Rooftop to Tabletop:
Repurposing Urban Roofs for Food Production

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Abstract

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Current environmental, social and economic realities have inspired a new generation of city dwellers to find innovative ways to live more sustainably. Food - how it is grown, processed, distributed and consumed - is a common factor in many of these conversations. New frontiers, especially in food production, are being explored in many U.S. cities. One with great untapped potential is our roofs. Indeed, rooftop agricultural production sits at the nexus of two established movements: green roofs and sustainable urban agriculture. This thesis focuses on rooftop food production in four U.S. cities (Portland, Seattle, Chicago and New York City), but it is structured to provide lessons and insights that can be applied more broadly. In doing so, it presents ways rooftop agriculture can cultivate environmentally, socially, and economically sound and productive cities. It also highlights opportunities for landscape architects to contribute to and shape this emerging movement. Through select case study explorations in these four American cities, the beginnings of a sustainable rooftop agriculture framework is developed.

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All images taken or produced by author except as noted in figure captions in italics.

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Chapter I: Introduction

"The idea that agriculture itself may have originated in cities, the thought to which I have been leading, may seem radical and disturbing. And yet even in our own time, agricultural practices do emerge from cities." Jane Jacobs, The Economy of Cities, 1969, pg 17

The long and rich history of urban gardening movements in America is feeding the current urban agriculture movement. A new generation of leaders, citizens, gardeners, activists, planners and designers are finding sustainable methods to support growing urban populations (Roehr and Kunigk 2009). On February 3, 2010, Seattle Mayor Mike McGinn and the Seattle City Council announced '2010: The Year of Urban Agriculture,' a campaign promoting urban agriculture efforts and improving community access to locally grown food (2010: Year of Urban Agriculture, 2010). In 2009, First Lady Michelle Obama responded to the gardening community's call to plant a 'victory garden' in the White House 'First Landscape' (Burros, "Obamas" 2009).

Concurrent with the rise of urban agriculture is an increasing interest in green roofs. Green roofs are gaining popularity as a tool to mitigate many of the negative environmental effects caused by urbanization. They have been proven to reduce the urban heat island effect, absorb stormwater, decrease energy used for heating and cooling, improve air quality, and sequester and store carbon and other greenhouse gases contributing to global climate change (Sohn 2009). As green roofs become more affordable and their benefits further documented, acceptance and application can be more pervasive.

While most green roofs are used for environmental reasons and not for urban agriculture, the body of evidence is growing that green roofs can effectively address current environmental challenges while also providing productive and healthy growing spaces for people, flora and fauna (Burros 2009).

Landscape architects, architects, urban planners and designers are actively engaging in this burgeoning movement on a variety of scales. From designing master plans for community farms and high-rise greenhouse structures, to detailing urban vertical gardens and residential vegetable oases, the potential to participate in this movement is expanding (Hou et al. 2009; Way 2009; Flisram 2009). As populations continue to grow and move into cities, urban design professionals are faced with the challenge of designing places for more people with fewer and fewer resources at their disposal. Our challenge is to participate in this design process more thoughtfully and creatively with the mission of weaving food systems into the built urban fabric.

Rooftops are ubiquitous and underutilized components of this urban landscape. With advancements in technology, desire for increased green space in a time of economic turmoil, and the public and political will to support urban gardens, the opportunity for rooftop food production has never been greater (Burros 2009).

My background in farming and construction and my studies in a landscape architecture program heavily focused on urban ecology and sustainability have shaped my critical look at this new movement of rooftop agriculture. My training in the fields of construction and agriculture provides me with an understanding of materials, construction methods and the cultivation of food, all of which have broadened my interest in connecting urban agriculture with the built environment.

My time spent living and working on farms deeply connected me to the natural cycles of life and the rewards they bring. Besides the many physical and emotional benefits that come from growing food I also learned the grueling physical labor required to achieve those benefits.
I am equally attracted to the pace and diversity of culture that cities offer. This desire for nature and culture in union drives the many innovations and popularity of the

current urban agriculture movement. I see people both young and old drawn to the benefits of fresh local food in dense urban communities. Finding a balance that includes nature, urban culture and maintaining personal connections to the sources of our food are central factors that make rooftop food production so relevant and promising.

I have worked on farms feeding thousands of people each year and was initially skeptical of the amount of food a rooftop could produce. I continue to be hesitant when referring to rooftop projects as farms because the largest case study I have found is only an eighth of an acre. That said, this topic piqued my interest and I have pursued it with excitement and alacrity.

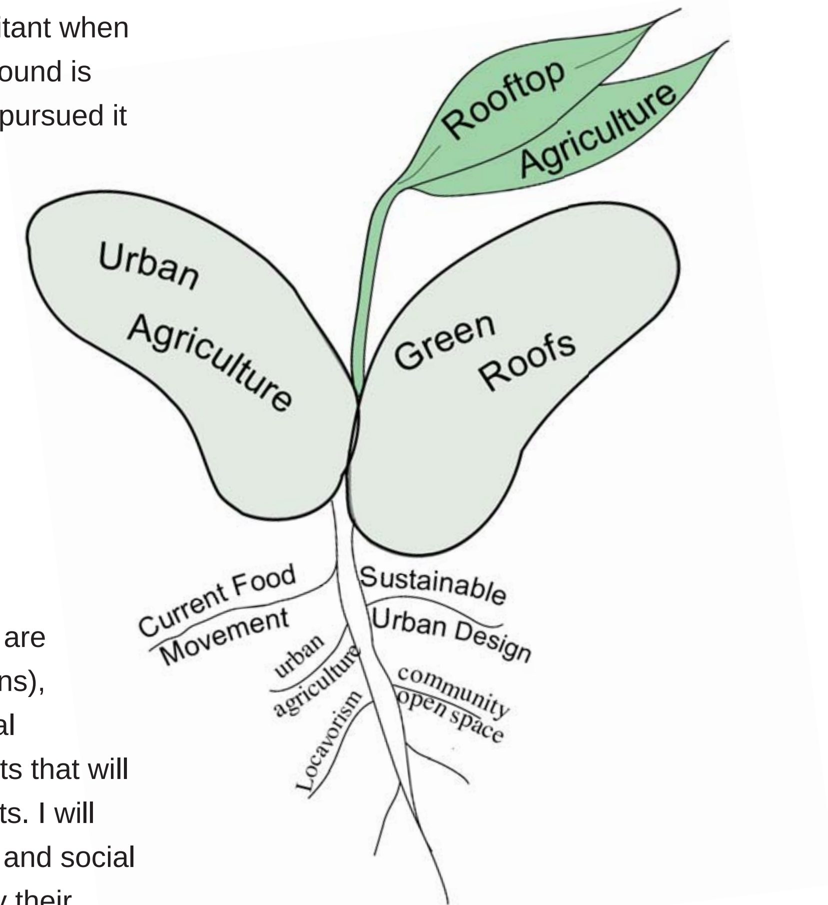

Fig. 1.1: Rooftop agriculture

Thesis/Critical Stance

This thesis is predicated on the idea that vegetated roofs for food production are beneficial. They produce food (though not enough to sustain entire populations), perform important ecological functions and provide jobs while supporting local economies. This thesis focuses on existing projects in order to identify insights that will help promote productive, sustainable and enduring rooftop agriculture projects. I will argue that these projects are good for cities from environmental, economical and social perspectives. Further, I explore the potential for landscape architects to apply their skills and knowledge in support of this movement. Through examination and analysis of urban rooftop food production projects, I explore the process that led to their development and identify the components that contribute to their success. While many different components are necessary for successful rooftop production, I focus on water use and reuse, nutrient cycling, growing medium, bed construction, policy, incentives and social programming. While considering the various types of urban food production, including residential, institutional, and community garden projects, I concentrate on commercial projects that are growing food on a larger scale. The resulting analysis is intended to help designers, developers, trades people and concerned citizens to more fully understand the processes involved in growing food on roofs.

Questions

Following are some questions I have identified in order to guide this thesis inquiry. I address them through a review of literature and in-depth case studies.

- What commercial rooftop agriculture projects are producing food at the largest scale in the U.S.?
  - + What process led to their creation?
  - + How do these projects function?
  - + What lessons can be learned from studying the pioneering projects?
  - + What are the ancillary benefits of growing food on rooftops?
- How do existing rooftop agriculture projects transform underutilized urban spaces to support sustainable communities?
  - + What are the goals of these projects?
  - + What past and current movements have influenced them?
- What roles can landscape architecture play in the future of rooftop agriculture?

Chapter II: Literature Review and Issues Studied

Rooftop food production sits at the unique nexus of urban gardens in America, larger progressive food trends and the green roof movement within the field of sustainable urban design. In this section I examine literature relating to each of these topics, both past and present, in order to contextually understand the movements influencing rooftop agriculture. I then discuss the roles landscape architects can play in this movement and the ways in which we are already involved. Lastly, I present organizations and precedent projects that are growing and working to promote rooftop food projects at an increasing scale, and in effect defining the beginnings of a movement.

Historical Overview of Urban Garden Movements

I begin with a brief contextual look at the allotment gardens in Europe which seeded the American urban gardening movement of the twentieth century. I then examine three key movements in the evolution of urban gardening in the United States: early food gardens, war and depression gardens and the modern urban community gardening movement. In each movement I identify the main personal and social benefits, and highlight key social and economic factors that precipitated the eventual expansion or demise of garden programs.

After the historical overview, I examine the major themes influencing the current food movement including sustainable agriculture, community food security, locavorism and the rise of a unified urban agriculture movement. This will demonstrate how the development of urban gardens in America along with trends in the current progressive food movement have set the stage for rooftop food production as the next frontier of urban agriculture.


Fig. 2.1: St. Anns Allotment, UK
staa-allotments.org.uk

European Precedent

Community gardens in the United States can be traced to their roots in the late eighteenth and nineteenth century allotment gardens of England. These allotments evolved overtime due to “agricultural transformation, urbanization, and industrialization” (Warner 1987, 8). The systematic commercialization of rural farmland and the crowded blocks of English company towns created a situation where citizens were left without the land that had historically been an important source of “food and pleasure” (8). Through the privatization of land and increased population densities came a new gardening movement influenced by altruism and self-sufficiency, termed “allotments”. Simply defined, an allotment garden is an area of land that is subdivided for cultivation for the benefit and enjoyment of working urban individuals (Lawson 2005). While the early arrangements were often humiliating to the landless poor, over time the concept became more broadly accepted. What started as just a spattering at the turn of the 19th century England grew to approximately 244,000 allotments in 1873. These gardens became important elements in the processing of human and animal waste from cities as well as offering green open space to alleviate oppressive urban conditions (Warner 1987, 10). Allotment gardens quickly caught on throughout Europe in the nineteenth century.

Early American Food Garden Movements

The American adoption of the idea came about as the result of a period of economic decline and crisis in this new nation’s industrial cities. At the turn of the twentieth century American cities were growing industrial centers. Factories employed a large workforce that had emigrated from rural America and all over the world. With this industrialization came overcrowded and polluted cities. Suburban neighborhoods replaced abandoned farmland without a plan for new food sources (Lawson 2005). An economic depression in 1893-97 devastated many Eastern and Midwest American cities . Many residents began to grow food on vacant lands in an effort to address the resulting poverty and hunger (2005).

Fig. 2.2: Potato harvest outside Detroit, 1896
wnyheritagepress.org

These early garden movements went by many names including farm gardens, school gardens and community gardens and farms. In Detroit, the vacant lot cultivation association was dubbed ‘potato patches’ after the predominant vegetable being grown. Under the direction of the progressive mayor Hazen S. Pingree, over 400 acres of unused land in Detroit was plowed. Teachers seized the opportunity and began incorporating gardening and outdoor activity into school curriculum (Warner 1987; Hou, Johnson and Lawson 2009). Other benefits included feelings of hope, self-sufficiency and self-respect, economic savings and the health benefits of fresh air and exercise. These spaces were also important for recent immigrants as they sought ways to socialize and assimilate into their newly adopted culture (Bassett 1981).

Fig. 2.3: Urban Farm at De Witt Clinton Park, NYC, 1908
www.nycgovparks.org

As the popularity of these programs increased, management of so many small gardens became an issue. Attempts to centralize the gardens often resulted in moving to remote suburban sites that were difficult for workers to access and maintain. This increase in scale from garden to farm required careful planning and the development of a new set of skills (Warner 1987).

War and Depression Gardens

The next iteration of gardens in America was similarly spurred by social and economic turmoil. During World Wars I and II, gardens offered food and shared community space. During this time of stress and uncertainty these gardens kept people occupied, made them feel productive and boosted overall national pride. The actual food produced was remarkable as well (Bassett 1981). In 1944, an estimated ”20 million gardeners produced 44 percent of the fresh vegetables in the United States” (Warner

Fig. 2.4: School rooftop garden, New York City, 1943
sidewalksprouts.wordpress.com

Fig. 2.5: Danny Woo Community Garden, Seattle, Washington
flickr.com

1987, 18-19). Self-help, initiative, self-worth, active lifestyles, jobs, and good nutrition are among the notable benefits attributed to gardening during this period (1987).

Unfortunately, much of the land used for war relief gardens was on leased or borrowed land that was recalled for development and other more profitable uses after the war concluded. This setup of support and dependence followed by abrupt withdrawal dispirited a number of gardeners and is a theme that continues to hurt the urban gardening movement (Bassett 1981).

Modern Community Gardens

The modern urban community garden movement in the United States was born in the 1960s. Before then "most garden programs were started by reformers, educators, and civic leaders who considered gardening to be a way to serve the broader population" (Hou et al. 2009, 15). Motivations began to change in this decade defined by the civil rights movement and grassroots community activism. While the recreational, therapeutic, social and health benefits of gardening remained, this new era of urban community gardens was community-driven by the people for the people. These modern gardens were responses to civic disinvestment, rising costs of living and food, environmental degradation and a growing divide between the have and the have nots (Lawson 2005). As growing numbers of people in cities had no land to cultivate, the strategy of sharing space to grow food became more appealing and necessary. What began with a handful of committed community groups, grew to 6,000 urban community gardens in the U.S. in 1996, according to the American Community Gardening Association (ACGA) (Hou. et al. 2009; Lawson 2005).

The many benefits of this urban community garden movement have been studied and measured by professionals, including psychologists and geographers. On a societal scale, a whole new generation was exposed to the benefits of urban gardening. Unemployment and lack of access to healthy affordable food had affected predominantly minority populations in the 1950's and 60's. Community gardens provided a means of self-help that in turn improved the morale of many struggling urban residents (Lawson 2005). Cultural traditions and family bonds were maintained through social engagement, increasing community cohesion. Personal benefits included "psychological restoration, connection to nature, cultural expression, self-esteem and personal growth" (Hou et al. 2009, 20).

Of the continuing factors that challenge the existence of urban gardens, land tenure remains paramount. Land once derelict and ripe for community gardens can be seen by city planners as opportunities to increase tax revenue. Unfortunately, in many cases the community members who have invested their time and energy end up losing the quality of life elements that helped make their neighborhood livable and affordable. Ownership, land trusts, long-term leases, and partnerships with cities are among the strategies used to ensure the resiliency of community gardens (Lawson 2005).

Illicit activities in public open spaces also continue to be a problem in many American cities. Drug sale and use, prostitution, and other such inappropriate activities in garden spaces can drive away gardeners. Strong community involvement, security and physical barriers are sometimes used to address these issues (Hou et al. 103).

Themes in Current Food Movement

With this historical grounding in urban gardens, I turn to the major trends and themes in the current progressive food movement.

To achieve sustainability in America, food and agriculture must be an important part of how we define our cities (Thompson et al. 2007). In 2008, popular author and sustainable food advocate Michael Pollan wrote a letter in the New York Times addressed to President elect "Farmer in Chief" Obama. In it he outlined an argument for a more thoughtful look at the U.S. food system as a central organizing principle of his administration and suggested that by systematically revising it we can see positive impacts on many of the issues facing 21st century America (2008). The issues we face include urban sprawl, an economic downturn, unemployment, food insecurity, poor nutrition, pollution, food injustices and climate change (Thompson et al. 2007). The trends and themes described below speak to ways people are working to develop a more sustainable urban food system in the United States.

Sustainable Agriculture

Of primary significance to urban food production is sustainable agriculture. According to the National Sustainable Agriculture Information Service, sustainable agriculture is defined as applying natural principles to grow enough food for people “without depleting the earth’s resources or polluting its environment” while maintaining healthy communities and economic viability (Earles 2005, 1). This movement builds on principles and practices that have been passed down through many generations. Sustainable agriculture is also often referred to as organic, biodynamic, alternative and biointensive (2005).

Sustainable agriculture as a movement grew in popularity as a response to the widespread acceptance of industrialized agriculture post-World War II . Many of the technologies and surplus chemicals developed during the war were repurposed and sold to American farmers as fertilizers, pesticides and herbicides. Farms expanded in size and became more mechanized and subsidized. Concurrently, Americans began eating more processed and packaged products. The ‘Green Revolution’ is a term that refers to the period in the middle of the 20th century when western companies and governments promoted these practices in developing countries (Berry 1977; Groh and McFadden 1997). The sustainable agriculture movement developed in response to this industrial model that emphasized high productivity and broad distribution at the expense of water, soil, biodiversity, food security and fuel independence (Earles 2005).

Soil, water, nutrients and biodiversity are fundamental to the biological systems that make up farms. Sustainability is achievable by establishing cultivation practices that encourage the health of these systems. This ecological approach increases plant and animal species diversity that is critical for disease resistance, pollination and healthy soil and water. Soil depletion due to erosion and chemical application can be mitigated through reduced tillage, cover cropping, and reincorporating composted plant nutrients (2005). This also prevents the release of carbon dioxide from the soil into the atmosphere. “Intensive soil tillage, erosion, and fertilization” on U.S. farms and around the world which are large contributors of greenhouse gas emissions contributing to global climate change. In 2004, agriculture was responsible for over 13% (6.5 billion tons) “of the total annual human-induced greenhouse gas emissions (49 billion tons), a majority of which came from the soil (Scherr and Sthapit 2009, 7,9). Water conservation also reduces erosion and nutrient runoff that can pollute water sources critical to biological systems. Managing irrigation strategies that closely monitor plant water needs is an important part of this strategy (Earles 2005). Farmers were once held with high esteem in society and many government programs aided all farms regardless of size by supporting prices and regulating surpluses. Since the 1970s that has slowly eroded and farm subsidies now tend to lower the prices for agricultural products by supporting the largest producers. This in effect encourages the industrial agricultural practices that are overtaxing the best soil, polluting fresh water sources and effectively pushing many small family farms out of business (Pollan 2006).

Community Food Security and Locavorism

The second major trend in today’s progressive food movement is a growing interest in community food security and eating locally. Like sustainable agriculture, both of these trends emerged in response to an increasingly industrialized food system. Like sustainable agriculture, they work to address some of the environmental and social issues caused by the current globalized, and increasingly inequitable food system.

Community Food Security (CFS) embodies a concept that has been guiding policy makers and practitioners to ensure that all people are entitled to safe, healthy and affordable food (Anderson and Cook 1999). While there remains no clear consensus as to the theoretical framework of CFS, practitioners share a mission to ensure “all persons in a community have access to culturally acceptable, nutritionally adequate food through local non-emergency sources at all times” (Brown 5). Supporting nearby food sources and distributors is a key element in improving food security.

Locavorism is another strategy being promoted to address many of the problems of the current globalized system. The desired outcome of supporting a local food system is that food will travel a shorter distance, relationships between grower and consumer will strengthen social cohesion and sustainable practices, and local economies will be more robust and self reliant. While supporting local food can bring each of these benefits it is important to remember they are not inherent to the term (Born and Purcell 2006).

Environmentally, CFS projects and local food initiatives strive to decrease consumer food miles. Food miles refer to the distance food travels from farm to fork. It is often quoted that American meals travel an average 1,500 miles--and this number is growing (Dixon 1998; Pirog 2001). The fossil fuel consumption, carbon emissions and other pollution associated with this staggering fact are not sustainable. Locavores limit their food choices from a defined distance from home. CFS programs, including the Healthy Corner Store Network and Farm to School Network, encourage businesses and institutions to source food from local farms (CFSC 2010).

CFS also addresses our nation’s food deserts. Food deserts are areas without reasonable access to traditional supermarkets or fresh affordable food options. This phenomenon is rural and urban, though it often affects low-income communities and communities of color in urban neighborhoods where the economic base has been eroded (Flisram 2009).

Projects such as Growing Power in Milwaukee, Wisconsin, are developing creative ways to address this issue. Its mission is “to grow food, to grow minds, and to grow community” (Growing Power 2010). Through demonstration, outreach and training, Growing Power supports people from diverse backgrounds and environments to help ensure safe, healthy affordable food for all. Farmer and MacArthur Foundation genius grant winner Will Allen, with his staff and community members grows enough food to support 2,000 people on only two city acres. Through these efforts, Growing Power is developing innovative ways to eliminate an urban food desert, provide jobs and training, and offer healthy affordable food options to underserved urban populations (2010).

Fig. 2.6: Will Allen, Growing Power aquaponics
flickr.com

The irony of food deserts in America is that they are often filled with an abundance of fast food restaurants and convenience stores stocked with highly processed food products (Winne 2008). Such food choices are linked to a variety of chronic illnesses, including obesity and type 2 diabetes. Studies have shown that “61 percent of Americans are now obese or overweight,” epidemic levels that are particularly alarming among American children (Winne 2008). The Institute of Medicine estimates that the health-related costs are between $98 and $117 billion annually (2008).

Fig. 2.7: Growing Power urban farm greenhouses
growingpower.com

Urban agriculture

The last major trend I discuss in the progressive food movement today is the rise of a unified and interconnected urban agriculture scene. Urban agriculture refers to food production in and on the fringes of cities. It encompasses the urban community gardens as well as school gardens, backyard plots, farmers markets, market gardens and small peri-urban farms. Millions of people are already engaged in urban agriculture worldwide, many of whom realize that building more robust urban agricultural networks can be instrumental in achieving sustainable and secure urban food systems (Brown et al. 2002).

As more Americans move to cities, connection to the sources and processing of their food is lost. As cities grow denser, many of the problems encountered in previous decades have been compounded. Motivations for interest in urban agriculture can be easily linked to those of the past century, such as environmentalism, human injustice, health, physical activity, self-help and jobs. While many motivations remain the same, new issues continue to develop including those related to consumption by ever larger populations and global climate change (Brown et al. 2002; Flisram 2009).

City policy affects urban agriculture in both direct and indirect ways. Policy can act as a barrier to successful urban agricultural activities. Zoning and building codes can unnecessarily restrict or discourage urban farming while protective zoning is an effective way planners and city governments can promote it. Certain cities like Seattle encourage urban agriculture with funding, land and inclusion in comprehensive plans. In 2005, Seattle further updated the already forward thinking Seattle Comprehensive Plan to require one community garden per 2,500 households (Mukherji and Morales 2010).

There are a number of ways cities can promote urban agriculture in sustainable development, including incorporating their practice in “residential, commercial, industrial, institutional, recreational, transportation and utility” zoning (Mougeot 2006, 65). Kansas City, Missouri, for example, developed a Climate Protection Plan through the Office of Environmental Quality that explicitly outlines ways urban agriculture can be encouraged. In 2009, the city of Vancouver, British Columbia, developed a “multidisciplinary taskforce representing various government offices and tasked it with developing recommendations for urban agriculture throughout the city” (Mukherji and Morales 2010). Seattle recently declared 2010 the ‘Year of Urban Agriculture’ (City of Seattle).

While these strategies no doubt are useful, “zoning is typically a restrictive, regulatory mechanism” (Mukherji and Morales 2010). It can also be used to allow urban agriculture in certain districts or land-use categories. Local zoning regulations can support a lot of agricultural practices or restrict them under certain conditions a community or city deems reasonable. Some cities are also currently “reviewing and redesigning ordinances” and codes that deal with food and agriculture (Mougeot 2006). This is being done in Portland, Oregon, through a program called Recode Oregon. The community-based organization Recode “is examining how city and state regulations can support rather than inhibit creative, sustainable living, while simultaneously educating and engaging grassroots communities in changing these regulations” (Recode). Urban agriculture and gray water reuse are two of the issues they are researching.

In spring 2010, I spoke with Andrea Petzel, a planner with the Seattle Department of Planning and Development. She discussed the ways Seattle is taking an approach that is similar to what is being done in Portland, OR. Revisiting existing codes that currently prohibit urban agricultural practices, like those for Industrial zoning, and rewriting them with more inclusive language, can protect the original purpose of the code while allowing for sustainable growth. This is particularly relevant for rooftop agriculture on buildings that can maintain their original industrial purpose (Petzel 2010).

Many major U.S. cities also have advisory groups of experts and activists that strategize ways for cities to have healthier and more sustainable food systems, called food policy councils. Toronto has one of the oldest food policy councils and has provided a framework for cities like Seattle, Portland, Vancouver, Chicago, and New York to emulate. Food policy councils and the policies they promote are ensuring unified and connected food systems (Winne 2008).

Conclusion

These factors—the development of urban gardens in America combined with the sustainable, CFS and local food movement trends—have set the stage for rooftop food production to be the next frontier of urban agriculture. Indeed, urban agriculture activists are working to maximize production on all available city spaces. This has meant an emergence of food production on previously unconsidered or leftover areas. From vertical walls to rooftops, urban agriculture is finding new ground in American cities.

"…the potential of green roofs was even greater than I imagined. Green roofs represent an elegant opportunity to simultaneously mitigate environmental problems and create immediate life-enhancing values." Leslie Hoffman, Executive Director, EarthPledge, 2005, 9.

While the progressive urban food movement is partially responsible for the recent growth in rooftop food production, the growing popularity of the green roof movement has also been very influential. Green roofs are primarily promoted for their ability to restore important ecological functions to the infrastructure of cities. Citizens, elected officials and professionals have advocated the environmental benefits of green roofs in academic publications and popular media outlets around the world.

Perhaps the two most touted and widely accepted benefits are decreasing stormwater runoff and reducing the urban heat island effect. These are among the more easily measured and scientifically validated green roof benefits. By slowing and absorbing rain in storm events, green roofs help reduce flooding in cities and of streams and rivers, lessen impacts on municipal wastewater treatment facilities, and prevent sewage from entering waterways through combined sewage overflow systems (Dunnett and Kingsbury 2004). Cities have high concentrations of concrete, asphalt and other man-made surfaces that are impervious to water but also absorb and retain solar heat. The water absorbed and stored by the vegetation and soil media on green roofs helps to regulate and cool the air through evaporation and transpiration (EarthPledge 2005).

Green roofs also increase habitat and biodiversity, from a microbial level to that of plants and animals. There are also resource and economic savings attributed to green roofs. By acting as self-regulating insulation they reduce heating and cooling costs for buildings. Also, by blocking harmful UV rays, they can increase the lifespan of waterproofing membranes by 2.5 to 3 times (McIntyre 2007; Dunnett and Kingsbury 2004; Carey 2003; Barnes 2007).

Two types of green roofs are generally referenced: extensive and intensive. Extensive green roofs are characterized by a shallow substrate, typically 1-6 inches deep and are easier to maintain but usually not meant for regular human use. Intensive green roofs typically have 6 or more inches of substrate, require greater structural support, demand a more regular maintenance schedule and are intended to be used by humans (Dunnett and Kingsbury 2004).

The ability of green roofs to sequester carbon from the atmosphere has recently been added to the growing list of benefits. A study done at Michigan State University estimated that an average of 375 grams of carbon per square meter can be stored in vegetated roofs. To contextualize this point, the research compares the carbon reductions from planting 65-85 million square meters of rooftops in Detroit to removing 10,000 SUVs from the road for one year (Sohn 2009).

The human impacts are less quantifiable but green roofs are also benefiting people in cities by reconnecting them to nature. Besides the tangible environmental benefits, green roofs offer visual and aesthetic relief in harsh urban environments as well. Vegetated roofs ameliorate numerous psychological and physical health effects of air and noise pollution (EarthPledge 2005).

While there is growing evidence that green roofs can mitigate many environmental challenges in cities, a more comprehensive understanding of their benefits is needed. Charlie Miller, engineer and President of Roofscapes, a leading Philadelphia based green roof research, design and installation company asserts that by standardizing research, green roof technology would be perceived as more credible, resulting in more projects at a variety of scales and scopes. These databases already exist in Germany and Austria where government support has helped in achieving more green roofs than any other region in the world (McIntyre 2007).

Incentives and Policy

In the U.S., local and national government has been slow in providing substantial incentives and education to support the growth of the green roof industry. While we have seen an increase in green roofs on large-scale new construction corresponding to the national LEED program and the local Seattle Green Factor, there is less focus on the large areas of roof space that already exist (Carey 2003). By providing information to the public about roofing alternatives and creating interest through financial subsidies, more roofing professionals and suppliers can be encouraged to expand their businesses to include green roofs. Through increased availability and affordability of materials, labor and experience, more community support is also possible. This can also lead to more opportunities for monitoring the performance of green roofs both regionally and nationally.

Since the 1980s the city of Linz, Austria, has made subsidies available for 35% of all green roof projects (Beatley 2000). These incentives and regulations result in a high number of visible and measurable projects, providing more data to further support increased scale, scope and efficiency of the next projects. Research conducted by Green Roofs for Healthy Cities reveals that 10% of all flat roofs in Germany, or 55 million square meters since 1989, have vegetated cover. Approximately 50 percent of all German cities (77 cities) have programs in place that support these projects, a standard still unmatched by any other city (Green Roof Monitor 2000).

Many U.S. cities have taken these cues and established incentive programs. In 2005 Chicago established the first U.S. Green Roof Grant program resulting in great success. With expedited permits, tax breaks and financial help, Chicago has helped promote more green roofs than any other U.S. city (City of Chicago). In Portland, green roofs, or ‘ecoroofs’ are increasingly being installed. Through the publicly funded stormwater management program, a fee is calculated by permeable surface on private property and charged through the city's utility department (Earth Pledge 2005). There is an impressive grant program due in large part to Tom Liptan, a city employee and green roof activist promoting green roof benefits for many years. According to the Portland Bureau of Environmental Services, "the grants will fund up to $5 per square foot of an ecoroof project (Portland Ecoroof Program 2010). New York City has a pilot program that awards $4.50 per square foot of green roof up to $100,000 through 2013 (New York 2008). Seattle has yet to develop an incentive comparable to any of these.

In Toronto, there is an equally impressive city wide incentive program with a $200,000 budget to fund $10 per square meter, with a maximum of $20,000. It is stated in the report that highly visible projects will get priority as "educational and promotional" benefits are sought. Accessibility and variety are also listed as desirable project characteristics (Canada 2007). Recently has raised the bar even higher taking cues from the Germans and effective this year, requires all new qualifying projects to install green roofs on a given minimum percentage of their roof (City of Toronto 2010).

Food and Green Roofs

The current momentum of the green roof and urban agriculture movements can be mutually beneficial, and through conference presentations and design exhibitions, connections between the two are regularly being discussed. Green Roofs for Healthy Cities, a leading authority on green roofs, recently initiated a special committee for food production on buildings (GRHC 2010). This committee was established in response to an outpouring of interest at their annual conference in Atlanta. The discussion session on urban agriculture had unprecedented attendance and enthusiastic support (Burros 2009). Published on the GRHC website is their goal to compile and disseminate information on "rooftop, wall, and other building-integrated food production" in order to teach others about food production on buildings (GRHC).

Most rooftop food production projects are still in their nascent stages. As the costs and benefits are weighed and impacts further studied, benefits on urban food systems, nature, and economies will be better understood. If the list of co-benefits grows for green roofs, the argument for them can be strengthened. Through this comprehensive layering of positive effects, rooftop food production can be an integral part of sustainable urban development.

Sustainable Urban Design

“The era has dawned for urban planners, designers and architects to commit themselves to knitting urban agriculture and adjacent infrastructures into urban planning in the most exquisite way.” Debra Solomon. “Cultured and Landscaped Urban Agriculture.” 2008: 132.

The green roof and urban agriculture movements fit within the general trend towards sustainable urban design. Urban designers are being motivated to find more sustainable solutions for developing cities. The increasing food requirements and detrimental environment impacts caused by growing populations are at a critical point. The argument for integrating sustainable urban agriculture with sustainable architecture is clear and urban designers are actively working to merge the two, however, designs that are holistic and compelling have yet to fully emerge (Solomon 2008; Viljoen 2005).

A century ago “50 percent of Americans lived on farms or in small rural communities,“ today it is only a fraction of that (Brown et al. 2002, 5). According to the United Nations over 80 percent of Americans now live in urban areas (United Nations 2008). As populations continue to grow and trends toward urbanization continue, the associated problems become more complex. In growing cities like Seattle, planning efforts focus on increasing densities, and incorporating green open space is ever more challenging (DPD Green Building 2010).

Density is a key term among urban sustainability advocates, planners and designers. While not everyone supports increasing density, the positive environmental impacts are hard to ignore. The direct decrease in resource use and traffic congestion can reduce urban pollution and greenhouse gas emissions significantly (Farr 2008). Increasing density is also used by planners to counter the trend of urban sprawl. One of the effects of urban sprawl is the loss of productive farmland to the growing demand for housing and infrastructure. As populations continue to grow, American’s risk losing food self-sufficiency (Daniels and Bowers 1997)

Douglas Farr presents an argument for increasing urban density in his book *Sustainable Urbanism*. Farr takes his experience as a green builder and “LEED for Neighborhood Development” advisor and combines it with New Urbanism principles to advocate for walkable, compact neighborhoods that increase energy efficiency and access to nature. Local food production and access, including rooftop agriculture, are discussed as thresholds for sustainable urbanism. Many of the examples he cites in his book demonstrate that this is already happening in U.S. cities and he argues more widespread acceptance and replication is needed in order to achieve sustainability (Farr 2008).

In *CPULs: Continuous Productive Urban Landscapes, Designing Urban Agriculture for Sustainable Cities*, Viljoen et al. present a new urban growth model that combines the sustainable concept of *productive urban landscapes* and the spatial concept of *continuous landscapes*. Connected to the larger system of infrastructure, parks, and built urban landscapes, “CPULs” use urban agriculture specifically to overlay and interweave into the web of diverse cultural and biotic networks. Cities in the U.S. can take cues from a number of international communities integrating more continuous productive urban landscapes. Cities in Cuba, Russia and China are using the heat, food, nutrient and water wastes that are produced in high population areas and converting them to useful energy for growing food (Viljoen 2005). Rooftops are a crucial element to the implementation of this strategy.

Green spaces are an essential component to urban sustainability. Francis, Cashdan and Paxson in *Community Open Spaces: Greening Neighborhoods through Community Action and Land Conservation* (1984) discuss the character of cities and the cultural and ecological requirements for people and nature to co-exist. Because cities are human centered and people drive development and innovation, our role must be understand in order to design for a sustainable future. Francis et al. discuss the cultural values of nature in cities, focusing on psychological and physical health, recreation, and ecological sustainability as the motivating factors for the community-driven open-space movement An example of this type of space is an urban garden (1984). I argue that rooftops are underutilized spaces in cities that can be repurposed to support and advance many of the benefits discussed.

The quality of life for city dwellers can greatly improve with more community open spaces. It has been shown that by activating unused spaces for urban agriculture community investment in neighborhoods can increase, reducing crime and creating more equitable and ethnically rich places (Mougeot 2006). The health benefits that come from eating fresh food and leading active lives can reduce health care needs and improve communities (Viljoen 2005). What is particularly remarkable is that communities, realizing the need for these spaces, are willing to pay for and maintain them when the city can't or won't. A large number of community-developed open spaces have taken form as community gardens or other food production spaces. By adding an element of productivity to these projects, a greater sense of ownership and reliance is developed (Francis et al. 1984; Francis 2003). Many rooftop gardens today are being situated in dense urban neighborhoods with populations that stand to reap these benefits.

Urban gardens are often accessible by relatively few people, "but many more can enjoy viewing them as passersby" (Lawson 2005, 7). This is true for rooftop gardens as well. Rooftops are flat, uninspiring and often the site of 'leftover' utilities, we usually don't recognize how prevalent these grayscale surfaces are. In addition to the ecological, social and productive functions rooftop gardens provide, an ancillary benefit is the visual amenity to urban populations. One can gain a birds-eye perspective of the surrounding city from many rooftop gardens however these gardens can also be a part of that view for the surrounding community. Neighboring apartments and offices can enjoy watching the activity and green in their daily routine instead of the standard view of blacktop and utilities. As Dave Hampton of Hampton-Avery Architects pointed out at a recent lecture, Chicago residents are typically well aware that their city has a reputation as the most progressive green roof city in America (Bellows 2009). What is remarkable is how few residents have actually been on or even seen one. The visual quality of green spaces in cities is priceless. The strategic siting of these projects has not been sufficiently explored and is necessary in order to garner further support and investment.

Land tenure continues to be an issue for green spaces in cities. Ensuring a project is protected by a land trust, a long-term lease agreement, or owned outright makes more durable and community invested projects. A recent article in the New York Times demonstrates the currency of this issue, describing a 40-year-old garden on the ninth floor roof of a Manhattan building. First, the city cited the gardener with a code violation. Then, the bank repossessed the building it was on and the gardener was forced to move (Dominus 2009). While this is a severe example, tenure for many of the rooftop projects being realized today remains a concern.

In Seattle, as in many densifying American cities, green open spaces are limited and building footprints encroach on desirable land for open space. Zoning, property values voters and profits often determine what land use is acceptable. As trends show, populations will continue rise and cities will grow denser. Rooftops are a ubiquitous component of these urban landscapes and by re-envisioning them, can become spaces that support social functions while simultaneously linking ecological and hydrologic systems in the city.

Landscape Architecture

Landscape architects and urban designers are beginning to participate in the discussion around rooftop food production. There are many ways sustainable agriculture and sustainable architecture can merge, and the next generation of designers is actively exploring these possibilities.

One way the potentials for integrating food and the built environment are being explored is through competitions, conferences and exhibitions. In October 2009, Toronto hosted Cities Alive, the first world conference on green roofs. Many of the sessions there involved discussions about food production on roofs, one was even dedicated to the topic. Many sessions were devoted to highlighting projects unrelated to food that are testing the boundaries of weight, scale, and ecosystem services. The urban agriculture session hinted at applying these advances to food production as well. According to a Toronto food policy expert Wayne Roberts, it won't be long before urban agriculture and sustainable urban design will be integral with one another (Roberts 2009).

Carrot City is a traveling exhibition put on by a group of designers and educators in Toronto. A number of ideas and designs were showcased, both realized and theoretical, that inspired discussion about urban agriculture and the built environment. A variety of scales were explored, from entire cities to specific technologies that have been developed to address food, waste, urban sustainability, and architecture (Nasr and Gorgolewski 2009)

In May 2010, students at the University of Washington College of Built Environments hosted a panel discussion and two-day design charrette that focused on the role of design in urban agriculture. Food production possibilities are entering the conversation for landscape architects, architects, and urban planners at the beginnings of their careers. It is exciting to see where the discussion is heading and the innovations and advancements that arise, however, it will be important for designers to remain cognizant the many foundational movements previously discussed as they move forward.

The Sustainable Sites Initiative, a partnership of the American Society of Landscape Architects (ASLA), the Lady Bird Johnson Wildflower Center and the United States Botanic Garden, recently published a set of “voluntary national guidelines and performance benchmarks for sustainable land design, construction and maintenance practices” (The Sustainable Sites Initiative 2010). Modeled after the LEED Green Building Rating System, the benchmarks in part support food production. While commercial food production is excluded from the types of sites covered by this rating system, gardening and edible landscapes are included as options in the outdoor space and social interaction credits. Further, projects with food production elements are required to recycle organic waste products. While many of the categories are relevant to rooftop agriculture, such as site selection, soils, water, construction materials and habitat, there is little mention of food production specifically (Sustainable Sites Initiative 2009).

Landscape architects have a skill set that is uniquely suited to the design and implementation of rooftop agriculture projects. There is potential for landscape architects to help rooftop gardens evolve into a more widely accepted and effective strategy for urban sustainability. Landscape architects bring site engineering, materials knowledge, community design, communication with other design and construction professionals, and understanding the complex ecological systems that are required for plants and animals to thrive, among other individual skills and expertise (Hou et al. 2009). Landscape architects have been involved with urban food gardens from community farms to backyard oases (Way 2009). However, their talents remain latent in rooftop agriculture.

Rooftop Agriculture Movement

Fig. 2.8: Rooftop Garden, Bosnia
Daniel Winterbottom

Fig. 2.9: Simple roof planter

Rooftop food gardens are not a new concept, however the increased scale and growing enthusiasm for them is. Small-scale rooftop kitchen gardens have been the testing ground and source of inspiration for many of the emerging projects today. Most examples of roof gardens have been minimally documented, typically consist of a few planters growing herbs and vegetables for personal use, and don't require structural changes to support their weight. The current rooftop agriculture movement is characterized by larger spaces, increased efficiencies, and growing community support. In this section I discuss the current rooftop agriculture movement and the process of selecting five case study projects.

Given the limited timeframe of this thesis, the lack of organized research about rooftop agriculture and the web-based nature of the sources, this section is not a comprehensive survey of rooftop gardens rather a contextual look at some of the small-scale solutions that have inspired the current movement. I have reviewed a number of precedent projects and organizations that are working to promote rooftop food production. Through this exploration I have identified a number of key considerations for rooftop agriculture.

Precedents

There are many examples of rooftop gardens that serve as precedents for this movement. Before looking at the larger commercial case studies I have chosen to examine in more depth, in this section I survey a few projects that deserve mention for the innovation and example they provide. Many planter strategies and designs have evolved out of the weight, water and access constraints unique to rooftop sites. In addition to the countless residential rooftop planter gardens that are perched on buildings around the world, a number of small commercial efforts stand out for increasing scale and productivity in a more deliberate way.

Chef Rick Bayless grows tomatoes and chilies in EarthBoxes on top of his restaurant Frontera Grill in Chicago to make 'Rooftop Salsa,' a featured item on his award-winning menu (Burros 2009). The EarthBox is a self-watering planter design that is gaining popularity with home gardeners around the world. The lightweight and low-maintenance design is ideal for roof gardens that aren't easily accessed and dry out easily due to increased heat and wind (earthbox.com).

Fig. 2.10: Rick Bayless, Chicago
www.wickedtastyharvest.com

The Fairmont Hotel and Resorts is a renowned company with hotels all over the world. With a stated environmental ethic at the core of their mission, many of their hotels have had roof gardens for years. The 3rd floor of the Fairmont Waterfront Hotel in Vancouver, B.C has 2100 square feet of herbs, vegetables, fruit and edible flowers. Since 1992, chefs at their Herons Restaurant have been cultivating the organic garden that inspires seasonal menus throughout the year (Green Partnership 2010). In Toronto, the Fairmont Royal York also grows a variety of herbs and vegetables in the 4,000 square foot 14th floor garden. Expanding on the example set in Vancouver, this garden has three beehives and a classy outdoor eating area for select diners (Farquharson 2008). The green minded company continues to expand their dedication to this model as more hotels, like the Fairmont Dallas, plant kitchen gardens on their roofs.

Fig. 2.11: Fairmont Royal York, Toronto
www.greenroofs.com

Zabar's Vinegar Factory, a family-owned grocery, bakery and deli on Manhattan's Upper East Side, has been growing vegetables in rooftop greenhouses since the mid-1990s. Currently, two full-time staff tends four 3rd story greenhouses of tomatoes, herbs and greens that are sold in the grocery store below. Heat from the bakery is cycled through the greenhouses during the cold winter months (Wilson 2009). It is unclear exactly how much money has been invested in this project, but the structural retrofit and greenhouse construction costs must have been significant.

Another great rooftop garden example is at the Environmental Sciences Building at Trent University in Peterborough, Ontario. Started in 2000 under the direction of


Fig. 2.12: Alcyone Apartments, Seattle


Fig. 2.13: Rooftop Garden Project, Montreal
rooftopgardens.ca

Professor Tom Hutchinson, over 2,000 square feet is cultivated for research, teaching and growing vegetables, flowers and herbs for a campus restaurant. This space offers a unique educational opportunity for students and faculty, provides a visual attraction for surrounding buildings, and produces an abundance of food for university consumption and fundraising (Martin 2008; Blyth 2006).

Gardening space integrated into the communal gathering area was part of the original design at Alcyone Apartments in Seattle's Cascade neighborhood. As a free amenity to renters in this 8-story LEED certified apartment complex, small raised-bed planters are offered on a first come first serve basis. The garden plots are irrigated with rainwater collected from the roof and stored in cisterns adjacent to the beds. The value for green space in dense urban environments is evidenced by the ever-present waitlist for these garden plots (Alcyone Apartments 2010).

The non-profit *Technology for the Poor*, founded by Dr. Job Ebenezer, has been experimenting with growing food on roofs in Chicago for over 15 years. Dr. Ebenezer has experimented with children's wading pools, feed sacks and used tires as inexpensive planters that can be adapted to many roof types. His work has inspired projects globally, including two recent projects in Portland and Seattle where wading pools have been used to grow food for restaurants (From the Rooftop 2008; Ebenezer 2009).

The "Use Your Roof! Project" in San Francisco, the "Rooftop Garden Project" in Montreal and the Greenskins Lab in Vancouver are all researching and experimenting with the potentials of growing food on roofs. Each of these projects in addition to the many precedents helped me in identifying important considerations for rooftop food production and laid the foundation for my interview questions and case study categories.

The Rooftop Garden Project is a team of volunteers in Montreal, Quebec that has combined the principles of hydroponics, permaculture, organic agriculture and collective gardening to develop a step-by-step guide to making your own rooftop garden. The authors were able to develop this guide and experiment with lightweight planter designs through partial funding from an international development organization. The goal is to inspire more people to discover the benefits of growing food on roofs and increase nature in the city. This user friendly illustrated pamphlet is a great general reference that focuses on small-scale lightweight projects (Rooftop Garden Project 2007). It begins by outlining the importance of the planning and design phase and works through the logistics of coordinating people and physical elements of the project. The guide has a clear objective of achieving human and environmental health and concludes by walking the reader through how to maintain a healthy garden. This section describes how to make a planter container based on hydroponic principles, similar to the earthbox, but using inexpensive materials and doing it yourself (2007).

Fig. 2.14: DIY rooftop planter
rooftopgardens.ca

Bay Localize is a nonprofit group in Oakland that is focused on strengthening local Bay area communities by reducing reliance on fossil fuels. The Use Your Roof! Project looks at three main ways rooftops can be repurposed in order to achieve these goals; roof gardens, solar energy and rainwater harvesting. With a team of engineers and urban planners they assessed Oakland neighborhoods to identify existing building types and requirements for each of these uses. In a guide called *Tapping the Potential of Urban Rooftops* they published these results as a series of best practices, sample designs and calculations of potential impact. Based on their study area the existing rooftops could supply irrigation water for 212 households, or 25% of the area energy demand, or vegetables for 8,500 residents. Their weight calculations are cautious and they strongly encourage consulting an engineer and other design professionals before getting started (Severson 2009).

The Greenskins Lab is a research team of landscape architects and architects at the Design Centre for Sustainability at University of British Columbia. Led by assistant professor Daniel Roehr they currently examine green roofs, facades, rainwater harvesting and urban agriculture. A recent study conducted in a combined residential and commercial neighborhood in Vancouver, B.C. revealed that 54% of the vegetable needs for the 8,500 resident could be grown on the flat rooftops in the area (Rohr and Laurenz 2008; Greenskins lab 2010).

In a similar study, three students at the University of Toronto conducted an impressive theoretical evaluation of the costs and benefits of growing food on rooftops in Toronto. By using existing data on transportation, energy use, measurable green roof benefits, human food requirements, plant yields, materials costs and other related information, they were able to extrapolate a formula to determine the profitability of converting 50 million square meters of flat roofs on commercial buildings throughout Toronto. Based on their research, the initial cost savings for the city would be nearly $400 million on an initial investment of $6.36 billion, with subsequent annual savings nearly $40 million. They further break it down to individual 350 square meter buildings. The initial cost estimated for each building is $44,526, with annual maintenance costing $11,365 to produce 1,050 kilograms of food annually. The annual return for each building would be $1,702, translating to $1.7 billion for all of Toronto (McDonald, Norman and Damsbaek 2009). This research is promising for the future of rooftop agriculture and as it is refined and applied to more cities, the potential of this movement will be further revealed.

This review of precedents helped inform the eventual selection of case study projects for more in-depth study. The innovations, strategies and research in this section were instrumental in developing the many considerations for rooftop agriculture outlined in the next section.

Chapter III: Case Studies

Case Study Project Selection Method

One way to further the effective integration of food production, cities and roof spaces, is to look at current projects as models. I conducted an in-depth study of five existing rooftop agriculture projects that are large scale, innovative, and have committed leadership. Some factors that prevented me from studying more projects in more depth include the limited timeframe of the thesis, few published details about projects, and difficulty contacting those involved in their planning and maintenance. My initial plan was to select projects that represented a variety of urban agriculture typologies including commercial, institutional (ie. churches, schools and retirement homes), community (both public and private) and residential. Ultimately the projects I decided to explore in the case studies stand out as the largest rooftop operations producing food commercially. Each of these projects has consistently been highlighted in the news, media and urban agriculture blogs including Michael Levinston's City Farmer News, Jason King's Landscape and Urbanism blog the New York Times and Green Roofs for Healthy Cities. I have chosen projects in four large U.S. cities from distinct North American political, social and climatic regions; Seattle, Washington, Portland, Oregon, Chicago, Illinois and Brooklyn, New York.

By breaking these projects down to their individual components, I set out to discover how these pioneering projects came into being and what has been learned in the process. Through a descriptive analysis, I look at how these rooftop case studies are thriving and what impacts they are having on urban food systems. Further, I highlight key components that have contributed to their success. By focusing on water use and reuse, nutrient cycling, growing medium and bed construction, I set out to compile some best practices from the largest current projects.

Each case study site has benefited from investments of time and money that have allowed new concepts and methods to develop. While each is unique in the treatment of the roof for food production, I have identified a number of key elements that are common with each of them. Learning from this case study research, hopefully future projects can benefit. Information about each of these projects was obtained through personal interviews with key players (see appendix A for a list of questions), articles, websites and other online resources, and site visits when possible. In the final chapter I summarize the lessons learned and reflect on the specific roles landscape architects can play in the emerging rooftop agriculture movement.

Case Study Projects

- Bastille Café and Bar, Seattle, Washington.
- Noble Rot, Portland, Oregon.
- Uncommon Ground, Chicago, Illinois.
- Rooftop Victory Garden, Chicago, Illinois.
- Eagle Street Rooftop Farm, Brooklyn, New York

Considerations

A number of considerations have emerged that have helped organize and frame the case studies in the next section. Below is an outline with brief summaries of each.

Project Overview

- beginnings
- costs and benefits
- designers

Site Infrastructure

- environment
  - exposure
  - habitat
- building

  - weight
  - access
  - neighborhood context

Growing Methods and Strategies

- beds
  - materials
  - medium
  - growing methods
  - season extending strategies
- water
  - irrigation
  - stormwater collection
  - runoff
- products
  - vegetable products and varieties
  - other products
- nutrients
  - fertilization
  - compost
- innovations

Social Elements

- jobs
  - growers
  - chefs
- markets
- education
- community engagement
- locavorism

Policy and Incentives

- incentives
- zoning
- codes
- permitting

Project Overview: Each project starts with an idea. Motivated by a range of people and inspirations, the genesis stories for these projects reveal the catalysts that have brought them into being. By telling each of these personal stories it demystifies the process and makes it easier to visualize how more of them can be realized.

Site Infrastructure: Choosing a site is an important step when deciding to grow food on a roof. Sun and wind exposure, ownership, location with respect to markets, infrastructure, weight and access are all key considerations.

Growing Methods and Strategies: Each project takes form in its own unique way however there are a number of elements and methods that are essential. Waterproofing, growing medium, bed materials, irrigation, fertilizer, seed, among other elements are important to consider before getting started. Maintaining the site for maximum production is key to any rooftop garden. Having an experienced grower can help get the project off to a quick start and ensure long-term success. In order to make the investment worthwhile it is important to have a schedule that ensures proper water, nutrient and harvest routines.

Social Elements: There are many social elements to rooftop food production projects that can support them and increase their robustness. This can include community involvement, educational programming, and connecting to local food systems.
There are a number of potential markets in the urban food system. Grocery stores, restaurants, hotels, schools and farmers' markets are just a few of the places food products are regularly bought and sold. Identifying a market for food produced on the roof can help make it a success.

Policy and Incentives: Growing food on rooftops can be supported or hindered by a number of political factors. Local food policy councils, city building codes, zoning, and public health regulations can all play a role in how successful a project is. Wide ranges of start-up costs are associated with each of the projects presented. These costs typically come from building and roof structure retrofits, labor, and materials for bed construction. Incentives through programs like municipal green roof grants can help offset many of these costs.

Case Study Projects

- Bastille Café and Bar, Seattle, Washington.
- Noble Rot, Portland, Oregon.
- Uncommon Ground, Chicago, Illinois.
- Rooftop Victory Garden, Chicago, Illinois.
- Eagle Street Rooftop Farm, Brooklyn, New York

Bastille Cafe and Bar

Seattle, Washington

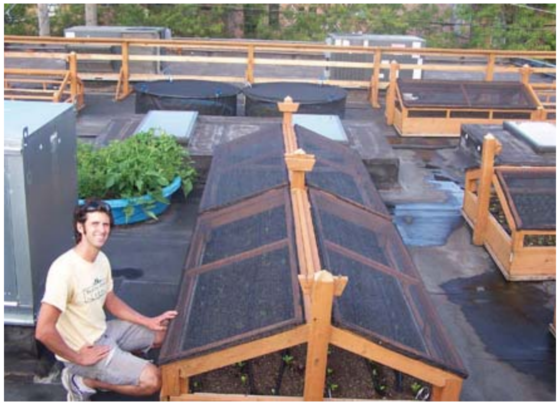

Fig. 3.1.1: Rooftop farmer Colin McCrate
Willi Galloway, digginfood.com

Fig. 3.1.2: Ballard farmers' market (Bastille on left)
myballard.com

Project Overview

Building Use: Restaurant

Address: 5307 Ballard Ave NW, Seattle, WA 98117

Year Installed: 2009

Owner: Deming Maclise and James Weimann

Grower: Colin McCrate

Design & Installation: Colin McCrate

Cost (per ft^2):

Roof Area (ft^2): 4500

Planted Area (ft^2): 750

project beginnings

In 2008 Seattle entrepreneurs Deming Maclise and James Weimann partnered to develop a Parisian bistro located on a historic commercial strip in northwest Seattle. Each Sunday the street in front of the restaurant transforms into one of the most popular farmers' markets in the city. Interested in supplementing the new kitchen with food grown locally, Maclise and Weimann contacted Judy Kirkhuff, director of the year-round market, to discuss how they could grow some of that food on the roof. Judy put them in contact with Colin McCrate, founder and owner of the Seattle Urban Farm Company, and the project was born. Colin's expertise in growing food in urban conditions was instrumental in designing a rooftop garden that would produce kitchen staples all year. An engineer determined the old building would need structural retrofitting, a task that ended up fitting well within the planned building remodel schedule. With a number of innovative growing strategies, a thriving business, and a devoted clientele of locavores, Bastille is proving to be a successful model for integrating rooftop food production into the restaurant business (McCrate 2010).

Site Infrastructure

Framing: Masonry
Height: Single story
Year: 1927
Weight allowance:
Engineer: Licensed engineer hired by owners
Waterproofing: Modified bitumen (torch down)

general

The structural retrofit for this building was integrated into the remodel process early on. Support columns were bolstered and the wood ceiling joists were doubled. There is a double layer of modified bitumen waterproofing on the roof to withstand the extra traffic expected in the garden area. Salvaged lumber in the restaurant remodel was the only evidence of green building practices.

access

Roof access is allowed under the supervision of restaurant staff and gardeners. A stairway in the back dining area leads to a roof pop-up that has a door leading to the garden area. This provides easy access for chefs and restaurant staff harvesting vegetables and herbs while restricting public access.

neighborhood context

This historic building is zoned C-commercial and is surrounded by a mix of similar historic brick buildings and more modern low-rise buildings in the recently gentrified adjacent blocks. Located in an actively regulated historic district within an urban village blocks from Salmon Bay in one direction and a thriving residential neighborhood in the other. There are spectacular views of the neighborhood, surrounding hills and waterways.

Fig. 3.1.3: Bastille Cafe and Bar, front

Fig. 3.1.4: New support columns.
bastillerestaurant.com

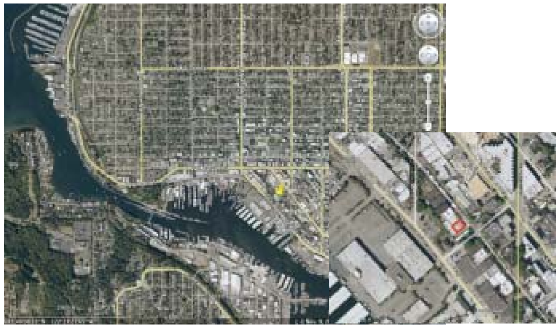

Fig. 3.1.5: Ballard neighborhood context
maps.google.com

Fig. 3.1.6: Raised bed planters, summer
Colin McCrate

Fig. 3.1.7: Raised bed planters, winter

Fig. 3.1.8: Wood and plastic planters
Colin McCrate

Beds (see roof layout diagram)

A. 2 12'x4'x12" deep raised bed planters

B. 4 24'x4'x12" deep raised bed planters

C. 6 45" diameter 4" deep kiddie pools

Total 750 ft2 planted area.

bed materials

The raised beds are made out of treated lumber and lined with filter fabric to keep the growing medium from washing away. The pool planters are of an unknown plastic and stacked two high. The top pool has holes drilled to allow for plant roots to access the water in the bottom pool acting as a reservoir. The original plan to have trellises visible from the street, a marketing strategy that would have tied in well with the weekly farmers' markets was blocked by historic district regulations.

growing medium

The Cedar Grove "Vegetable Garden Mix" used in the beds is a blend of 1/3 parts screened sandy loam, 1/3 Cedar Grove compost screened to 7/16" and 1/3 sand. This locally made product uses compost made from the community yard waste collection. To make installation quick and easy, the growing medium was brought to the roof with a blower truck with a hose just long enough to reach the beds from the street.

season extending strategies

There are a number of innovations used to extend the growing season in this garden. Colin designed the planters with removable hinging lids built into the frames. There is one set of covers that are stretched with greenhouse plastic that act as cold frames in the winter and another set with shade cloth for the hottest summer months. With plenty of room to store the unused lids this strategy has worked out well. There are also heating cables that run through each of the beds. During the cold winter months this heats the soil and therefore roots which keep otherwise dormant plants productive (McCrate 2010, www.digginfood.com).

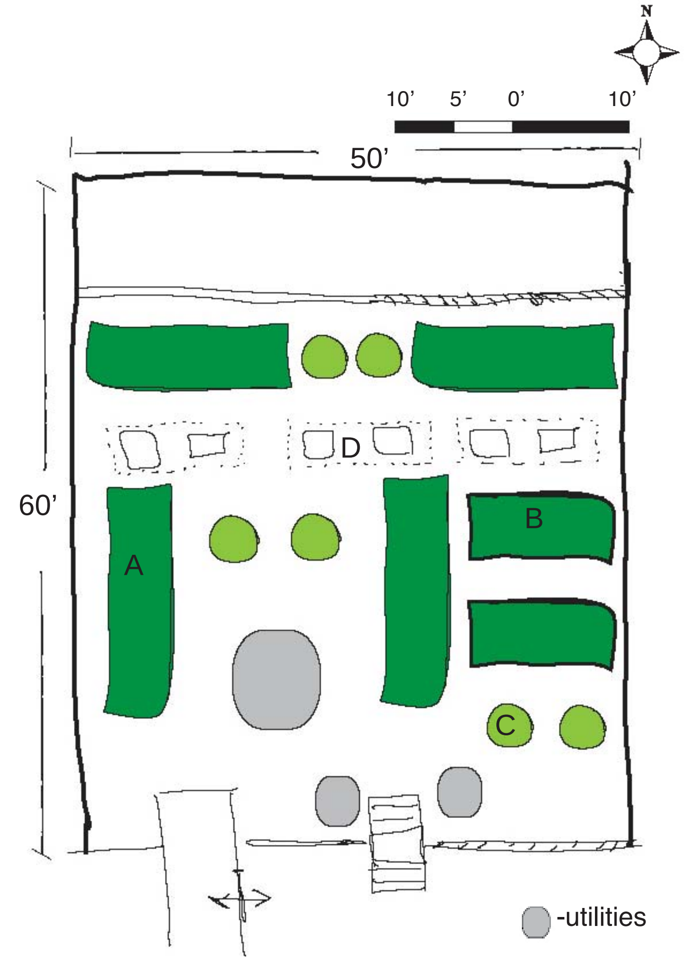

Fig. 3.1.9: Roof Layout

Fig. 3.1.10: Raised planter beds (**A**) with plastic covers

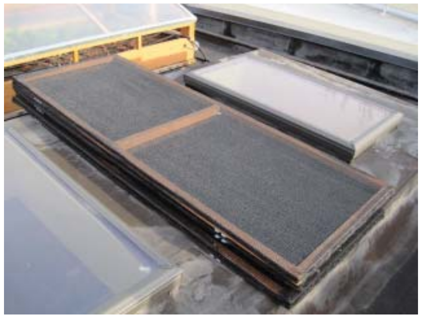

Fig. 3.1.11: Shade screen lid storage between skylights (**D**)

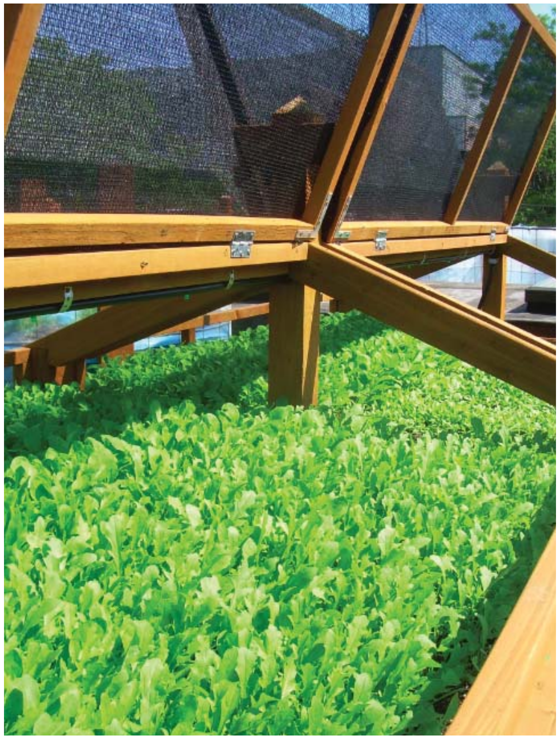

Fig. 3.1.12: Raised planter beds (**B**)
Colin McCrate

Fig. 3.1.13: Kiddie pool (**C**) in cold frame

Fig. 3.1.14: Kiddie pool (**C**) with basil
Colin McCrate

Fig. 3.1.15: Drip irrigation
Willi Galloway, digginfood.com

Fig. 3.1.16: Spiraling pool irrigation

Fig. 3.1.17: Heat cable
Willi Galloway, digginfood.com

Water

irrigation

Low pressure surface drip for 5 minutes per day in summer is the most this garden requires for irrigation. The pools have been set up with spiraling surface pipe to maximize soaking capacity. A spigot with municipal water was installed on the roof during the remodel. The irrigation system is on timers to ensure crops aren't lost to hot dry summer days if no one is around to water (McCrate 2010).

rainwater/graywater

Rainwater harvesting was considered in the original discussions however it has not been implemented yet (McCrate 2010).

runoff

The runoff from the beds drains to downspouts connected to the city stormwater system. The runoff from some of the beds has been observed to create algae in the scuppers however as their fertilization and watering schedule has been fine tuned this is no longer a problem (Hughes 2010).

Products

vegetable products

This organic garden produces mostly greens and herbs, the products most useful for the restaurant kitchen. In the first season salad greens were grown in almost all of their beds. Colin is the head gardener and maintains the beds on a schedule with his other Seattle Urban Farm Co. gardens. He is actively compiling the weight of the vegetables being harvested and will calculate them after this season. In their first season some of their densely planted basil had some dampening off in the cool wet spring but otherwise disease has not been a problem. Some cabbage loopers and aphids show up but Colin says they are generally less of a problem than on the ground level gardens he maintains. In general basil is their main crop. This season Colin and the chefs plan on experimenting with 40-50 tomato plants (McCrate 2010).

varieties

Fall/Winter/Spring: Arugula ('Astro' and 'Surrey'), baby head lettuce and other greens ('Flashy Trout Back' and 'Deer Tongue' are green; 'Red Oak' and 'Lola Rosa' are red), kale, chard, and cabbage.
Summer: Tomato, basil, baby greens.

other products

Beehives were just set up this spring, installed and maintained by the Ballard Bee Company. Honey from the hives will be used for desserts (McCrate 2010).

Fig. 3.1.18: Winter greens

Fig. 3.1.19: Bees at Bastille
ballardbeecompany.com

Fig. 3.1.20: Cedar Grove compost
Scott Learn,The Oregonian

Nutrients

fertilization

There is at least monthly fertilizer application for the most productive months of the year. As greens are intensively grown and cycled through the beds regularly for the kitchen there is less priority placed on building up the soil. Earthworm castings and bloodmeal based fertilizer are the organic products preferred.

compost

Compost is an essential part of the soil building strategy for the Bastille garden. The organic waste from the roof and the kitchen are collected with the municipal yard waste program. An interesting note here is that the company that processes the city yard waste, Cedar Grove, is the same local company that supplies Bastille with their growing medium that contains 1/3 compost. This is a very convenient way to close the nutrient cycle loop.

climate considerations

This roof has full solar exposure and doesn’t appear to be at risk of taller buildings coming in around it in this historic district. The one story building with nearby trees is minimally impacted by wind.

Social elements

Bastille has done a great job of sourcing vegetables locally even when their rooftop produce isn't available. Many local magazines, newspapers and blogs have effectively spread the word about the conscious choices they are making to be a more sustainable business. There is very limited access to this rooftop garden and currently there is no educational or community focused programming being promoted. Their outdoor seating area lined with herbs faces the farmers' market and lures the local food community.

markets

The vegetables here are only grown for Bastille. Their goal is to have rooftop greens in their salads every night of the year. The "Salade Du Toit" or "Roof Salad" features fresh cut greens from the roof, however they must mix in other local greens to supplement in the winter. Colin works with the chefs so they know when and how to harvest and he knows when and what they need (McCrate 2010, myballard.com).

Policy and Incentives

This project complied with all relevant codes and zoning restrictions. Seattle is currently updating codes relating to urban agriculture and may be able to use this project as a precedent for more like it (Petzl 2010).

On a routine fire inspection for the restaurant it was determined that a railing around the perimeter of the workspace of the garden was required in order to meet code. This was further complicated by the historical society's policy that no elements be visible from the ground level. An inexpensive and easy solution quickly remedied this (McCrate 2010).

Fig. 3.1.21: Outdoor patio at Bastille
myballard.com

Fig. 3.1.22: Bastille entree
Bob Peterson, seattlemet.com

Noble Rot Restaurant (Rocket)

Portland, Oregon

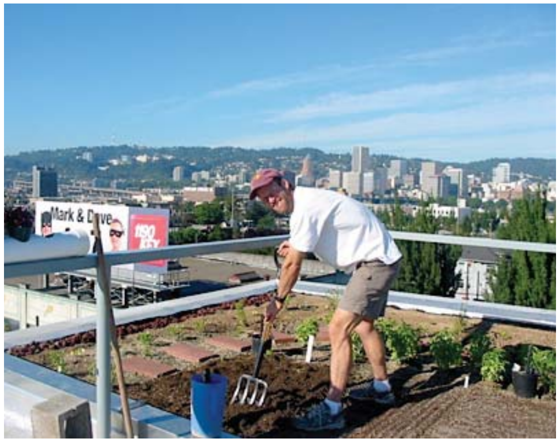

Fig. 3.2.1: Rooftop farmer, Marc Boucher-Colbert
cityfarmer.com

Fig. 3.2.2: Inspiration, Job S. Ebenezer Ph.D
technologyforthepoor.com

Project Overview

Building Use: Restaurant and Commercial offices

Address: 1111 E. Burnside, Portland, Oregon 97214

Year Installed: 2007

Owner: Kevin Cavenaugh

Executive Chef: Leather Storr

Design & Installation: Marc Boucher-Colbert

Cost (per ft^2):

Roof Area (ft^2): 3600

Planted Area (ft^2): 1400

project beginnings

In 2005, Marc Boucher-Colbert was researching the practical component of a project for his master's degree in education. During this research he found an article about Dr. Job Ebenezer, a Chicago man who was growing vegetables on a roof using children's swimming pools. This intrigued Marc and he asked his friend, chef Leather Storrs, if he could test this out on the roof of his restaurant, The Noble Rot. With the blessing and minor retrofitting by building owner and green designer Kevin Cavenaugh, the project was born. After experimenting on this roof for two seasons, and liking the results, the trio decided to scale-up the efforts and move onto Kevin's new LEED Platinum "Rocket" building. Leather opened a new restaurant on the 4th floor called the Rocket Restaurant and wanted to source some of their staple ingredients on the roof above. Leather funded the alterations to the rooftop and hired Marc to manage the operation. As there were already two large areas designated for green roofs, the growing started immediately. Three years later, with a new restaurant Noble Rot and a few lessons learned, this rooftop is a thriving urban oasis (Boucher-Colbert 2010).

Framing: Masonry walls, steel trusses
Height: 4 stories
Year: 2007
Weight allowance: 20 lbs/ft^2 dead load
Engineer: Wade Younie, DCI Engineers
Waterproofing: Modified bitumen (torch-down)

general

The Burnside Rocket is a mixed-use building on a 3,800sf infill site. The building has 16,500sf of indoor area throughout its spacious four stories with outdoor terraces on each level. After completion in April 2007, the building was quickly leased to capacity. The Rocket building is a certified USGBC LEED Platinum building (Rocket press release 2008).

access

Roof access is reserved for restaurant employees, garden managers and supervised tours for patrons and school groups. Stairs in fourth floor kitchen lead to roof hatch.

neighborhood context

This mixed-use building is on a small footprint on the east edge of downtown Portland. It is on a light-industrial and commercial strip adjacent to an indoor rock climbing gym, a residential neighborhood, and a number of public transit and bicycle routes. “The building brings 50+ employees and hundreds of visitors to the site each week to participate in an urban renaissance under way in Portland’s Central Eastside District” (Rocket press release 2008).

Fig. 3.2.3: The Rocket building

Fig. 3.2.4: The roof hatch

Fig. 3.2.5: Rocket birds-eye view
googleearth.com

Fig. 3.2.6: Rooftop beds
Marv Bondarowicz

Fig. 3.2.7: Polycarbonate cover on perimeter beds

Beds (see roof layout diagram)

A. 2 3” deep green roof sections (approximately 780 ft2 total),

B. 6 3’x9’x18” raised planters (approximately 160 ft2 total)

C. 39 45” diameter 4” deep kiddie pools (approx. 480 ft2)

D. Currently pools are being replaced by 4 4’X16’ (approx. 250 ft2) and 2 4’x24’x4” raised beds (approx. 200 ft2).

Total 1400 ft2 planted area.

bed materials

The two green roof sections are essentially large raised beds, lined with typical green roof root barrier, drainage mat, and filter fabric. This sits atop the roof built up with a modified bitumen waterproofing layer. The six planters are all steel and welded to the framing structure of roof. The kiddie pools are plastic of unknown rating. The new beds are framed with untreated fir 2X6s, lined with a polypropylene/rubber-based waterproof membrane (Firestone fPP-R Geomembrane), a base layer of horticultural grade perlite, and a layer of polypropylene filter fabric (GEOTEX 601) to retain the growing medium.

growing medium

Marc, Leather and a group of volunteers brought all of the soil up to the roof by hand. “Black Gold Waterhold cocoblend” is a lightweight and fertile growing mix used in all planters. The potting medium base is coconut fiber, or coir, and Canadian sphagnum peat moss with added pumice and earthworm castings. The original lightweight expanded shale mix is in the green roof beds and has been amended with compost. Perlite is used as a base layer for drainage in the new raised beds.

season extending strategies

Marc covers (cloches) beds in colder winter weather. The perimeter beds have polycarbonate covers in winter for easy access for chefs (fig.3.2.7). The new beds will have cold frames built into them but details have not yet been worked out (Boucher-Colbert 2010).

Fig. 3.2.8: **A**. Green roof beds

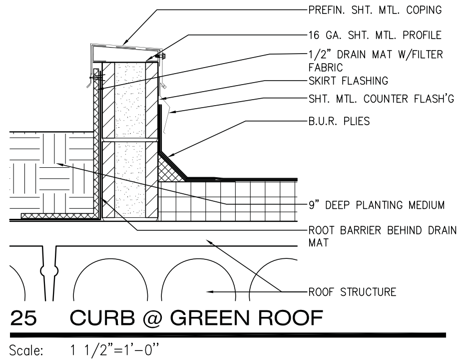

Fig. 3.2.9: **A**. Green roof diagram
Kevin Cavenaugh

Fig. 3.2.10: **B**. Raised perimeter planters
Alice Joyce

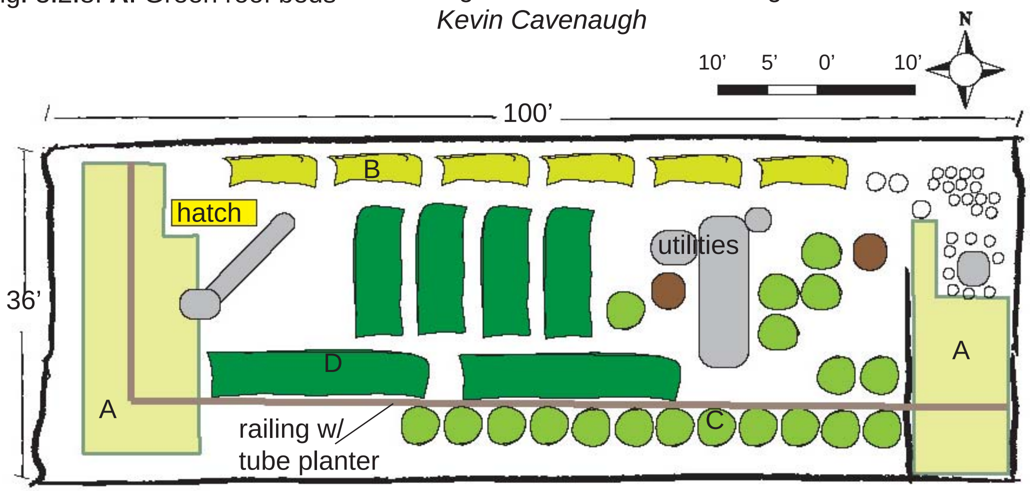

Fig. 3.2.11: Roof Layout

Fig. 3.2.12: A chef helps transition **C.** for **D**
Marc Boucher-Colbert

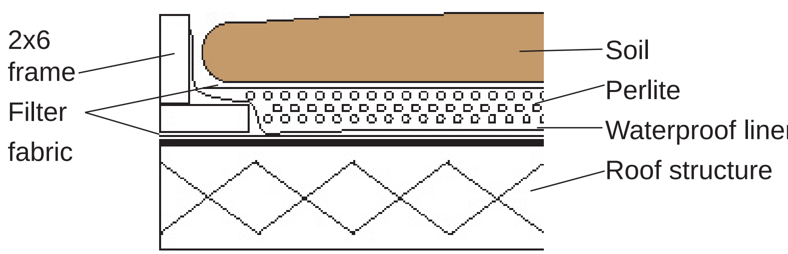

Fig. 3.2.13: **D**. New bed section, 1"=1'
based on design by Marc Boucher-Colbert

Fig. 3.2.14: **D**. New bed assembly

Water

Fig. 3.2.15: Drip Irrigation

Fig. 3.2.16: Perimeter bed drains

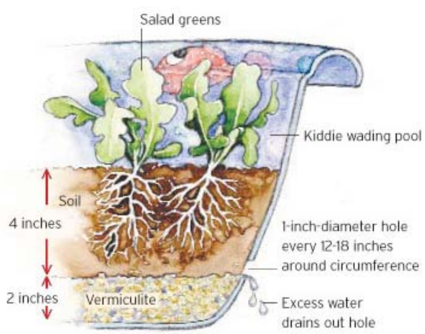

Fig. 3.2.17: Pool irrigation diagram
cityfarmernews.com

irrigation

Surface drip and hand watering, artesian well taps into aquifer 300 feet below building. Plastic drip tape, hose and low pressure drip emmitters incorporated into each bed. The mist emitters originally installed on each of the perimeter beds are no longer being used. Each mister was disconnected after Marc observed a majority of the water being blown away in the wind.

rainwater/graywater

There is no rainwater collection on site however runoff from the raised beds is collected in buckets and reused for hand watering. (see fig. 3.2.17)

runoff

The diligent irrigation schedule produces little runoff from the beds but excess water on roof roof drains to the city stormwater system. Raised planters have drains built in to fill the buckets and runoff properties can then be monitored (Boucher-Colbert 2010).

innovations

Marc has developed a technique for filling the base of the pool with perlite so water can fill the reservoir and give the plant's roots a steady irrigation supply. (see figure 3.2.18) This system has been adapted to the new beds that have replaced the pools. Marc also designed a planter made of PVC pipe with cutouts for individual plants. It has drip irrigation running through it and maximizes vertical space when bolted to the safety railing during the growing season (Boucher-Colbert 2010).

Products

vegetables

The goal at Noble Rot is to grow restaurant staples year round. Early attempts in the green roof section of the site produced minimal yields however hardy perennial herbs are now thriving there. Greens are by far the most successful crop. Marc designed a paraffin wax hinge on one of the covered raised beds. The heat activated hinge opens a vent when the temperature inside the box gets too hot. This self regulating system acts as a mini greenhouse to start plants and push them along in cooler temperatures without the worry of leaving the lid on and burning the fragile starts.

varieties

Fall/Winter/Spring: Arugula! (also known as rocket, the namesake of the restaurant), 10+ lettuce varieties (especially speckled trout back and outredgeous), delfino cilantro, cress, mache, endive, and garlic.

Summer: tomato, eggplant, peppers, summer squash, cucumbers, beans and peas.

All products go directly to the restaurant for seasonal menu options.

other products

There is one unidentified fruit tree in a large pot independent of the others. Plans for adding three apiaries this season are also in the works (Boucher-Colbert 2010).

Fig. 3.2.18: Garlic in February

Fig. 3.2.19: Kiddie pool kale

Fig. 3.2.20: Rocket flowers


Fig. 3.2.21: Compost tumbler and product


Fig. 3.2.22: Tool and fertilizer storage area

Nutrients

fertilization

The method varies with each type of fertilizers but on this project it is typically added with new starts and as a top dressing as plants mature. Kelp meal, glacial rock dust, bone meal, blood meal, earthworm castings and 5-5-5 (N-P-K) organic fertilizer.

compost

Compost is used as a top dressing and is an important part of their strategy to build the soil nutrients. Two 55-gallon tumbling drums are used on the roof in an alternating cycle, one finishes the final decomposition while the other is being filled. Originally, Marc planned on composting vegetable waste from the restaurant but didn't anticipate the quantity a commercial kitchen produces. Now the organic waste from the restaurant is collected by the city's yard waste service and the rooftop drums process the vegetable waste from the roof only. An interesting fact about this is that the yard waste from Portland is shipped to Seattle area to be processed at the Cedar Grove facility.

climate considerations

As this is the tallest building on the block, the roof has full exposure to sun and wind. A trellis was blown over by the wind and destroyed an entire bean crop. Also a bed cover blew off the roof once and is now secured with a cable (Boucher-Colbert 2010). Lesson learned: always secure loose materials on the roof!

Social elements

Diners are drawn to the Noble Rot restaurant for their use of local produce and regular menu items feature vegetables and herbs grown on the roof. When I asked the head chef Leather if he gave many tours of the roof during business hours and he was enthusiastic about as many people seeing the roof as possible. If a customer asks about the roof he often offers to bring them up. The night before I visited, a couple used the roof as a picturesque setting to get engaged. Marc plans to host school tours on the roof, starting this summer with a class from the school where he teaches, his “real job.” A group of students have opted to look at urban sustainability for a research project and Marc will use the garden as a demonstration site.

Fig.3.2.23: Outdoor patio dining
noblerotpdx.com

Fig.3.2.24: Chef Leather Storr
Doug Perry, theoregonian.com

markets

On the elevator up to the fourth floor there are reminders of the sustainable dining experience Noble Rot provides. Rooftop products are regularly featured on their acclaimed menu. While this is an added benefit for the many loyal customers that have accumulated over the years, this new marketing approach appears to be bringing in a steady stream of intrigued new locavores (Boucher-Colbert 2010).

Policy and Incentives

This particular project didn’t benefit from any of the incentives offered by the City of Portland Ecoroof incentive program though the green roof did contribute to their LEED Platinum certification. Marc is currently working with a team to design a food production demonstration garden on a city building to educate the public and hopefully increase the chances for future rooftop production projects to be eligible for government grant support (Portland Ecoroof Program 2010).

Eagle Street Rooftop Farm

Brooklyn, New York

Fig. 3.3.1: Rooftop farmers, Annie Novak and Ben Flanner
newyork.seriouseats.com

Fig. 3.3.2: First season, looking west toward Manhattan skyline
Erin Upton

Project Overview

Building Use: Broadway Stages Production, Ltd, (formerly a bagel factory)

Address: 44 Eagle St., Brooklyn, NY 11222

Year Installed: 2009

Owner: Tony and Gina Argento

Grower: Annie Novak

Design & Installation: Goode-Green, Chris and Lisa Goode

Cost (per ft^2): $60,000 ($10/sf) plus $2000 for vegetable production setup

Roof Area (ft^2): 6000 +

Planted Area (ft^2): 6000

project beginnings

In the winter of 2008/09 Chris and Lisa Goode, the couple who owns and operates the green roof installation company Goode-Green, consulted with friends and neighbors the Argentos. A family who has invested in their Greenpoint Brooklyn neighborhood for over 30 years, the Argentos were looking to improve the roof of their Brooklyn Stages production set building and were drawn to the environmental benefits of a green roof. Originally they agreed to plant a traditional sedum green roof, but when the Goodes suggested growing vegetables instead, as they have done on their own roof for many years, it was clear this would not be an ordinary project. As the idea spread through local media, idealistic young farmers and aspiring growers compelled by the concept inundated the Goodes with emails and phone calls. As Lisa Goode puts it, “the planets aligned”. Ben Flanner, a former marketing manager from the neighborhood, stood out as the visionary thinker required to realize this idea. Ben had no farming experience, so they found Annie Novak, a seasoned gardener and the children’s programming director at the New York Botanical Garden, to join the team. The roof installation took only two days and it was ready for the 2009 season. Ben has moved on to other projects but Annie continues to innovate and cultivate this impressive rooftop farm (Novak 2010; Goode 2010).

Site Infrastructure

Framing: Brick masonry

Height: 2 stories

Year: 1935

Weight allowance: 40 lbs/ft^2 dead load, 200,000 lbs. total

Engineer: Licensed engineer hired by owners
Waterproofing: Modified bitumen (torch-down)

general

This project was installed remarkably fast. First, there was no retrofit needed as Goode-Green designed the green roof to the weight approved by the engineer. Things were further hastened because the owners already had an engineer who knew the building. The NYC Department of Buildings still categorizes green roofs as ballast-type projects so there is no special building permit required. The owners of the Broadway Stages building have maintained the sturdy 1935 structure in order to preserve its historical character and prevent any unnecessary need for new materials. The green roof was initiated by the owners' environmental ethics and long-term energy cost savings.

access

Roof access is allowed under the supervision of farm staff and building owners.
The entrance is on Eagle Street and stairs are in the inner courtyard. Volunteers, customers and visitors come on days Annie is sure to be there.

neighborhood context

The warehouse is zoned F9 Factory/Industrial on a secluded block on the East River docks, an easy location for operating cranes and dump trucks with soil without disturbing many neighbors. The surrounding buildings are of similar age, use and height. The views from the roof are incredible, including the Manhattan skyline (Goode 2010).

Fig. 3.3.3: Manhattan skyline and East River
Erin Upton

Fig. 3.3.4: Street access
Erin Upton

Fig. 3.3.5: Neighborhood context
googleearth.com

Fig. 3.3.6: Green roof installation series, before, green roof drainage layers, crane lifting medium to roof, medium distribution
Lisa Goode

Beds (see roof layout diagram)

A. 16 4’x60’x6” deep rows with approximately 2’ paths between rows on a 100’x60’ green roof bed
Total 6000 ft^2 planted area.

The roof is set up like a typical green roof so it retains all of the ecological benefits even though it is planted with vegetables and herbs instead of sedum and wildflowers. There is access to an adjacent roof to the north that also belongs to the Argentos. This area is used as workspace, gathering space, and compost which frees up the entire 6000 ft^2 for cultivation.

bed materials

This project is essentially one large raised bed garden. The green roof is the base on which the rows are formed. Over the waterproofing membrane are root barrier, drain mat, and separation fabric all made by Optigrun, and framed by salvaged 2”x10” wood edging. The growing medium was dispersed evenly over the roof, based on the engineer’s weight specifications. The growers then mounded rows and added mulch to the walkways in between.

growing medium

A crane lifted 200,000 pounds of lightweight “rooftop mix” to the roof in large bags which was spread evenly by hand to 4” over the entire roof. This medium consists of half expanded shale and half compost. The benefits of this mix are the great drainage, weed blocking characteristics and resistance to compaction. A couple of disadvantages are the lack of nutrients in the mix and a fungus based innoculant that is ideal for sedum, not vegetables.

season extending strategies

Remay, a light woven bed cover fabric, is pulled over beds to protect seedlings in the spring and to keep plants growing in the fall. Plastic is used in colder weather (Novak 2010).


Fig. 3.3.7: Reclaimed wood edging
Erin Upton


Fig. 3.3.8: Green roof beds
Erin Upton


Fig. 3.3.9: Edging and work area, facing east
Erin Upton

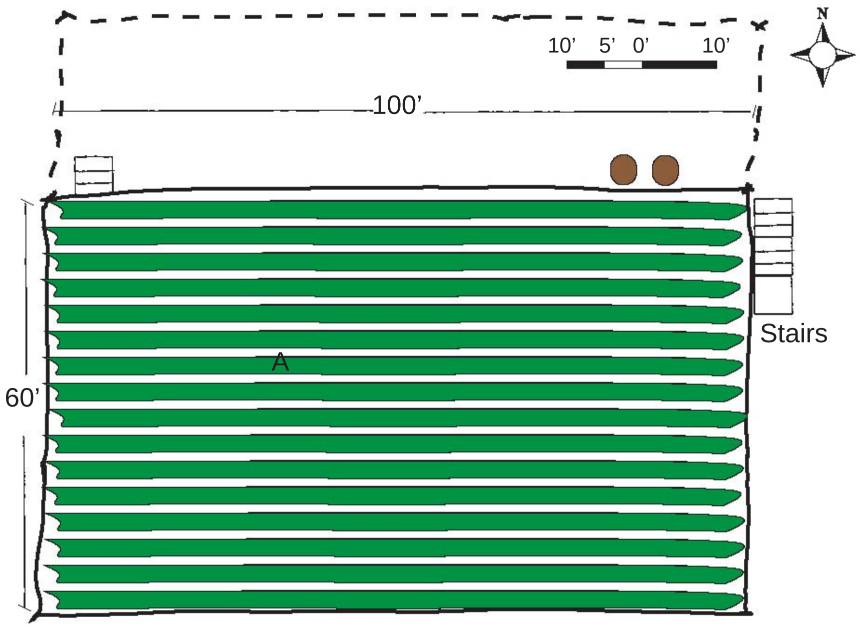

Fig. 3.3.10: Roof Layout


Fig. 3.3.11: Roof access
Erin Upton


Fig. 3.3.12: Rows with mulch path
Leanne, peasandpetals.blogspot.com

Fig. 3.3.13: Drip irrigation
Erin Upton

Fig. 3.3.14: Rooftop spigot
Erin Upton

Water

irrigation

Low pressure surface drip for 5 minutes per day in summer is supplemented by some hand watering. Inexpensive “T-tape” drip tape lines each row, directing municipal water from the rooftop spigot.

rainwater/graywater

There is currently no water harvesting on site however they are working through the permitting issues to install a rainwater cistern to be used for irrigation. No graywater reuse was discussed.

runoff

The green roof functions to slow rain and melting snow from entering the stormwater system. There is currently no monitoring but there is interest in collecting runoff data in the future.

innovations

The rooftop rows resemble traditional farm beds however the depth that the roots can grow is limited. Mounding up the medium into deeper rows provides space for those roots to spread, reducing the need for irrigation (Novak 2010).

Products

vegetables

In their first season they experimented with over 30 varieties of vegetables, herbs and flowers with an emphasis on heirloom varieties. Tomatoes, peppers and basil did especially well while winter and summer squash did not.

varieties

Fall/Winter/Spring: Arugula, lettuce and other greens, garlic, kale, chard, pumpkins and winter squash.

Summer: greens, radishes, tomato, eggplant, peppers, summer squash, cucumbers, beans, and peas.

other products

Two apiaries are located nearby on the adjacent roof.

markets

Located in the courtyard, the farm market is generally open on Sundays when volunteers come, neighborhood residents can buy fresh produce harvested on the roof along with other local products like fresh eggs. The 2010 season marks the first year for the community supported agriculture program and shares were sold out quickly. Rooftop Farm also supplies a number of local restaurants and stores by bicycle, including Anella, Eat, Marlow and Sons, Manducati Rustica, and Paulie Gee's. They sell some hops to the local brewery and beer garden Six Point Craft Ales and Brewery. All of the produce is either sold on site or delivered by bicycle to the business that is buying their wholesale produce. Many of the volunteers that show up on Sundays also arrive by foot or by bike or a mode of public transportation. Annie hopes to continue expanding this commercial aspect of the business (Eagle Stret 2010).

Fig. 3.3.15: Rooftop greens
Erin Upton

Fig. 3.3.16: Rooftop apiary
Rachel Clift, thinkeat.wordpress.com

Fig. 3.3.17: Rooftop compost
Erin Upton

Fig. 3.3.18: Rooftop compost
Leanne, peasandpetals.blogspot.com

Nutrients

fertilization

A variety of fertilizers are used with new starts and as top dressing. Some of the products used are kelp meal, glacial rock dust, bone meal, blood meal, earthworm castings and 5-5-5 (N-P-K) organic fertilizer.

compost

Compost is an essential part of the soil building strategy for Rooftop Farm. All of their compost is produced on the adjacent roof in two large bins made of pallets. The bins are on rotation so one has fresh organic matter added while the other is finishing. In addition to organic waste from the farm, volunteers from the neighborhood can add their kitchen scraps when they come on workdays or market days. Mulch was added to the walkways to keep soil in place, reduce weeds and retain moisture in the beds (Novak 2010).

climate considerations

The roof is fully exposed to sun and wind. Located on the East River there can be gusty wind conditions.

Social elements

Education and community programming has helped make the first season of Rooftop Farm a great success. The farm provides a great location for workshops, volunteer gatherings and classes that connect the growers and consumers in a local food system. The numbers of volunteers and the frequency with which they come on the weekends is remarkable. They have had as many as 60 volunteers show up in one day. There is high community acceptance and attendance is growing at the free workshops they host. The 1 1/2 hour workshops are offered weekly for students, residents and business owners and cover topics from seasonal planting, composting, harvesting and beekeeping. Also hosted on site is Growing Chefs, a group founded by Annie Novak that offers a variety of workshops that teach garden-based cooking, growing techniques and sourcing seasonal vegetables (growingchefs.org). Their mission states “to eat well from field to fork is to stewart good soil, celebrate the genetic diversity of seeds, practice organic agriculture in growing food, eat well-balanced, fresh, hand-cooked meals among friends” (growingchefs.org). Something worth noting is that Annie doesn’t pay rent for the use of the roof so the operating costs are kept to a minimum.

Policy and Incentives

The New York Department of Buildings has a tax abatement program that covers $4.50 per square foot for new green roofs. The Goodes considered this but after figuring out the time lost filing for this incentive the end benefit would have been only .50 per square foot. Lisa Goode suggests that “unless the city says ‘you must do this’ it won’t really grow because it can’t be sold any better than it already is” (Goode 2010). It turns out the regulation requires any green roof that is receiving an incentive to have 4” or less growing medium. Since Rooftop Farm specified 6” for their vegetable production, this project wouldn’t have qualified for a tax break.

Fig. 3.3.19: Kale beds and volunteers weeding
Erin Upton

Fig. 3.3.20: Sunday market, rooftop produce
Leanne, peasandpetals.blogspot.com

Fig. 3.3.21: Dish at restaurant Anella
flickr.com user, greenpointers

Rooftop Victory Gardens

Chicago, Illinois

Fig. 3.4.1: Rooftop farmers
urbanhabitatchicago.org

Fig. 3.4.2: Urban rooftop garden
urbanhabitatchicago.com

Overview of project

Building Use: True Nature Health Foods Store

Address: 6034 North Broadway, Chicago, IL 60660

Year Installed: 2006

Owner: True Nature Foods

Grower: Emily Lake and crew

Design & Installation: Dave Hampton, Echo Studio

Landscape/biological consultant: Mike Repkin, Michael Repkin Designs

Cost (per ft^2): $5.20

Roof Area (ft^2): 3000

Planted Area (ft^2): 960 (phase I)

project beginnings

This project would not be possible without the many hours of design, labor and maintenance volunteered by a group of dedicated citizens that make up Urban Habitat Chicago (UHC). Started in 2004, UHC is an all-volunteer not for profit that uses active participation to educate and be educated about urban sustainability. Partnering with True Nature Foods, UHC found an opportunity to carry out these principles on a “rooftop-integrated food production project which provides a safe, secure source of food, introduces beauty into the urban environment, manages site stormwater, mitigates the Urban Heat Island effect through evaporative cooling and moderate-albedo surfaces (0.30), and demonstrates to the public the management of resource cycles in an urban locale” (urbanhabitatchicago.com). As the name of the case study suggests, a WWII victory garden once occupied the site where True Nature Foods now sits. The rooftop project was funded entirely by the City of Chicago Green Roof Grants Program as a pilot food production project. When additional funding is secured the garden will be expanded to cover an additional 800 square feet (Hampton 2010).

Site Infrastructure

Framing: Masonry
Height: Single story
Year: 1985
Weight allowance: 22 lbs/ft^2 dead load
Engineer: Louis Shell, Louis Shell Structures, Inc.
Waterproofing: Modified bitumen (torch down)

Fig. 3.4.3: Street view
echostudiochicago.com

general

This brick and CMU building was once the site of an auto mechanic shop. With typical 14" bar joists 6' on center and a metal deck on top, the building was able to support this garden without any structural retrofitting (Hampton 2010). Dave Hampton, the architect and lead designer for this project is principle and founder of Echo Studios, an architecture firm that "strives to uphold sustainable, energy-efficient, and socially-conscious principles" (echostudiochicago.com). The goal of UHC is to "work at the intersections of urban agriculture, the built environment, materials recovery and reuse, and emerging local industries, focusing on creating seamless transitions in the cycles of resources at all scales" (urbanhabitatchicago.org).

access

The only access to the roof is by extension ladder used in the back of the building.

Fig. 3.4.4: Neighborhood context
googleearth.com

neighborhood context

True Nature Foods is located on the commercial arterial street North Broadway, surrounded by residential neighborhoods. The specific zoning designation of B1-2, Neighborhood Mixed-Use, is a business district designation that allows a greater range of development options. Residential uses are allowed here in order to stimulate development. (www.cityofchicago.org)

Fig. 3.4.5: Roof before
urbanhabitatchicago.com

Fig. 3.4.6: Manual medium transport
urbanhabitatchicago.com

Beds (see roof layout diagram)

A. Approximately 24’x40’x1”-4” deep bed, 2” average
Total 960 ft2 planted area.

bed materials

This green roof is essentially one large raised bed bisected by a narrow pathway. A series of layers were designed to maximize the efficiency of the green roof while containing the growing medium. Directly above the roof sits an isolation sheet that keeps the rigid insulation off the waterproof membrane. A synthetic netting prevents erosion and a layer of filter fabric allows water drainage while holding in the layers of perlite and growing medium. On top of this is a layer of burlap that keeps the medium from washing or blowing away until the plants are established. There have been some problems losing soil on the perimeter of the beds to heavy rains and wind so this season they plan on adding some edging to remedy this (Hampton 2010, urbanhabitatchicago.com).

growing medium

The growing medium is a hand mixed lightweight soil consisting mostly of compost and perlite. A group of volunteers carried it in buckets up the ladder to the roof. One of the problems with such a limited depth of growing medium is how quickly it can dry out on a hot windy summer day (Lake 2010).

season extending strategies

The integration of a variety of perennials into the planting scheme adds year-round insulation to the beds. Currently there are no cold frames or other season extending strategies being employed.

Fig. 3.4.7: Roof after
urbanhabitatchicago.com

Fig. 3.4.8: **A.** Rooftop beds
urbanhabitatchicago.com

Fig. 3.4.9: Dense planting
urbanhabitatchicago.com

Fig. 3.4.11: Bed cross-section
urbanhabitatchicago.com

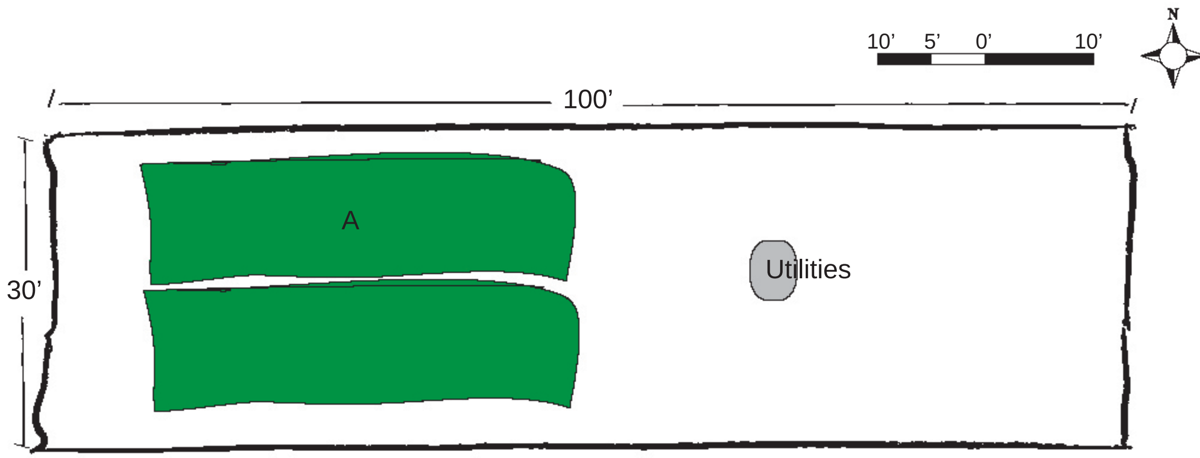

Fig. 3.4.10: Roof Layout

Fig. 3.4.12: Rooftop biodiversity
urbanhabitatchicago.com

Fig. 3.4.13: Irrigation timer and soaker hose
urbanhabitatchicago.com

Water

irrigation

Low pressure surface soaker hoses are hooked up to a municipal water source and controlled by a timer. During the first season all plants were hand watered as there was no outdoor water hookup. Some of the establishing plants died as a result of this time intensive method. The next season they were able to hook up sprinklers but came to the conclusion that windy conditions made this inefficient. Soaker hoses on a timer is a much more reliable method though a more efficient drip irrigation system will soon replace this.

rainwater/graywater

There is no rainwater harvesting on this site however UHC is currently trying to secure funding so more infrastructure can be purchased.

runoff

The green roof functions to slow rain and melting snow from entering the stormwater system. The runoff currently drains to the downspout where it enters the municipal stormwater system. There is currently no monitoring but it is their goal to collect runoff data in the future.

innovations

Working with a limited budget and a trial and error method, this project has evolved from hand watering to sprinklers to soaker hoses to drip irrigation. If there is any lesson to be learned here, it is to invest in drip irrigation from the beginning (Lake 2010).

Products

vegetables

Landscape consultant Mike Repkin's planting plan for this roof started with one full year of building the soil and establishing native pollinators and soil builders. The second and third years started to incorporate vegetables while still focusing on ecosystem development and green manure. The last season was an experiment with a more intensive planting of greens and brassicas that successfully proved the soil strategy was working (Lake 2010).

Fig. 3.4.14: Chard and clover
urbanhabitatchicago.com

varieties

Some of the plant varieties that have been grown for the establishment of a healthy ecosystem and soil media are clover, burdock, cleome, cosmos, dandelion marigolds and many grasses.

Fall/Winter/Spring: Amaranth, lettuce and other greens, basil, buckwheat, kale, chard, collards, mustard greens, mushrooms, onions, sage, thyme, lavender and wheat.

Summer: greens, tomatoes, eggplant, peppers, summer squash, beans, and peas (Lake 2010, urbanhabitatchicago.com).

Fig. 3.4.15: Rooftop lettuce
urbanhabitatchicago.com

other products

There will be three beehives installed on the roof in spring 2010 (Lake 2010).

markets

Most of the food produced here is sold in the True Nature health food store. It is labeled as "grown on the roof" and typically sells out immediately. Some of the high-value summer crops like tomatoes and herbs are sold at the farmers' market hosted in the True Nature parking lot on Saturdays during the summer months (Lake 2010).

Fig. 3.4.16: True Nature produce section
urbanhabitatchicago.com

Fig. 3.4.17: Cabbage and clover in green manure
urbanhabitatchicago.com

Nutrients

fertilization

Organic fertilizers are added to the garden on a monthly schedule throughout the growing season. “Chickity doo doo” (a composted poultry manure) and worm compost tea are most commonly used.

compost

Compost is an essential part of the soil building strategy for the Rooftop Victory Gardens. ‘Green manure’ is a method used on this project to close the nutrient cycle. Certain cover crops are grown specifically for the nutrients and organic matter they provide for the soil. For example buckwheat, peas and clover are grown in order to be incorporated back into the soil rather than harvested for food. Mulch was brought in as walkway material to keep soil in place, reduce weeds and retain moisture in the beds.

climate considerations

The roof is fully exposed to sun and wind. Wind and heavy rains have begun to erode the edges of the beds and valuable soil and nutrients are being washed away. Mulch, edging and establishing perennials in the beds are all strategies being used to address this.

Social elements

One of the benefits of this rooftop garden is its visibility from surrounding buildings. UHC has been developing a strategy with local government to increase green roof visibility along one of the elevated train lines in north Chicago and this project serves as a popular precedent. In the first year of production the garden was divided into individual plots to be managed by different people. After limited participation during this inaugural year they restructured it so a core group of volunteers make sure it doesn't get out of control. Supervised tours and volunteer workdays remain an important aspect of the garden maintenance plan. True Nature Market also hosts the Edgewater green city farmers' market in its parking lot every Saturday from 7am-1pm, a time when community members are encouraged to see what is possible on the roof. (Lake 2010) Dave Hampton would like to continue experimenting with rooftop gardens because he feels they have a great potential to increase food security while creating green jobs. He estimates that access, public perception and cost remain the most prohibitive elements to this taking off. He also insists that the benefits of food productivity, jobs, energy savings and extending the life of the roof membrane remain strong arguments for continuing this work (Hampton 2010).

Policy and Incentives

In 2005, UHC secured $5,000 from the City of Chicago Green Roof Grants Program which was immediately put towards engineering calculations and materials. This was the first project funded through this program with a food production component. UHC is attempting to find additional funding to continue improving the project. They have applied for the Energy Efficiency and Conservation Block Grant, funded by the American Recovery and Reinvestment Act (Recovery Act) of 2009, however Dave Hampton says this program is giving priority to traditional renovation projects involving window and insulation over green roofs and urban agriculture (Hampton 2010, eecbg.energy.gov, uhc.com).

Fig. 3.4.18: Volunteer planting crew
urbanhabitatchicago.com

Fig. 3.4.19: Science Channel film crew
urbanhabitatchicago.com

Fig. 3.4.20: Mayor Daley on Chicago City Hall
greenspacetoday.com

Uncommon Ground on Devon

Chicago, Illinois

Fig. 3.5.1: Rooftop farmer
Natalie Pfister, eatthisgrowthat

Fig. 3.5.2: Owner, Helen Cameron
cityfarmer.com

Project Overview

Building Use: Restaurant

Address: 1401 W. Devon, Chicago, IL 60660

Year Installed: 2008

Owner: Helen and Michael Cameron

Grower: Dave Snyder, formerly Natalie Pfister

Design: Helen and Michael Cameron, Natalie Pfister and Jeanne Pinsof Nolan

Cost (per ft^2): $120,000 total for building remodel

Roof Area (ft^2): 4000 total, 2500 deck

Planted Area (ft^2): 650

project beginnings

Helen and Michael Cameron have been chefs and owners of the original Uncommon Ground in the Wrigleyville neighborhood for almost 20 years. In 2008 they were hoping to find a location to expand their successful business. One cold Chicago day they were investigating a property in the historic Edgewater neighborhood and climbed a ladder to look at the roof. Helen reached over the edge of the parapet and felt the warmth brightness of the sun and immediately envisioned food growing for their new restaurant. From that moment on, they incorporated the idea of a farm on a roof throughout their plan from the footings to the appetizers. Helen and Michael hope that their endeavor can be an example to other restaurant owners and educate their clientele about the importance of locally produced goods and the value of growing your own organic produce, even if it's on the roof. Helen says their "mission is to stand as a working model for other restaurants, businesses and home owners" (Cameron 2010). With green themed events, locally sourced food, organic principles and 120 dedicated restaurant employees, this first certified organic rooftop farm in the country is walking the walk as a model of sustainability.

Site Infrastructure

Framing: Masonry
Height: single story
Year: 1908
Weight: at least 40 lbs/ft^2
Engineer: Chris Perry, Perry & Associates, LLC
Architect: Peter Moser LEED AP, Swiss Design Group
Waterproofing: Modified bitumen (torch down)

general

The building was retrofitted with a rooftop farm in mind. To ensure the weight of the soil, people and snow would be supported, all load bearing walls were reinforced. The building was excavated 5 feet below the foundation and new underpinnings and footings were poured to support the replacement steel beams. A new steel beam structure was installed on the roof to support the deck. Helen and Michael Cameron are committed to green building practices. They hired a LEED certified architect to ensure a green design. Recycled plastic and wood composite was used for decking, solar thermal panels on the roof provide hot water to the restaurant, locally harvested wood was used where possible, and rainwater cisterns collect runoff from the roof (Uncommon Ground 2010).

access

Roof access is allowed under the supervision of farm and restaurant staff and owners. The roof is accessible by a steel fire escape located in the parking lot.

neighborhood context

The building is zoned commercial on a retail thoroughfare north of downtown Chicago. Located in a diverse residential and commercial neighborhood, Devon is known for its Orthodox Jewish, Russian, Indian, Pakistani, and Bangladeshi immigrants.

Fig. 3.5.3: View down to parking lot, market
chicagonow.com

Fig. 3.5.4: Street view
chicagostudioclub.net

Fig. 3.5.5: Neighborhood context
googleearth.com

Fig. 3.5.6: Raised beds on casters
Natalie Pfister

Fig. 3.5.7: Spring beds
chicagonow.com

Fig. 3.5.8: Seating area with earthboxes
Natalie Pfister

Beds (see roof layout diagram)

A. Perimeter beds are 42" wide and 12" deep, act as 42" fence per code and are welded to the structural steel framework

B. 10 10'x4'x12" deep planters on casters and at various heights

C. 27 29"x13.5"x11" deep EarthBox planters on casters

Total 650 ft2 planted area.

The garden layout is on a 2500 square foot roof deck. In addition to the growing space this includes seating areas (G on roof layout diagram), a workstation, and a utility closet (F on roof layout diagram) for tools and supplies.

bed materials

The perimeter beds and the rolling planters are custom made steel and cedar frames. Materials were chosen for their durability and non-toxicity. Each planter has been designed to accept framing for trellises and cold frames. The "EarthBoxes" are recyclable, UV resistant, food grade, polypropylene #5 plastic. These sub-irrigated planters are also retrofitted with a trellis support framework (earthboxes.com).

growing medium

Being a certified organic farm, the products used must also be certified organic. They use the "Happy Frog" mix from the Fox Farm company. This mix consists of forest humus, sphagnum peat moss, perlite, earthworm castings, bat guano, humic acid, oyster shell and dolomite lime. Two cubic feet of soil weighs about 52 pounds, so the total soil weight is approximately 17,000 pounds. Helen and Michael were assisted by neighborhood volunteers and employees carrying all of the soil up the stairs manually (Cameron 2010).

Fig. 3.5.9: **A**. Continuous perimeter bed
Natalie Pfister

Fig. 3.5.10: **B**. Raised planters
Natalie Pfister

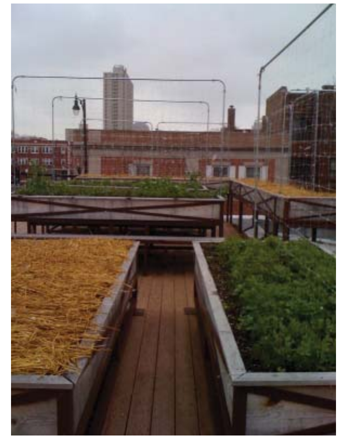

Fig. 3.5.11: **B**. Raised planters
Natalie Pfister

Fig. 3.5.12: **B**. Remay
Natalie Pfister

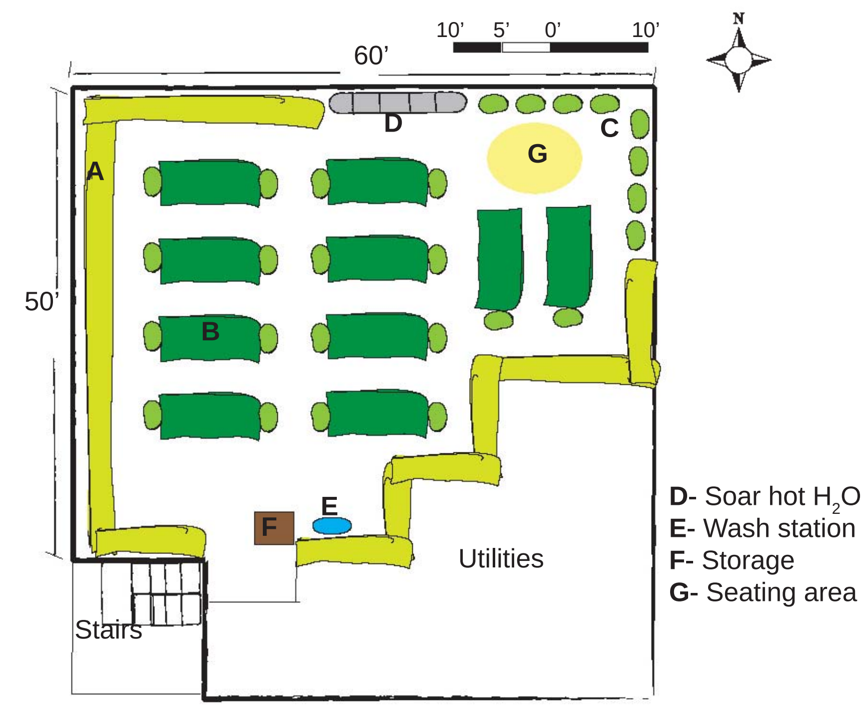

Fig. 3.5.13: Roof Layout

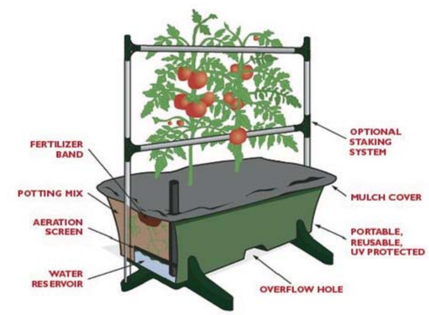

Fig. 3.5.14: **C**. Earthboxes
earthbox.com

Fig. 3.5.15: **B**. Rooftop earthboxes
Natalie Pfister

Fig. 3.5.16: Drip irrigation installation
Natalie Pfister

Water

irrigation

All of the planters are hooked up to a programmable low pressure surface drip irrigation system. The minimal water needs from their municipal water source and the simple drip tape system with timer was a negligible cost. The EarthBoxes are sub-irrigated, meaning a reservoir beneath the bed is filled with water so the roots can use what they need and runoff is eliminated.

rainwater/graywater

The roof runoff is collected in two cisterns that irrigate the garden beds on the ground level. Helen plans to also install cisterns on the roof for irrigation. She discussed the fact that graywater use is currently illegal in Chicago besides the fact that it may not comply with the organic standards that must be followed for certification (Cameron 2010).

runoff

The roof deck sits above the waterproof membrane so all runoff collects in the cisterns. The overflow is released to the city stormwater system. Helen is particularly proud of the minimal runoff that comes from their irrigation system and bed design. There is also a wash station at the top of the stairs for a first rinse before entering the clean kitchen (E on roof layout diagram).

Fig. 3.5.17: Raised bed cold frames
Natalie Pfister

season extending strategies

Cold frames were constructed over their ground level beds as part of their neighborhood cold frame construction class. The rooftop beds have removable cold frames built into them. They supplement this with a layer of straw over the soil. Lightweight polyester row cover fabric is used in non-freezing temperature and plastic is used for colder winter weather (2010).

Products

vegetables

In their first season, Uncommon Ground had great success despite the cold and wet spring. The early blight on their tomatoes was exceptionally early however with an organic fungicide they came back with vigor and produced a bumper crop of their new favorite variety, “Oregon Spring”. Peas also did particularly well in their first season. They are keeping an inventory of saved seeds that successful on their roof. Seeds are also purchased from Johnny’s, Seed Savers, and Seeds of Change. Uncommon Ground is aiming to grow 1000 pounds of produce on the rooftop farm this year but hope future harvests to far exceed that (2010).

Fig. 3.5.18: Summer growth
visionforourcities.wordpress.com

varieties

Fall/Winter/Spring: Arugula, lettuce and other greens, garlic, kale, and chard. Summer: greens, lettuce, radishes, heirloom tomatoes, eggplant, hot and sweet peppers, okra, mustard greens, fennel, bush beans, shallots, beets, and peas. Herbs include rosemary, thyme, chives, tarragon, sage, parsley, dill, mint, lavender, basil, anise and hyssop. A variety of flowers are also grown as edibles and pollinator lures (uncommonground.com).

Fig. 3.5.19: Bountiful harvests
Natalie Pfister

other products

Two hives have been on the roof since 2008, producing 40 pounds of honey in the first year. The first population of bees didn’t survive the winter but since then have been replaced by two more apiaries and a Russian species from Tennessee that seems to be thriving. The bees are tended and blogged by Liam Ford at chicagobeeblog.wordpress.com/ (Cameron 2010).

Fig. 3.5.20: Bee hives
Natalie Pfister

Fig. 3.5.21: Fresh load of organic compost
Natalie Pfister

Fig. 3.5.22: Incorporating compost into beds
Natalie Pfister

Nutrients

fertilization

Fertilizer is applied by hand and the rates and amounts are still being adjusted. The organically certified products include “Chickity doo doo” (a composted poultry manure) and fish emulsion (a decomposed fish parts slurry).

compost

Certified organic compost is used to supplement all of their beds. They would like to make their own compost on site but would over complicate the organic certification process. Currently they either turn “green manure” into the beds or give compostables to farmers at the weekly farmers’ market they host in their parking lot (Cameron 2010).

climate considerations

The roof has full solar exposure with no risk of construction blocking the sun. Wind has been an issue on some of their perimeter beds blowing over trellised plants. Next season they will be putting up a bamboo sheet as a wind break around perimeter. It would be advisable to follow the success this intervention has in the Windy City.

Social elements

The roof is an active place during the growing season. Helen Cameron hopes Uncommon Ground will “become a beacon for (their) community and raise awareness of the power of local production and what is possible in urban agriculture” (uncommonground.com). Community and environmental awareness key elements of this goal. Besides Helen and the farm manager, all of the chefs are trained on how and when to harvest for the kitchen. Helen has opened her rooftop farm up to the community as well and says she has had a “big quality of life improvement” (Cameron 2010). She has become much more involved with her immediate community since making this food system connections. She now lectures at Loyola University where she also happens to donate used oil to their biodiesel lab. Uncommon Ground is host to a weekly Friday farmers’ market/block party with music, food and activities for kids. The food grown on the roof however only supplies the Uncommon Ground kitchens. Regular garden work parties are hosted on the weekends and neighborhood residents are encouraged to participate. Also hosted monthly is the Green Room Sessions, an eco-themed social gathering for community members and local organizations with free appetizers, music, local growers and a full assortment of signature rooftop cocktails. Schools also benefit from regular garden workshops, tours and class activities. Helen says that people are connecting to their local and global community here, drawn by their innate gardening sense. Helen hopes to inspire future rooftop farmers and other green job opportunities through her efforts here (Cameron 2010).

Policy and Incentives

This project was awarded $20,000 by the Chicago Department of Energy Green Roof Grant program. Typically a maximum of $5000, a special grant was given as an incentive to promote productive green roofs. There are two local aldermen who also supported this project by helping expedite the permitting process. The grant application took a total of 1 year to complete. The timing worked out well for Mayor Daley to hand deliver the check for a ribbon cutting press ceremony (uncommonground.com).

Fig. 3.5.23: Family fun: Friday farmers’ market
Natalie Pfister


Fig. 3.5.24: Volunteers helping assemble trellis
Natalie Pfister

Fig. 3.5.25: Dedication with Mayor Daley
chicagonow.com

Chapter IV: Summary and Reflections

Since my initial research into this topic, interest in rooftop agriculture, urban agriculture, food systems and green roofs has continued to grow at a rapid pace. As a result, new rooftop projects are cropping up across the country. In Chicago, many restaurants are taking cues from existing projects and installing gardens on their own roofs. (chicago.metromix.com). In New York, BrightFarm Systems has a number of large rooftop projects slated for construction this year, including a 10,000 square foot farm on the roof of a low-income housing development in the South Bronx (http://www.brightfarmsystems.com). Goode Green, the firm that installed the Eagle Street Project in Brooklyn, has also reported that more of their green roof clientele than ever are interested in incorporating vegetables and chickens into their projects (Feldman 2010).

The roots of this current activity in rooftop food production can be traced to the urban garden movements of the past century. A review of literature reveals the historical precedents for rooftop agriculture. Just like many earlier garden movements, today's rooftop projects are responding to poor environmental, social and economic conditions in cities. Global climate change, hunger and an economic recession are among those issues shaping current urban gardens. A number of movements, including Community Food Security, sustainable agriculture and locavorism, are addressing these issues and a growing number of consumers who are conscious of the impacts of their food choices are supporting them. While there are many encouraging signs for the growth of rooftop agriculture, land tenure, natural resources, zoning, funding and development trends continue to affect their success.

Each of the case study projects has a stated commitment to improving the food system.

By cultivating roofs, each project is reducing fossil fuel consumption associated with transportation from distant farms or distribution centers. The number of consumers who value this enough to support these projects is impressive. The restaurants Noble Rot, Bastille, and Uncommon Ground as well as those supplied by Eagle Street, are all committed to sourcing food locally. These menus are popular and business appears to be thriving, though precisely how much is due to their rooftop production is difficult to determine. It is clear that each restaurant advertises menu items that use products from the roof and in most of the articles and reviews this is highlighted. The rooftop-grown products sell first at the True Nature Health Food Store. The fact that each of these projects can't keep up with the demand shows that this movement has room to grow.

Cities across the country face the continued challenge of finding ways to support growing populations in a sustainable way. Increased density often leads to less green open space in cities. Valued for their important ecological and social functions, green spaces are increasingly sprouting in previously unconsidered locations like rooftops. Popular for managing stormwater, reducing urban heat and creating habitat, green roofs are one tool being used in sustainable urban development. Urban agriculture has recently been included in the green roof discourse, adding a productive element to their growing list of accolades. Rooftop agriculture, green roofs and urban agriculture all stand to mutually benefit from the increased attention that each is receiving.

Many cities provide incentives in order to encourage their use, and both Chicago case studies have benefited from this. Emphasizing these government incentives along with the environmental, productive and economic benefits could be an effective promotional strategy for rooftop agriculture

Case Study Analysis

The case studies offer a unique opportunity to identify successful methods and practices appropriate to the emerging rooftop agriculture movement and extrapolate “best practices” that can inform future projects. The categories identified in the case studies represent critical considerations for rooftop food production. As a caveat, these case study projects continue to evolve and many have changed significantly since research began. Also, in a few instances, a portion of the case study may be incomplete if I was unable to attain specific details. This thesis represents a starting point for future analysis and research, and as rooftop agriculture evolves, more opportunities and constraints will become apparent.

Costs and Benefits

Each project required significant financial investment, some more than others, as there is a wide range of costs associated with the projects studied. Each has been the beneficiary of money, time and energy from dedicated volunteers who see the value in having these green spaces in their neighborhoods. Many of the case study projects were funded for the environmental benefits they provide, without financial profitability as the principle measure of success The restaurant gardens had considerable investment from their owners and in the case of the Noble Rot, the executive chef as well. This suggests confidence that the amount of food grown, customer interest generated and environmental benefit combined justify the initial cost. Long-term reduction in energy use for the building was stated as an added incentive for most owners, with the exception of Uncommon Ground, where the roof deck does not insulate the building. With reduced exposure to UV rays, the longer life of the roof membrane is also an acknowledged benefit. At Bastille, the waterproofing membrane was doubled in anticipation of the heavy traffic on the exposed sections of the roof. At Eagle Street, the entire roof is covered by the growing medium and one layer of waterproofing material is sufficient.

Retrofitting a building can be cost prohibitive and only two projects invested in upgrading the structural framework. In each project there were significant remodel costs as part of the initial investment. Experienced food service entrepreneurs who had capital to invest and foresight from the beginning started Uncommon Ground and Bastille. The remodels allowed greater flexibility when laying out functional elements due to the increased load capacity. In contrast, the Eagle Street project required no retrofitting and supports the deepest medium over the largest area. Identifying more buildings with similar characteristics could be useful in replicating the cost efficiencies of this model.

Three of the projects studied are constructed like a green roof, with drainage layers and root barriers installed directly on the roof. They vary in depth from two inches of medium at the Rooftop Victory Garden, three inches at Noble Rot, and four inches built up to 6-inch rows at Eagle Street. Vegetable production is generally associated with intensive green roofs, characterized by six to 12 inches of substrate. Lightweight growing medium like that used on these three projects weighs approximately 50 pounds per cubic foot (pcf), therefore six inches of lightweight medium weighs 25 pounds per square foot (psf). As these projects demonstrate, vegetable production can be successful in a substrate shallower than six inches. This could translate to more buildings previously discounted based on load values being reconsidered for vegetable production.

Tools, seeds, starts, and other costs associated with processing and distribution are important considerations in any large garden project. Seed is an ongoing cost that can be minimized by saving seeds from the previous season.

Having a clear plan and well-researched growing methods can reduce short and long-term costs associated with materials and labor. Investing a little more initially on proven techniques like drip irrigation can save a lot of money and water in the long run. Projects that invested in community, like Eagle Street and Uncommon Ground, resulted in the neighbors investing their time and energy back into the project.

Site Infrastructure

Weight is an extremely important consideration for any roof alteration. Consulting a licensed structural engineer is essential early in the design process. The designed elements, amount of soil, location and number of people who can occupy it will be affected by the weight capacity of the roof. The case studies provide examples of beds that have fit within these restrictions and others that required structural retrofitting. As in Bastille, doubling the exposed rafters increased the load capacity of the roof. In the Eagle Street project, Goode Green’s strategy of designing to the weight limit provided by the engineer eliminated the extra costs for retrofitting.

Access to the roof is also a key component. Ease of transporting materials up to and down from the roof is essential for efficient functioning. Security, safety and liability must be considered with accessibility for cultivating and harvesting. Railings or raised planters can act as barriers and have been installed around the perimeter in order to meet building codes. ADA accessibility continues to be an issue with all of the projects and the cost of an elevator, the only viable solution, is significant.

Each case study building is masonry-framed with a flat roof and full solar exposure. The buildings are zoned commercial or industrial and are surrounded by dense residential neighborhoods. These residential populations are often valuable customers and volunteers.

Environment

Wind on exposed rooftops is common and must be considered though it is not as significant a concern as I originally thought. On the fourth floor of Noble Rot a bed cover that had blown off in a strong windstorm was a safety liability and a risk to the plants, but was quickly anchored with cables. Uncommon Ground is testing a bamboo windscreen this season, a strategy to prevent a repeat of last years wind damage to the vegetables. All loose materials must be secured as wind uplift can move larger objects than one might expect.

Fig. 4.1: Urban bee, rooftop habitat
urbanhabitatchicago.com

Each site has full exposure to sun and some of the buildings are the tallest in a many block radius. Future development on surrounding lots could block this exposure so before investing time and materials into a site for rooftop production it would be advisable to assess exposure along with plans for nearby development.

Habitat creation is another ancillary benefit of rooftop gardens. Representatives at each of the projects have reported regular visits from birds, butterflies and bees, not to mention the millions of tiny microbes that are living in the compost amended soil. The most diverse planting scheme is found at the Rooftop Victory Garden. The unique planting scheme designed by Mike Repkin requires minimal tilling and is densely planted with native perennials and annual vegetables. While improving biodiversity and increasing urban habitat, this design may result in less area available for intensive vegetable production.

Beds

The most successful planting beds are made of non-toxic durable materials including steel and wood. Exposure to soil, water and sun results in faster degrading of materials. At the Noble Rot, plastic pools were chosen for their low cost and light weight but began breaking down after only two seasons. Concerns about toxic leaching in the growing medium resulted in their being replaced with a safer and more durable material.

Fig. 4.2: Plastic pool planter

Case study projects that use green roof technology for growing beds boast many of the functions that traditional green roofs do. They absorb and store stormwater on a greater surface area, provide uniform insulation and decrease urban heat. Eagle Street Rooftop Farm and the Rooftop Victory Garden are exemplary projects in this respect.

All of the growing media were selected for their lightweight characteristics. Clay loams are ideal for growing vegetables but are heavy to transport and increase the roof loads significantly. Soils on hot windy rooftop environments tend to dry out quickly so the moisture-holding capacity of the media is very important. These soils also have fewer essential nutrients for the plants, so regular fertilization is required. Since compost can help build nutrients and microbes, soil is amended with regular compost application at each of the projects studied.

The growing season was extended in all of the case studies. Bastille and Noble Rot have removable lids on their beds. Uncommon Ground and Noble Rot have beds that can easily be converted into cold frames. These beds are anchored into the framing of the building to resist wind uplift. An untapped opportunity for each of these projects is use of waste heat from the buildings exhaust systems. This is being done on other projects and could be incorporated, especially on buildings with restaurants below. A notable innovation at Noble Rot is the paraffin wax hinges Marc Boucher-Colbert installed on ventilation doors for the covered beds. The wax expands with heat, which activates the vent door to prevent crop failure due to human error. The planters that Colin McCrate designed have been very successful in the first year. The versatility of the removable covers and the ease of access for the chefs are remarkable. After just one winter, how well the heating cables have extended the growing season is still unclear.

Trellises are relatively inexpensive and simple design elements that take advantage of the vertical growing space on roofs. Uncommon Ground has removable trellises built into each planter. Bastille, Noble Rot and Eagle Street all take advantage of vertical trellising as well. Uncommon Ground has many planters on casters, a design element that makes them movable for maximized exposure and accessibility.

Nutrients

Restaurants require a steady supply of produce and Bastille, Uncommon Ground and Noble Rot have high intensity growing schedules. This means more fertilizers are needed to keep the growing medium productive, resulting in the risk of nutrient-rich runoff. Just as traditional agricultural runoff can pollute surrounding freshwater and marine ecosystems, urban agricultural runoff is also a concern as it enters the same fragile hydrological systems we rely on for food, recreation and drinking water. There is opportunity to measure these outputs to better understand the impacts. It is promising that each project is committed to using organic fertilizers and pest and weed control, thereby minimizing the flow of toxic chemicals into the waste stream.

Compost is an essential soil-building component for each project. Processing compost on the roof is possible but requires extra space. Eagle Street and Noble Rot have found effective ways to do this. Eagle Street even offers a place for volunteers to bring their kitchen scraps. The municipal composting systems in Seattle and Portland make it easy to dispose of organic waste from the gardens however, disposing of waste adds to the cost by necessitating the purchase of compost. Closing this nutrient loop by composting on or off-site is important and reduces the impact on overtaxed landfills.

Water

Water is a key consideration for rooftop food production however, I found fewer opportunities than expected to examine methods for water re-use on roofs. The potential exists to capture significant amounts of stormwater and runoff more effectively, but the added cost, weight and required permits are limiting factors. Uncommon Ground collects runoff in cisterns for reuse in ground level beds. Eagle Street is currently working with the city to get the necessary permits to install a new stormwater collection system. At Bastille the beds are covered with plastic in the winter to keep heat in. This means all of the rain in Seattle's wet season runs off the beds and enters stormwater drains. There is an incredible opportunity to collect water in cisterns for later use in the summer when rainfall is reduced.

The green roof grant programs in Portland and New York exclude vegetable producing roof projects based on their need for irrigation. While this exclusion remains controversial, all of the growers I interviewed are very attentive to the amount of water used. At Noble Rot the water comes from a well and the runoff from their raised planters is collected in buckets for reuse. At Bastille, the irrigation schedule required some early adjustments to prevent over watering. Perhaps moisture sensors could be used in the future to increase efficiencies further.

Products

Plants with deep taproots, such as carrots and parsnips, are generally avoided due to the risk of penetrating the waterproofing membrane. At Eagle Street the mounded rows provide greater root depth to support a larger variety of vegetables. Greens and herbs have been most widely successful. Tomatoes, beans and peas are also frequently grown. Trellising plants is an effective way of growing these vegetables in limited space. Eagle Street uses freestanding bamboo trellises while Uncommon Ground and Noble Rot both have built them into raised planter beds.

Bees and chickens are gaining popularity on urban rooftops. Each case study project either has bees or plans to install apiaries in 2010. Important for pollination, the bees are also providing honey for restaurant dessert and drink menus. Mites and cold winters have a negative impact on bees, so many of the projects have outside help tending them. The first bee population at Uncommon Ground didn't survive their first winter but their new Russian stock is proving to be robust in Chicago. Annie Novak of Eagle Street hopes to eventually oversee multiple rooftops and use crop rotation, allowing one roof to remain fallow. Chickens could then feed forage on cover crops on the fallow roof while adding essential nutrients for the next growing season with their waste.

Jobs

All of the growers interviewed have experience working on organic farms and coordinating groups of volunteers. Traditionally those interested in agricultural work were destined to live in rural areas. It appears that more city dwellers are finding ways to make a living in urban agriculture. In most cases, rooftop farming is not their sole source of income. One exception is Uncommon Ground where Dave Snyder was hired in early 2010 as the full-time gardener and community outreach coordinator where he feels fortunate to be paid for something he would be doing anyway. He is now blogging about his work on the Huffington Post. Besides providing jobs for urban growers, these projects provide the unique opportunity for consumers and growers to met and develop relationships.

Chefs at Uncommon Ground, Bastille and Noble Rot are actively involved in plant selection, garden maintenance and harvesting. Chef Leather Storr trains each of his employees when they are first hired in the proper ways and times to harvest. He works closely with grower Marc Boucher-Colbert throughout the season buying seed, scheduling crop rotations and tasting different vegetable varieties at various stages of development. This hands-on experience provides chefs a unique perspective through cultivating the freshest and tastiest seasonal ingredients at their source.

Volunteers are valuable to the success of most case studies. At Rooftop Victory Garden volunteer run cultivation has created problems in the past. A shallow growing medium and dry, hot, summer rooftop environment make the plants much more susceptible to withering, and the success of the garden is therefore reliant on regular monitoring. With the leadership and initiative of Emily Lake the current volunteer system is working but the long-term viability of volunteer management remains unknown.

Community Engagement

In dense urban settings, local food systems have great potential to improve through community participation and educational programming. Uncommon Ground and Eagle Street Rooftop Farms are good examples of spaces that connect to their surrounding communities. Both offer classes and encourage active community participation in their farm operations. Helen Cameron from Uncommon Ground shared that the quality of life benefits alone that she has gained by getting to know her neighbors have made the entire project worthwhile. She believes people have an innate gardening impulse that draws them to the site, a win-win outcome in her mind. She considers the restaurant farm a public/private open space where her neighbors can come to garden, congregate and share in community. This project has done a good job of encouraging community gathering by designing a group seating area in the original layout plan. Annie Novak has a similar outlook. At Eagle Street she promotes democratic access and reaches out to the community. Through volunteer work days, offering classes that address specific gardening topics and promoting Growing Chefs, a group for aspiring cooks who want to learn more about using fresh, local and seasonal foods, community involvement is encouraged. The popularity of Annie's classes and the fact that dozens of volunteers from around New York City show up weekly to help with the farm tasks are evidence that green open roof space can bring people together.

Another benefit of community participation is the increased physical activity associated with outdoor gardening work. Incorporating more spaces like these into dense urban neighborhoods can be an effective strategy for addressing childhood obesity and diabetes. One benefit that can't be overstated about these projects is the importance of the built environment for improving community health.

Education

Rooftop agriculture projects located in neighborhoods with little or no green open space can be a convenient, affordable space where people can learn, grow food and benefit from being outdoors. I am impressed with the way Uncommon Ground, Eagle Street and Noble Rot are all committed to hosting school groups and through education, connecting the next generation to their food. Many kids growing up in the city rarely get exposed to the sources of their food. These projects provide a venue for highlighting the various stages of food production. Annie Novak, Helen Cameron and Marc Boucher-Colbert are all educators who work with local schools to ensure that children are equipped with a basic understanding of their food sources.

Markets

Many types of markets support these agriculture projects. Restaurants are undoubtedly the biggest recipients of the rooftop products. A health food store, farmers' markets, and a CSA program are other methods used to sell and distribute the produce. Marketing food products as "rooftop grown" appears to be a successful strategy for many of the case study projects. Good press was mentioned in multiple interviews as a means to gain support and remain viable. Local markets allow Eagle Street farmers to deliver produce by bicycle.

Many more markets that could support rooftop agriculture remain untapped, and as the movement evolves I believe they will be utilized. Already, schools in Portland and New York City are investing in productive rooftop spaces for lunch programs. Seattle and New York are participating in a national "healthy corner store initiative" that aims at getting more healthy and fresh produce to small stores in neighborhoods where larger grocery stores are not easily accessible. This could be a great opportunity to highlight rooftop agriculture products grown and sold in the neighborhood.

Zoning and Codes

Cities like Seattle and Portland are looking for ways to revise codes in order to support widespread urban agriculture. I believe rooftops should be specifically addressed as a unique way to further urban agriculture. The Seattle Department of Planning and Development recently released a list of proposed code changes aimed at supporting existing urban agriculture and encouraging new projects. Many of the changes could directly or indirectly affect rooftop production. These recommendations would expand square foot allowance for urban farms in Commercial zones; introduce horticultural uses in Industrial zoned land, rooftops and sides of buildings; and permit 4,000 square feet of planting area in Residential zones where it is currently prohibited. Additionally, rooftop greenhouses dedicated to food production would be given a 15-foot exemption to height restrictions in most of these zones. As antiquated codes in more cities are revisited and updated for current urban realities, the rooftop agriculture movement stands to benefit.

Incentives

Government incentives are a great way to offset some of the extra costs that come with these altruistically motivated projects. Uncommon Ground and the Rooftop Victory Garden have both benefited from the City of Chicago Green Roof Grants Program. Although Seattle, New York and Portland are all experimenting with green roof incentive programs, none include food production as a qualification that could receive funding. Cities could do more to encourage a greater diversity of environmentally and socially beneficial projects.

Chicago, Portland and New York City continue experimenting with green roof incentives and grant programs. Unfortunately, due to the economic downturn many of these programs are experiencing cutbacks. For instance, Chicago's Green Roofs Grant Program made projects like Uncommon Ground and Rooftop Victory Garden possible. Unfortunately, this grant recently ended and its future is uncertain. In cities like Seattle and Portland where incentives exist, there is a need to expand the programs and address food production in the categories considered for funding and code exemptions. Portland's tax on stormwater runoff volumes is a good method for offsetting any increased impact an irrigated garden can have. We can also learn from other countries like Canada. Toronto's recent mandate that all new buildings with flat roofs have a certain percentage of green roof is a model to be emulated. My only criticism of this program is the numerous design restraints on substrate depth, square footage of roof footprint and slope of roof. Such restriction will limit the number of qualifying projects.

In a recent interview Annie Novak eloquently summed up her philosophy on growing food on roofs. She said "The best aspect of rooftop growing, practically speaking, is knowing you're making one more building that much greener: as a green roof, first and foremost; as a site for pollinators and city fauna, and finally, as a conversation-creating food source. That alone is invaluable. Americans should question their food system, and if putting food on a rooftop revolutionizes the way we think about our health, the effect agriculture has on our ecosystem, and where our food comes from, then I'm happy to grow it up against the skyline." (http://growingchefs.org/in-action/2010/qa-on-rooftops/)

Landscape Architecture

Landscape architects have a skill set that is uniquely suited to the design and implementation of rooftop agriculture projects. When I first became interested in researching this topic, I assumed there would be more landscape architects involved in the large-scale projects already in production. As it turns out, no landscape architects have been involved in an official capacity with those I found. There is potential, however, for landscape architects to help rooftop gardens evolve into a more widely accepted and effective strategy for urban sustainability. Landscape architects bring site engineering, materials knowledge, community design, communication with other design and construction professionals, and an understanding of the complex ecological systems that are required for plants and animals to thrive. While landscape architects have been involved with urban food gardens from community farms to backyard oases, their talents remain latent in rooftop agriculture (Hou et al. 2009; Way 2009).

- Site Engineering: Drainage is essential to the landscape architecture trade. This knowledge can be extremely helpful when designing infrastructural elements such as stormwater capture and drainage, paths, and erosion control on rooftops.
- Programming: Landscape architects are trained to design sites with a diversity of programmatic elements in mind. Considering the opportunities and constraints along with the intended uses of the site from the beginning of the project can help minimize costly changes during construction and maximize functional efficiencies.
- Communication: Landscape architects are able to communicate effectively with other design and construction professionals. Translating the intent of designed elements to architects, engineers, and builders is as important as translating the wants and needs of the users into the design.
- Ecology: Knowledge of plants and their growth requirements such as water, nutrients and medium is fundamental to a landscape architect’s work. Irrigation systems, microclimate considerations, maintenance requirements, root depth, and growth habits are important to consider in any planted landscape.
- Materials: Landscape architects are trained to understand materials, their sources, durability and interaction with other materials.
- Socio-Cultural: There are socio-cultural elements associated with urban food production. When designing sites for a diversity of users with a broad range of cultural considerations, a landscape architect’s experience with community participatory design can be valuable for ensuring all users are effectively represented.
- Systems approach: Landscape architects are trained to look at projects from a systems-based approach. It is typical to look at the flows and interactions of hydrologic, topographic, energy, social, economic, and ecologic systems. Including food systems in this greater suite of systems can help inform more holistic and robust designs.

It is important to acknowledge that in some cases it may not be cost effective to hire a designer however, the long-term savings in efficiency, materials and functionality are benefits worth weighing. Many urban food gardens are community driven and rely heavily on volunteers and donations. Landscape architects can be valuable as volunteers on community-based projects or as paid consultants for those with allocated funds for design such as commercial and institutional gardens.

At the core of the University of Washington Landscape Architecture Department is a focus on “urban ecological design.” Within this broad category are specific focuses on ecological infrastructure, culturally-based place-making, design for ecological literacy, and human and environmental health. Including rooftop food production in the discussion of urban ecology as a systems-based solution is an important step in understanding and implementing it as an effective strategy. There are promising signs that rooftop food production is becoming a regular consideration in studios, lectures and college events.

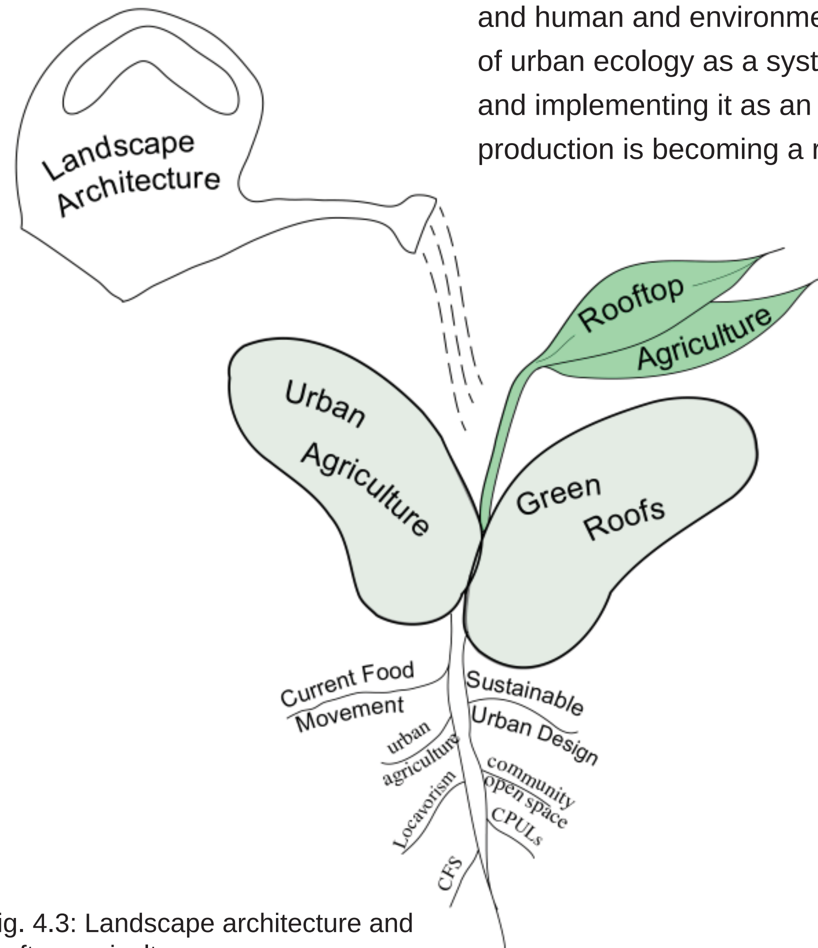

Fig. 4.3: Landscape architecture and rooftop agriculture

Personal Reflections

I maintain that growing food on urban roofs is beneficial to urban environments and the case studies presented support this. Thinking back on the process of researching this thesis I am satisfied to have gained a better understanding of the many ways rooftop agriculture stands to improve the urban environment. The physical, social and political complexities of each case study offer insights into what can be learned from current projects and what is possible in the future.

The lessons learned through this research are valuable and timely however, I believe the analysis would be more complete and comprehensive with a larger set of more established projects from which to draw. Initially, my goal was to present the case studies in a wiki format that would make it easy for others to give input and update other current projects. It became apparent that fewer large-scale projects were under cultivation than I anticipated, and this goal was eventually abandoned. As the rapid growth of the rooftop agriculture movement and the associated formal research continues, presenting in that format may soon be more appropriate.

In retrospect, I would have liked to examine more ways that rooftop agriculture could help promote a just food system. Most of the case study projects do not serve low-income residents and finding fresh and healthy local food at an affordable price in many U.S. cities remains a challenge. I plan on working to improve access to fresh food in urban settings and believe rooftop food production is one promising avenue for establishing a more equitable food system.

Looking ahead to the future of food on roofs, I believe that understanding the basic elements I have outlined will help in making informed improvements and expansions on the systems that have been shown to work. Currently, there are many designs that propose highly mechanized systems to grow food in high-rise buildings. The leap to these expensive and untested concepts is, I believe, premature. We must start by mastering the basics, using materials and spaces already in abundance and tapping into existing urban waste streams. As more formalized research becomes available, I believe more precedents will also become available.

Rooftop agriculture can evolve into a lasting movement with continued support from growers, consumers, educators and designers, perhaps in the form of a "Local Foodscape Architecture." The urban agriculture and sustainable urban design movements serve as solid foundations. While I contend that food production on roofs is not a realistic substitute for traditional farming, its numerous benefits should be lauded. Rooftop agriculture can restore urban ecology, connect urban populations to their food sources, generate jobs and build community. Rooftop agriculture can in the final analysis help make our cities more sustainable. I hope the research presented in this thesis helps further these goals, and I look forward to following and actively participating in the evolution of the rooftop agriculture movement.

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Apendix A: Interview Questions

Hello, my name is Benn Engelhard and I am in the masters program of landscape architecture at the University of Washington. I am compiling a precedent study of rooftop farm projects in an attempt to highlight existing projects that are growing food on roofs in North American cities. By demystifying the process and elements that make up a functional rooftop farm I hope to make it easier for other designers and practitioners to realize more of these productive rooftop projects so more can benefit from all of the social, economic, environmental and gastronomic benefits. I really appreciate your time answering some questions about key components, challenges and successes of the project you are involved in.

I. **Overview of project**:

Owner:
Designer:
Engineer:
Cost:
Area (ft^2):
Year of building:

II. **Inception**

1. When and how was the idea for this project formed?

2. Why was **this** rooftop chosen for growing food?

3. What were the biggest hurdles on the way to getting this roof planted?

4. Conversely, what were some of the things that actually worked really well in realizing this project?

5. Are there any local/regional/national policies or incentives that have helped support this project?

6. How was the project funded?

III. **Process**

7. **(retrofit)** What was on the roof before the garden?

Modifications to the membrane:

Structure:

(new construction) If the garden is on a newly constructed building, was it part of the original design?

8. Did you have to permit this project? If so did you encounter any resistance?

9. How did you get the growing medium onto the roof?

IV. **Details**

10. What medium was selected for planting vegetables and why?

Weight [pounds per cubic foot (pcf) or pounds per square foot (psf)]
Cost?
Natural soil vs. manufactured mix?

11. What types of beds are being used? Describe them.

Materials?
Size? Depth/width/length?

12. What is the main water source for these beds and is stormwater harvested?

13. Where does the run-off go?

14. Is wind a problem? If so, what has been done to remediate it?

15. How do the vegetable plants get the nutrients they require?

16. Is there a way to compost waste on the roof?

17. Are there any climatic considerations unique to your climate that has influenced the design of this garden?

18. Who are the users?

19. Where does the food that is harvested from the garden go for consumption?
20. What types of vegetables and fruits are being grown?

21. What considerations were taken when deciding?

22. Which ones thrive and which ones have been eliminated?

V. **Post-completion reflections**

23. What innovations or adaptations set this roof garden apart from others?

24. Has this approach of gardening on the roof proven economical?

25. What are some of the glitches or unforeseen problems that have affected this project?

26. Have there been any ancillary benefits, for example: heat conservation, easy distribution from garden to consumer?

27. What would you do differently if you were to do it over again in the future?