms south of market

diana grandi



growing a foodshed

biointensive urban agriculture transforms south of market

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university of california, davis

landscape architecture

senior thesis

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signatures

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Presented to the faculty of the Landscape Architecture Department of the University of California, Davis, in partial fulfillment of the requirements for the Degree of Bachelors of Science in Landscape Architecture

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abstract

Motivated and inspired by the growing sense of food insecurity, my project analyzes opportunities for a self-sufficient foodshed by means of analysis, planning, and design. I chose the South of Market (SoMa) neighborhood in San Francisco, CA as the intervention site to demonstrate how biointensive urban agriculture can succeed in contributing to the creation of a foodshed. The term “foodshed” is defined as an area of land with a fixed boundary in which food is grown, harvested, processed, transported, purchased, consumed, and its waste is reused in a regenerative cycle. My project does not actually create and example of a foodshed as defined above, but instead demonstrates some possibilities of the productive land needed to help in the creation of a foodshed. My proposals include capturing and transforming much of the vacant or underused land in the SoMa neighborhood into food producing landscapes. Examples of different urban agriculture typologies ranging in scale, productivity, time commitment, and resources are found throughout the site. I have chosen to analyze and design five different demonstration sites; a balcony garden, a roof garden, a yard garden, a community garden, and an urban farm. Aside from various urban agriculture examples, I propose the use of biointensive agriculture practices throughout the site. As a result, it is concluded that about 70% of the SoMa population’s fruit and vegetable dietary needs can be met with the implementation of urban agriculture projects throughout the neighborhood. This number comes from various calculations using the square feet of the proposed productive land, how much fruit and vegetables people consume, and the amount of land needed to produce those amounts. It is important to note that a foodshed is a large interconnected system with many components aside from just the cycling of food within a boundary. Other important factors needed to create a foodshed include but are not limited to; marketing, policy, pricing, regulations, education, job training, and social marketing campaigns. My project focuses on the food cycle portion of a foodshed, but does not aim to lessen the importance of these other factors. It is also noted that the food produced in a foodshed include fruit, vegetables, meat, dairy, and all other necessary items found in an average diet. However, my project only analyses the amount of viable space for fruit and vegetable production, and therefore I only performs calculations using fruit and vegetable production and consumption rates.

dedication

for my mom

for teaching me how to garden
for always advocating for fresh and local food
for making me delicious vegetarian meals

for my dad

for encouraging me to be different
for being truly interested in my work
for never failing to let me know how proud you are of me

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for all of your guidance, knowledge, and interest in my project

thanks to all of my UC Davis professors

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thanks to the 2014 LDA senior class

for working along side me for the past three years

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introduction

food insecurity

Food most simply defined is a substance that supplies nourishment to organisms to sustain life, provide energy, and promote growth. Food is essential to human existence yet people know very little about where their food comes from, how it is grown, its nutritional value, and how to make use of their food waste. A large issue that creates this gap in knowledge is the fact that most food is grown miles away from its consumers. This way the consumer does not physically see the food being grown and doesn't understand the processes behind growing, harvesting, processing, and transporting. This problem plagues U.S. city dwellers because they are so far removed from the food source. These city dwellers already consist of 80% of the U.S. population and are still on the rise (US Census). The increase in population and the gap between the consumers and the source of their food causes food insecurity (figure 1.1). Food insecurity is when the food supply fails to match the food demand. This unbalanced system is a result of insufficient flows of resources to agricultural practices, low income consumers not being able to afford fresh food and instead turning to cheaper options, increasing populations, monoculture farming, and drought and other climatic disasters (Nafis).

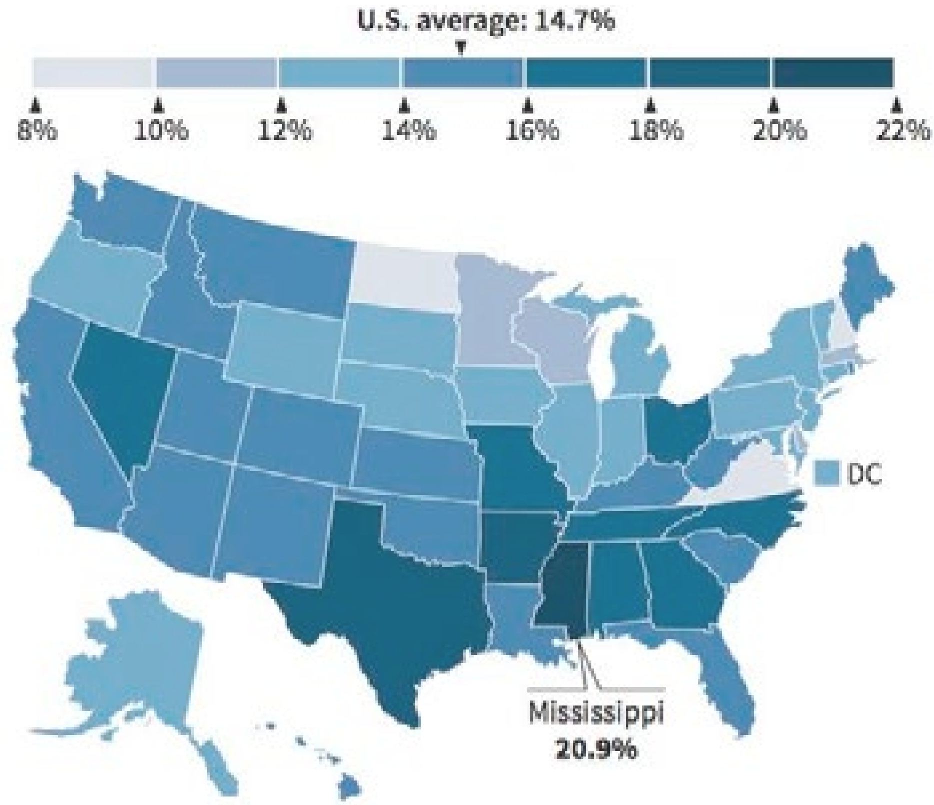


figure 1.1
food insecurity by state 2010-2012

Urban areas are often faced with food insecurity because they depend heavily on external resources that are needed for bringing food into the cities. Very minimal amounts of food are produced in cities. These productive landscapes consist mostly of community gardens – a relatively unreliable food source. If for some reason global food production slows due to the decreasing amount of arable land, lessened support of farmers, or any other number or reasons, many U.S. cities will be facing food insecurity.

The current food system and all of its different sectors require many resources to harvest the food, process the food, and move the food. The average distance food in a North American supermarket travels before reaching the shelves is 1400 miles (Nafis). If this food system were to fall apart, what would urban centers do for food? How would they survive? Where would they turn? Creating an urban foodshed by means of analysis, planning, design, implementation, regulation, and support is a solution to the threatening food crisis.

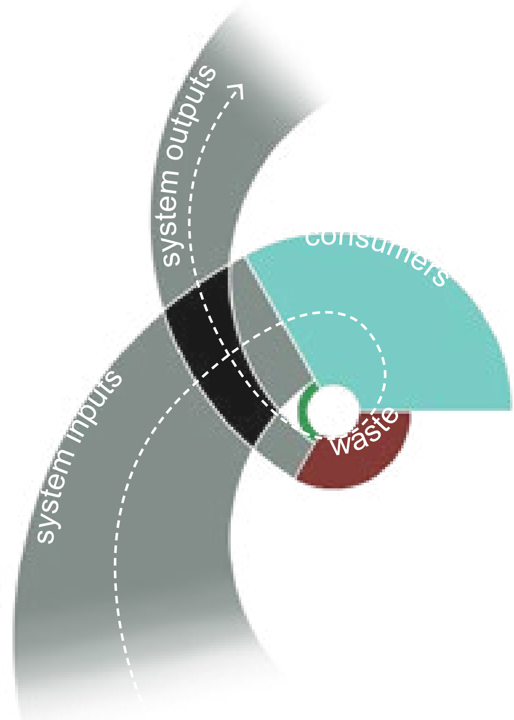


figure 1.2
conventional food systems

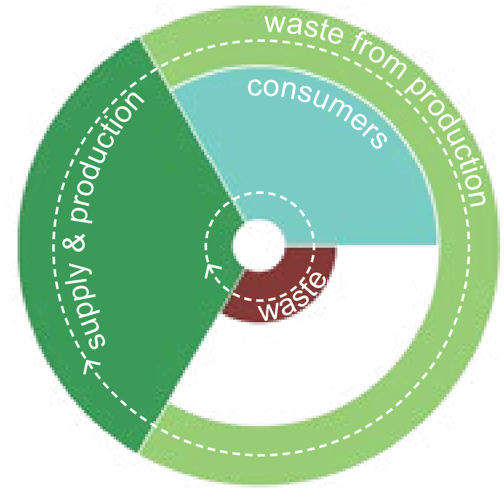


figure 1.3
ideal self-sustaining foodshed

foodshed defined

For the purpose of this project, the term "foodshed" is defined as an area of land with a fixed boundary in which food is grown, harvested, processed, transported, purchased, consumed, and its waste is reused in a regenerative cycle. Conventional food systems – especially urban food systems – are not cyclical (figure 1.2). Consumption rates far exceed production rates, which results not only in a need for external food imports, but also a heavy flow of outputs in the form of waste that must be managed outside of the city limits (Nafis). In contrast, a foodshed describes an ideal food system. Foodsheds require no external support – they are self sustaining in that production rates match consumption rates, and food waste is reused in the form of compost for the next generation of food production (figure 1.3).

The growing population and the distant and decreasing agricultural land must be countered with a solution that will produce self-sustaining urban centers that do not depend on external food imports to feed their growing populations. If cities were designed and planned in a way that created foodsheds they would not have to fear the pressing food crisis. My research and design project demonstrate how a city can be planned in a way that contributes to the creation of a foodshed.

the project

For my project I have defined the term "foodshed" and analyzed whether or not the South of Market (SoMa) neighborhood in San Francisco, California is capable of meeting the requirements of the fruit and vegetable portion of the food production sector of a foodshed. My resulting plans and designs involve the revitalization of vacant space into productive landscapes using different typologies of biointensive urban agriculture at varying scales. Everything from a balcony garden to an urban farm can be found in the proposed land conversions.

My projects purpose is to determine the feasibility of SoMa producing enough fruit and vegetables within its boundary to sustain the population's fruit and vegetable dietary needs. A foodshed is a large interconnected system with many components aside from just the cycling of food within a boundary. Other important factors needed to create a foodshed include but are not limited to; marketing, policy, pricing, regulations, education, job training, and social marketing campaigns. This project focuses on the food cycle portion of a foodshed, but does not aim to lessen the importance of these other factors. All components must be addressed when creating a complete foodshed. Within the food cycle portion of a foodshed, this project focuses on available space for the production of fruit and vegetables along with their production and consumption rates.

I understand that the food produced in a foodshed include fruit, vegetables, meat, dairy, and all other necessary items found in an average diet. However, my project only analyses the amount of viable space for fruit and vegetable production, and therefore I only perform calculations using fruit and vegetable production and consumption rates.

figure 1.4
san francisco and south of market context

research questions

Many circling questions drove the research, analysis, planning, and design of this project.

What percent of the SoMa population's fruit and vegetable dietary needs can be met with the implementation of urban agriculture projects throughout the neighborhood?

How much land needs to be transformed into productive landscapes in order for fruit and vegetable productions rates to match their consumption rates?

Is there enough land in SoMa to create this "semi- fruit and vegetable foodshed"?

To begin answering these questions I researched the best ways to produce fruit and vegetables in a city landscape. Understanding the benefits of urban agriculture and the practice of biointensive agriculture was essential in answering these questions and planning and designing the following project.

biointensive urban agriculture

urban agriculture

Urban agriculture is the practice of producing, processing, and distributing food and other products in and around cities with the goal of yielding enough crops to provide a sufficient amount of food for the local populations. Urban agriculture has many different typologies ranging from small to large scale. Some of these typologies include balcony gardens, community gardens, and rooftop gardens (figures 2.1-2.3). It is a local process that thrives on the community to purchase the products and involve themselves in the entire process from the dirt to the plate (Urban Agriculture). The most important aspect of urban agriculture that makes it different from conventional agricultural practices is the fact that it is located in urban areas. This is an obvious observation, but when considering the benefits urban agriculture provides, it is what makes the difference. The benefits from urban agriculture are many: it decreases the dependency on external sources, it contributes to a closed loop system within the city boundaries, it improves the overall health of the residents, it boosts the local economy, and it reduces the urban heat island effect.

figure 2.1
urban balcony garden example

figure 2.2
urban community garden example

figure 2.3
urban rooftop garden example

decreases dependency on external sources

The current food distribution and consumption systems rely heavily on imported food. Food travels thousands of miles before reaching the plate of the consumer (Weber, Mathews, 3508) (figure 2.4). This is not only harmful in terms of health for the consumer, but perhaps more importantly, it contributes greatly to an increased use of greenhouse gases by means of airplanes, trains, trucks, boats, and other transportation methods (Weber, Mathews, 3509). Not only does imported food from large agriculture companies require more transportation related resources, but also consume more resources in their production and processing practices (figure 2.5). If more food were grown and available for purchase within a couple hundred miles of a city, dependence on fossil fuels and other countries for their food products would greatly decrease. Urban agriculture contributes to the local food supply creating a more stable and circular food system while simultaneously decreasing greenhouse gas emissions – a main contributor to global warming and the health implications that result from a polluted atmosphere.

figure 2.4
foodmiles of common produce from their place of production

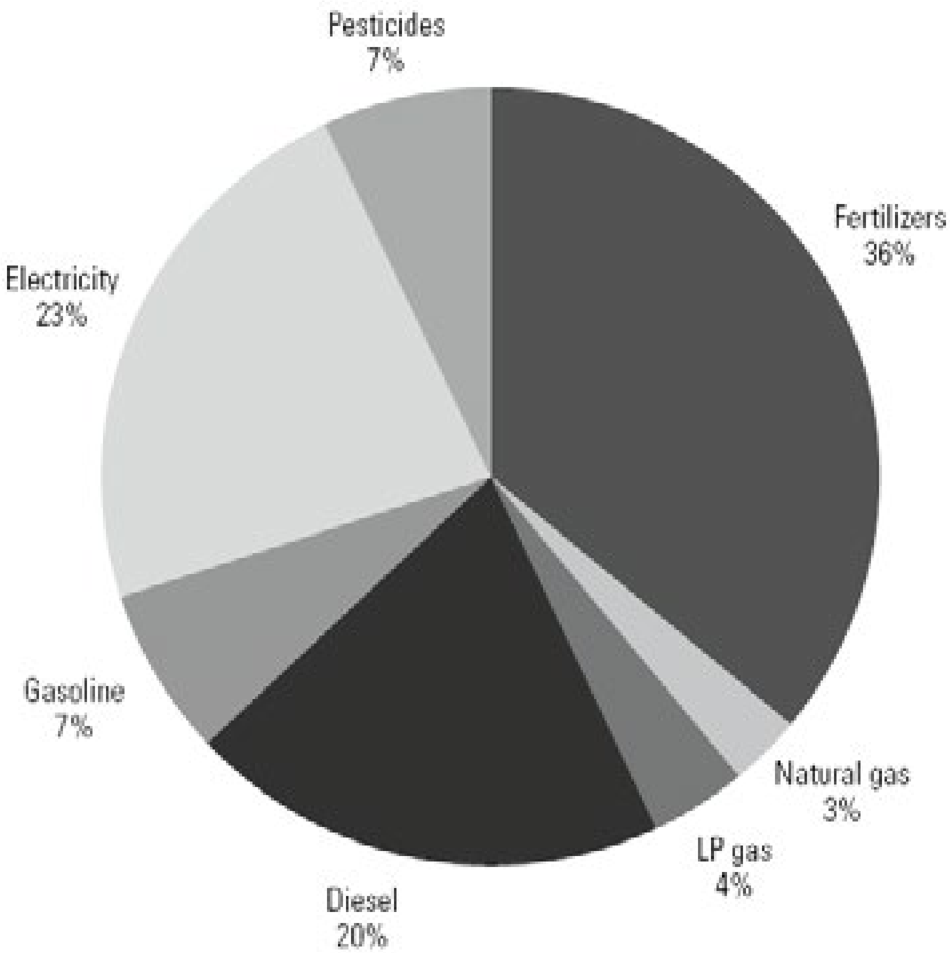


figure 2.5

total energy directly and indirectly consumed on U.S. farms

contributes to a closed loop system

As stated in the previous section, urban agriculture creates a more stable and circular food system. A closed loop system is ideal in terms of food because it decreases dependency on both imports and exports – creating a self-sufficient city that can survive and thrive if and when there comes a time when food and other resources cannot be traded globally (Natural Resources Defense Council). Closed loop systems not only improve a city's food security, they also increase sustainable practices of residents, businesses, and the local government. For example, composting is one way to contribute to a successful closed loop system. This process captures food waste, biomass waste, and other compostable waste from within the city and creates a healthy and organic compost material that can be used on the farms and other productive landscapes in the city. This practice decreases waste exports, decreases the amount of waste entering already overflowing landfills, and decreases the need for imported organic material, compost, and other soil enhancing matter (Jeavons, 34).

improves the health of residents

Fresh picked produce loses nutrients quickly. On average, produce in local grocery stores have been harvested four to seven days prior to when they were stocked on the shelves (figure 2.6). Local produce found at farmers markets were likely picked that day or the day before (Bellows, Brown, Smit). Additionally, local produce is often grown organically with limited genetic modifications making it the healthier choice over imported food items that are grown with the intention of a long shelf life – meaning that the farmers use pesticides generously and the crop's genetic material is altered for a longer lasting "freshness" (Bellows, Brown, Smit). Nutrient and diet benefits are not the only way urban agriculture improves the health of the residents within the city. Urban agriculture provides more green space for enjoyment, and more opportunity for physical activity. Green space within a hardscaped city is hard to come by, but once found is enjoyed by many. People enjoy green and natural landscapes and benefit in mental and physical ways when experiencing these places. Urban agriculture in the form of community gardens allows for people to get outside, participate in physical work, get active and involved with other community members, and reap the benefits of their own personal harvest (Bellow, Brown, Smit).

produce	from field to plate	nutrient loss
 green beans	11-15 days	45%
 broccoli	6-16 days	25%
 sweet peas	8-10 days	15%
 carrots	9-10 days	10%

figure 2.6

nutrient loss as it relates to how long ago it was picked

boosts the local economy

The money spent on purchasing food from grocery stores or other corporate businesses does not stay in the local economy. Most of the revenue goes back to the larger corporation that is often located in another state or even another country. Additionally the farmer who grew the food sees a very little profit.

This is harmful to the local economy because it means money is leaving the system at a faster rate than money is entering the system (Benefits of Buying Local). Buying food from local farmers encourages their business and allows them to continue to grow and produce a good product. Not only do the hard working farmers benefit more without the middle man, but the money spent stays in the local economy. The farmer down the street will then take the money earned from their food and spend it somewhere else in the city – keeping the money circulating within the city limits. This type of system allows for a stable, strong, and thriving economy that is self-sufficient and beneficial to all consumers and local businesses (Benefits of Buying Local).

reduces the urban heath island effect

The urban heat island effect is the process of a city or urban area becoming significantly warmer in comparison to more rural areas (figure 2.7). This happens because urban areas have much higher amount of hardscape and other materials that capture the heat from the sun and ultimately warm the entire city (Arnfield, 4). The urban heat island creates a very warm urban bubble – making residents use more energy to cool their dwellings (Arnfield, 5). Urban spaces lack green space, shade from large trees, and fresh air from natural plant systems – all things that naturally cool cities. Urban agriculture captures hardscaped space and converts it to green space, lessening the effects of the urban heat island.

Additionally, rooftop urban agriculture greatly decreases the use of energy used for cooling homes and other internal spaces. Currently rooftops are mostly hard material and very bare. If rooftops were transformed into gardens and greenroofs, buildings would be naturally cooler and the city would depend less on energy to run air conditioning systems (Bellows, Brown, Smit).

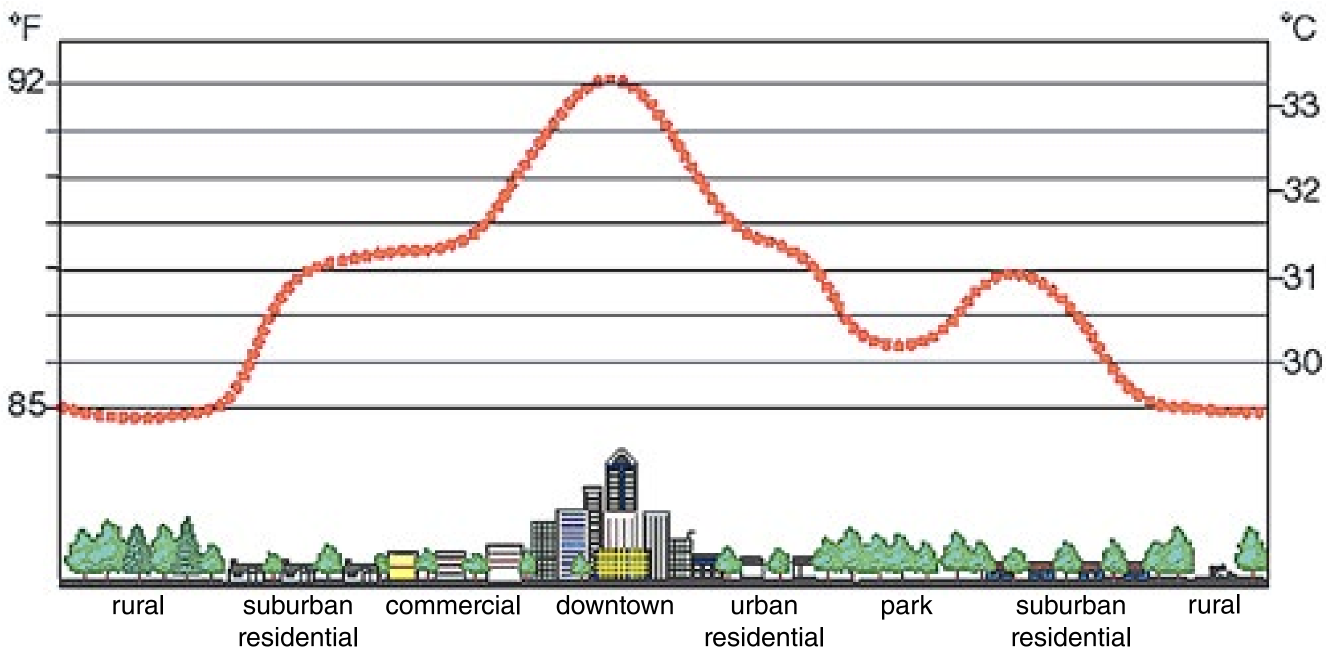


figure 2.7

urban heat island effect

concerns of urban agriculture

Although the benefits of urban agriculture are hugely important, there is some adversity to the practice. Urban areas are dense – meaning there isn't an abundance of open space. Space for urban agricultural practices may be limited and hard to come by (figure 2.8). Even when land is found, there are specific zoning codes and other regulations that need to be addressed before starting the project. Also, it is argued that urban agriculture cannot yield enough crops to be sold and profited from. A community-wide lack of knowledge about food production and gardening is another concern often raised. Public health issues caused by nearby pesticide use is also brought up when discussing urban agriculture (FAO) (figure 2.9). Lastly, and possibly most importantly, there seems to be a lack of interest or desire from workers and laborers with enough time and dedication who would be willing to work on an urban farm (San Francisco Collaborative Food Assessment, 63).

This list is daunting and strikingly negative, however there are solutions around the above listed points. A lot of the solutions have to do with city codes, regulations, incentives, and planning purposes. If a city were to understand and want to benefit from everything urban agriculture has to offer, the city government would be able to set aside space for productive land within the city. If all food producing land in urban areas follow the guidelines

figure 2.8
dense urban fabric limits available space for food production

figure 2.9
public health issues from pesticide application is a major concern

of biointensive agricultural techniques, then they are actually much more efficient that regular agricultural practices (Jeavons, xiii). If as much space as possible were captured, including rooftops, brownfields, and other smaller spaces like balconies, yards, and school yards, there is plenty of space for urban gardening. However, the most space will come from rooftops and brownfields, which means that the city government must agree to development changes and roof retrofits to ensure the transformations (FAO). Community workshops and classes on gardening and food production can help increase knowledge of how to create and maintain productive landscapes. Teaching gardening and the importance of local food production in schools is another way of increasing community knowledge about urban agriculture and all of its benefits (San Francisco Collaborative Food Assessment). Currently, San Francisco has an unemployment rate of 5.6% (Bureau of Labor Statistics). Large scale urban agriculture projects like urban farms create jobs, meaning that those 5.6% would be the labor needed to maintain these projects throughout the city. Lastly, the argument about the public health issues as a result of pesticide use can be countered with a study done by the Food and Agriculture Organization of the United Nations claiming that if wastewater from domestic sources is properly treated for agricultural reuse it can provide sufficient amounts of nitrogen, phosphorus and potassium, so that pesticides are not necessary for high yields (FAO).

the benefits outweigh the concerns

Although urban agriculture is a complex topic with many benefits, adversity to the practice will always linger. With enough knowledge, education, and examples to demonstrate the success of urban agriculture projects, it will soon be clear that the benefits of productive landscapes within cities are far greater than the concerns that come along with them. Problems and concerns will continue to arise, but solutions can always be found. Perhaps the most important factor in the progression of urban agriculture is convincing local governments that these practices need to take place in order to improve the city in necessary ways. If the government sees the benefits and agrees that change needs to happen, urban agriculture can advance at a faster and more successful rate. Urban centers need food security, they desire healthy populations, they are always striving for a stronger and more stable economy, and they desperately need a cooler and less polluted environment – urban agriculture can provide all of these things.

biointensive agriculture

Biointensive agriculture is a farming technique that was commonly used in many ancient agricultural practices, but has most recently been developed by John Jeavons in his book "How to Grow More Vegetables, Fruits, Nuts, Berries, Grains, and Other Crops Than You Even Thought Possible On Less Land Than You Can Imagine" ("Meet John Jeavons") (figure 2.10). Biointensive agriculture focuses mainly on maximum yields with limited amounts of land. It is a technique commonly found in small scale farms, backyard gardens, and other agricultural practices with low land availability. This farming technique involves eight principles that focus on soil health, specifically planned planting plans, and whole system methods (figure 2.11). These eight principles are; deep soil preparation, composting, intensive planting, companion planting, carbon farming, calorie farming, open-pollinated seeds, and whole system method (Jeavons, ix-x).

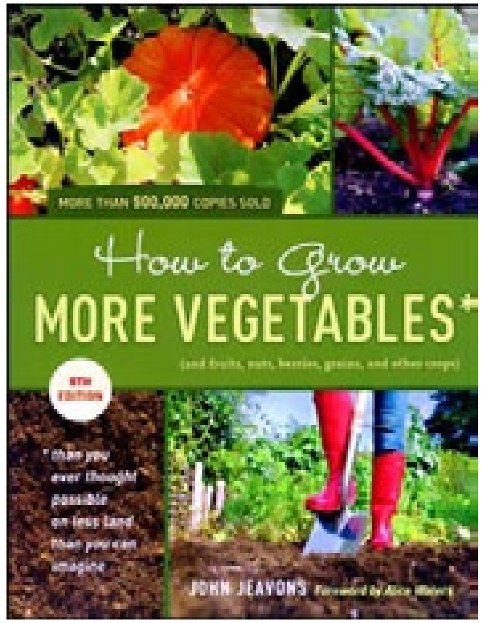


figure 2.10
John Jeavons book cover

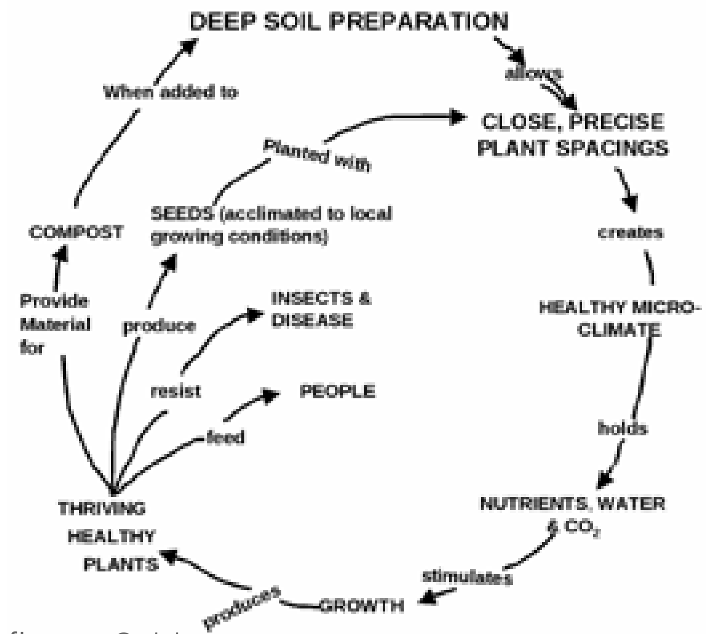


figure 2.11
biointensive agriculture cycle

figure 2.12
typical biointensive garden employing the eight principles

deep soil preparation

Ideal soil for agricultural crops is aerated with pore space for both air and water movement. This type of soil holds water more efficiently than compacted soil, improves root penetration for healthy plants, and decreased erosion because it allows for more infiltration and less runoff. Deep soil preparation creates this type of desired soil structure by loosening soil to a depth of 60 centimeters and allowing it to stay loose instead of compacting it in again (Jeavons, 6).

3 feet high raised planting beds for the necessary 24 inches of soil digging

steps up to top level of planting beds for easy access during the soil preparation process

raised planting beds with varying shapes and sizes based on the produce being grown

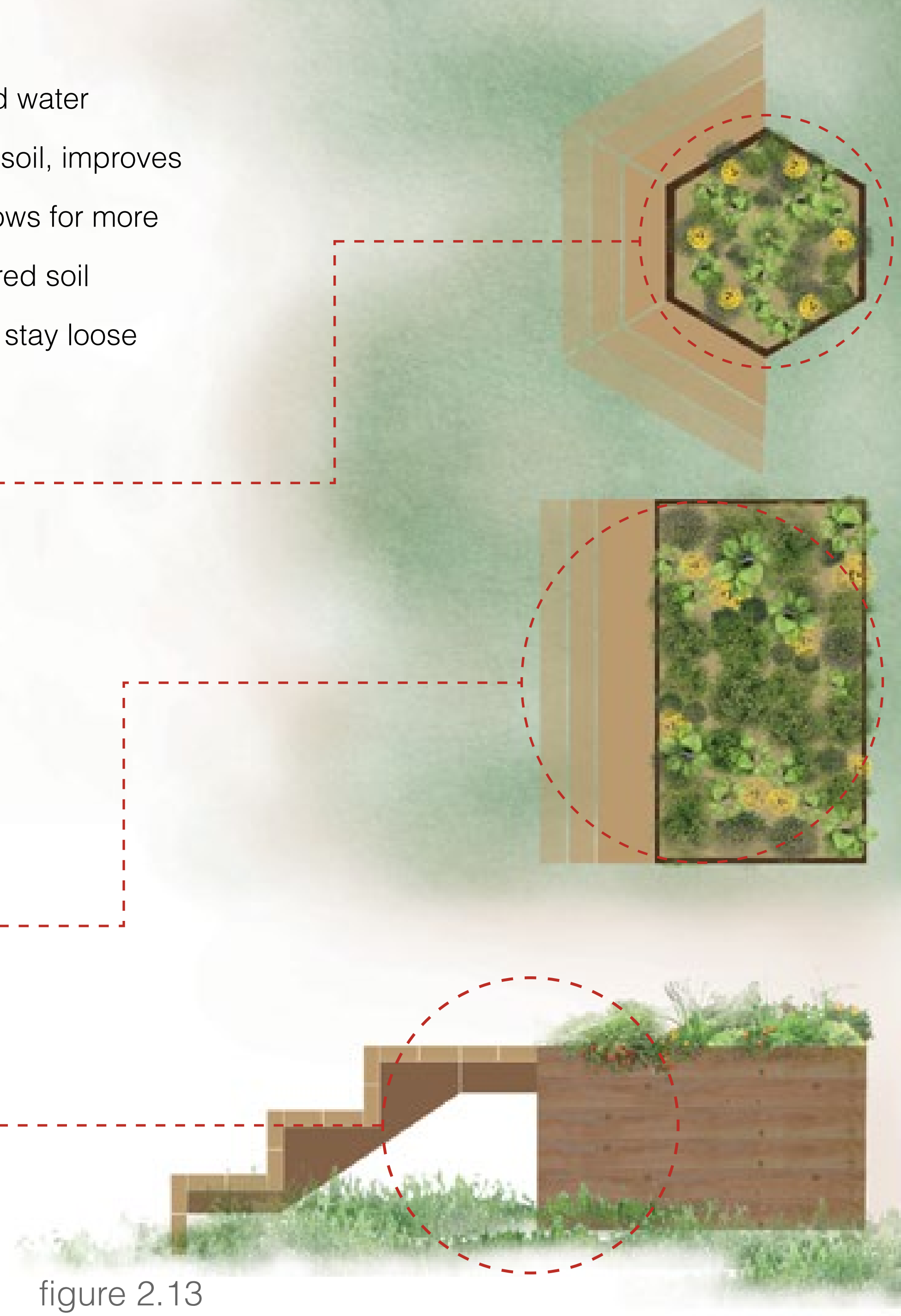


figure 2.13

varying types of raised beds for deep soil preparation

composting

Biointensive agriculture takes all used organic material and creates a compost mix that increases microbial biodiversity and overall soil health. By taking plant material on location, food scraps, and soil, successful compost can be made and applied to planting beds (Jeavons, 34).

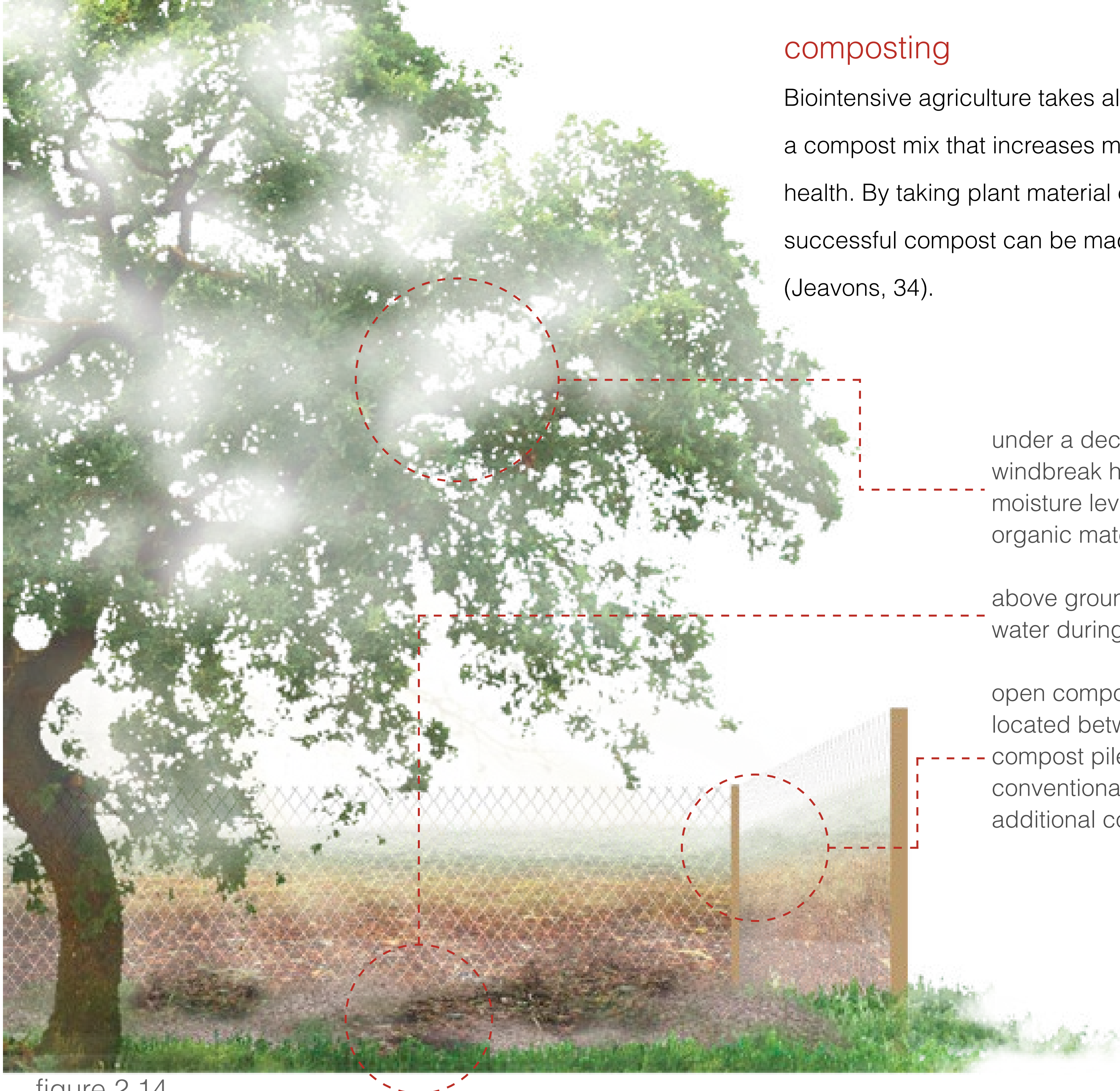


figure 2.14

open compost pile under a deciduous oak tree surrounded by a wire framed compost fence

intensive planting

Conventional agricultural practices often plant crops too far away from one another. Intensive planting takes the opposite approach and instead plants crops in an off-set pattern as close as possible so that mature plants are just barely touching their neighbors (figure 2.15). This method allows for an uninterrupted root and plant system while supplying the soil with living mulch coverage (The 8 Major Principles of Bio-Intensive Gardening). Hexagons are a common pattern plants are often placed in due to the shape plants grow to when mature and because it saves much more space than other planting patters.

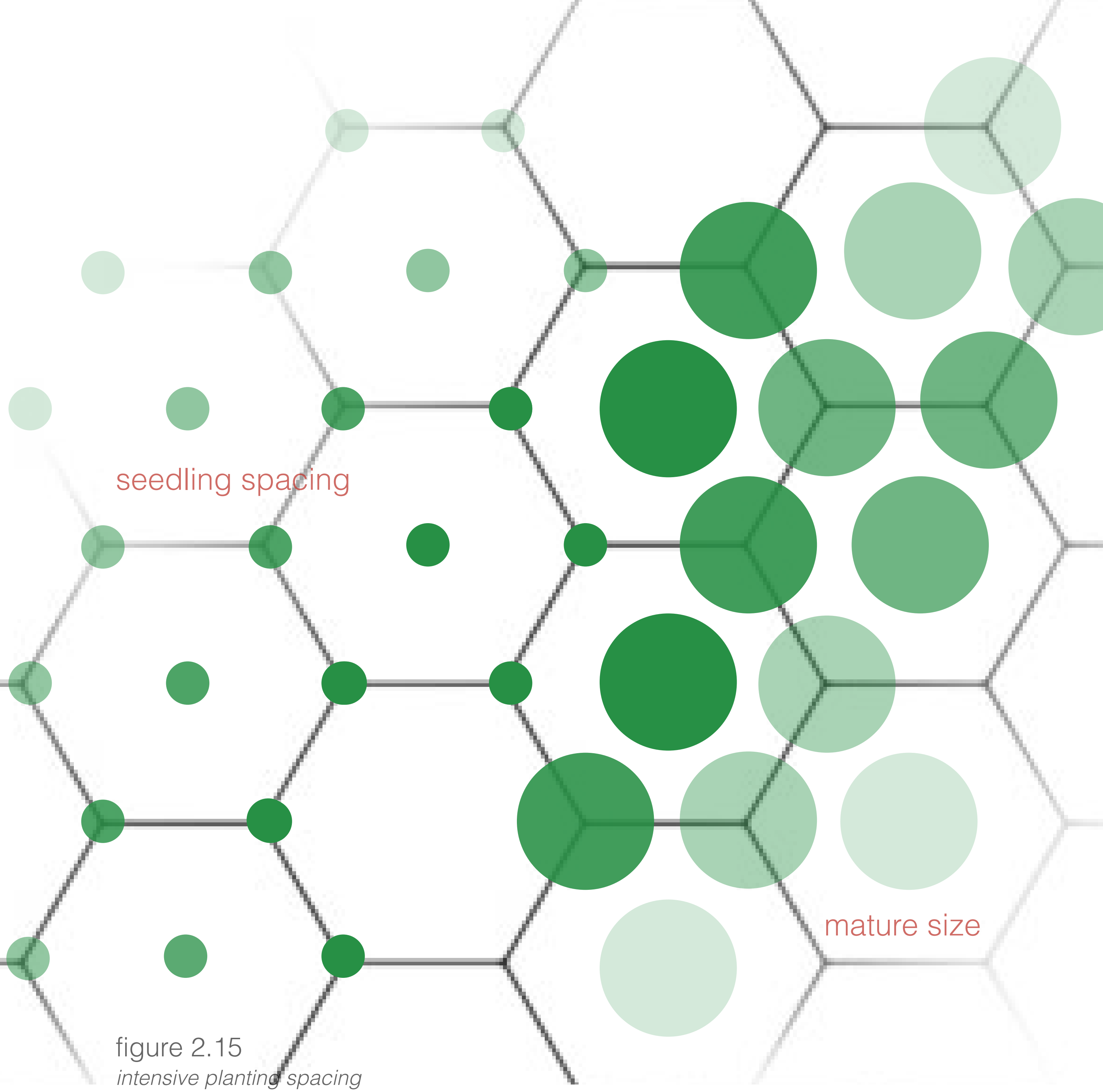


figure 2.15
intensive planting spacing

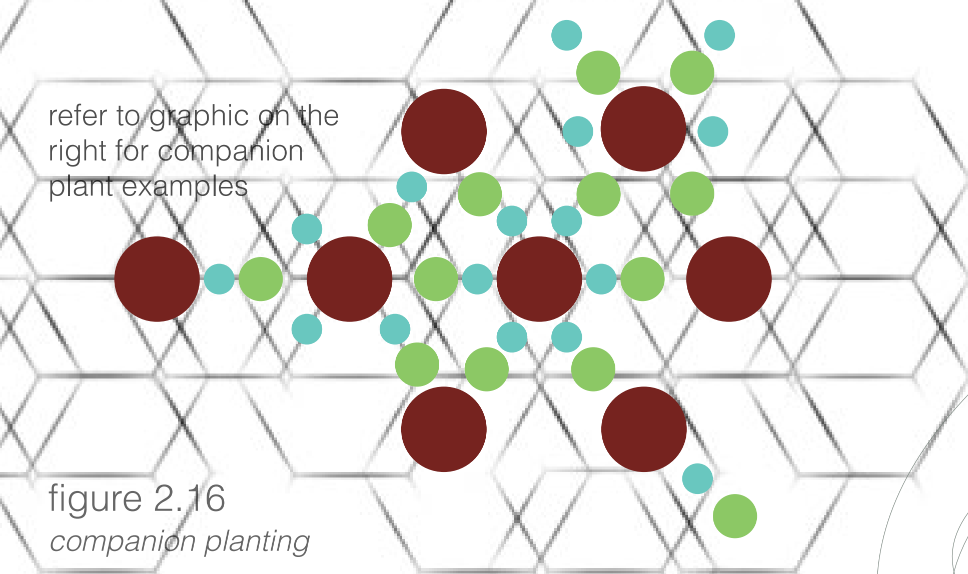


figure 2.16
companion planting

companion planting

This technique organically manages unwanted pests, supports beneficial insects, and improves growing conditions for the crops. This method requires knowledge of the plants being planted so that certain plants that benefit (or are harmed from) other plants can be placed accordingly (Jeavons, 142). Some plants grow better when near others due to both of their nutrient, mineral, and water needs. Some pests do not like certain types of plants, so placing those around the crops that are often attacked by those pests is a way to organically manage pests. Also, a wide variety of plants and a mosaic-like planting plan creates greater biodiversity and allows for diverse beneficial insects and pollinators to thrive in the garden (The 8 Major Principles of Bio-Intensive Gardening).

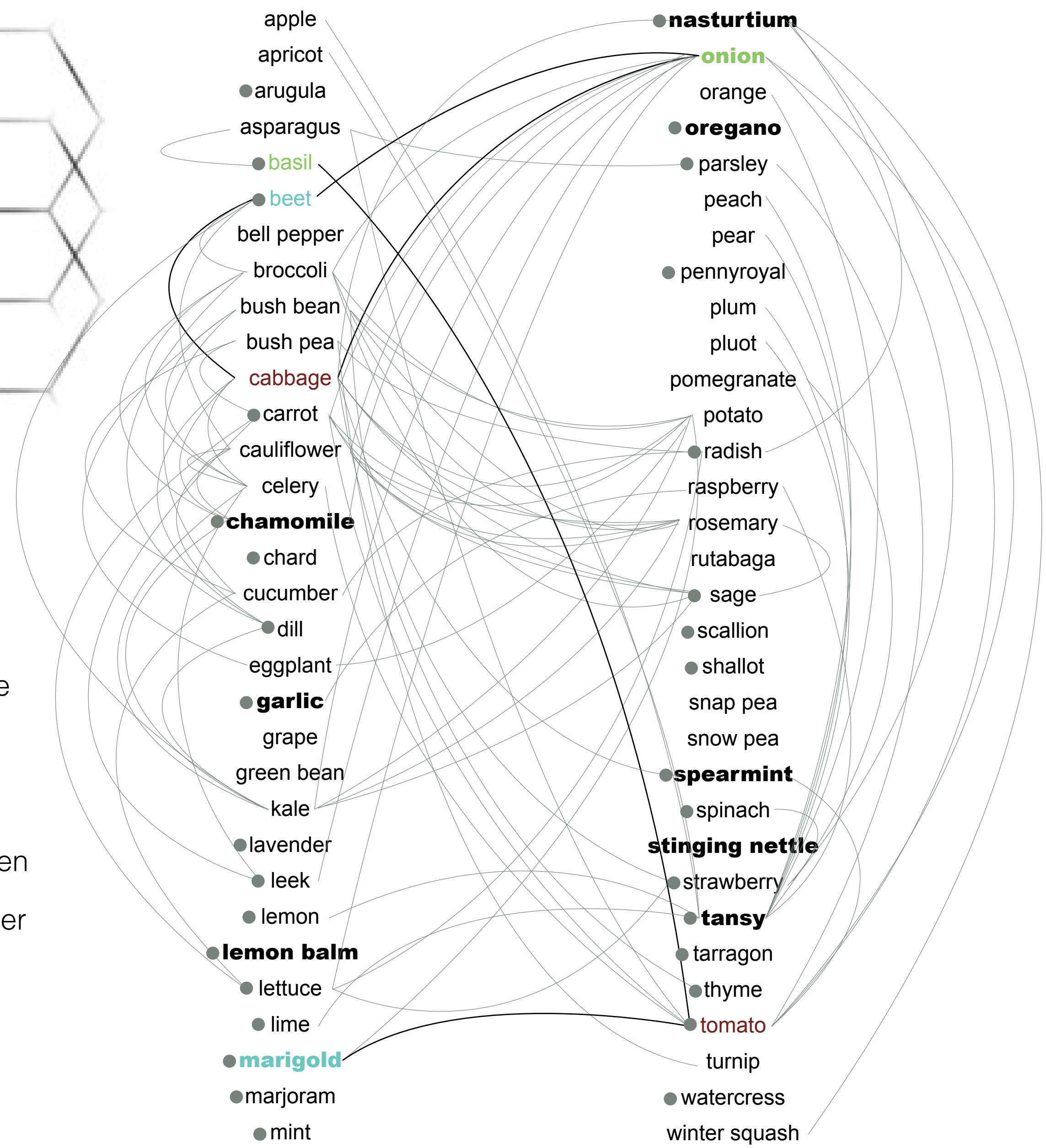


figure 2.17
san francisco planting palette and companionship

plants in **bold** are beneficial throughout the garden
● indicates that the plant can be grown in a container
the colors and bold lines are examples of companion plants

carbon farming

Carbon here refers to plant material with complex cell structures that is ideal for composting purposes. Carbon farming is the method of planting crops that will provide a large quantity of this type of plant material (figure 2.18). This increases self-sufficiency because it relies on using and benefiting from the crop waste for soil fertility instead of having to outsource and pay for other methods of compost (Jeavons 121).

calorie farming

This method aims at producing a complete diet with the essential calories (or energy found in all of the food people consume) in the smallest space possible. To do this, farmers and gardeners focus on special root crops that are calorie-dense and have a large yield despite small area. Some examples of special root crops include; potatoes, parsnips, leeks, garlic, and artichoke (The 8 Major Principles of Bio-Intensive Gardening). However, when practicing calorie farming other crops that provide important vitamins and minerals must not be forgotten. Dark green and orange vegetables should also cover some of the land.

figure 2.18
carbon and calorie farming

open-pollinated seeds

This method allows the seeds from the crops to be saved and replanted – ensuring future healthy and locally acclimatized crops in the seasons to come (Jeavons, 62). This increases self-sufficiency by reducing dependence on other seed providers.

whole system approach

Integration of all principles creates a balanced, self-sufficient system that thrives within the greater ecosystem.

the combination

As stated previously, a concern that arises about the success of urban agriculture is not being able to produce enough food to actually see the benefits it is capable of providing. A solution to this issue is to combine the practices of biointensive agriculture and urban agriculture. Space is limited in urban areas – even if governmental decisions support urban agricultural practices, available space for farming and gardening is still a problem. Biointensive agriculture is a highly developed technique derived from historical practices that has proven successful in producing the highest quantities of produce on very small amounts of land. This practice produces two to six times more food as current agricultural practices (Moore). By implementing biointensive agriculture techniques in urban agricultural practices, the concern of not producing enough food to feed the populations is mitigated.

The success of this project relies heavily on all urban agriculture implementations to employ biointensive practices. Biointensive agriculture is a way of growing food that increases production rates with very limited amounts of land. These techniques include deep soil preparation, composting, intensive planting, companion planting, carbon farming, calorie farming, open-pollinated seeds, and a whole system method. Only 2,000 square feet of land is needed to produce enough fruit and vegetables for one person with an average American diet. In sharp contrast, 10,000 square feet of land is needed in conventional farming practices to produce the same amount of fruit and vegetables (Jeavons, xii).

figure 2.19
biointensive urban agriculture

planning and design

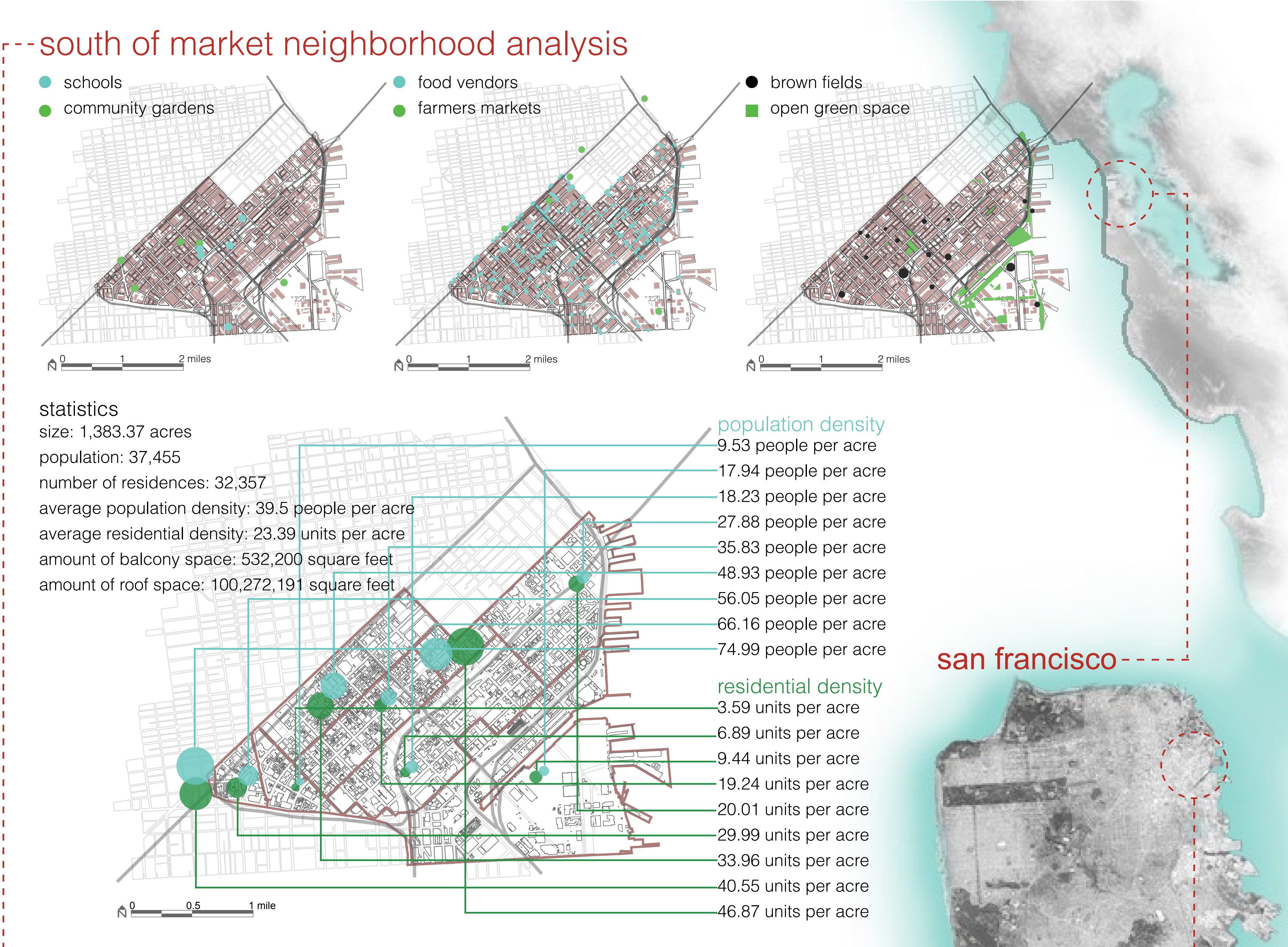


figure 3.1

south of market neighborhood site analysis

south of market neighborhood analysis

I began by analyzing the neighborhood for opportunity spaces in the form of school yards, brownfields, balconies, and rooftops. I studied local farmers markets and other food vendors to better understand where the majority of food in the neighborhood is coming from. Population and residential densities are essential for later calculations regarding food production and consumption.

proposed south of market master plan

My proposed master plan for the SoMa site includes the reclamation of about 50 percent of brownfields, balconies, and roof tops, the addition of productive gardens in school yards, and the preservation of existing productive landscapes (figure 3.2). Implementing edible school yards is an important aspect when designing a foodshed. Educating the youth about food production and the importance of locally grown food is essential when attempting to create a self-sustaining system. They are the future law-makers, the future farmers, and the future residents. If they know of the importance of urban agriculture, changes and advancements in the future will be easier.

After deep analysis of the site and the current San Francisco food system, I determined that transforming about 50 percent of vacant land was the most acceptable conversion rate. This decision was due to future development plans for brownfields, balconies facing the wrong direction in terms of sun hours, and roof tops not being accessible, flat, or strong enough to support a garden. Ideally, as much land as possible would be converted to productive landscape, however, due to the previously listed reasons along with public opinion, financing, time, resources, and willing workers, a 50 percent conversion rate was determined. This rate is still extremely high in reality and would require vigorous incentives, training, and technical support from both the public sector and nonprofits, all of which contribute to a larger societal shift towards local food systems. However, my project aims at making a strong statement about food production and the amount of available land in urban areas. There is space, and if and when used correctly, it is possible to produce enough food to sustain a substantial portion of the population.

I call attention to five different typologies of urban agriculture to demonstrate that implementation can happen at any scale and that anyone can be an urban food grower. The five sites of focus include a balcony garden, a roof garden, a yard garden, a community garden, and an urban farm. The balcony and roof gardens do not have physical locations within the neighborhood, and are based on average sized balconies and roofs in San Francisco.

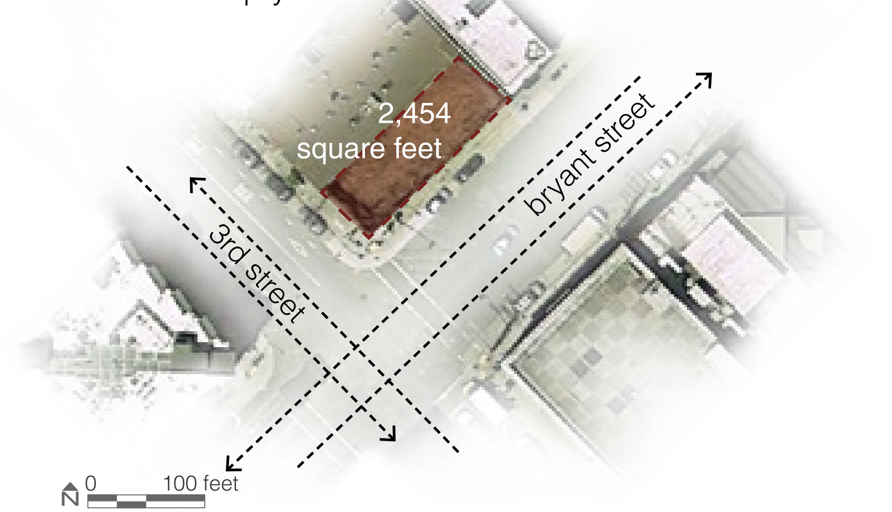
proposed south of market master plan

figure 3.2

south of market master plan

yard garden analysis

current use: empty dirt lot

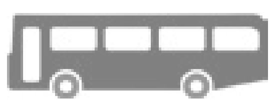


distance to nearest

open green space .1 miles

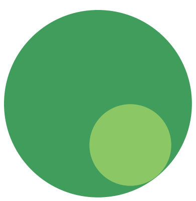
community garden .6 miles

farmers market .5 miles

37 

public transportation stops within a .5 mile radius

densities



population

18.23 people per acre

residences

6.89 units per acre

context

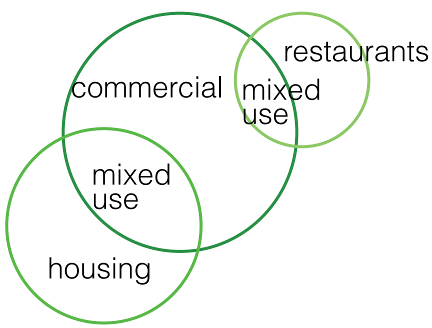
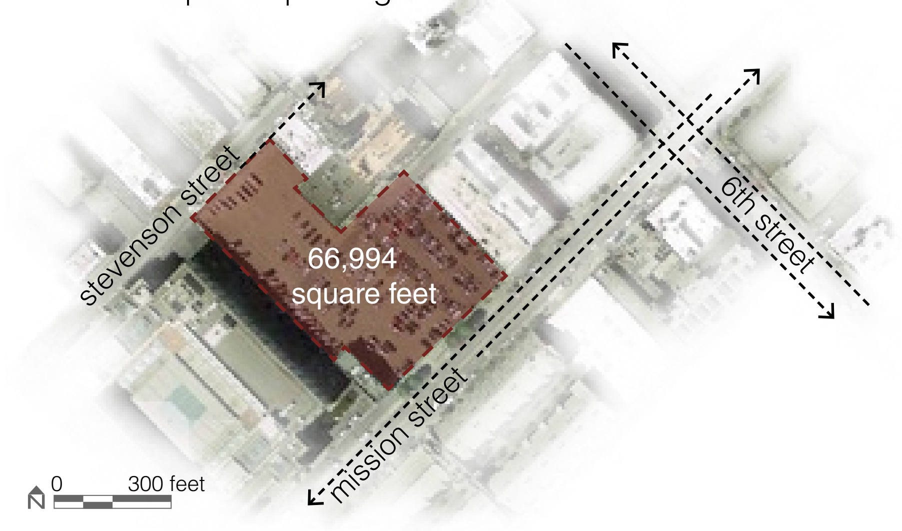


figure 3.3

yard garden analysis

community garden analysis

current use: paved parking lot

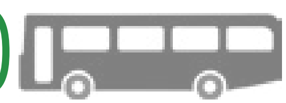


distance to nearest

open green space .2 miles

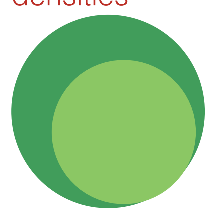
community garden .4 miles

farmers market .2 miles

80 

public transportation stops within a .5 mile radius

densities



population

56.05 people per acre

residences

33.96 units per acre

context

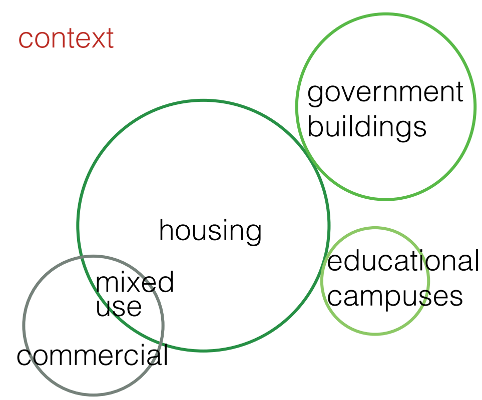


figure 3.4

community garden analysis

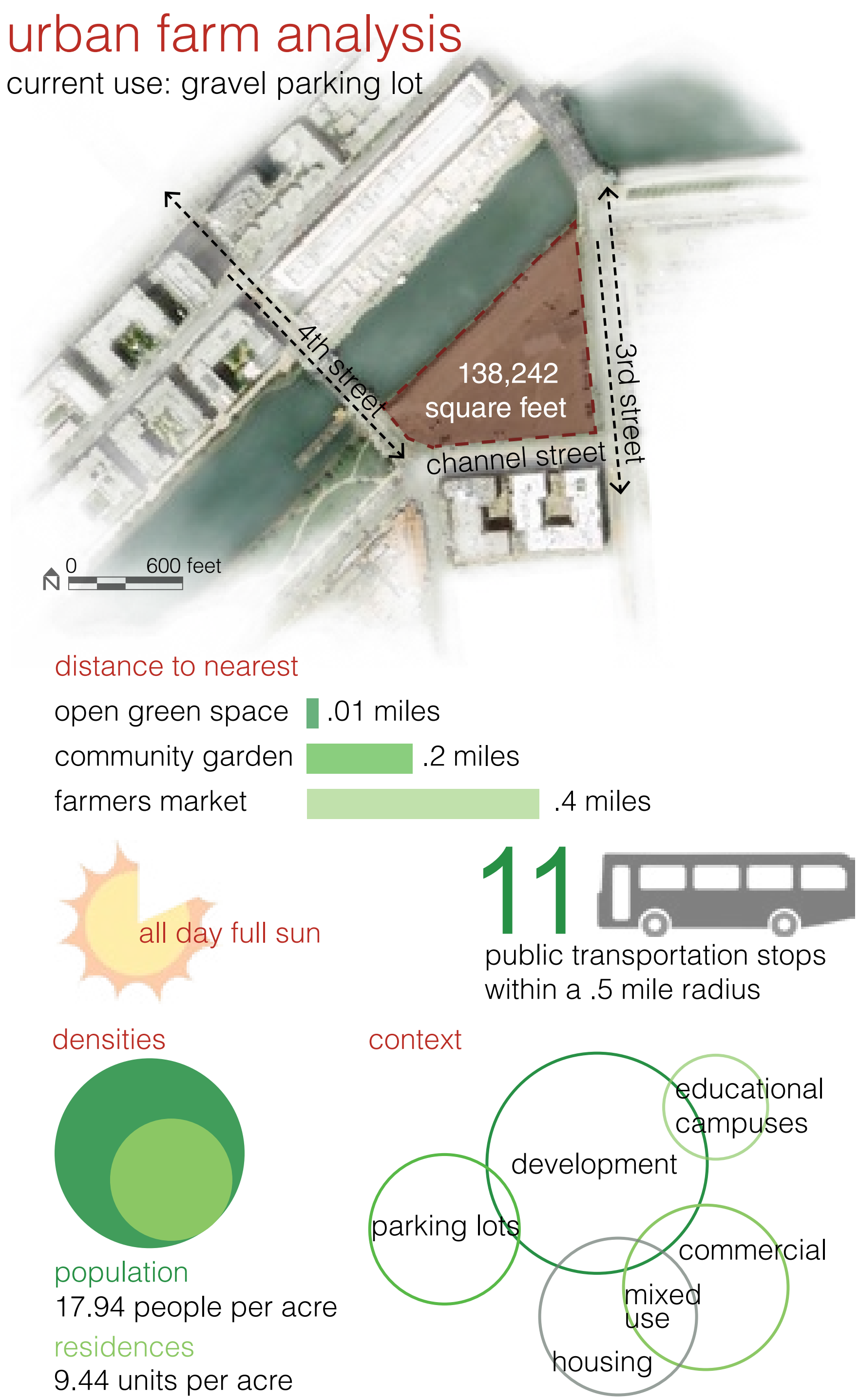


figure 3.5

urban farm analysis

yard garden, community garden, and urban farm analysis

The three sites of the yard garden, the community garden, and the urban farm were chosen for several reasons (figures 3.3-3.5). To begin, they are all easily accessible. Not only are they sites easily connected to the rest of the city due to public transportation, but they are all easily seen and open to pedestrians who happen to pass by on foot. One of the primary reasons for choosing the sites I did was that they can be seen and experienced by the community. I see them as demonstration gardens to be learned from and used as examples.

Aside from accessibility, I analyzed these sites for location and proximity to other green space within the neighborhood. The yard garden for example is over a half mile away from the nearest community garden making it a good site because the residents of the attached apartment would benefit from having a nearby food producing landscape.

Some other considerations when deciding on these three locations include their surrounding neighborhood context, population and residential densities, sun exposure, and existing site uses.

Based on these elements and the other available space throughout SoMa, these three sites proved to be the most viable options for successful biointensive urban agriculture examples.

balcony garden

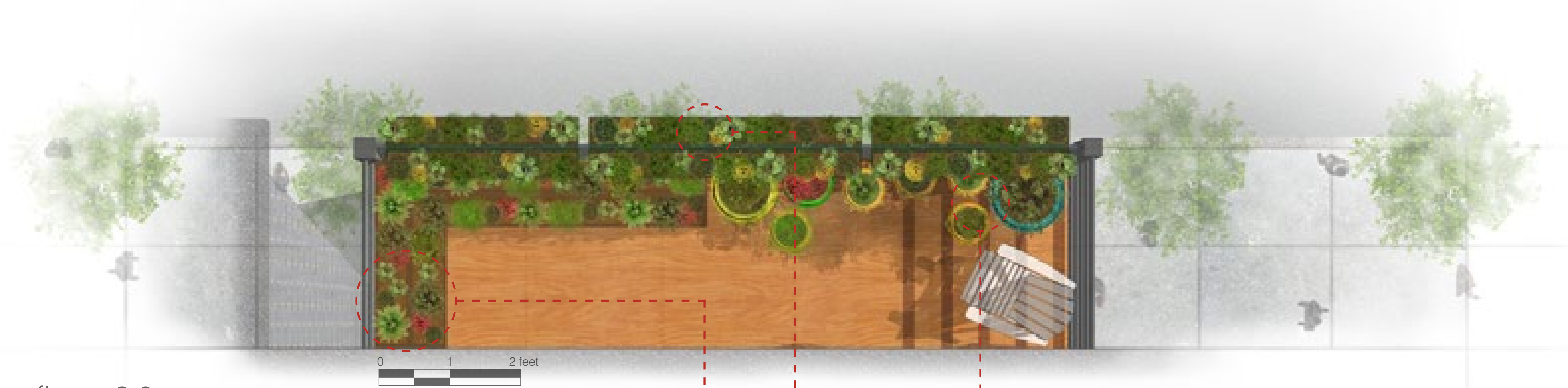


figure 3.6

balcony garden plan

figure 3.7

potted vegetable plants

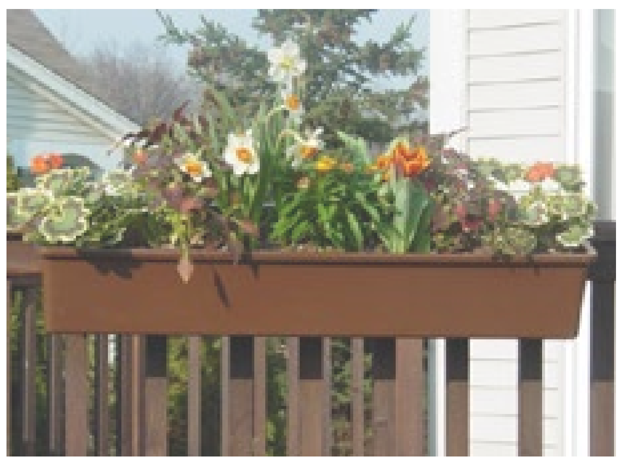


figure 3.8

double sided railing planters

figure 3.9

raised and tiered wooden vegetable beds

A standard sized San Francisco balcony is shown to demonstrate how a small space can be used for food production. This example utilizes potted plants, railing planters, and a small tiered garden bed (figures 3.7-3.9). This type of garden would be ideal for the busy apartment renter who doesn't have extra time or money for a plot at the nearest community garden. It is easy to maintain and one of the cheapest forms of gardening in a city. There are many other ways to save space when balcony gardening; hanging pots, shelves of pots, green walls, etc.

This specific balcony example has about 20 square feet of productive landscape. However, for the purpose of my project it is assumed that on average each balcony will have 15 square feet available for gardening. With data collected on number of balconies and average balcony sizes, I calculated that there is 532,200 square feet of balcony space in SoMa. However, with only 15 square feet turned into productive land per balcony, that leaves 199,576 square feet available for gardening. As stated previously, only about 50% of balcony space will be converted into gardens, so in total, my projects creates about 99,788 square feet of productive land from balconies.

figure 3.10
balcony garden perspective

roof garden

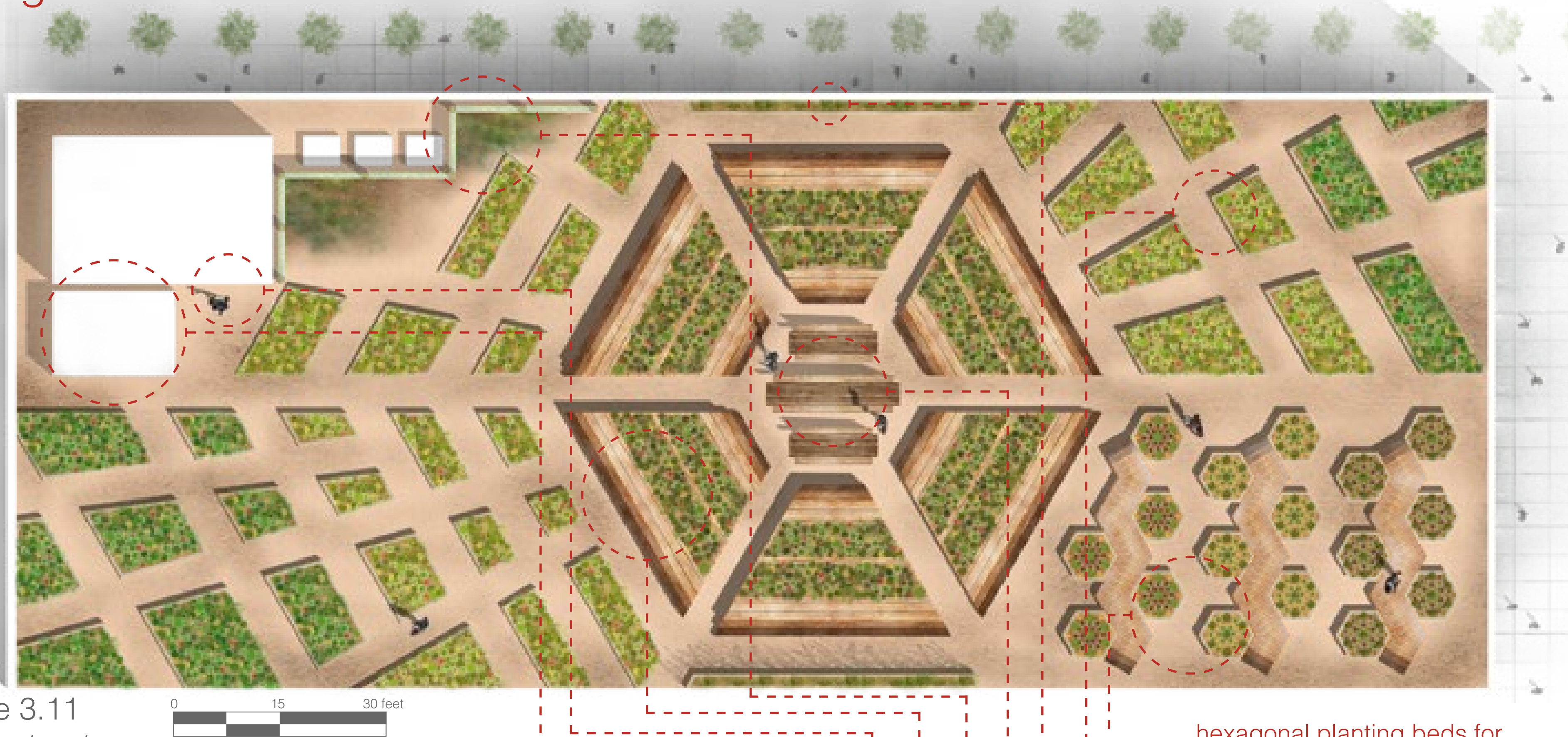


figure 3.11
roof garden plan

An average sized roof top of 16,000 square feet is shown in this design to demonstrate how a roof in San Francisco can implement biointensive urban agriculture techniques. The design of this roof garden was inspired by the hexagon shape (figure 3.11). The hexagon is important in biointensive agriculture because it is the ideal shape for plant spacing and garden beds. This design includes raised hexagon planting beds with accessible boardwalks to allow for deep soil preparation and produce harvesting.

This roof garden example is about 16,000 square feet, which is an average sized rooftop in SoMa. There is a total of 100,272,191 square feet of rooftop space in the neighborhood. If about 50% of that space were converted to food producing landscapes, then 50,136,096 square feet of rooftop land can be used for gardening.

figure 3.12
roof garden perspective

yard garden

This site is an empty lot of land directly next to a four unit residential building. San Francisco residences often lack yard space due to the density of the city. However, reclaiming unused space near housing units like this one can prove beneficial not only to the tenants, but to the surrounding neighborhood as well. This type of land conversion can provide the owners or renters with a personal gardening space for fresh home-grown produce.

Having a garden right on the street and visible to passing pedestrians is ideal because it showcases how to use empty space to its full potential.

This design includes small personal green houses, raised panting beds, a few fruit trees, and a gathering area.

This yard garden example contributes 2,454 square feet of productive land to the project.

figure 3.13
yard garden plan

figure 3.14
yard garden perspective

community garden

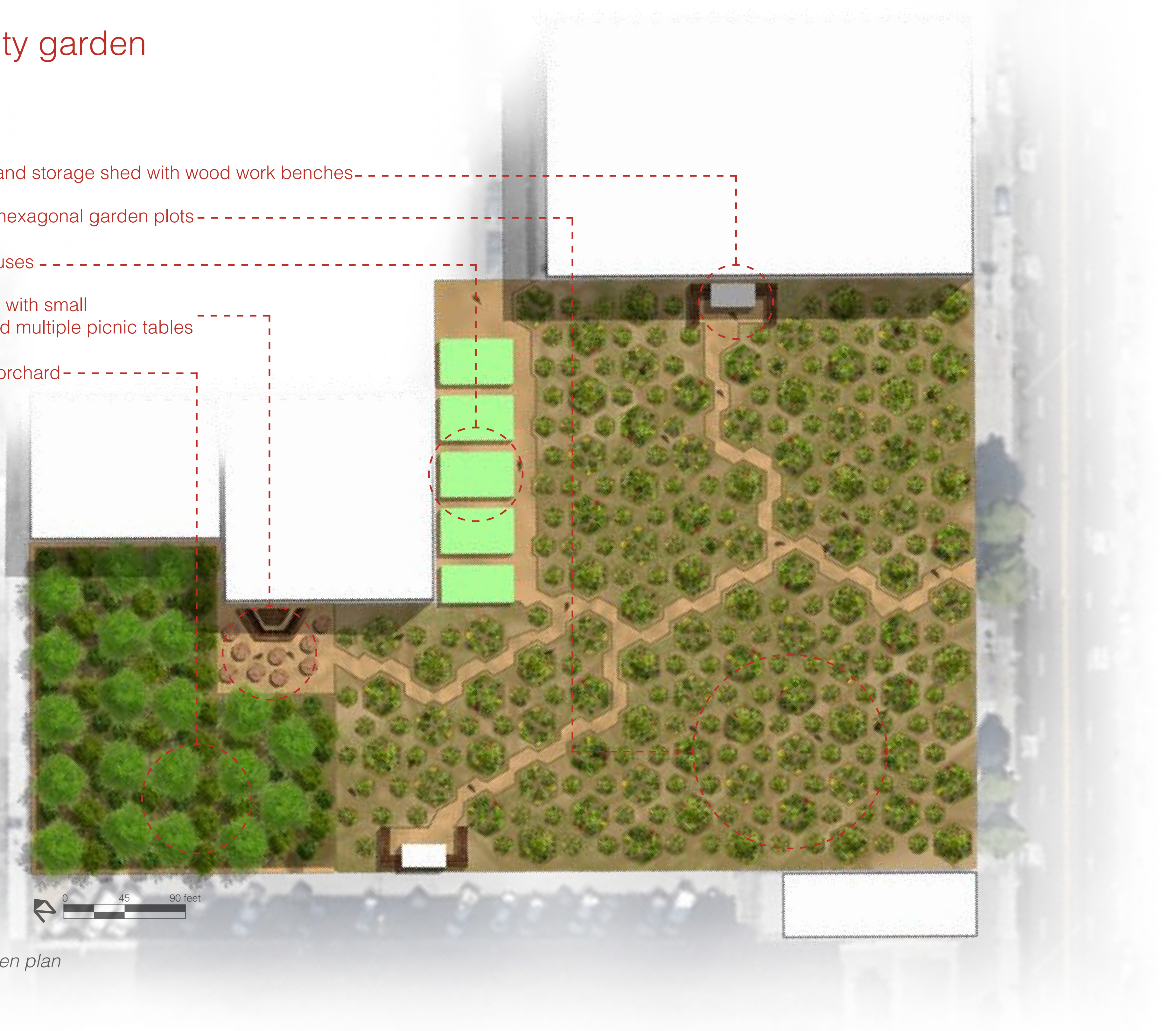


figure 3.15

community garden plan

Space for personal gardening in cities in limited. Community gardens are large urban agriculture examples with a small scale and personal sense of place. They allow people without yard or balcony space to garden and produce food on their own. Every community garden in San Francisco has a waiting list because of high demand and limited land.

This design dedicates as much space as possible for individual plots with some space for social gatherings. The plots are hexagonal shapes and vary in size so that people with less time or money can still be a part of the community garden. The design also features a fruit tree orchard that is available to anyone who owns a plot (figure 3.15).

This community garden example contributes 66,994 square feet of productive land to the project.

figure 3.16

community garden perspective

urban farm

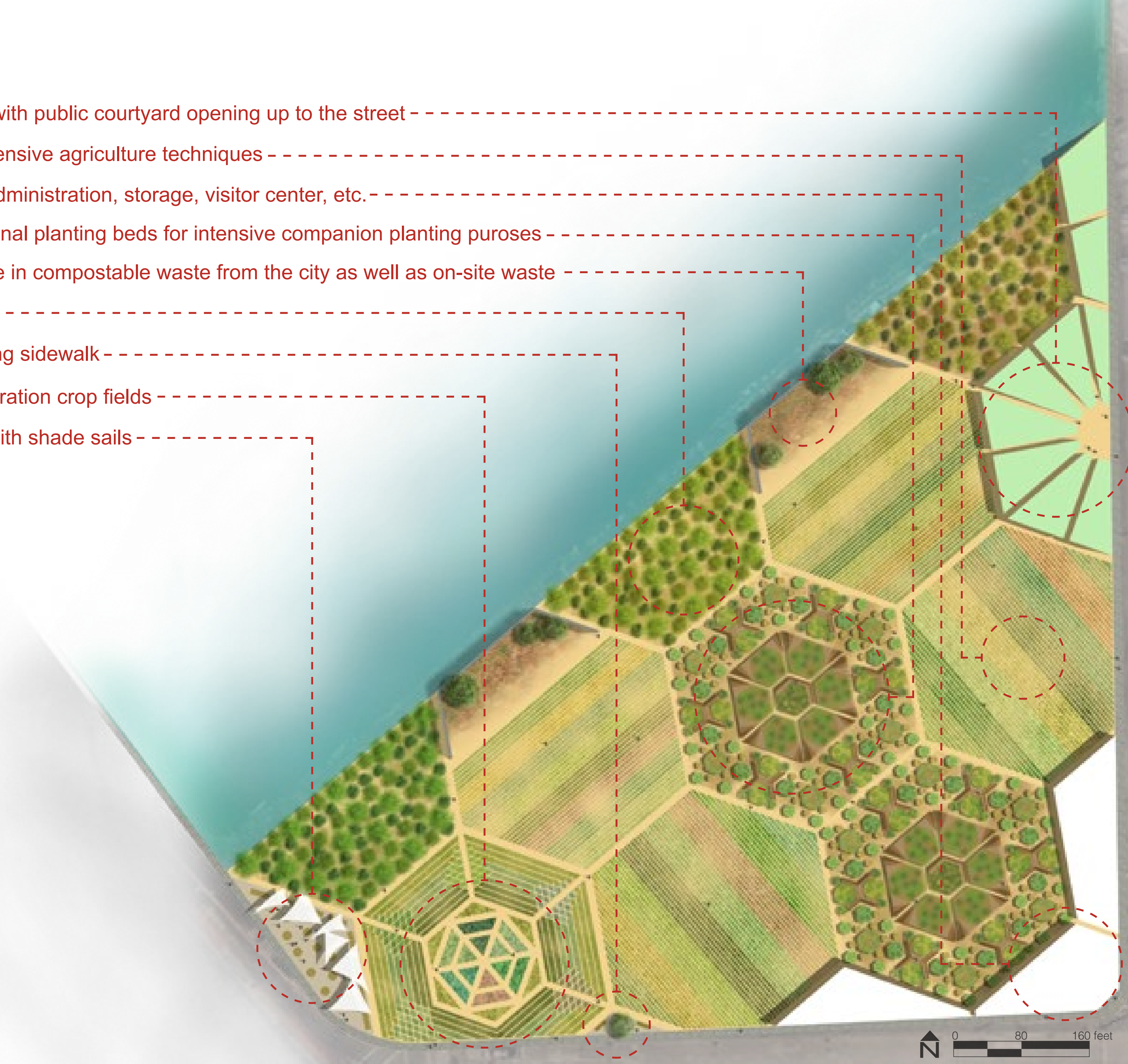


figure 3.17
urban farm plan

Urban farms are one of the most efficient ways to produce food within a city. Not only do they reclaim unused space and beautify the area, they are extremely productive. Urban farms should be designed to demonstrate the workings and importance of food production.

This design emphasizes the importance of spreading knowledge to the community about food growing. As much space as possible is claimed for production. However, the public courtyard at the greenhouse complex, visitors center in the building complex, farmers market, research and demonstration biointensive agriculture garden, and pedestrian-friendly parklet are all examples of how the public can be involved in their cities food-growing process (figure 3.17). The residents of the city should be involved and knowledgeable in the production of their local food.

This urban farm example contributes 138,242 square feet of productive land to the project.

figure 3.18
urban farm perspective

conclusions

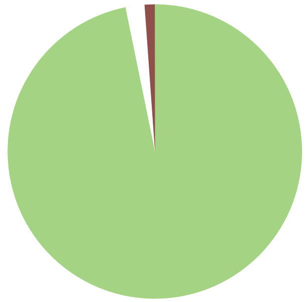
calculations

My project proposes finding, capturing, and transforming vacant land in the South of Market neighborhood of San Francisco into food producing landscapes that employ biointensive agriculture practices. Not every square foot of land is converted because realistically not every balcony, rooftop, and undeveloped brownfield is able to sustain urban agriculture projects. My proposed changes results in 53,253,925 square feet of productive landscape (this number includes 669,700 square feet from existing productive landscapes). If this amount of land is farmed using biointensive agriculture techniques, then 26,626 people (about 70% of the SoMa population) will be provided with enough fruit and vegetables to sustain their diets. In contrast, if conventional

1,383.37 acres

37,455 people

669,699.93 square feet of existing productive landscape



existing open space

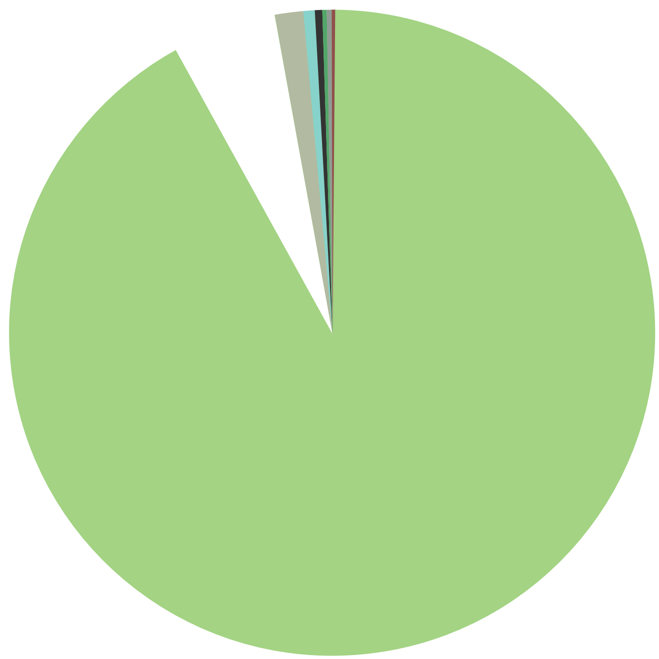
100,272,191 square feet of roof tops

4,547,786 square feet of brownfields

532,200 square feet of balconies

105,352,177 total square feet of open unused space

figure 4.1
south of market statistics



proposed productive land

50,136,096 square feet from rooftops

2,135,651 square feet from brownfield conversion

669,700 square feet from existing productive landscape

138,242 square feet from the urban farm example site

99,788 square feet from balcony gardens

66,994 square feet from the community garden example site

5,000 square feet from new school yard gardens

2,454 square feet from the yard garden example site

53,253,925 total square feet of productive landscape

figure 4.2
project projections

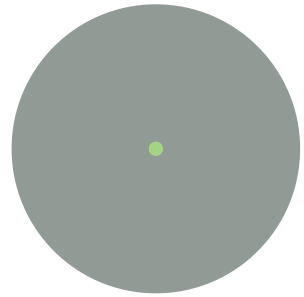
farming practices were employed instead, the project would only feed 5,243 people (14% of the SoMa population).

A foodshed is a closed-loop and self-sustaining system. The results of this project conclude that if an average of 50% of vacant land is converted to productive landscapes, fruit and vegetables need only be imported from external sources for 29% of the SoMa population. This greatly reduces the amount of external inputs and outputs and pushes SoMa one step closer to a foodshed.

answers

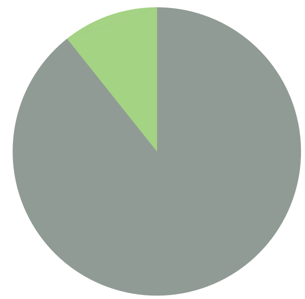
The calculations above answer the first question from the list of three research questions originally asked in the introduction. About 70% of the SoMa population's fruit and vegetable dietary needs can be met with the implementation of urban agriculture projects throughout the neighborhood. If the project were to transform enough space so that fruit and vegetable consumption rates match production rates in SoMa, then 74,910,000 square feet of land must be converted to food producing landscapes. There is a total of 105,352,177 square feet of vacant land in SoMa in the form of brownfields, balconies, and rooftops. To answer the final question, yes, there is enough land in SoMa to create a "semi- fruit and vegetable foodshed" in SoMa. Whether or not it is a viable development option for the city of San Francisco is another question entirely.

fruit and vegetable production



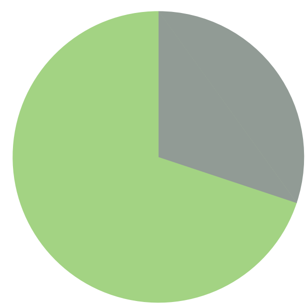
- 10,000 square feet of land is needed to produce and provide one person with the recommended amount of fruit and vegetables using conventional agriculture techniques
- 2,000 square feet of land is needed to produce and provide one person with the recommended amount of fruit and vegetables using biointensive agriculture techniques

conventional agriculture techniques



- if this project were to propose the same amount of productive land, but employ conventional agriculture techniques as opposed to biointensive techniques, 5,243 people or 14% of the SoMa population's fruit and vegetable needs would be produced

biointensive agriculture techniques



this project proposes not only capturing and transforming as much underused land as possible into food producing landscapes, but proposes biointensive agriculture techniques as the means by which this food is grown

- by using these techniques on 53,253,925 square feet of land, this project will provide enough fruit and vegetables for 26,626 people or 71% of the SoMa population

figure 4.3

biointensive agriculture production compared to conventional agriculture production

future

Based on the results, the possibilities of a future San Francisco foodshed can be seen. Biointensive urban agriculture along with other vigorous governmental, community, and social programs can transform San Francisco's current conventional food system into a more self-sustaining foodshed. Although the city is very far away from becoming a complete foodshed, hopefully the results from my research, analysis, and planning provide enough knowledge and motivation for the future state of the city's food system.

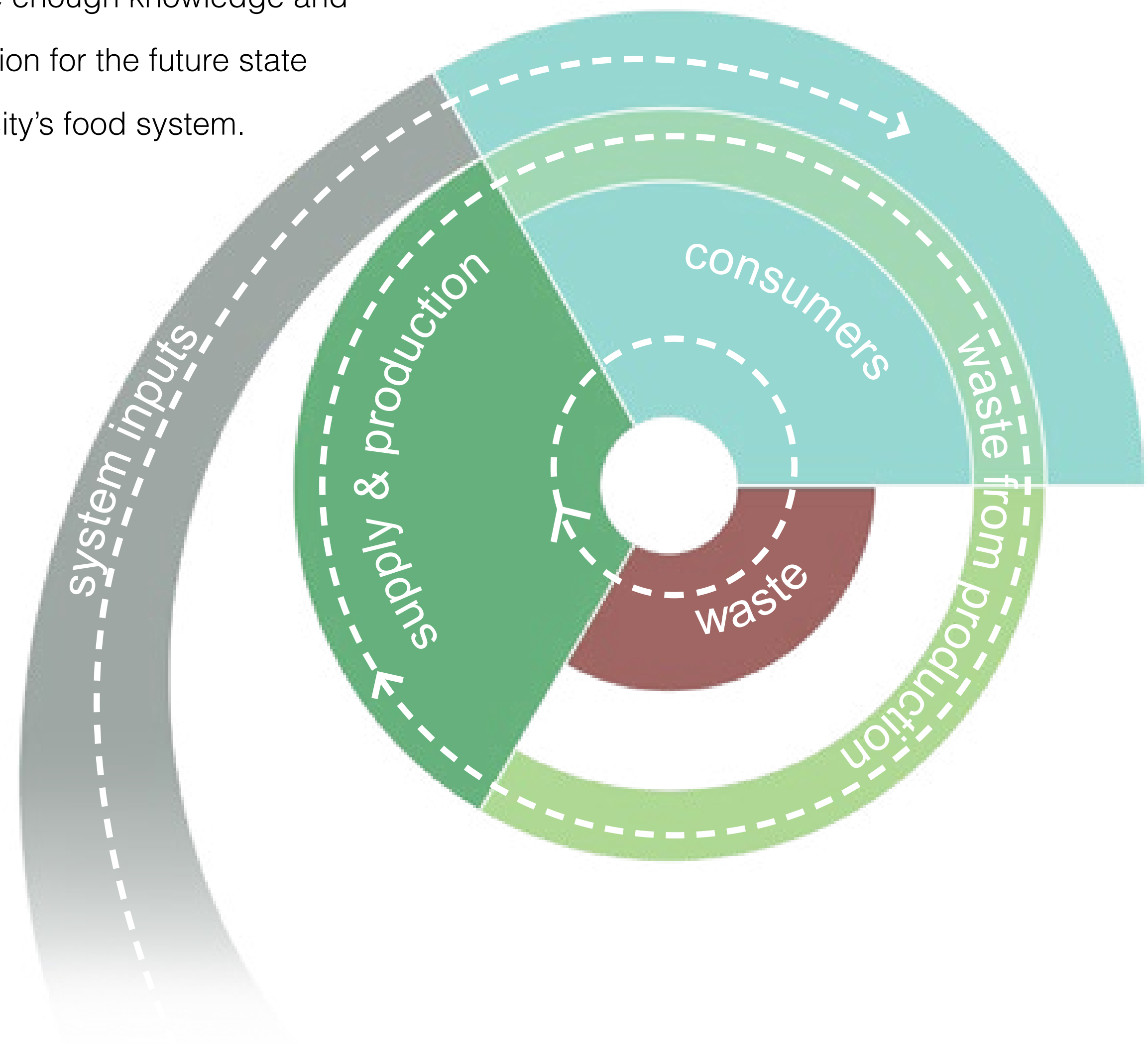


figure 4.4
south of market future foodshed

figure 4.5
conventional food systems

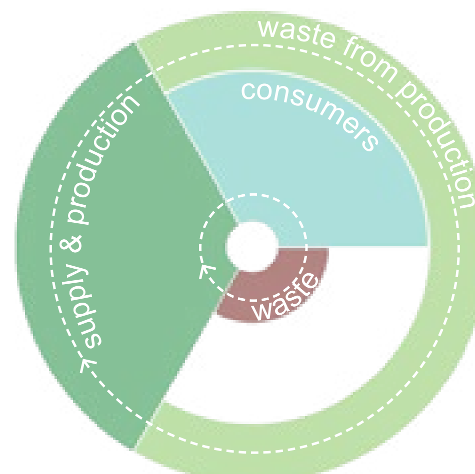


figure 4.6
ideal foodshed

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